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Application Number: 16819831 Document Date: 03/16/2020

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Form Revision Date: March 1, 2019

PTO/AIA/15 (03-13)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	054985-000055-US-02-01
First Named Inventor	Jonathan Lewis NOOK
Title	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTE
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [✔] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [✔] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [✔] **Specification** [*Total Pages* 18] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [✔] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 13]
6. **Inventor's Oath or Declaration** [*Total Pages* 4] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [ ] Newly executed (original or copy)
   b. [✔] A copy from a prior application (37 CFR 1.63(d))
7. [✔] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. [ ] Computer Readable Form (CRF)
   b. [ ] Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ADDRESS TO:

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

ACCOMPANYING APPLICATION PAPERS

10. [ ] **Assignment Papers** (cover sheet & document(s))
    Name of Assignee _____
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [ ] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
14. [ ] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [ ] **Other:** _____

Note*: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[✔] The address associated with Customer Number: 20230 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/William L. Klima/	Date	March 16, 2020
Name (Print/Type)	William L. Klima	Registration No. (Attorney/Agent)	32422

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	054985-000055-US-02-01
	Application Number	
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jonathan	Lewis	NOOK	

Residence Information (Select One) ● US Residency ○ Non US Residency ○ Active US Military Service

City	State/Province	Country of Residence
Gates Mills	OH	US

Mailing Address of Inventor:

Address 1	c/o The Noco Company, 30339 Diamond Parkway, #102
Address 2	
City	Glenwillow
State/Province	OH
Postal Code	44139
Country	US

Inventor 2 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	William	Knight	NOOK	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	State/Province	Country of Residence
Shaker Heights	OH	US

Mailing Address of Inventor:

Address 1	c/o The Noco Company, 30339 Diamond Parkway, #102
Address 2	
City	Glenwillow
State/Province	OH
Postal Code	44139
Country	US

Inventor 3 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	James	Richard	STANFIELD	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

ADC EX1002
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	054985-000055-US-02-01
	Application Number	
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION	

City	Glendale	State/Province	AZ	Country of Residence	US

Mailing Address of Inventor:

Address 1	c/o The Noco Company, 30339 Diamond Parkway, #102		
Address 2			
City	Glenwillow	State/Province	OH
Postal Code	44139	Country	US

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Derek	Michael	UNDERHILL	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Tempe	State/Province	AZ	Country of Residence	US

Mailing Address of Inventor:

Address 1	c/o The Noco Company, 30339 Diamond Parkway, #102		
Address 2			
City	Glenwillow	State/Province	OH
Postal Code	44139	Country	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	20230		
Email Address	Patlaw@vorys.com	Add Email	Remove Email

Application Information:

Title of the Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION		
Attorney Docket Number	054985-000055-US-02-01	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	13	Suggested Figure for Publication (if any)	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	054985-000055-US-02-01
	Application Number	
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	20230		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	15691884	2017-08-31

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	054985-000055-US-02-01
	Application Number	
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION	

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15691884	Continuation of	14619655	2015-02-11	9770992	2017-09-26
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14619655	Division of	14325938	2014-07-08	9007015	2015-04-14
Prior Application Status	Pending				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14325938	Continuation of	PCT/US14/45434	2014-07-03		

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	054985-000055-US-02-01
	Application Number	
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	054985-000055-US-02-01
	Application Number	
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	THE NOCO COMPANY		
Mailing Address Information For Applicant:			
Address 1	30339 Diamond Parkway, #102		
Address 2			
City	Glenwillow	**State/Province**	OH
Country	US	Postal Code	44139
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

ADC EX1002
IPR2025-00885

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	054985-000055-US-02-01
	Application Number	
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	THE NOCO COMPANY

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	30339 Diamond Parkway, #102		
Address 2			
City	Glenwillow	**State/Province**	OH
Country i	US	Postal Code	44139
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet must be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, all joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of all joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/William L. Klima/			Date (YYYY-MM-DD)	2020-03-16
First Name	William L.	Last Name	Klima	Registration Number	32422

Additional Signature may be generated within this form by selecting the Add button. Add

ADC EX1002
IPR2025-00885

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	054985-000055-US-02-01
	Application Number	
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION	

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The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

FIELD OF THE INVENTION

[0001] The present invention relates generally to apparatus for jump-starting a vehicle having a depleted or discharged battery.

BACKGROUND TO THE INVENTION

[0002] Prior art devices are known for jump-starting a vehicle, which provide either a pair of electrical connector cables that connect a fully-charged battery of another vehicle to the engine start circuit of the dead battery vehicle, or portable booster devices which include a fully-charged battery which can be connected in circuit with the vehicle's engine starter through a pair of cables.

[0003] Problems with the prior art arose when either the jumper terminals or clamps of the cables were inadvertently brought into contact with each other while the other ends were connected to a charged battery, or when the positive and negative terminals were connected to the opposite polarity terminals in the vehicle to be jumped, thereby causing a short circuit resulting in sparking and potential damage to batteries and/or bodily injury.

[0004] Various attempts to eliminate these problems have been made in the prior art. U.S. Patent No. 6,212,054 issued April 3, 2001, discloses a battery booster pack that is polarity sensitive and can detect proper and improper connections before providing a path for electric current flow. The device uses a set of LEDs connected to optical couplers oriented by a control circuit. The control circuit controls a solenoid assembly controlling the path of power current. The control circuit causes power current to flow through the solenoid assembly only if the points of contact of booster cable clamp connections have been properly made.

[0005] U.S. Patent No. 6,632,103 issued October 14, 2003, discloses an adaptive booster cable connected with two pairs of clips, wherein the two pairs of clips are respectively attached to two batteries to transmit power from one battery to the other battery. The adaptive booster cable includes a polarity detecting unit connected to each clip, a switching unit and a current detecting unit both provided between the two pairs of clips. After the polarity of each clip is sensed by the polarity detecting unit, the switching unit generates a proper connection between the two batteries. Therefore, the positive and negative terminals of the two batteries are correctly connected based on the detected result of the polarity detecting unit.

[0006] U.S. Patent No. 8,493,021 issued July 23, 2013, discloses apparatus that monitors the voltage of the battery of a vehicle to be jump started and the current delivered by the jump starter batteries to determine if a proper connection has been established and to provide fault monitoring. Only if the proper polarity is detected can the system operate. The voltage is monitored to determine open circuit, disconnected conductive clamps, shunt cable fault, and solenoid fault conditions. The current through the shunt cable is monitored to determine if there is a battery explosion risk, and for excessive current conditions presenting an overheating condition, which may result in fire. The system includes an internal battery to provide the power to the battery of the vehicle to be jump started. Once the vehicle is started, the unit automatically electrically disconnects from the vehicle's battery.

[0007] U.S. Patent No. 5,189,359 issued February 23, 1993, discloses a jumper cable device having two bridge rectifiers for developing a reference voltage, a four-input decoder for determining which terminals are to be connected based on a comparison of the voltage at each of the four terminals to the reference voltage, and a pair of relays for effecting the correct connection depending on the determination of the decoder. No connection will be made unless only one terminal of each battery has a higher voltage than the reference voltage, indicating "positive" terminals, and one has a lower voltage than the reference voltage, indicating "negative" terminals, and that, therefore, the two

high voltage terminals may be connected and the two lower voltage terminals may be connected. Current flows once the appropriate relay device is closed. The relay device is preferably a MOSFET combined with a series array of photodiodes that develop MOSFET gate-closing potential when the decoder output causes an LED to light.

[0008] U.S. Patent No. 5,795,182 issued August 18, 1998, discloses a polarity independent set of battery jumper cables for jumping a first battery to a second battery. The apparatus includes a relative polarity detector for detecting whether two batteries are configured cross or parallel. A three-position high current capacity crossbar pivot switch is responsive to the relative polarity detector for automatically connecting the plus terminals of the two batteries together and the minus terminals of the two batteries together regardless of whether the configuration detected is cross or parallel, and an undercurrent detector and a delay circuit for returning the device to its ready and unconnected state after the device has been disconnected from one of the batteries. The crossbar pivot switch includes two pairs of contacts, and a pivot arm that pivots about two separate points to ensure full electrical contact between the pairs of contacts. The invention can also be used to produce a battery charger that may be connected to a battery without regard to the polarity of the battery.

[0009] U.S. Patent No. 6,262,492 issued July 17, 2001, discloses a car battery jumper cable for accurately coupling an effective power source to a failed or not charged battery, which includes a relay switching circuit connected to the power source and the battery by two current conductor pairs. First and second voltage polarity recognition circuits are respectively connected to the power source and the battery by a respective voltage conductor pair to recognize the polarity of the power source and the battery. A logic recognition circuit produces a control signal subject to the polarity of the power source and the battery, and a driving circuit controlled by the control signal from the logic recognition circuit drives the relay switching circuit, enabling the two poles of the power source to be accurately coupled to the two poles of the battery.

[0010] U.S. Patent No. 5,635,817 issued June 3, 1997, discloses a vehicle battery charging device that includes a control housing having cables including a current limiting device to prevent exceeding of a predetermined maximum charging current of about 40 to 60 amps. The control housing includes a polarity detecting device to verify the correct polarity of the connection of the terminals of the two batteries and to electrically disconnect the two batteries if there is an incorrect polarity.

[0011] U.S. Patent No. 8,199,024 issued June 12, 2012, discloses a safety circuit in a low-voltage connecting system that leaves the two low-voltage systems disconnected until it determines that it is safe to make a connection. When the safety circuit determines that no unsafe conditions exist and that it is safe to connect the two low-voltage systems, the safety circuit may connect the two systems by way of a "soft start" that provides a connection between the two systems over a period of time that reduces or prevents inductive voltage spikes on one or more of the low-voltage systems. When one of the low-voltage systems has a completely-discharged battery incorporated into it, a method is used for detection of proper polarity of the connections between the low-voltage systems. The polarity of the discharged battery is determined by passing one or more test currents through it and determining whether a corresponding voltage rise is observed.

[0012] U.S. Patent No. 5,793,185 issued August 11, 1998, discloses a hand-held jump starter having control components and circuits to prevent overcharging and incorrect connection to batteries.

[0013] While the prior art attempted solutions to the abovementioned problems as discussed above, each of the prior art solutions suffers from other shortcomings, either in complexity, cost or potential for malfunction. Accordingly, there exists a need in the art for further improvements to vehicle jump start devices.

SUMMARY OF THE INVENTION

[0014] In accordance with an aspect of the invention, an apparatus is provided for jump starting a vehicle engine, comprising: an internal power supply; an output port having positive and negative polarity outputs; a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs; a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port; a power switch connected between said internal power supply and said output port; and a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

[0015] In accordance with an embodiment of the invention, the internal power supply is a rechargeable lithium ion battery pack.

[0016] A jumper cable device may also be provided, having a plug configured to plug into said output port; a pair of cables integrated with the plug at one respective end thereof; said pair of cables being configured to be separately connected to terminals of a battery at another respective end thereof.

[0017] Comprises/comprising and grammatical variations thereof when used in this specification are to be taken to specify the presence of stated features, integers, steps or components or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Fig. 1 is a functional block diagram of a handheld vehicle battery boost apparatus in accordance with one aspect of the present invention;

[0019] Figs. 2A – 2C are schematic circuit diagrams of an example embodiment of a handheld vehicle battery boost apparatus in accordance with an aspect of the invention;

[0020] Fig. 3 is a perspective view of a handheld jump starter booster device in accordance with one example embodiment of the invention; and

[0021] Fig. 4 is a plan view of a jumper cable usable with the handheld jump starter booster device in accordance with another aspect of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] FIG. 1 is a functional block diagram of a handheld battery booster according to one aspect of the invention. At the heart of the handheld battery booster is a lithium polymer battery pack 32, which stores sufficient energy to jump start a vehicle engine served by a conventional 12 volt lead-acid or valve regulated lead-acid battery. In one example embodiment, a high-surge lithium polymer battery pack includes three 3.7V, 2666 mAh lithium polymer batteries in a 3S1P configuration. The resulting battery pack provides 11.1V, 2666Ah (8000Ah at 3.7V, 29.6Wh). Continuous discharge current is 25C (or 200 amps), and burst discharge current is 50C (or 400 amps). The maximum charging current of the battery pack is 8000mA (8 amps).

[0023] A programmable microcontroller unit (MCU) 1 receives various inputs and produces informational as well as control outputs. The programmable MCU 1 further provides flexibility to the system by allowing updates in functionality and system parameters, without requiring any change in hardware. According to one example embodiment, an 8 bit microcontroller with 2K x 15 bits of flash memory is used to control the system. One such microcontroller is the HT67F30, which is commercially available from Holtek Semiconductor Inc.

[0024] A car battery reverse sensor 10 monitors the polarity of the vehicle battery 72 when the handheld battery booster device is connected to the vehicle's electric system. As explained below, the booster device prevents the lithium battery pack from being connected to the vehicle battery 72 when the terminals of the battery 72 are connected to the wrong terminals of the booster device. A car battery isolation sensor 12 detects whether or not a vehicle battery 72 is connected to the booster device, and prevents the lithium battery pack from being connected to the output terminals of the booster device unless there is a good (e.g. chargeable) battery connected to the output terminals.

[0025] A smart switch FET circuit 15 electrically switches the handheld battery booster lithium battery to the vehicle's electric system only when the vehicle battery is determined by the MCU 1 to be present (in response to a detection signal provided by isolation sensor 12) and connected with the correct polarity (in response to a detection signal provided by reverse sensor 10). A lithium battery temperature sensor 20 monitors the temperature of the lithium battery pack 32 to detect overheating due to high ambient temperature conditions and overextended current draw during jump starting. A lithium battery voltage measurement circuit 24 monitors the voltage of the lithium battery pack 32 to prevent the voltage potential from rising too high during a charging operation and from dropping too low during a discharge operation.

[0026] Lithium battery back-charge protection diodes 28 prevent any charge current being delivered to the vehicle battery 72 from flowing back to the lithium battery pack 32 from the vehicle's electrical system. Flashlight LED circuit 36 is

provided to furnish a flashlight function for enhancing light under a vehicle's hood in dark conditions, as well as providing SOS and strobe lighting functions for safety purposes when a vehicle may be disabled in a potentially dangerous location. Voltage regulator 42 provides regulation of internal operating voltage for the microcontroller and sensors. On/Off manual mode and flashlight switches 46 allow the user to control power-on for the handheld battery booster device, to control manual override operation if the vehicle has no battery, and to control the flashlight function. The manual button functions only when the booster device is powered on. This button allows the user to jump-start vehicles that have either a missing battery, or the battery voltage is so low that automatic detection by the MCU is not possible. When the user presses and holds the manual override button for a predetermined period time (such as three seconds) to prevent inadvertent actuation of the manual mode, the internal lithium ion battery power is switched to the vehicle battery connect port. The only exception to the manual override is if the car battery is connected in reverse. If the car battery is connected in reverse, the internal lithium battery power shall never be switched to the vehicle battery connect port.

[0027] USB charge circuit 52 converts power from any USB charger power source, to charge voltage and current for charging the lithium battery pack 32. USB output 56 provides a USB portable charger for charging smartphones, tablets, and other rechargeable electronic devices. Operation indicator LEDs 60 provide visual indication of lithium battery capacity status as well as an indication of smart switch activation status (indicating that power is being provided to the vehicle's electrical system).

[0028] Detailed operation of the handheld booster device will now be described with reference to the schematic diagrams of Figs. 2A-2C. As shown in Fig. 2A, the microcontroller unit 1 is the center of all inputs and outputs. The reverse battery sensor 10 comprises an optically coupled isolator phototransistor (4N27) connected to the terminals of vehicle battery 72 at input pins 1 and 2 with a diode D8 in the lead conductor of pin 1 (associated with the negative terminal CB-), such that if the battery 72 is connected to the terminals of the booster

device with the correct polarity, the optocoupler LED 11 will not conduct current, and is therefore turned off, providing a "1" or high output signal to the MCU 1. The car battery isolation sensor 12 comprises an optically coupled isolator phototransistor (4N27) connected to the terminals of vehicle battery 72 at input pins 1 and 2 with a diode D7 in the lead conductor of pin 1 (associated with the positive terminal CB+), such that if the battery 72 is connected to the terminals of the booster device with the correct polarity, the optocoupler LED 11A will conduct current, and is therefore turned on, providing a "0" or low output signal to the MCU, indicating the presence of a battery across the jumper output terminals of the handheld booster device.

[0029] If the car battery 72 is connected to the handheld booster device with reverse polarity, the optocoupler LED 11 of the reverse sensor 10 will conduct current, providing a "0" or low signal to microcontroller unit 1. Further, if no battery is connected to the handheld booster device, the optocoupler LED 11A of the isolation sensor 12 will not conduct current, and is therefore turned off, providing a "1" or high output signal to the MCU, indicating the absence of any battery connected to the handheld booster device. Using these specific inputs, the microcontroller software of MCU 1 can determine when it is safe to turn on the smart switch FET 15, thereby connecting the lithium battery pack to the jumper terminals of the booster device. Consequently, if the car battery 72 either is not connected to the booster device at all, or is connected with reverse polarity, the MCU 1 can keep the smart switch FET 15 from being turned on, thus prevent sparking/short circuiting of the lithium battery pack.

[0030] As shown in Fig. 2B, the FET smart switch 15 is driven by an output of the microcontroller 1. The FET smart switch 15 includes three FETs (Q15, Q18, and Q19) in parallel, which spreads the distribution of power from the lithium battery pack over the FETs. When that microcontroller output is driven to a logic low, FETs 16 are all in a high resistance state, therefore not allowing current to flow from the internal lithium battery negative contact 17 to the car battery 72 negative contact. When the microcontroller output is driven to a logic high, the FETs 16 (Q15, Q18, and Q19) are in a low resistant state, allowing current to flow

freely from the internal lithium battery pack negative contact 17 (LB-) to the car battery 72 negative contact (CB-). In this way, the microcontroller software controls the connection of the internal lithium battery pack 32 to the vehicle battery 72 for jumpstarting the car engine.

[0031] Referring back to Fig. 2A, the internal lithium battery pack voltage can be accurately measured using circuit 24 and one of the analog-to-digital inputs of the microcontroller 1. Circuit 24 is designed to sense when the main 3.3V regulator 42 voltage is on, and to turn on transistor 23 when the voltage of regulator 42 is on. When transistor 23 is conducting, it turns on FET 22, thereby providing positive contact (LB+) of the internal lithium battery a conductive path to voltage divider 21 allowing a lower voltage range to be brought to the microcontroller to be read. Using this input, the microcontroller software can determine if the lithium battery voltage is too low during discharge operation or too high during charge operation, and take appropriate action to prevent damage to electronic components.

[0032] Still referring to Fig. 2A, the temperature of the internal lithium battery pack 32 can be accurately measured by two negative temperature coefficient (NTC) devices 20. These are devices that reduce their resistance when their temperature rises. The circuit is a voltage divider that brings the result to two analog-to-digital (A/D) inputs on the microcontroller 1. The microcontroller software can then determine when the internal lithium battery is too hot to allow jumpstarting, adding safety to the design.

[0033] The main voltage regulator circuit 42 is designed to convert internal lithium battery voltage to a regulated 3.3 volts that is utilized by the microcontroller 1 as well as by other components of the booster device for internal operating power. Three lithium battery back charge protection diodes 28 (see Fig. 2B) are in place to allow current to flow only from the internal lithium battery pack 32 to the car battery 72, and not from the car battery to the internal lithium battery. In this way, if the car electrical system is charging from its alternator, it

cannot back-charge (and thereby damage) the internal lithium battery, providing another level of safety.

[0034] The main power on switch 46 (Fig. 2A) is a combination that allows for double pole, double throw operation so that with one push, the product can be turned on if it is in the off state, or turned off if it is in the on state. This circuit also uses a microcontroller output 47 to “keep alive” the power when it is activated by the on switch. When the switch is pressed the microcontroller turns this output to a high logic level to keep power on when the switch is released. In this way, the microcontroller maintains control of when the power is turned off when the on/off switch is activated again or when the lithium battery voltage is getting too low. The microcontroller software also includes a timer that turns the power off after a predefined period of time, (such as, e.g. 8 hours) if not used.

[0035] The flashlight LED circuit 45 shown in Fig. 2B controls the operation of flashlight LEDs. Two outputs from the microcontroller 1 are dedicated to two separate LEDs. Thus, the LEDs can be independently software-controlled for strobe and SOS patterns, providing yet another safety feature to the booster device. LED indicators provide the feedback the operator needs to understand what is happening with the product. Four separate LEDs 61 (Fig. 2A) are controlled by corresponding individual outputs of microcontroller 1 to provide indication of the remaining capacity of the internal lithium battery. These LEDs are controlled in a “fuel gauge” type format with 25%, 50%, 75% and 100% (red, red, yellow, green) capacity indications. An LED indicator 63 (Fig. 2B) provides a visual warning to the user when the vehicle battery 72 has been connected in reverse polarity. "Boost" and on/off LEDs 62 provide visual indications when the booster device is provide jump-start power, and when the booster device is turned on, respectively.

[0036] A USB output 56 circuit (Fig. 2C) is included to provide a USB output for charging portable electronic devices such as smartphones from the internal lithium battery pack 32. Control circuit 57 from the microcontroller 1 allows the USB Out 56 to be turned on and off by software control to prevent the internal

lithium battery getting too low in capacity. The USB output is brought to the outside of the device on a standard USB connector 58, which includes the standard voltage divider required for enabling charge to certain smartphones that require it.

[0037] The USB charge circuit 52 allows the internal lithium battery pack 32 to be charged using a standard USB charger. This charge input uses a standard micro-USB connector 48 allowing standard cables to be used. The 5V potential provided from standard USB chargers is up-converted to the 12.4VDC voltage required for charging the internal lithium battery pack using a DC-DC converter 49. The DC-DC converter 49 can be turned on and off via circuit 53 by an output from the microcontroller 1.

[0038] In this way, the microcontroller software can turn the charge off if the battery voltage is measured to be too high by the A/D input 22. Additional safety is provided for helping to eliminate overcharge to the internal lithium battery using a lithium battery charge controller 50 that provides charge balance to the internal lithium battery cells 51. This controller also provides safety redundancy for eliminating over discharge of the internal lithium battery.

[0039] Fig. 3 is a perspective view of a handheld device 300 in accordance with an exemplary embodiment of the invention. 301 is a power on switch. 302 shows the LED "fuel gauge" indicators 61. 303 shows a 12 volt output port connectable to a cable device 400, described further below. 304 shows a flashlight control switch for activating flashlight LEDs 45. 305 is a USB input port for charging the internal lithium battery, and 306 is a USB output port for providing charge from the lithium battery to other portable devices such as smartphones, tablets, music players, etc. 307 is a "boost on" indicator showing that power is being provided to the 12V output port. 308 is a "reverse" indicator showing that the vehicle battery is improperly connected with respect to polarity. 309 is a "power on" indicator showing that the device is powered up for operation.

[0040] Fig. 4 shows a jumper cable device 400 specifically designed for use with the handheld device 300. Device 400 has a plug 401 configured to plug into 12 volt output port 303 of the handheld device 300. A pair of cables 402a and 402b are integrated with the plug 401, and are respectively connected to battery terminal clamps 403a and 403b via ring terminals 404a and 404b. The port 303 and plug 401 may be dimensioned so that the plug 401 will only fit into the port 303 in a specific orientation, thus ensuring that clamp 403a will correspond to positive polarity, and clamp 403b will correspond to negative polarity, as indicated thereon. Additionally, the ring terminals 404a and 404b may be disconnected from the clamps and connected directly to the terminals of a vehicle battery. This feature may be useful, for example, to permanently attach the cables 302a-302b to the battery of a vehicle. In the event that the battery voltage becomes depleted, the handheld booster device 300 could be properly connected to the battery very simply by plugging in the plug 401 to the port 303.

[0041] The invention having been thus described, it will be apparent to those skilled in the art that the same may be varied in many ways without departing from the spirit or scope of the invention. Any and all such variations are intended to be encompassed within the scope of the following claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Apparatus for jump starting a vehicle engine, comprising:

an internal power supply;

an output port having positive and negative polarity outputs;

a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs;

a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port;

a power switch connected between said internal power supply and said output port; and

a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

2. The apparatus of claim 1, wherein said internal power supply comprises a lithium ion battery.

3. The apparatus of claim 2, wherein said lithium ion battery comprises a battery pack of multiple lithium ion batteries.

4. The apparatus of claim 1, wherein said power switch comprises a plurality of FETs in parallel.

5. The apparatus of claim 1, wherein said vehicle isolation sensor and reverse polarity sensor comprise optically coupled isolator phototransistors.

6. The apparatus of claim 1, further comprising a plurality of power diodes coupled between said output port and said internal power supply to prevent back-charging of said internal power supply from an electrical system connected to said output port.

7. The apparatus of claim 1, further comprising a temperature sensor configured to detect temperature of said internal power supply and to provide a temperature signal to said microcontroller.

8. The apparatus of claim 1, further comprising a voltage measurement circuit configured to measure output voltage of said internal power supply and to provide a voltage measurement signal to said microcontroller.

9. The apparatus of claim 1, further comprising a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus.

10. The apparatus of claim 1, further comprising a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device.

11. The apparatus of claim 1, further comprising a USB charging port configured to provide charging power from an external power source to said internal power supply.

12. The apparatus of claim 1, further comprising a flashlight circuit configured to provide a source of light to a user.

13. The apparatus of claim 12, wherein said source of light is at least one LED.

14. The apparatus of claim 13, wherein said microcontroller is configured to control said at least one LED to provide a visual alarm indicating an emergency situation.

15. The apparatus of claim 1, further comprising a plurality of visual indicators configured to display remaining capacity status of said internal power supply.

16. The apparatus of claim 15, wherein said plurality of visual indicators comprises a plurality of LEDs providing output light of different colors.

17. The apparatus of claim 1, further comprising a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity.

18. The apparatus of claim 1, further comprising separate visual indicators configured to display the power on status of the apparatus, and the jump start boost power status of power supplied to said output port.

19. The apparatus of claim 1, further comprising a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect presence of a vehicle battery.

20. The apparatus of claim 19, wherein said microcontroller is configured to detect actuation of said manual override switch for at least a predetermined period of time before activation of said manual override mode.

21. The apparatus of claim 1, further comprising a jumper cable device including a plug configured to plug into said output port, a pair of cables integrated with the plug at one respective end thereof and being configured to be connected to terminals of a battery at another respective end thereof.

22. The apparatus of claim 21, wherein said jumper cable device further comprises a pair of ring terminals configured to respectively connect said pair of cables at said another end thereof with one of a battery terminal and a battery terminal clamp.

23. The apparatus of claim 21, wherein said output port and said plug are dimensioned so that the plug will fit into the output port only in one specific orientation.

ABSTRACT

A handheld device for jump starting a vehicle engine includes a rechargeable lithium ion battery pack (32) and a microcontroller (1). The lithium ion battery is coupled to a power output port of the device through a power switch circuit (15) actuated by the microcontroller. A vehicle battery isolation sensor (12) connected in circuit with positive and negative polarity outputs detects the presence of a vehicle battery (72) connected between the positive and negative polarity outputs. A reverse polarity sensor (10) connected in circuit with the positive and negative polarity outputs detects the polarity of a vehicle battery connected between the positive and negative polarity outputs, such that the microcontroller will enable power to be delivered from the lithium ion power pack to the output port only when a good battery is connected to the output port and only when the battery is connected with proper polarity of positive and negative terminals.

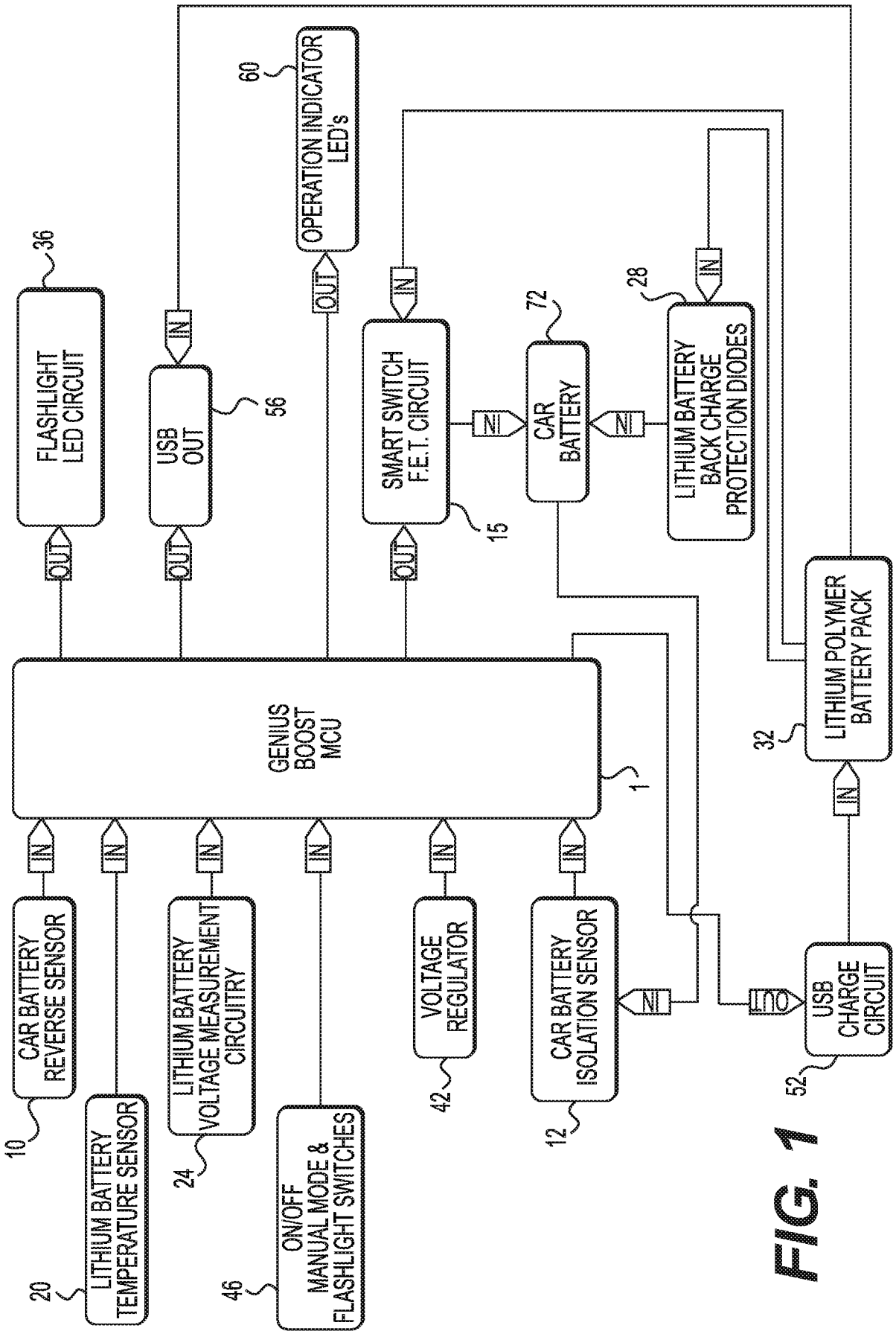

GENIUS BOOST MCU
1
FLASHLIGHT LED CIRCUIT
36
USB OUT
56
OPERATION INDICATOR LED's
60
SMART SWITCH F.E.T. CIRCUIT
15
CAR BATTERY
72
LITHIUM BATTERY BACK CHARGE PROTECTION DIODES
28
LITHIUM POLYMER BATTERY PACK
32
USB CHARGE CIRCUIT
52
CAR BATTERY REVERSE SENSOR
10
LITHIUM BATTERY TEMPERATURE SENSOR
20
LITHIUM BATTERY VOLTAGE MEASUREMENT CIRCUITRY
24
ON/OFF MANUAL MODE & FLASHLIGHT SWITCHES
46
VOLTAGE REGULATOR
42
CAR BATTERY ISOLATION SENSOR
12
IN
OUT

FIG. 1

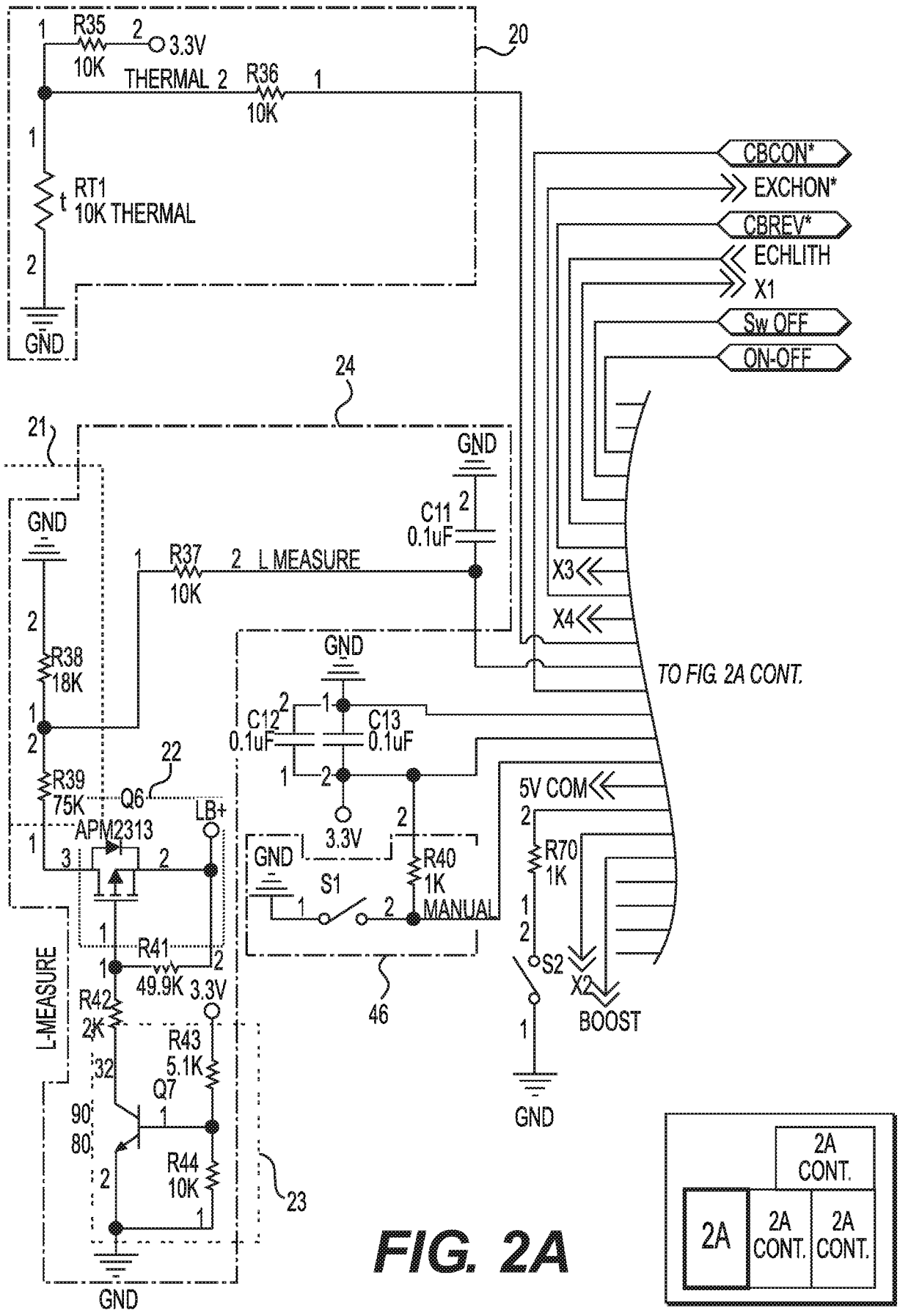

20
R35
10K
3.3V
THERMAL
R36
10K
RT1
10K THERMAL
GND
CBCON*
EXCHON*
CBREV*
ECHLITH
X1
Sw OFF
ON-OFF
24
21
GND
C11
0.1uF
R37
10K
L MEASURE
X3
X4
TO FIG. 2A CONT.
R38
18K
C12
0.1uF
C13
0.1uF
22
R39
75K
Q6
APM2313
LB+
3.3V
5V COM
R70
1K
R40
1K
S1
MANUAL
S2
X2
BOOST
46
L-MEASURE
R41
49.9K
R42
2K
R43
5.1K
Q7
R44
10K
23
2A
2A CONT.
2A CONT.
2A CONT.

FIG. 2A

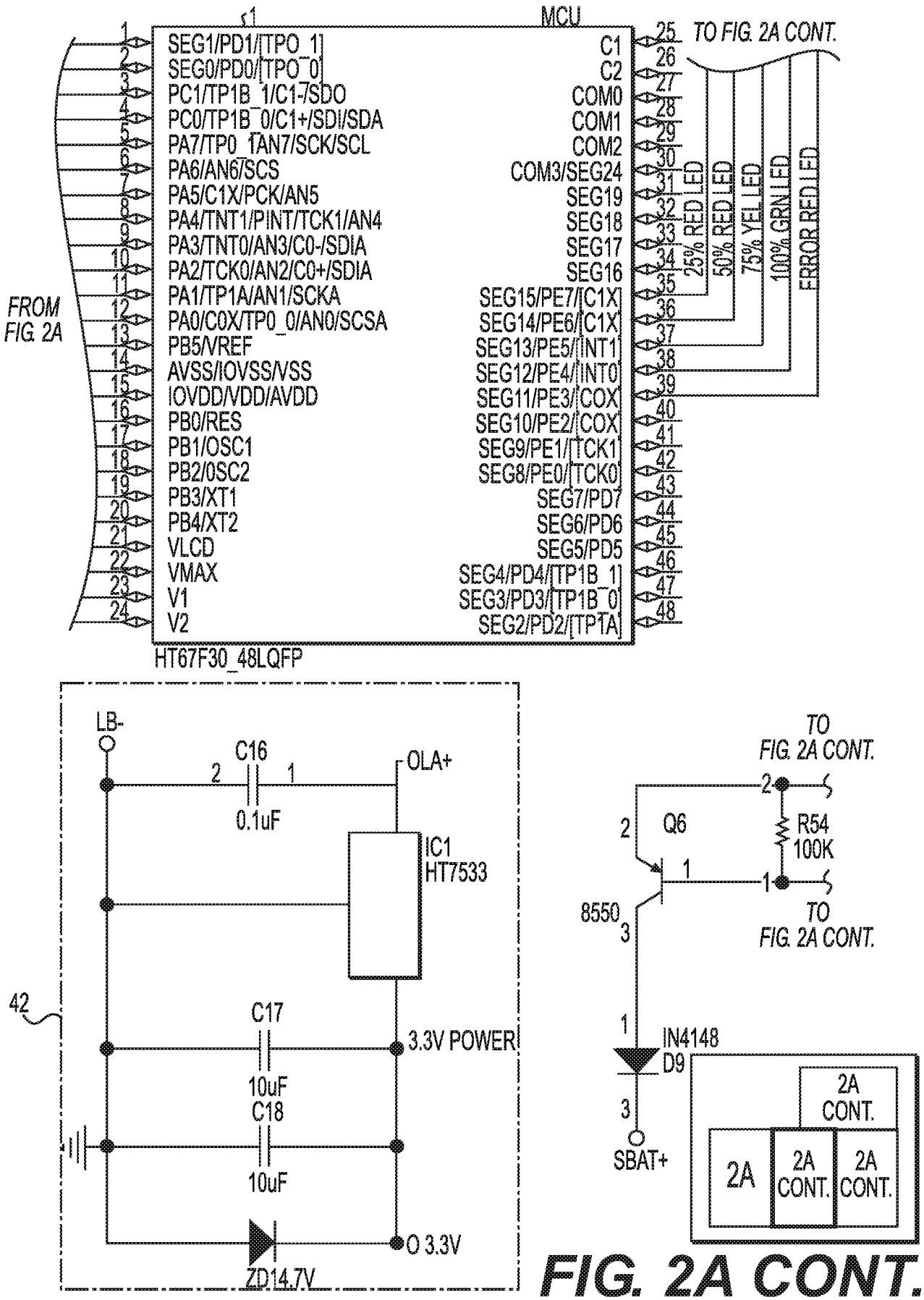

MCU
FROM FIG. 2A
SEG1/PD1/[TPO_1]
SEG0/PD0/[TPO_0]
PC1/TP1B_1/C1-/SDO
PC0/TP1B_0/C1+/SDI/SDA
PA7/TP0_1AN7/SCK/SCL
PA6/AN6/SCS
PA5/C1X/PCK/AN5
PA4/TNT1/PINT/TCK1/AN4
PA3/TNT0/AN3/C0-/SDIA
PA2/TCK0/AN2/C0+/SDIA
PA1/TP1A/AN1/SCKA
PA0/C0X/TP0_0/AN0/SCSA
PB5/VREF
AVSS/IOVSS/VSS
IOVDD/VDD/AVDD
PB0/RES
PB1/OSC1
PB2/0SC2
PB3/XT1
PB4/XT2
VLCD
VMAX
V1
V2
HT67F30_48LQFP
C1
C2
COM0
COM1
COM2
COM3/SEG24
SEG19
SEG18
SEG17
SEG16
SEG15/PE7/[C1X]
SEG14/PE6/[C1X]
SEG13/PE5/[INT1]
SEG12/PE4/[INT0]
SEG11/PE3/[COX]
SEG10/PE2/[COX]
SEG9/PE1/[TCK1]
SEG8/PE0/[TCK0]
SEG7/PD7
SEG6/PD6
SEG5/PD5
SEG4/PD4/[TP1B_1]
SEG3/PD3/[TP1B_0]
SEG2/PD2/[TPTA]
TO FIG. 2A CONT.
25% RED LED
50% RED LED
75% YEL LED
100% GRN LED
ERROR RED LED
LB-
C16
0.1uF
OLA+
IC1
HT7533
C17
10uF
C18
10uF
3.3V POWER
O 3.3V
ZD14.7V
42
TO FIG. 2A CONT.
Q6
R54
100K
8550
TO FIG. 2A CONT.
IN4148
D9
SBAT+
2A CONT.
2A
2A CONT.
2A CONT.

FIG. 2A CONT.

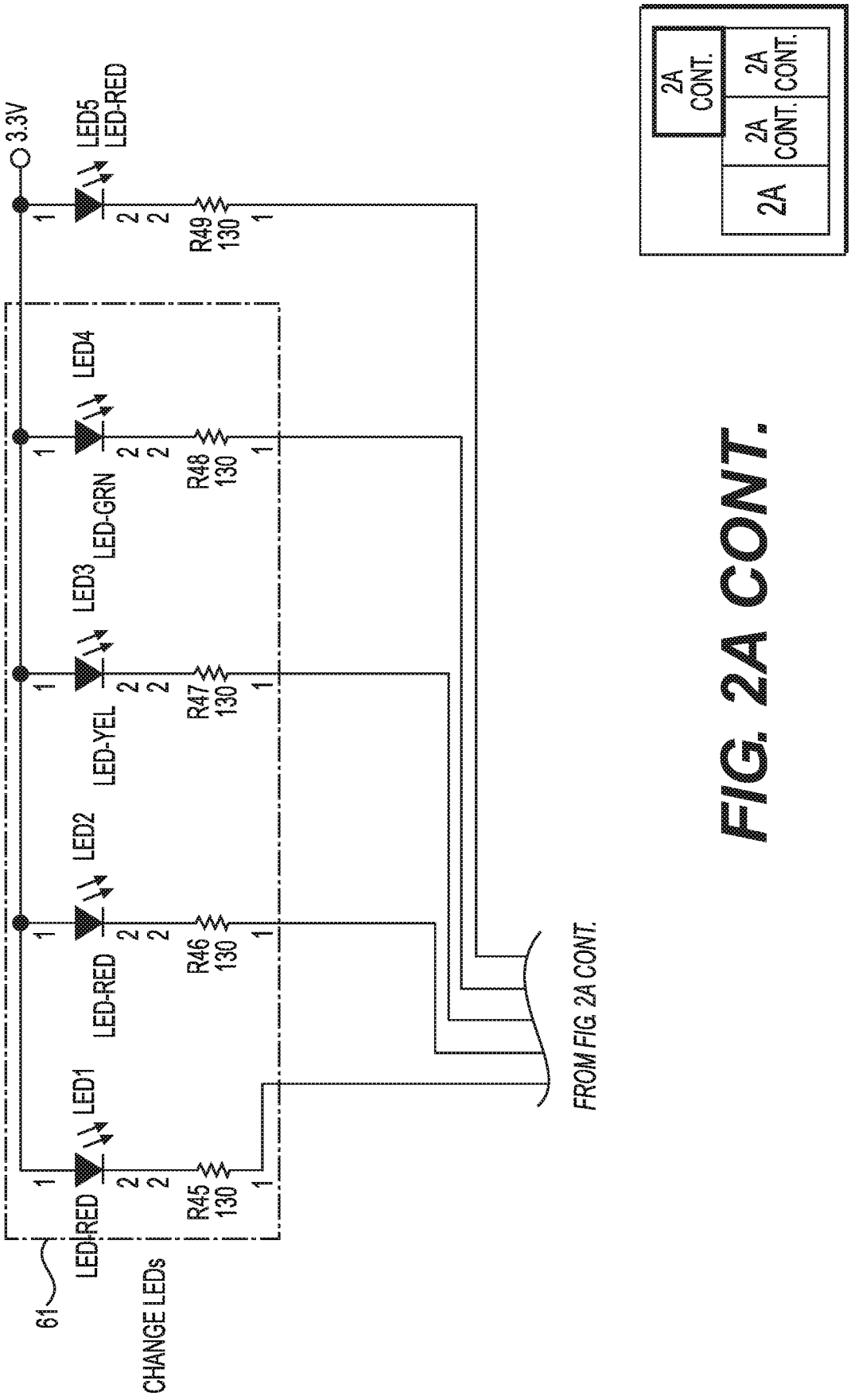

3.3V
LED5
LED-RED
R49
130
LED4
LED-GRN
R48
130
LED3
LED-YEL
R47
130
LED2
LED-RED
R46
130
LED1
LED-RED
R45
130
61
CHANGE LEDs
FROM FIG. 2A CONT.
2A CONT.
2A CONT.
2A CONT.
2A

FIG. 2A CONT.

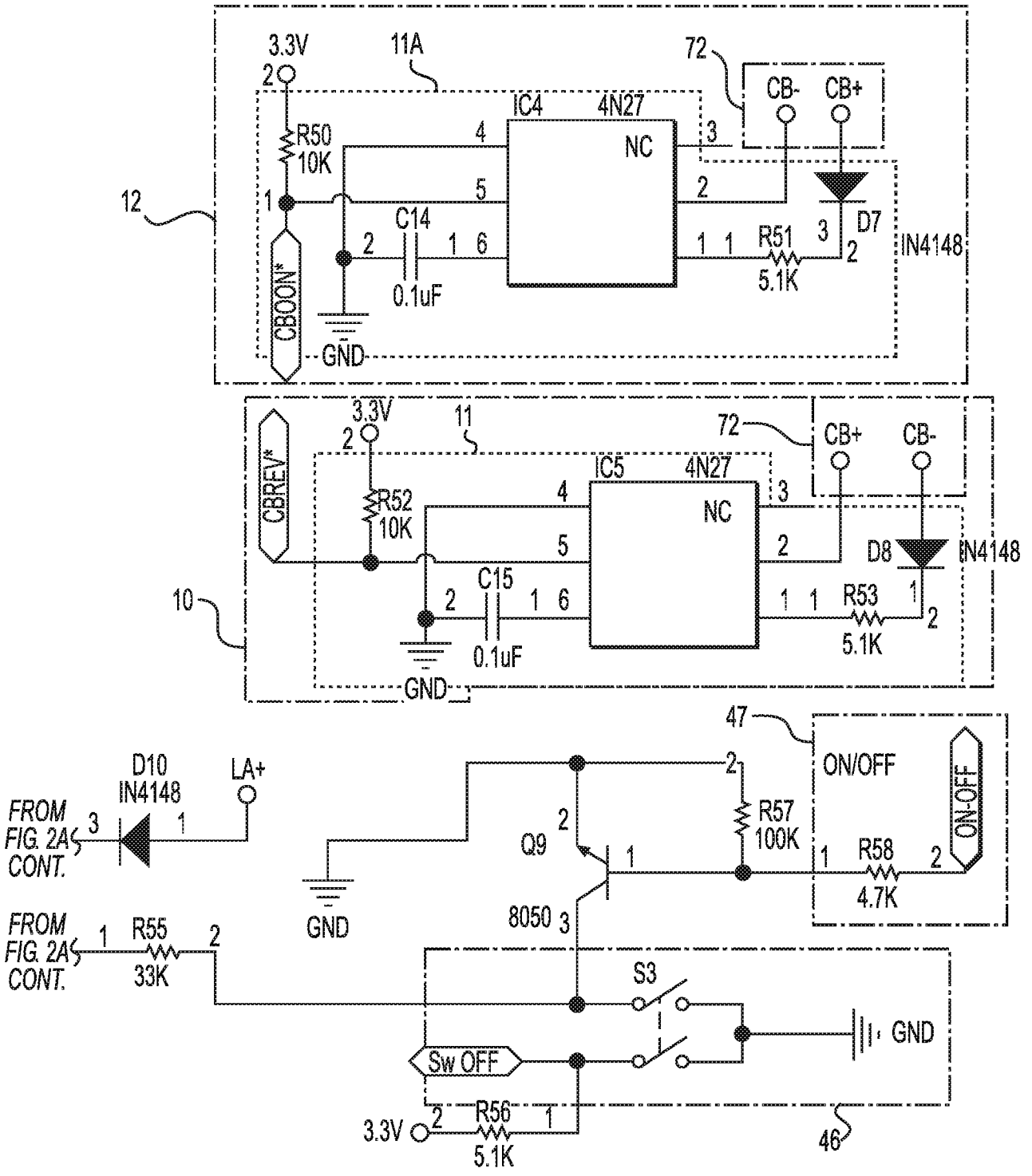
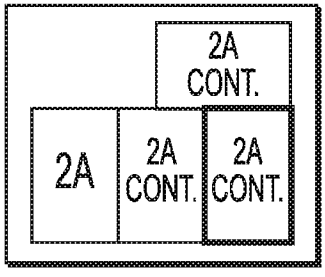

3.3V
11A
72
CB-
CB+
IC4
4N27
R50
10K
NC
12
C14
0.1uF
R51
5.1K
D7
IN4148
CBOON*
GND
3.3V
11
72
CB+
CB-
CBREV*
IC5
4N27
R52
10K
NC
D8
IN4148
C15
0.1uF
R53
5.1K
10
GND
47
ON/OFF
ON-OFF
D10
IN4148
LA+
FROM
FIG. 2A
CONT.
R57
100K
Q9
8050
R58
4.7K
GND
R55
33K
S3
GND
Sw OFF
3.3V
R56
5.1K
46

FIG. 2A CONT.


2A
CONT.
2A
2A
CONT.
2A
CONT.

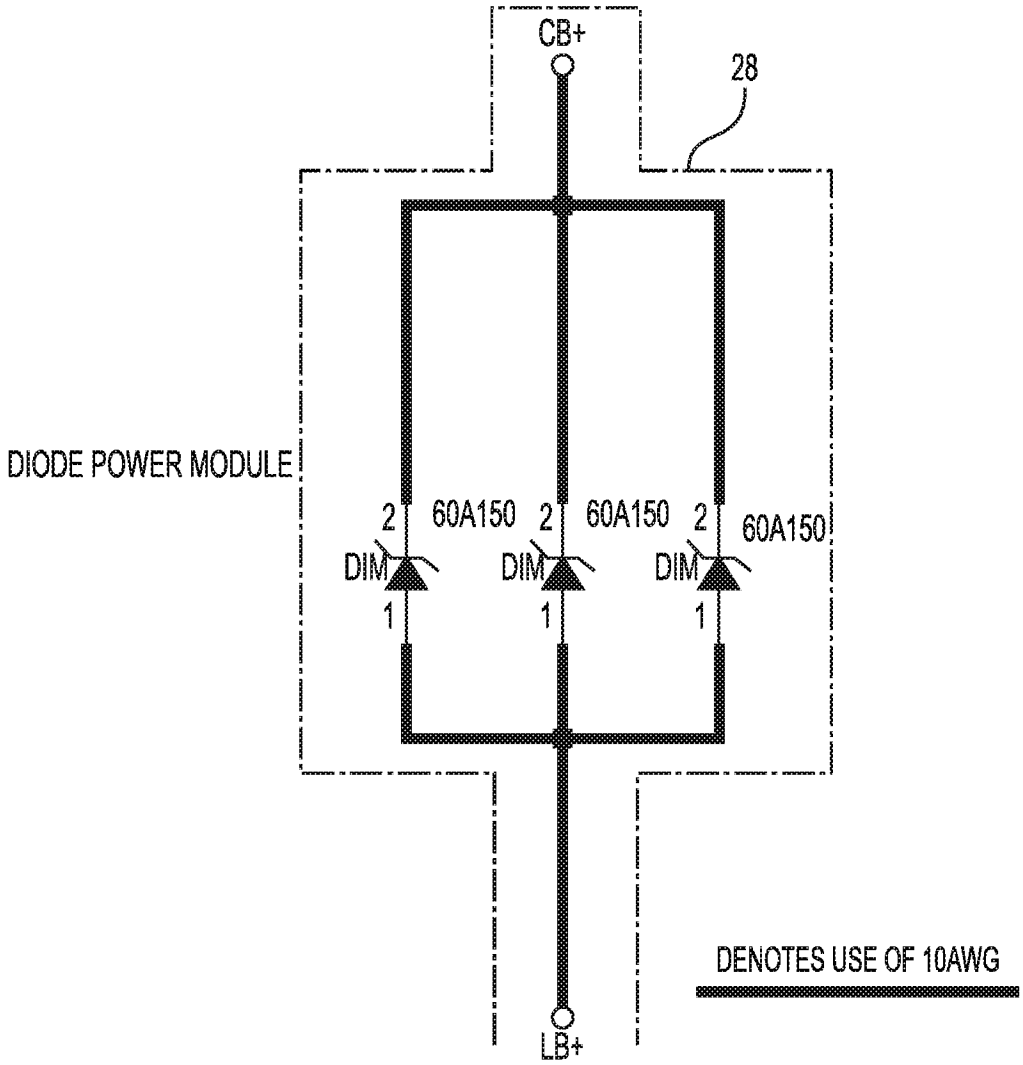
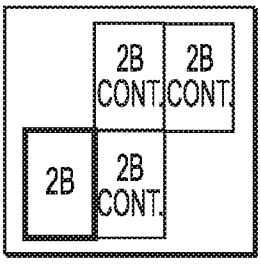

CB+
28
DIODE POWER MODULE
2
60A150
2
60A150
2
60A150
DIM
DIM
DIM
1
1
1
DENOTES USE OF 10AWG
LB+

FIG. 2B


2B CONT.
2B CONT.
2B
2B CONT.

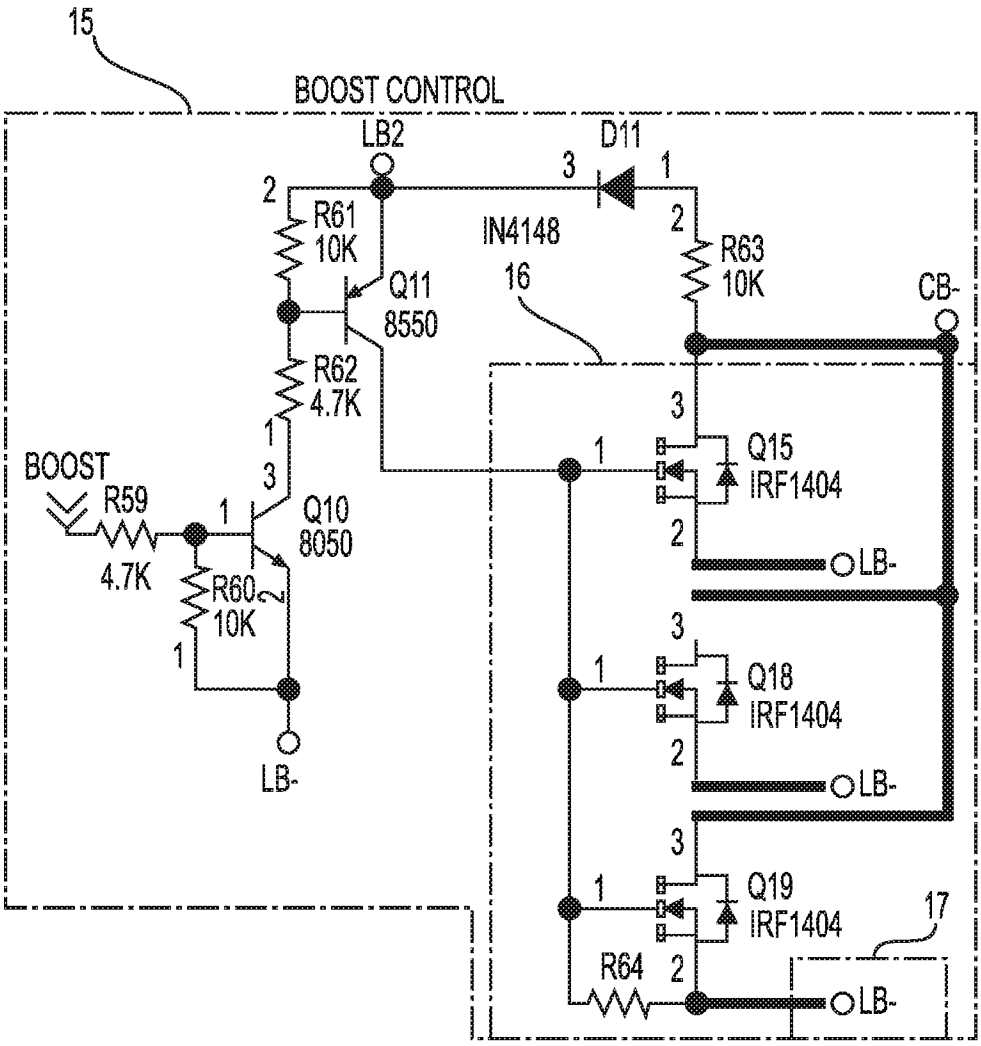
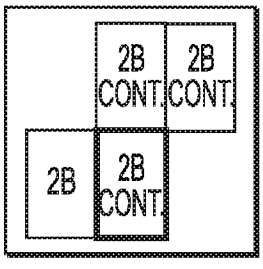

15
BOOST CONTROL
LB2
D11
IN4148
R61
10K
Q11
8550
R62
4.7K
R63
10K
CB-
16
BOOST
R59
4.7K
Q10
8050
R60
10K
LB-
Q15
IRF1404
LB-
Q18
IRF1404
LB-
Q19
IRF1404
17
R64
LB-

FIG. 2B CONT.


2B CONT.
2B CONT.
2B
2B CONT.

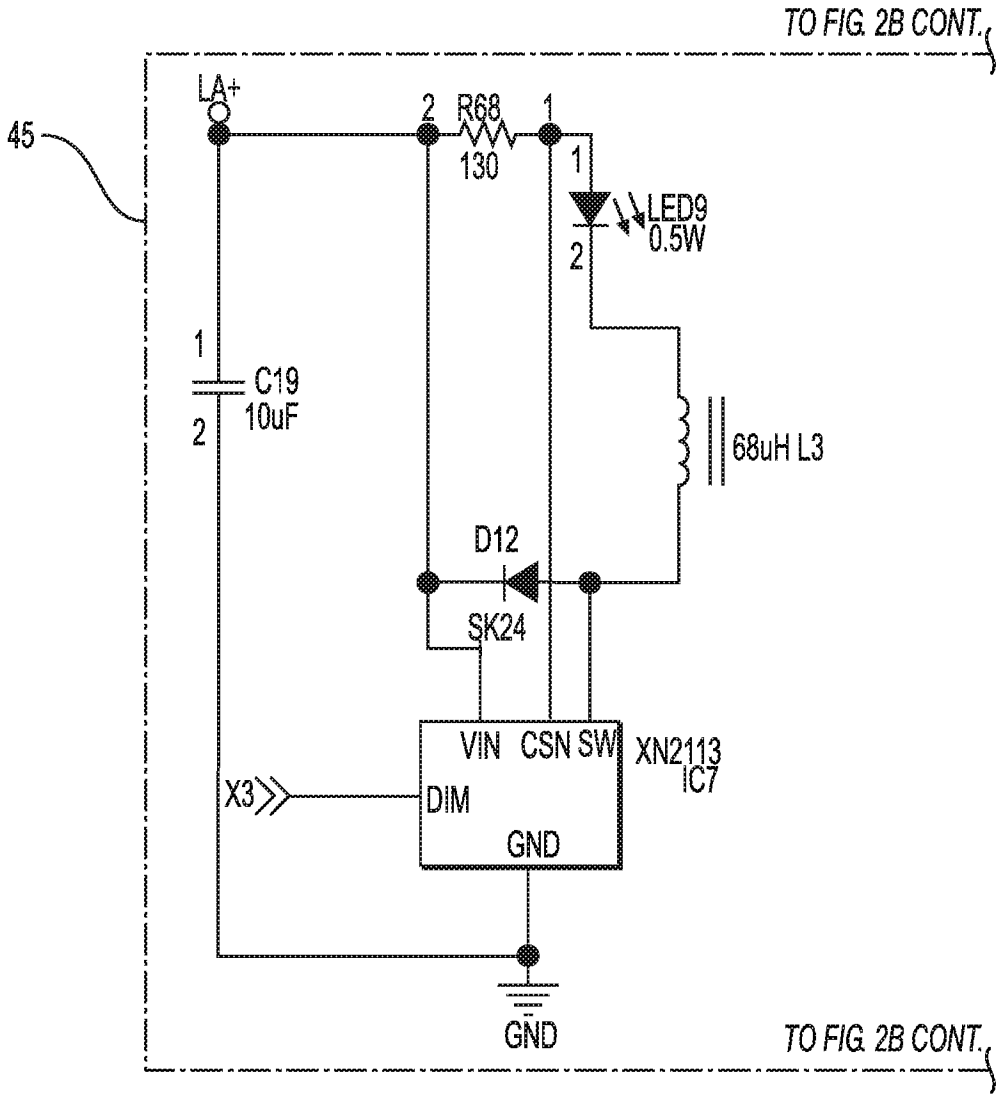
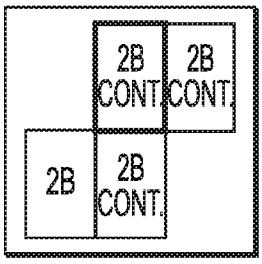

TO FIG. 2B CONT.
45
LA+
2
R68
130
1
1
LED9
0.5W
2
1
C19
10uF
2
68uH L3
D12
SK24
VIN
CSN
SW
XN2113
IC7
X3
DIM
GND
GND
TO FIG. 2B CONT.

FIG. 2B CONT.


2B CONT.
2B CONT.
2B
2B CONT.

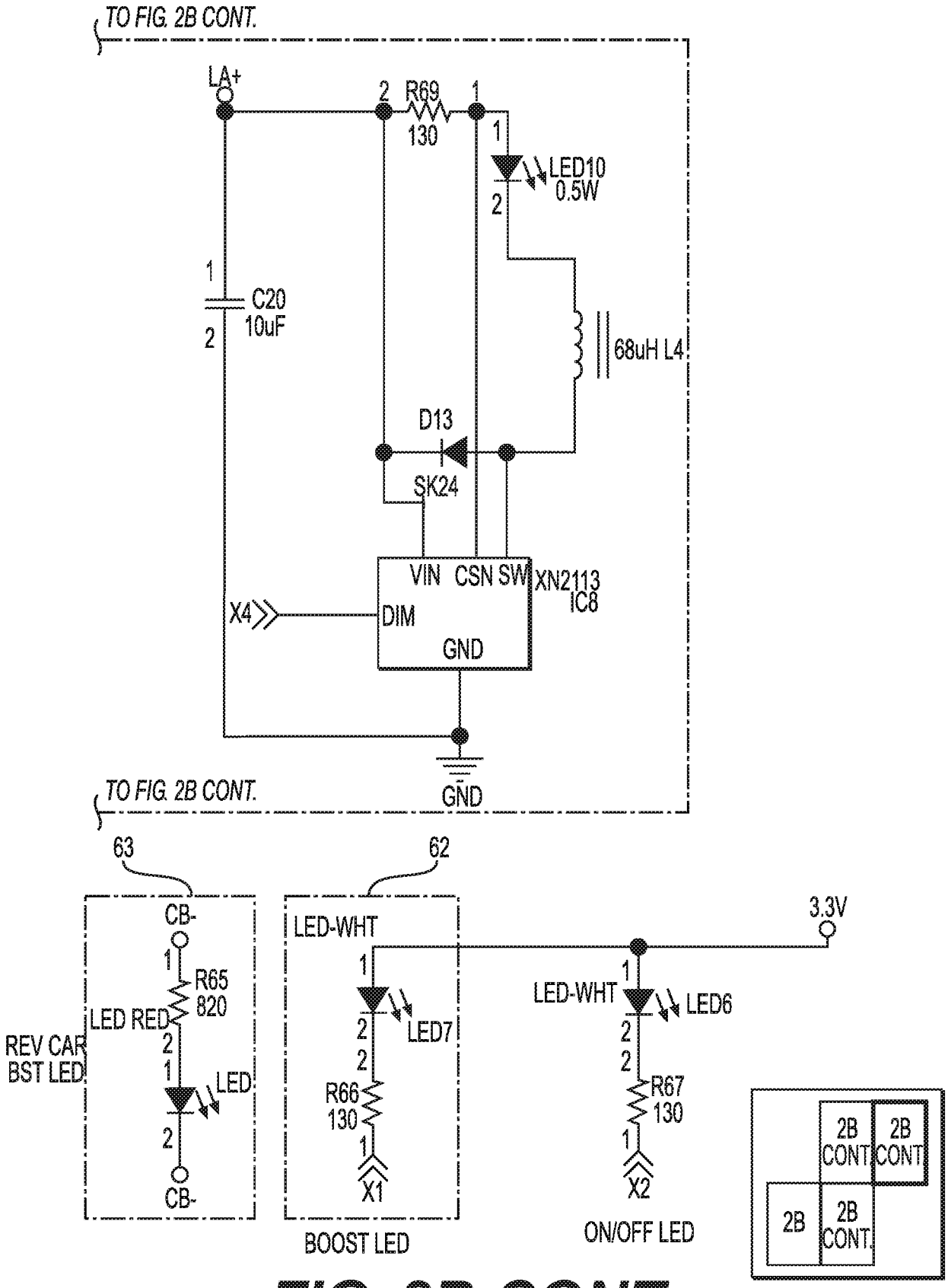

TO FIG. 2B CONT.
LA+
2
R69
130
1
1
LED10
0.5W
2
1
C20
10uF
2
68uH L4
D13
SK24
VIN
CSN
SW
XN2113
IC8
X4
DIM
GND
GND
TO FIG. 2B CONT.
63
62
CB-
1
R65
820
LED RED
2
REV CAR
BST LED
1
LED
2
CB-
LED-WHT
1
LED7
2
2
R66
130
1
X1
BOOST LED
3.3V
1
LED-WHT
LED6
2
2
R67
130
1
X2
ON/OFF LED
2B CONT
2B CONT
2B
2B CONT.

FIG. 2B CONT.

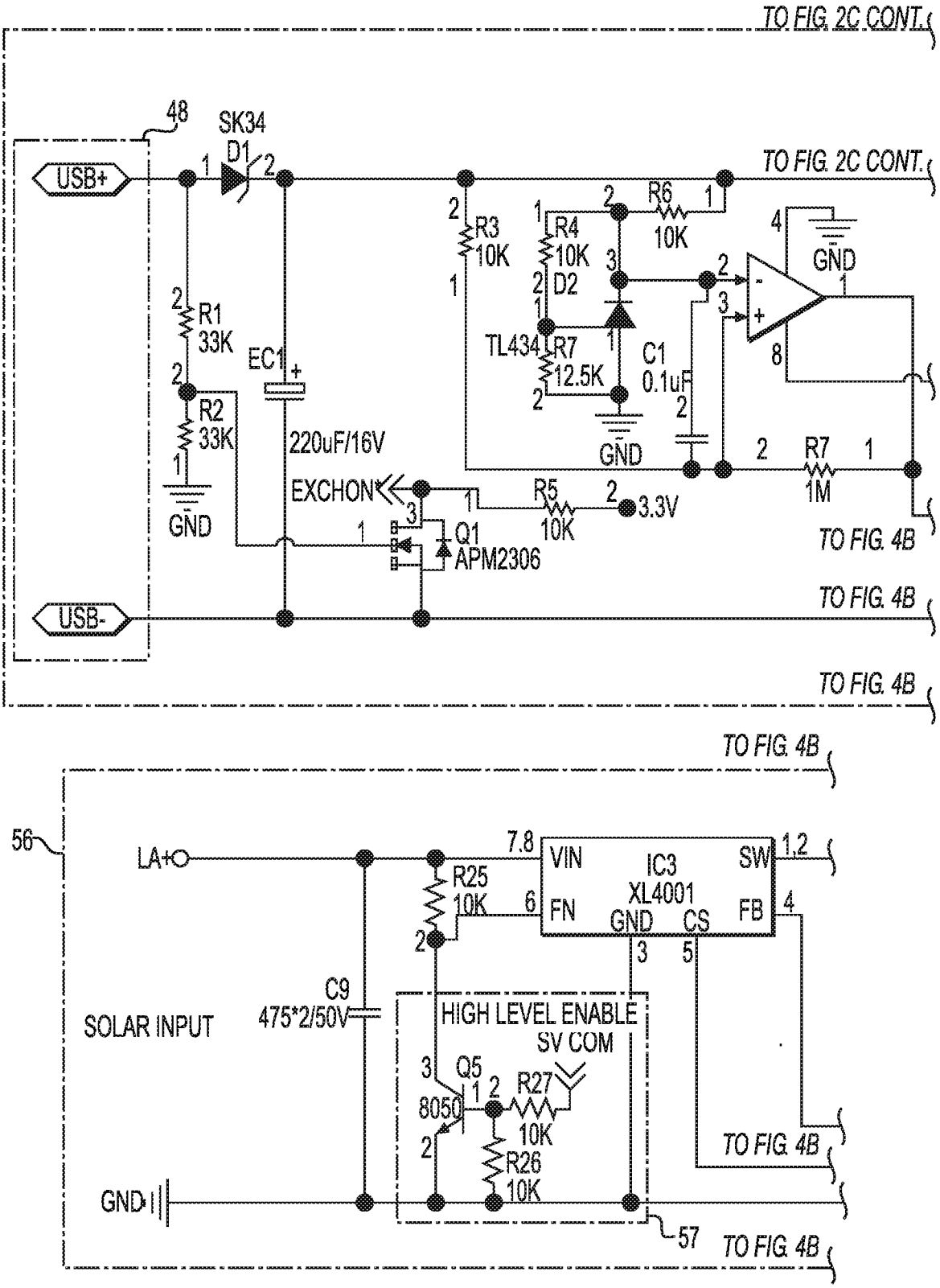
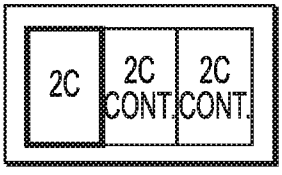

TO FIG. 2C CONT.
48
SK34
D1
USB+
USB-
R1
33K
R2
33K
GND
EC1
220uF/16V
EXCHON
Q1
APM2306
R3
10K
R4
10K
D2
TL434
R7
12.5K
R6
10K
C1
0.1uF
R5
10K
3.3V
R7
1M
TO FIG. 4B
56
LA+
SOLAR INPUT
C9
475*2/50V
R25
10K
IC3
XL4001
VIN
SW
FN
GND
CS
FB
HIGH LEVEL ENABLE
5V COM
Q5
8050
R27
10K
R26
10K
57

FIG. 2C


2C
2C CONT.
2C CONT.

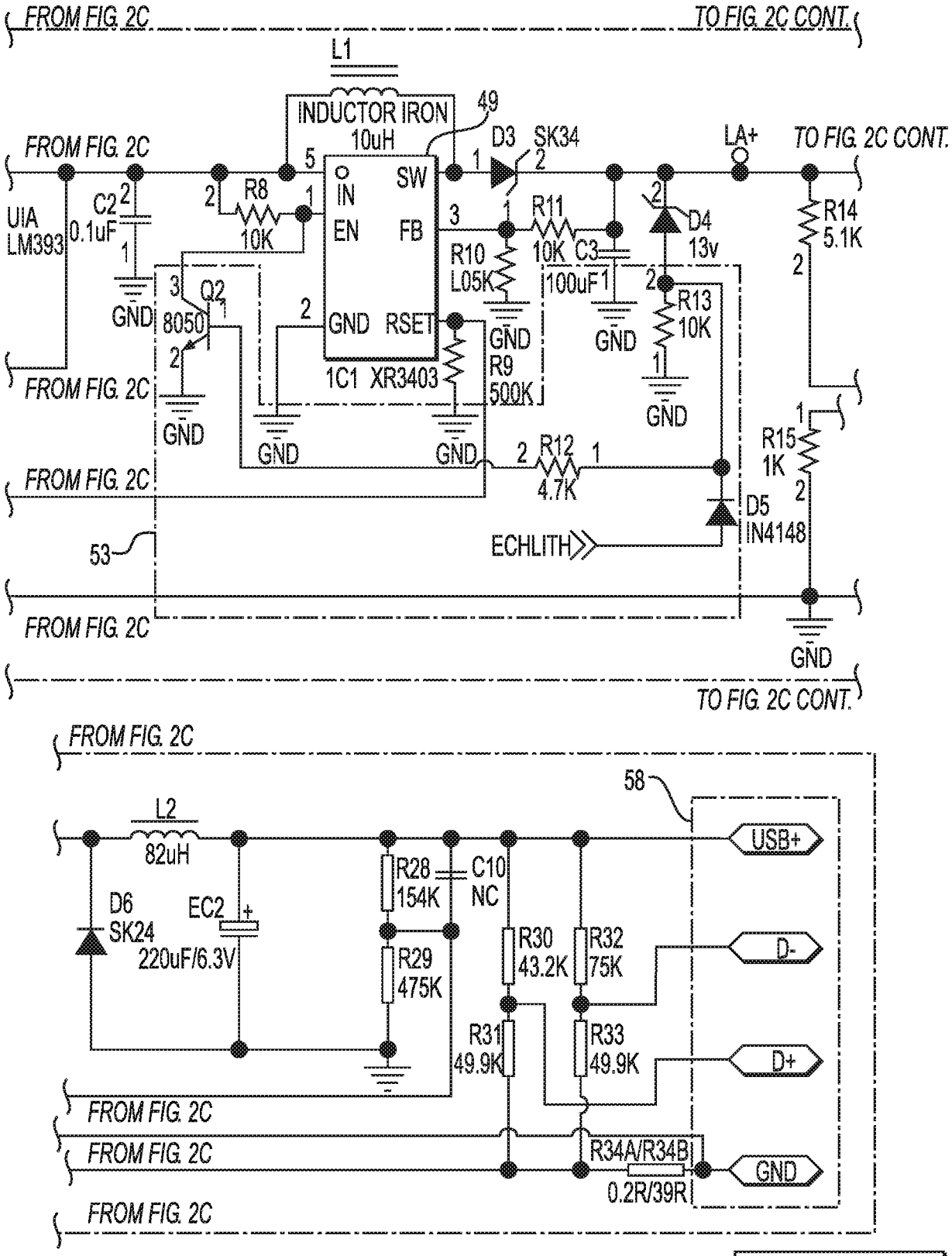
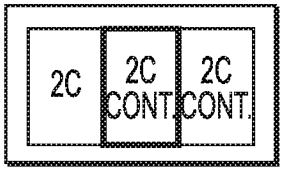

FROM FIG. 2C
TO FIG. 2C CONT.
L1
INDUCTOR IRON
10uH
49
D3 SK34
LA+
UIA
LM393
C2
0.1uF
R8
10K
IN
SW
EN
FB
R10
L05K
R11
10K
C3
100uF
D4
13v
R14
5.1K
R13
10K
Q2
8050
GND
GND RSET
1C1 XR3403
R9
500K
R12
4.7K
R15
1K
D5
IN4148
ECHLITH
53
L2
82uH
58
USB+
D-
D+
GND
D6
SK24
EC2
220uF/6.3V
R28
154K
C10
NC
R29
475K
R30
43.2K
R32
75K
R31
49.9K
R33
49.9K
R34A/R34B
0.2R/39R

FIG. 2C CONT.


2C
2C CONT.
2C CONT.

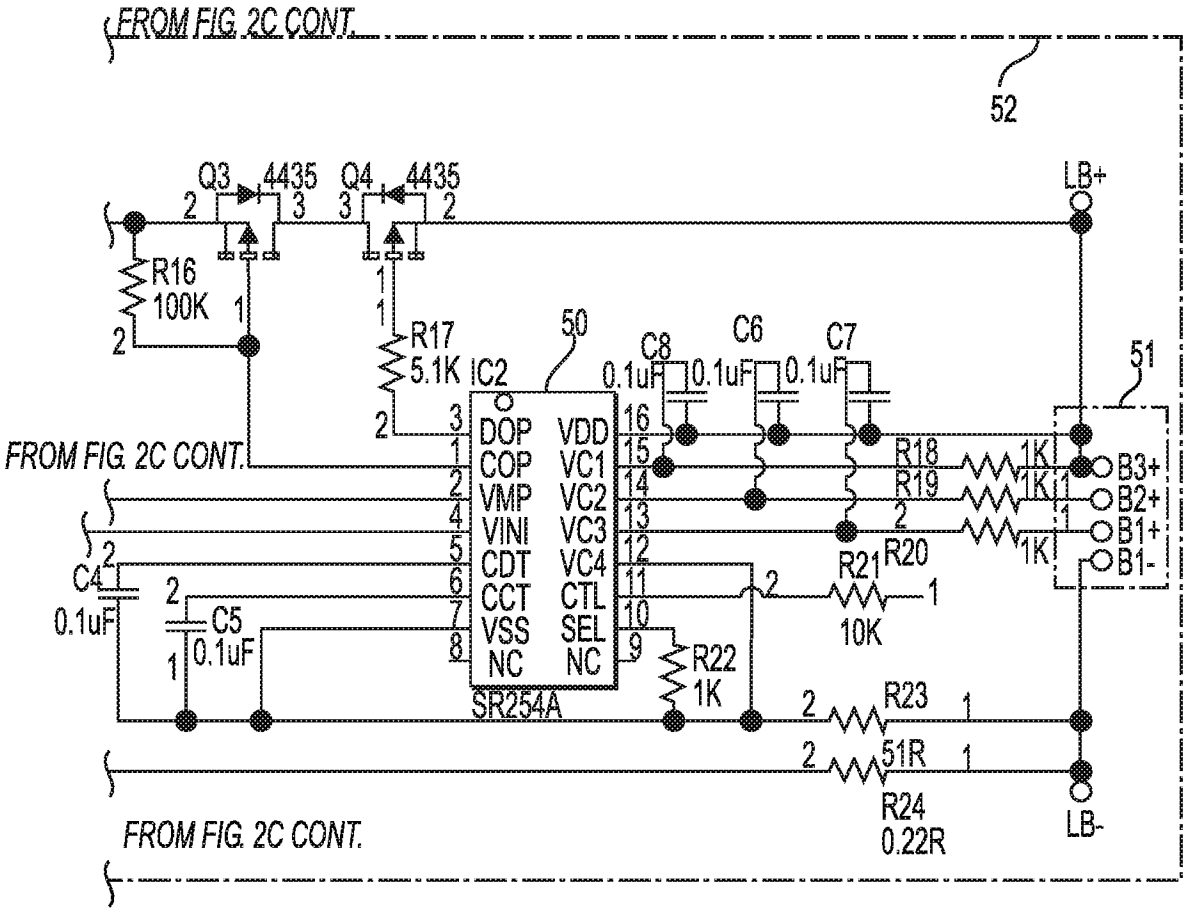
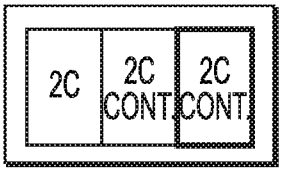

FROM FIG. 2C CONT.
52
Q3 4435
Q4 4435
LB+
R16
100K
R17
5.1K
IC2
50
C8
C6
C7
0.1uF
0.1uF
0.1uF
51
FROM FIG. 2C CONT.
DOP
COP
VMP
VINI
CDT
CCT
VSS
NC
VDD
VC1
VC2
VC3
VC4
CTL
SEL
NC
SR254A
R18 1K
R19 1K
1K
B3+
B2+
B1+
B1-
C4
0.1uF
C5
0.1uF
R21
10K
R20
R22
1K
R23
51R
R24
0.22R
LB-
FROM FIG. 2C CONT.

FIG. 2C CONT.


2C
2C CONT
2C CONT

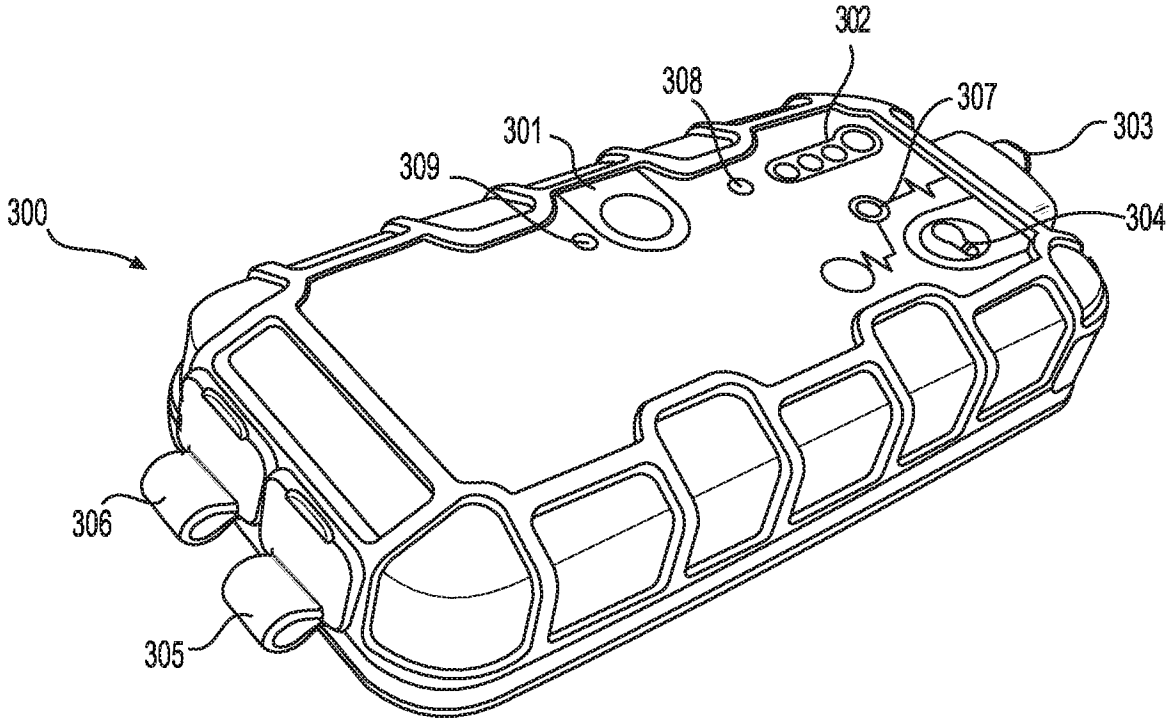

302
308
307
303
301
309
304
300
306
305

FIG. 3

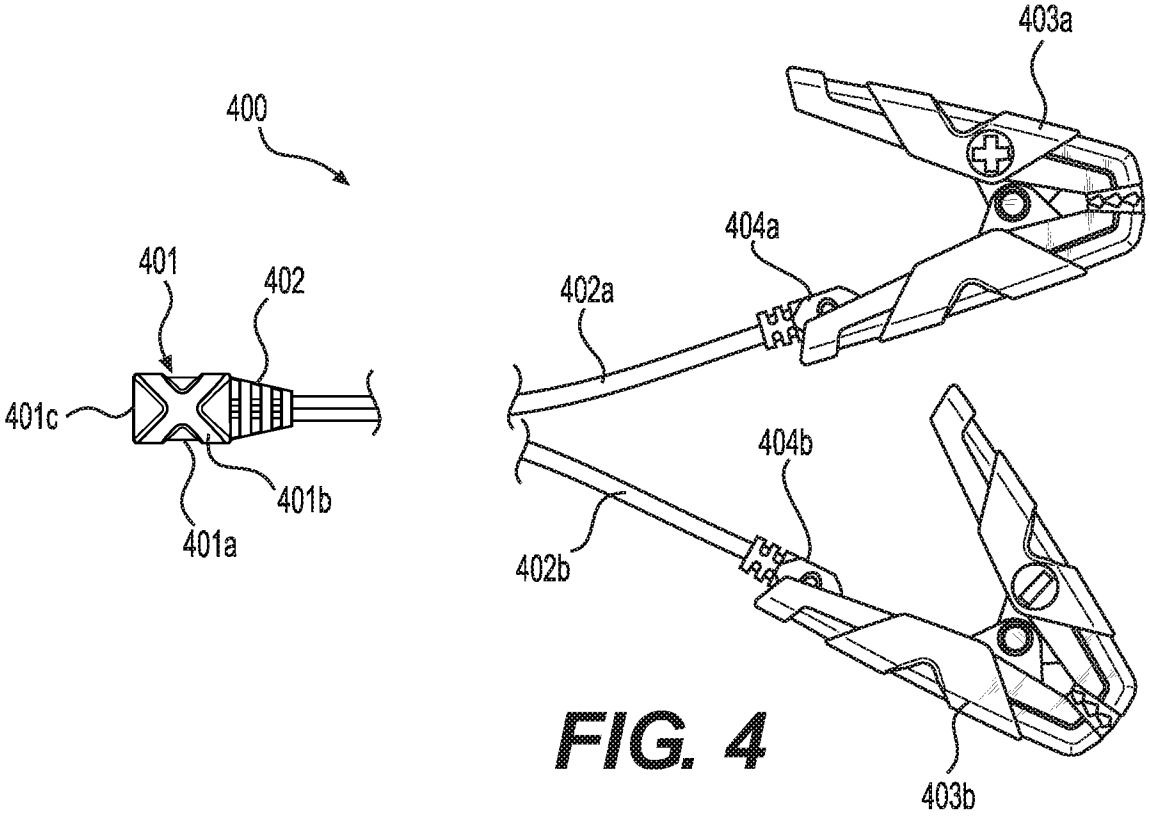

403a
400
404a
401
402
402a
401c
404b
401b
401a
402b
403b

FIG. 4

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION
First Named Inventor/Applicant Name:	Jonathan Lewis NOOK
Filer:	William Leonard Klima/Lisa Elliott
Attorney Docket Number:	054985-000055-us-02-01

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2202	3	50	150
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**935**

Electronic Acknowledgement Receipt

EFS ID:	38877028
Application Number:	16819831
International Application Number:	
Confirmation Number:	1630
Title of Invention:	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION
First Named Inventor/Applicant Name:	Jonathan Lewis NOOK
Customer Number:	20230
Filer:	William Leonard Klima/Lisa Elliott
Filer Authorized By:	William Leonard Klima
Attorney Docket Number:	054985-000055-us-02-01
Receipt Date:	16-MAR-2020
Filing Date:	
Time Stamp:	15:28:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	TL.pdf	316133 cbc77f05696e98c7a2653dd5450e4f525d4c4c10	no	2

Warnings:

ADC EX1002
IPR2025-00885

Information:					
2	Application Data Sheet	ADS.pdf	1862819 1bb572a616436ed61344dc5fcd8bbbabbbed3fe9	no	9
Warnings:					
Information:					
3		DECLARATIONS.pdf	718788 18c076270b390a6ebe8850a8b13a4dcfbec9942b	yes	8

Multipart Description/PDF files in .zip description

Document Description	Start	End
Oath or Declaration filed	1	2
Oath or Declaration filed	3	4
Oath or Declaration filed	5	6
Oath or Declaration filed	7	8

Warnings:					
Information:					
4		Appl.pdf	72765 804be03b61a204c938ccef1eb3ae1d9380ae3925	yes	18

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	13
Claims	14	17
Abstract	18	18

Warnings:					
Information:					
5	Drawings-other than black and white line drawings	Drawings.pdf	726412 b70a2ea9f975688dd59cdf8145e65c6fd0b9555b	no	13
Warnings:					

Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	36816 4826a5ba0d36ebe9bd2581c6f5453d5a9d7c4667	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3733733		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number
16/819,831

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	330		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	23 minus 20 =	* 3	x 50 =	150	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x 230 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	935		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/819,831	03/16/2020	Jonathan Lewis NOOK	054985-000055-US-02-01

CONFIRMATION NO. 1630

20230
Vorys, Sater, Seymour and Pease LLP
1909 K St., NW
9th Floor
WASHINGTON, DC 20006-1152

FORMALITIES LETTER

OC000000115779146

Date Mailed: 03/31/2020

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
- The application search fee must be submitted.
- The application examination fee must be submitted.
- Additional claim fees of $ **150** as a small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.
  The surcharge is due for any one of:
  - late submission of the basic filing fee, search fee, or examination fee,
  - late submission of inventor's oath or declaration,
  - filing an application that does not contain at least one claim on filing, or
  - submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. Small entity discount is in effect. If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- $ **75** basic filing fee.
- $ **80** surcharge.
- $ **330** search fee.
- $ **380** examination fee.
- $ **150** for **3** total claims over 20.

- $(**0**) previous unapplied payment amount.
- $ **1015** TOTAL FEE BALANCE DUE.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/elbanaybanay/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/819,831	03/16/2020	2859	0.00	054985-000055-US-02-01	23	1

CONFIRMATION NO. 1630

FILING RECEIPT

20230
Vorys, Sater, Seymour and Pease LLP
1909 K St., NW
9th Floor
WASHINGTON, DC 20006-1152



Date Mailed: 03/31/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Jonathan Lewis NOOK, Gates Mills, OH;
William Knight NOOK, Shaker Heights, OH;
James Richard STANFIELD, Glendale, AZ;
Derek Michael UNDERHILL, Tempe, AZ;

Applicant(s)

THE NOCO COMPANY, Glenwillow, OH;

Assignment For Published Patent Application

THE NOCO COMPANY, Glenwillow, OH

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 15/691,884 08/31/2017 PAT 10604024
which is a CON of 14/619,655 02/11/2015 PAT 9770992
which is a DIV of 14/325,938 07/08/2014 PAT 9007015
which is a CON of PCT/US14/45434 07/03/2014

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 03/27/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/819,831**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Preliminary Class

320

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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ADC EX1002
IPR2025-00885

To: patlaw@vorys.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 20230

Mar 31, 2020 03:45:15 AM

Dear PAIR Customer:

Vorys, Sater, Seymour and Pease LLP
1909 K St., NW
9th Floor
WASHINGTON, DC 20006-1152
UNITED STATES

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Application	Document	Mailroom Date	Attorney Docket No.
16819831	NTC.MISS.PRT	03/31/2020	054985-000055-US-02-01
	APP.FILE.REC	03/31/2020	054985-000055-US-02-01

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

Electronic Patent Application Fee Transmittal

Application Number:	16819831
Filing Date:	16-Mar-2020
Title of Invention:	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION
First Named Inventor/Applicant Name:	Jonathan Lewis NOOK
Filer:	William Leonard Klima/Lisa Elliott
Attorney Docket Number:	054985-000055-US-02-01

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2202	3	50	150
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	2051	1	80	80

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 1 month with $0 paid	2251	1	100	100
Miscellaneous:				
		Total in USD ($)		**1115**

Electronic Acknowledgement Receipt

EFS ID:	39719017
Application Number:	16819831
International Application Number:	
Confirmation Number:	1630
Title of Invention:	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION
First Named Inventor/Applicant Name:	Jonathan Lewis NOOK
Customer Number:	20230
Filer:	William Leonard Klima/Lisa Elliott
Filer Authorized By:	William Leonard Klima
Attorney Docket Number:	054985-000055-US-02-01
Receipt Date:	15-JUN-2020
Filing Date:	16-MAR-2020
Time Stamp:	14:29:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1115
RAM confirmation Number	E20206EE30183570
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Fee Worksheet (SB06)	fee-info.pdf	40349 87db2a56a32c37ecbc1e14bbdb99c05419b9b9cc	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	40349		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number
16/819,831

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	330		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	23 minus 20 =	* 3	x 50 =	150	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x 230 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	935		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/819,831	03/16/2020	2859	1015	054985-000055-US-02-01	23	1

CONFIRMATION NO. 1630

UPDATED FILING RECEIPT

20230
Vorys, Sater, Seymour and Pease LLP
1909 K St., NW
9th Floor
WASHINGTON, DC 20006-1152

OC000000118177921

Date Mailed: 07/02/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Jonathan Lewis NOOK, Gates Mills, OH;
William Knight NOOK, Shaker Heights, OH;
James Richard STANFIELD, Glendale, AZ;
Derek Michael UNDERHILL, Tempe, AZ;

Applicant(s)

THE NOCO COMPANY, Glenwillow, OH;

Assignment For Published Patent Application

THE NOCO COMPANY, Glenwillow, OH

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 15/691,884 08/31/2017 PAT 10604024
which is a CON of 14/619,655 02/11/2015 PAT 9770992
which is a DIV of 14/325,938 07/08/2014 PAT 9007015
which is a CON of PCT/US14/45434 07/03/2014

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 03/27/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/819,831**

Projected Publication Date: 10/08/2020

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Preliminary Class

320

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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NOT GRANTED

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community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

ADC EX1002
IPR2025-00885

To: patlaw@vorys.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 20230

Jul 02, 2020 03:50:46 AM

Dear PAIR Customer:

Vorys, Sater, Seymour and Pease LLP
1909 K St., NW
9th Floor
WASHINGTON, DC 20006-1152
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 20230 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

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Application	Document	Mailroom Date	Attorney Docket No.
16819831	APP.FILE.REC	07/02/2020	054985-000055-US-02-01

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If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

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PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

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APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
16/819,831	07/16/2020 11:51:54 AM ET	054985-000055-US-02-02

Title of Invention

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	1630	FILED BY	Lisa Elliott
PATENT CENTER #	60054749	FILING DATE	03/16/2020
CUSTOMER #	20230	FIRST NAMED INVENTOR	Jonathan NOOK
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	William Klima

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2020_07_16_preliminary_amendment.pdf	16	Preliminary Amendment	134 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2020_07_16_preliminary_amendment.pdf	6BCE9417A939928497E8E1165DA21E78C802A49E9F08BEF0E402D412CFDF7B1F52381CAA4220B997619C229AEC1A745EB35801006E893AD9F594EA98C69E981

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
16/819,831	07/16/2020 11:51:54 AM ET	054985-000055-US-02-02

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CUSTOMER #	20230	FILING DATE	03/16/2020
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Jonathan NOOK

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 220585	E20207FB53010511	Lisa Elliott

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2202	EACH CLAIM IN EXCESS OF 20	50.00	28	1400.00
2201	EACH INDEPENDENT CLAIM IN EXCESS OF THREE	230.00	1	230.00
			TOTAL AMOUNT:	$1,630.00

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Jonathan Lewis NOOK	Docket No.:	054985.000055-US-02-02
Application No.:	16/819,831	Examiner:	M Baye DIAO
Filed:	March 16, 2020	Art Unit:	2859
Customer No.:	20230	Conf. No.:	1630

For: JUMP STARTING APPARATUS

PRLIMINARY AMENDMENT

Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

This Preliminary Amendment is being filed in the above-identified applicant. Applicant requests entry prior to Examination on the merits.

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AMENDMENTS TO THE CLAIMS

Please amend the claims as follows:

1.-23. (Cancelled)

24. (New) A jump starter apparatus for boosting or charging a depleted or discharged battery having a positive battery terminal and a negative battery terminal, the apparatus comprising:

a power supply;

a positive battery terminal connector for connecting the jump starter apparatus to the positive battery terminal of the depleted or discharged battery;

a negative battery terminal connector for connecting the jump starter apparatus to the negative battery terminal of the depleted or discharged battery;

a power switch configured to electrically connect the power supply to the depleted or discharged battery when boosting or charging the depleted or discharged battery; and

a control system or circuit connected to and controlling the power switch, the control system or circuit configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit switching on power from the power supply to the depleted or discharged battery when

the following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are connected to the depleted or discharge battery; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity.

25. (New) A jump starter apparatus for boosting or charging a depleted or discharged battery having a positive battery terminal and a negative battery terminal, the apparatus comprising:

a power supply;

a positive battery terminal connector for connecting the jump starter apparatus to the positive battery terminal of the depleted or discharged battery;

a negative battery terminal connector for connecting the jump starter apparatus to the negative battery terminal of the depleted or discharged battery;

a power switch configured to electrically connect the power supply to the depleted or discharged battery when boosting or charging the depleted or discharged battery; and

a control system or circuit connected to and controlling the power switch, the control system or circuit configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit automatically switching on power from the power supply to the depleted or discharged battery when the following two (2) conditions are achieved, including i) the positive and

negative battery terminal connectors are connected to the depleted or discharge battery; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity.

26. (New) A jump starter apparatus for boosting or charging a depleted or discharged battery having a positive battery terminal and a negative battery terminal, the apparatus comprising:

a power supply;

a positive battery terminal connector for connecting the jump starter apparatus to the positive battery terminal of the depleted or discharged battery;

a negative battery terminal connector for connecting the jump starter apparatus to the negative battery terminal of the depleted or discharged battery;

a power switch configured to electrically connect the power supply to the depleted or discharged battery when boosting or charging the depleted or discharged battery; and

a control system or circuit connected to and controlling the power switch, the control system or circuit comprising a presence circuit configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and a polarity circuit configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit switching on power from the power supply to the depleted or discharged battery when the following two (2) conditions are achieved, including i) the positive and negative battery terminal

connectors are connected to the depleted or discharge battery; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity.

27. (New) A jump starter apparatus for boosting or charging a depleted or discharged battery having a positive battery terminal and a negative battery terminal, the apparatus comprising:

a power supply;

a positive battery terminal connector for connecting the jump starter apparatus to the positive battery terminal of the depleted or discharged battery;

a negative battery terminal connector for connecting the jump starter apparatus to the negative battery terminal of the depleted or discharged battery;

a power switch configured to electrically connect the power supply to the depleted or discharged battery when boosting or charging the depleted or discharged battery; and

a control system or circuit connected to and controlling the power switch, the control system or circuit comprising a presence circuit and a polarity circuit, the presence circuit comprising a presence sensor configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the polarity circuit comprising a polarity sensor configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit switching on power from the power supply to the depleted or discharged battery when the

following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are connected to the depleted or discharge battery; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity.

28. (New) The apparatus according to claim 24, wherein the control system or circuit automatically switches on power from the power supply to the depleted or discharged battery when the following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are connected to the depleted or discharged battery; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity.

29. (New) The apparatus according to claim 24, further comprising a manual switch to allow a user to manually switch on power from the power supply to the deplete or discharged battery.

30. (New) The apparatus according to claim 28, further comprising a manual switch to allow a user to manually switch on power from the power supply to the deplete or discharged battery.

31. (New) The apparatus according to claim 28, further comprising a manual switch to allow a user to override the automatic switching and manually switch on power from the power supply to the deplete or discharged battery.

32. (New) The apparatus according to claim 31, wherein the manual switch comprises a manual override button.

33. (New) The apparatus according to claim 32, wherein the manual switch is configured so that a user presses and holds down the manual override button for a predetermined period of time to prevent inadvertent actuation of a manual mode.

34. (New) The apparatus according to claim 24, further comprising a manual switch for manually switching on power from the power supply to the deplete or discharged battery in the event the control system or circuit is unable to automatically switch on power from the power supply to the depleted or discharged battery.

35. (New) The apparatus according to claim 29, wherein the manual switch is configured to prevent manual override if the depleted or discharged battery is connected in reverse to the positive and negative battery terminal connectors.

36. (New) The apparatus according to claim 29, wherein the manual switch is configured to allow a user to jump start a vehicle having either a missing battery, or the depleted or discharged battery of the vehicle having a battery voltage so low that automatic detection of the battery voltage and switching by the control system or circuit is not possible.

37. (New) The apparatus according to claim 24, wherein the control system or circuit comprises a presence circuit configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and a polarity circuit configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors.

38. (New) The apparatus according to claim 26, wherein the presence circuit comprises a presence sensor and the polarity circuit comprises a polarity sensor.

39. (New) The apparatus according to claim 26, wherein the presence circuit is a presence sensor and the polarity circuit is a polarity sensor.

40. (New) The apparatus according to claim 27, wherein the presence circuit comprises a presence sensor and the polarity circuit comprises a polarity sensor.

41. (New) The apparatus according to claim 27, wherein the presence circuit is a presence sensor and the polarity circuit is a polarity sensor.

42. (New) The apparatus according to claim 24, wherein the control system or circuit comprises a microcontroller.

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43. (New) The apparatus according to claim 25, wherein the control system or circuit comprises a microcontroller.

44. (New) The apparatus according to claim 26, wherein the control system or circuit comprises a microcontroller electrically connected to and receiving inputs from the presence circuit and the polarity circuit.

45. (New) The apparatus according to claim 27, wherein the control system or circuit comprises a microcontroller electrically connected to and receiving inputs from the presence circuit and the polarity circuit.

46. (New) The apparatus according to claim 24, wherein the control system or circuit comprising a presence circuit or sensor configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, a polarity circuit or sensor configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, and a microcontroller electrically connected to the presence circuit or sensor and the polarity circuit sensor and receiving signals from the presence circuit or sensor and the polarity circuit or sensor.

47. (New) The apparatus according to claim 42, wherein the control system or circuit is configured so that microcontroller determines when it is safe to turn on the power switch.

48. (New) The apparatus according to claim 47, wherein the control system or circuit is configured so that microcontroller software of the microcontroller determines when it is safe to turn on the power switch.

49. (New) The apparatus according to claim 42, wherein the microcontroller is a programmable microcontroller configured to allow updates in functionality and system parameters.

50. (New) The apparatus according to claim 42, wherein the microcontroller is a programmable microcontroller configured to allow updates in functionality and system parameters, without requiring any change in hardware.

51. (New) The apparatus according to claim 42, wherein the microcontroller comprises flash memory, and wherein the microcontroller with flash memory is used to control the control system or circuit.

52. (New) The apparatus according to claim 42, wherein the control system or circuit further comprises a voltage regulator providing regulation of internal operating voltage for the microcontroller and sensors.

53. (New) The apparatus according to claim 26, wherein the presence circuit comprises a first optically coupled isolator phototransistor and the polarity circuit comprises a second optically coupled isolator phototransistor.

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54. (New) The apparatus according to claim 26, wherein the presence circuit further comprises a first diode connected between the first optically coupled phototransistor and the depleted or discharged battery, and the polarity circuit further comprises second diode connected between the second optically coupled phototransistor and the depleted or discharged battery

55. (New) The apparatus according to claim 24, wherein the power supply is a rechargeable battery.

56. (New) The apparatus according to claim 55, wherein the rechargeable battery is a lithium ion rechargeable battery.

57. (New) The apparatus according to claim 56, wherein the lithium ion battery comprises a battery pack of multiple lithium ion batteries.

58. (New) The apparatus according to claim 24, wherein the power switch is a FET switch.

59. (New) The apparatus according to claim 58, wherein the FET switch comprises a plurality of FETs in parallel.

60. (New) The apparatus according to claim 24, wherein the positive battery terminal connector is a positive battery clamp releasably connectable to the positive terminal of the depleted or discharged battery, and wherein the negative battery terminal connector is a negative battery clamp releasably connectable to the negative terminal of the depleted or discharged battery.

61. (New) The apparatus according to claim 24, further comprising a plurality of power diodes coupled between an output of the jump starting apparatus to the depleted or discharged battery and the power supply to prevent back-charging of the power supply from an electrical system connected to the output.

62. (New) The apparatus according to claim 24, further comprising a temperature sensor configured to detect temperature of the power supply and to provide a temperature signal to a microcontroller.

63. (New) The apparatus according to claim 24, further comprising a voltage measurement circuit configured to measure output voltage of the power supply and to provide a voltage measurement signal to the microcontroller.

64. (New) The apparatus according to claim 24, further comprising a voltage regulator configured to convert output voltage of the power supply to a voltage level appropriate to provide operating power to internal components of the jump starting apparatus.

65. (New) The apparatus according to claim 26, wherein the polarity circuit is a reverse polarity circuit.

66. (New) The apparatus according to claim 26, wherein the polarity circuit comprises a reverse polarity sensor.

67. (New) The apparatus according to claim 24, wherein the positive battery connector and negative battery connector together form a jumper cable device comprising a plug connected to one of the cables and configured to plug into an output port of the battery jump starting apparatus.

68. (New) The apparatus according to claim 67, wherein an output port and the plug are dimensioned so that the plug fits into the output port only in one specific orientation.

69. (New) The apparatus according to claim 24, further comprising a USB charging port configured to provide charging power from an external power source to the power supply.

70. (New) The apparatus according to claim 69, further comprising a USB charging circuit connecting the USB charging port to the power supply.

71. (New) The apparatus according to claim 70, wherein the USB charging circuit comprises a DC-DC converter.

72. (New) The apparatus according to claim 71, wherein the DC-DC converter increases the voltage from a USB charger to charge the power supply.

73. (New) The apparatus according to claim 72, wherein the DC-DC converter is configured to convert 5V potential provided from a USB charger to 12.4VDC

74. (New) The apparatus according to claim 70, wherein the DC-DC converter is configured to be turned on and off via a circuit by an output from a microcontroller.

REMARKS

Claims 1-23 are pending in the present application.

Claim 1-23 are cancelled without prejudice or disclaimer of the subject matter contained therein.

Claims 24-74 are newly added. No new matter has been added.

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CONCLUSION

Applicant also petitions for any additional extensions of time to maintain the present application alive.

The Director is hereby authorized to charge any deficiency in fees filed, asserted to be filed, or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account 22-0585. Please credit any excess fees to such account.

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Date: July 16, 2020

Respectfully submitted,

/William L. Klima/

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Attorney for Applicant

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/819,831	Filing Date 03/16/2020	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $50 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $230 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	07/16/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 51	Minus	** 23	= 28		x $50 =	1400
	Independent (37 CFR 1.16(h))	* 4	Minus	*** 3	= 1		x $230 =	230
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	1630

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
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Application Number	16819831
Filing Date	2020-03-16
First Named Inventor	Jonathan Lewis NOOK
Art Unit	2859
Examiner Name	M. Baye DIAO
Attorney Docket Number	054985-000055-US-02-01

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	3590357		1971-06-29	REID	
	2	3638108		1972-01-25	CHANNING	
	3	5194799		1993-03-16	TOMANTSCHGER	
	4	5281904		1994-01-25	TOMKINS	
	5	5319298		1994-06-07	WANZONG	
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	10	6679212		2004-01-20	KELLING	
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	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

	20	10328808		2019-06-25	NOOK ET AL.	
	21	10604024		2020-03-31	NOOK ET AL.	
	22	D597029		2009-07-28	LI	

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	1	20010025618	A1	2001-10-04	KELLING	
	2	20040066168	A1	2004-04-08	GEORGE	
	3	20040130298	A1	2004-07-08	KRIEGER	
	4	20030141845	A1	2003-07-31	KRIEGER	
	5	20040150373	A1	2004-08-05	CHAN	
	6	20040239290	A1	2004-12-02	KRIEGER	

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	First Named Inventor	Jonathan Lewis NOOK
	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

	7	20050116688	A1	2005-06-02	YIN	
	8	20060176011	A1	2006-08-10	LUI	
	9	20060220610	A1	2006-10-05	SOLBERG	
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	12	20110175461	A1	2011-07-21	TINAPHONG	
	13	20120025766	A1	2012-02-02	READE	
	14	20130162029	A1	2013-06-27	REICHOW	
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	16	20140210399	A1	2014-07-31	URSCHEL	
	17	20140368155	A1	2013-12-18	CHEN	

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	Attorney Docket Number	054985-000055-US-02-01

	18	20150054336	A1	2015-02-26	LIU	
	19	20150340907	A1	2015-11-26	LEI	

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	1	2011/113734	WO		2011-09-22	REICHOW		
	2	2012/036556	WO		2012-03-22	EIDSVIG		
	3	2012/080996	WO		2012-06-21	TRACY		
	4	2014/106407	WO		2014-10-07	LEI		
	5	0616409	EP		2014-09-07	HERBERT		
	6	103066662	CN		2013-04-24	LEI	English abstract attached	X

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16819831
	Filing Date	2020-03-16
	First Named Inventor	Jonathan Lewis NOOK
	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Copy of Exhibit 1008, www.xcar360.com	
	2	Copy of Exhibit 1009, www.electronicshub.org	
	3	Copy of Exhibit 1010, USB Battery Charging 1.2 Compliance Plan	
	4	Copy of the Petition for Inter Partes Review of U.S. Patent No. 9,007,015; IPR 2020-00944, filed May 14, 2020, 99 pages	
	5	Copy of Exhibit 1012, Model: Epower-20B brochure, 1 page	
	6	Copy of Exhibit 1013, Model: Epower-21 brochure, 1 page	
	7	Copy of Exhibit 1015, Fairchild Semiconductor brochure, MC78XX/LM78XX/MC78XXA, 28 pages	
	8	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. Shenzhen Valuelink E-Commerce Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division,1 page.	
	9	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. Shenzhen ChangXin Yang Technology Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page.	
	10	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. SZ Jingxinghui Electronics Technology Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page	

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	12	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/30/17, The NOCO Company, Inc. v. Shenzhen Dika Na'er E-Commerce Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page.	
	13	Copy of PTAB notice regarding petition filed in Patent Number 9007015, Application Number 14/325938, filed on 01/15/2018, IPR2018-00503, 1 page	
	14	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 09/13/18, The NOCO Company, Inc. v. Halo2 Cloud, LLC, QVC, Inc., U.S. District Court Delaware, 1 page.	
	15	Copy of Notice of Filing Date Accorded to Petition and Time for Filing Patent Owner Preliminary Response, mailed May 21, 2020, Shenzhen Carku Technology Co., Ltd. v. The NOCO Company, IPR2020-00944, Patent 9,007,015, 4 pages.	
	16	International Search Report in corresponding PCT/US2014/045434, November 3, 2014.	
	17	Australian Patent Opposition #1, Australian Patent Application No. 2016269555, Statement of Grounds of Particulars, Brown & Watson International Pty Ltd., June 6, 2019, 6 pages; particular (e), the offering for sale and sale by Asia Bright Industrial (Hong Kong) Co, Ltd. of products identified as the JPS Jump Starter and the JPR Jump Starter prior to July 2014.	
	18	Australian Patent Opposition #1, Australian Patent Application No. 2016269555, Evidence in Support, filed September 6, 2019, 24 pages.	
	19	Australian Patent Opposition #1, Australian Patent Application No. 2016269555, Evidence in Support – Exhibits, filed September 6, 2019,166 pages; Annexure MD-1, early specification sheets for "the BW Jumpstarter", 4 pages; Annexure MD-2, product manual for "the BW Jumpstarter", PROJECTA; "2x22 Amp Hour High Performance Jumpstarter"; 2013; 20 pages.	
	20	Australian Patent Opposition #2, Australian Patent Application No. 2019201559, Statement of Grounds and Particulars, filed May 21, 2020, 8 pages.	
	21	THE NOCO COMPANY v. DELTONA TRANSFORMER CORPORATION and DELTRAN USA, LLC, Defendant Deltran USA, LLC's Invalidity Contentions, In the United States District Court for the Middle District of Florida, Orlando Division, USB Implementers Forum, Inc.,Battery Charging Specification, Revision 1.1, 04-15-2009 on page 8, Prior Art Offered for Sale or Publicly Used or Known on pages 8-10, MICRO-START/PPS, E-Power, Battery Tender Power Pack, PowerAll, and Electromate 400 on page 10; 141 pages.	

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	Attorney Docket Number	054985-000055-US-02-01

	22	THE NOCO CO., INC. v. SMARTECH PRODUCTS, INC., et al., Smartech, Inc.'s Invalidity and Unenforceability Contents, Bestek 2400A Peak Current Portable Car Jump Starter Power Bank with 1000mAh Capacity (SMARTECH 00062-00069)("Bestek") on page 2; HALO 7800 mAh Portable Charger for Cell Phones & Tablets (SMARTECH 00070-00071)("HALO") on page 2; Schumacher Lithium Iron Jump Starter – SL1 Red Fuel (SMARTECH 00072-00073)("Schumacher") on page 2, filed June 19, 2019, 8 pages.
	23	THE NOCO COMPANY v. SHENZHEN DIKA NA'ER E-COMMERCE (Lead Case No. 1:17-cv-02282), THE NOCO COMPANY v. SHENZHEN CHANGXINYANG TECHNOLOGY CO., LTD (Case No. 1:117-cv-02209). THE NOCO COMPANY v. SHENZHEN VALUELINK E-COMMERCES CO., LTD (Case No. 1:17-cv-02210), Defendants' Amended Final Invalidity and Unenforceability Contents, The Powerall PBJS12000RD Jump Starter ("Powerall Jump Starter"), offered for sale by Gryphon Mobile Electronics at least as early as November 5, 2013, on page 2, The Lightning 12V

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Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	Attorney Docket Number	054985-000055-US-02-01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/William L. Klima/	Date (YYYY-MM-DD)	2020-07-23
Name/Print	William L. Klima	Registration Number	32422

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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FAIRCHILD SEMICONDUCTOR®

MC78XX/LM78XX/MC78XXA

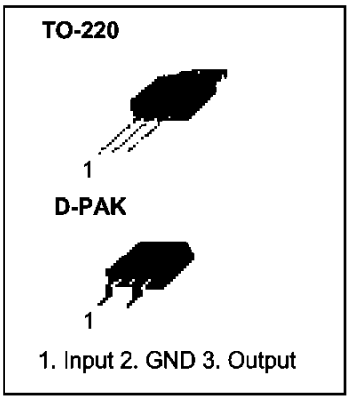
3-Terminal 1A Positive Voltage Regulator

Features

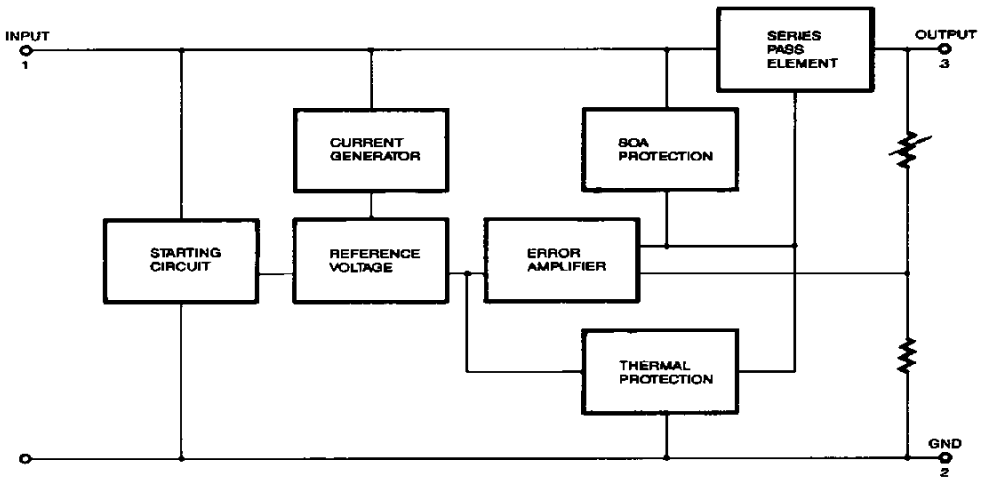
- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

Description

The MC78XX/LM78XX/MC78XXA series of three terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.



Internal Block Digram



Rev. 1.0.1

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Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage (for V_O = 5V to 18V) (for V_O = 24V)	V_I V_I	35 40	V V
Thermal Resistance Junction-Cases (TO-220)	$R_{\theta JC}$	5	°C/W
Thermal Resistance Junction-Air (TO-220)	$R_{\theta JA}$	65	°C/W
Operating Temperature Range	T_{OPR}	0 ~ +125	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C

Electrical Characteristics (MC7805/LM7805)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I = 10V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7805/LM7805			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		4.8	5.0	5.2	V
		5.0mA Io 1.0A, P_O 15W V_I = 7V to 20V		4.75	5.0	5.25	
Line Regulation (Note1)	Regline	T_J=+25 °C	V_O = 7V to 25V	-	4.0	100	mV
			V_I = 8V to 12V	-	1.6	50	
Load Regulation (Note1)	Regload	T_J=+25 °C	I_O = 5.0mA to1.5A	-	9	100	mV
			I_O =250mA to 750mA	-	4	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	0.03	0.5	mA
		V_I= 7V to 25V		-	0.3	1.3	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O= 5mA		-	-0.8	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A=+25 °C		-	42	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_O = 8V to 18V		62	73	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	15	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A =+25 °C		-	230	-	mA
Peak Current	I_{PK}	T_J =+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7806)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I =11V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7806			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		5.75	6.0	6.25	V
		5.0mA I_O 1.0A, P_O 15W V_I = 8.0V to 21V		5.7	6.0	6.3	
Line Regulation (Note1)	Regline	T_J =+25 °C	V_I = 8V to 25V	-	5	120	mV
			V_I = 9V to 13V	-	1.5	60	
Load Regulation (Note1)	Regload	T_J =+25 °C	I_O =5mA to 1.5A	-	9	120	mV
			I_O =250mA to750A	-	3	60	
Quiescent Current	I_Q	T_J =+25 °C		-	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		-	-	0.5	mA
		V_I = 8V to 25V		-	-	1.3	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O = 5mA		-	-0.8	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A =+25 °C		-	45	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_I = 9V to 19V		59	75	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	19	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A=+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J =+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7808)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I =14V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7808			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		7.7	8.0	8.3	V
		5.0mA I_O 1.0A, P_O 15W V_I = 10.5V to 23V		7.6	8.0	8.4	
Line Regulation (Note1)	Regline	T_J =+25 °C	V_I = 10.5V to 25V	-	5.0	160	mV
			V_I = 11.5V to 17V	-	2.0	80	
Load Regulation (Note1)	Regload	T_J =+25 °C	I_O = 5.0mA to 1.5A	-	10	160	mV
			I_O= 250mA to 750mA	-	5.0	80	
Quiescent Current	I_Q	T_J =+25 °C		-	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	0.05	0.5	mA
		V_I = 10.5A to 25V		-	0.5	1.0	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O = 5mA		-	-0.8	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A =+25 °C		-	52	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, V_I= 11.5V to 21.5V		56	73	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J=+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	17	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25 °C		-	230	-	mA
Peak Current	I_{PK}	T_J =+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7809)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I =15V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7809			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25°C		8.65	9	9.35	V
		5.0mA≤ I_O ≤1.0A, P_O ≤15W V_I= 11.5V to 24V		8.6	9	9.4	
Line Regulation (Note1)	Regline	T_J=+25°C	V_I = 11.5V to 25V	-	6	180	mV
			V_I = 12V to 17V	-	2	90	
Load Regulation (Note1)	Regload	T_J=+25°C	I_O = 5mA to 1.5A	-	12	180	mV
			I_O = 250mA to 750mA	-	4	90	
Quiescent Current	I_Q	T_J=+25°C		-	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	-	0.5	**mA**
		V_I = 11.5V to 26V		-	-	1.3	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O = 5mA		-	-1	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A =+25 °C		-	58	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_I = 13V to 23V		56	71	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J=+25°C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	17	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25°C		-	250	-	mA
Peak Current	I_{PK}	T_J= +25°C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

Ex. 1015
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Electrical Characteristics (MC7810)

(Refer to test circuit ,0°C< T_J < 125°C, I_O = 500mA, V_I =16V, C_I= 0.33µF, C_O=0.1µF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7810			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		9.6	10	10.4	V
		5.0mA ≤ I_O≤1.0A, P_O ≤15W V_I = 12.5V to 25V		9.5	10	10.5	
Line Regulation (Note1)	Regline	T_J =+25°C	V_I = 12.5V to 25V	-	10	200	mV
			V_I = 13V to 25V	-	3	100	
Load Regulation (Note1)	Regload	T_J =+25°C	I_O = 5mA to 1.5A	-	12	200	mV
			I_O = 250mA to 750mA	-	4	400	
Quiescent Current	I_Q	T_J =+25°C		-	5.1	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	-	0.5	mA
		V_I = 12.5V to 29V		-	-	1.0	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O = 5mA		-	-1	-	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A =+25 °C		-	58	-	µV/Vo
Ripple Rejection	RR	f = 120Hz V_I = 13V to 23V		56	71	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J=+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	17	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A=+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J =+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7812)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I =19V, C_I= 0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7812			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		11.5	12	12.5	V
		5.0mA ≤ I_O≤1.0A, P_O≤15W V_I = 14.5V to 27V		11.4	12	12.6	
Line Regulation (Note1)	Regline	T_J =+25 °C	V_I = 14.5V to 30V	-	10	240	mV
			V_I = 16V to 22V	-	3.0	120	
Load Regulation (Note1)	Regload	T_J =+25 °C	I_O = 5mA to 1.5A	-	11	240	mV
			I_O = 250mA to 750mA	-	5.0	120	
Quiescent Current	I_Q	T_J =+25 °C		-	5.1	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	0.1	0.5	mA
		V_I = 14.5V to 30V		-	0.5	1.0	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O = 5mA		-	-1	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A =+25 °C		-	76	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_I = 15V to 25V		55	71	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J=+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	18	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A=+25 °C		-	230	-	mA
Peak Current	I_{PK}	T_J = +25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7815)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I =23V, C_I= 0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7815			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		14.4	15	15.6	V
		5.0mA ≤ I_O ≤ 1.0A, P_O ≤ 15W V_I = 17.5V to 30V		14.25	15	15.75	
Line Regulation (Note1)	Regline	T_J =+25 °C	V_I = 17.5V to 30V	-	11	300	mV
			V_I = 20V to 26V	-	3	150	
Load Regulation (Note1)	Regload	T_J =+25 °C	I_O = 5mA to 1.5A	-	12	300	mV
			I_O = 250mA to 750mA	-	4	150	
Quiescent Current	I_Q	T_J =+25 °C		-	5.2	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	-	0.5	mA
		V_I = 17.5V to 30V		-	-	1.0	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O = 5mA		-	-1	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A =+25 °C		-	90	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_I = 18.5V to 28.5V		54	70	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J=+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	19	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A=+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J =+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7818)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I =27V, C_I= 0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7818			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		17.3	18	18.7	V
		5.0mA ≤ I_O ≤1.0A, P_O ≤15W V_I = 21V to 33V		17.1	18	18.9	
Line Regulation (Note1)	Regline	T_J =+25 °C	V_I = 21V to 33V	-	15	360	mV
			V_I = 24V to 30V	-	5	180	
Load Regulation (Note1)	Regload	T_J =+25 °C	I_O = 5mA to 1.5A	-	15	360	mV
			I_O = 250mA to 750mA	-	5.0	180	
Quiescent Current	I_Q	T_J =+25 °C		-	5.2	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	-	0.5	mA
		V_I = 21V to 33V		-	-	1	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O = 5mA		-	-1	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A =+25 °C		-	110	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_I = 22V to 32V		53	69	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J=+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	22	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A=+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J =+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7824)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I =33V, C_I= 0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7824			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		23	24	25	V
		5.0mA ≤ I_O ≤ 1.0A, P_O ≤ 15W V_I = 27V to 38V		22.8	24	25.25	
Line Regulation (Note1)	Regline	T_J =+25 °C	V_I = 27V to 38V	-	17	480	mV
			V_I = 30V to 36V	-	6	240	
Load Regulation (Note1)	Regload	T_J =+25 °C	I_O = 5mA to 1.5A	-	15	480	mV
			I_O = 250mA to 750mA	-	5.0	240	
Quiescent Current	I_Q	T_J =+25 °C		-	5.2	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	0.1	0.5	mA
		V_I = 27V to 38V		-	0.5	1	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O = 5mA		-	-1.5	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A =+25 °C		-	60	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_I = 28V to 38V		50	67	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J=+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	28	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A=+25 °C		-	230	-	mA
Peak Current	I_{PK}	T_J =+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7805A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I = 10V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25 °C		4.9	5	5.1	V
		I_O = 5mA to 1A, P_O ≤ 15W V_I = 7.5V to 20V		4.8	5	5.2	
Line Regulation (Note1)	Regline	V_I = 7.5V to 25V I_O = 500mA		-	5	50	mV
		V_I = 8V to 12V		-	3	50	
		T_J =+25 °C	V_I= 7.3V to 20V	-	5	50	
			V_I= 8V to 12V	-	1.5	25	
Load Regulation (Note1)	Regload	T_J =+25 °C I_O = 5mA to 1.5A		-	9	100	mV
		I_O = 5mA to 1A		-	9	100	
		I_O = 250mA to 750mA		-	4	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.0	6	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		-	-	0.5	mA
		V_I = 8 V to 25V, I_O = 500mA		-	-	0.8	
		V_I = 7.5V to 20V, T_J =+25 °C		-	-	0.8	
Output Voltage Drift	$\Delta V/\Delta T$	Io = 5mA		-	-0.8	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A =+25 °C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 8V to 18V		-	68	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	17	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J= +25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7806A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I =11V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25 °C		5.58	6	6.12	V
		I_O = 5mA to 1A, P_O ≤ 15W V_I = 8.6V to 21V		5.76	6	6.24	
Line Regulation (Note1)	Regline	V_I= 8.6V to 25V I_O = 500mA		-	5	60	mV
		V_I= 9V to 13V		-	3	60	
		T_J =+25 °C	V_I= 8.3V to 21V	-	5	60	
			V_I= 9V to 13V	-	1.5	30	
Load Regulation (Note1)	Regload	T_J =+25 °C I_O = 5mA to 1.5A		-	9	100	mV
		I_O = 5mA to 1A		-	4	100	
		I_O = 250mA to 750mA		-	5.0	50	
Quiescent Current	I_Q	T_J =+25 °C		-	4.3	6	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		-	-	0.5	mA
		V_I = 9V to 25V, I_O = 500mA		-	-	0.8	
		V_I= 8.5V to 21V, T_J =+25 °C		-	-	0.8	
Output Voltage Drift	$\Delta V/\Delta T$	I_O = 5mA		-	-0.8	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A =+25 °C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 9V to 19V		-	65	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	17	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J=+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7808A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I = 14V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25 °C		7.84	8	8.16	V
		I_O = 5mA to 1A, P_O ≤15W V_I = 10.6V to 23V		7.7	8	8.3	
Line Regulation (Note1)	Regline	V_I= 10.6V to 25V I_O = 500mA		-	6	80	mV
		V_I= 11V to 17V		-	3	80	
		T_J =+25 °C	V_I= 10.4V to 23V	-	6	80	
			V_I= 11V to 17V	-	2	40	
Load Regulation (Note1)	Regload	T_J =+25 °C I_O = 5mA to 1.5A		-	12	100	mV
		I_O = 5mA to 1A		-	12	100	
		I_O = 250mA to 750mA		-	5	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.0	6	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1A		-	-	0.5	mA
		V_I = 11V to 25V, I_O = 500mA		-	-	0.8	
		V_I= 10.6V to 23V, T_J =+25 °C		-	-	0.8	
Output Voltage Drift	$\Delta V/\Delta T$	I_O = 5mA		-	-0.8	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A =+25 °C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 11.5V to 21.5V		-	62	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	18	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J=+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7809A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I = 15V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25°C		8.82	9.0	9.18	V
		I_O = 5mA to 1A, P_O≤15W V_I = 11.2V to 24V		8.65	9.0	9.35	
Line Regulation (Note1)	Regline	V_I= 11.7V to 25V I_O = 500mA		-	6	90	mV
		V_I= 12.5V to 19V		-	4	45	
		T_J =+25°C	V_I= 11.5V to 24V	-	6	90	
			V_I= 12.5V to 19V	-	2	45	
Load Regulation (Note1)	Regload	T_J =+25°C I_O = 5mA to 1.0A		-	12	100	mV
		I_O = 5mA to 1.0A		-	12	100	
		I_O = 250mA to 750mA		-	5	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.0	6.0	mA
Quiescent Current Change	ΔI_Q	V_I = 11.7V to 25V, T_J=+25 °C		-	-	0.8	mA
		V_I = 12V to 25V, I_O = 500mA		-	-	0.8	
		I_O = 5mA to 1.0A		-	-	0.5	
Output Voltage Drift	$\Delta V/\Delta T$	I_O = 5mA		-	-1.0	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A =+25 °C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 12V to 22V		-	62	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2.0	-	V
Output Resistance	r_O	f = 1KHz		-	17	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J=+25°C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant, junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7810A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I = 16V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25°C		9.8	10	10.2	V
		I_O = 5mA to 1A, $P_O \leq$ 15W V_I =12.8V to 25V		9.6	10	10.4	
Line Regulation (Note1)	Regline	V_I= 12.8V to 26V I_O = 500mA		-	8	100	mV
		V_I= 13V to 20V		-	4	50	
		T_J =+25°C	V_I= 12.5V to 25V	-	8	100	
			V_I= 13V to 20V	-	3	50	
Load Regulation (Note1)	Regload	T_J =+25°C I_O = 5mA to 1.5A		-	12	100	mV
		I_O = 5mA to 1.0A		-	12	100	
		I_O = 250mA to 750mA		-	5	50	
Quiescent Current	I_Q	T_J =+25°C		-	5.0	6.0	mA
Quiescent Current Change	ΔI_Q	V_I = 13V to 26V, T_J=+25°C		-	-	0.5	mA
		V_I = 12.8V to 25V, I_O = 500mA		-	-	0.8	
		I_O = 5mA to 1.0A		-	-	0.5	
Output Voltage Drift	$\Delta V/\Delta T$	I_O = 5mA		-	-1.0	-	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A =+25°C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 14V to 24V		-	62	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25°C		-	2.0	-	V
Output Resistance	r_O	f = 1KHz		-	17	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25°C		-	250	-	mA
Peak Current	I_{PK}	T_J=+25°C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7812A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I = 19V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25 °C		11.75	12	12.25	V
		I_O = 5mA to 1A, P_O ≤15W V_I = 14.8V to 27V		11.5	12	12.5	
Line Regulation (Note1)	Regline	V_I= 14.8V to 30V I_O = 500mA		-	10	120	mV
		V_I= 16V to 22V		-	4	120	
		T_J =+25 °C	V_I= 14.5V to 27V	-	10	120	
			V_I= 16V to 22V	-	3	60	
Load Regulation (Note1)	Regload	T_J =+25 °C I_O = 5mA to 1.5A		-	12	100	mV
		I_O = 5mA to 1.0A		-	12	100	
		I_O = 250mA to 750mA		-	5	50	
Quiescent Current	I_Q	T_J =+25°C		-	5.1	6.0	mA
Quiescent Current Change	ΔI_Q	V_I = 15V to 30V, T_J=+25 °C		-		0.8	mA
		V_I = 14V to 27V, I_O = 500mA		-		0.8	
		I_O = 5mA to 1.0A		-		0.5	
Output Voltage Drift	$\Delta V/\Delta T$	I_O = 5mA		-	-1.0	-	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A =+25°C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 14V to 24V		-	60	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25°C		-	2.0	-	V
Output Resistance	r_O	f = 1KHz		-	18	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J=+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7815A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I =23V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25 °C		14.7	15	15.3	V
		I_O = 5mA to 1A, P_O ≤15W V_I = 17.7V to 30V		14.4	15	15.6	
Line Regulation (Note1)	Regline	V_I= 17.9V to 30V I_O = 500mA		-	10	150	mV
		V_I= 20V to 26V		-	5	150	
		T_J =+25°C	V_I= 17.5V to 30V	-	11	150	
			V_I= 20V to 26V	-	3	75	
Load Regulation (Note1)	Regload	T_J =+25 °C I_O = 5mA to 1.5A		-	12	100	mV
		I_O = 5mA to 1.0A		-	12	100	
		I_O = 250mA to 750mA		-	5	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.2	6.0	mA
Quiescent Current Change	ΔI_Q	V_I = 17.5V to 30V, T_J =+25 °C		-	-	0.8	mA
		V_I = 17.5V to 30V, I_O = 500mA		-	-	0.8	
		I_O = 5mA to 1.0A		-	-	0.5	
Output Voltage Drift	$\Delta V/\Delta T$	I_O = 5mA		-	-1.0	-	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A =+25 °C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 18.5V to 28.5V		-	58	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2.0	-	V
Output Resistance	r_O	f = 1KHz		-	19	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J=+25°C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7818A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I = 27V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25 °C		17.64	18	18.36	V
		I_O = 5mA to 1A, P_O ≤15W V_I = 21V to 33V		17.3	18	18.7	
Line Regulation (Note1)	Regline	V_I= 21V to 33V I_O = 500mA		-	15	180	mV
		V_I= 21V to 33V		-	5	180	
		T_J =+25 °C	V_I= 20.6V to 33V	-	15	180	
			V_I= 24V to 30V	-	5	90	
Load Regulation (Note1)	Regload	T_J =+25°C I_O = 5mA to 1.5A		-	15	100	mV
		I_O = 5mA to 1.0A		-	15	100	
		I_O = 250mA to 750mA		-	7	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.2	6.0	mA
Quiescent Current Change	ΔI_Q	V_I = 21V to 33V, T_J=+25 °C		-	-	0.8	mA
		V_I = 21V to 33V, I_O = 500mA		-	-	0.8	
		I_O = 5mA to 1.0A		-	-	0.5	
Output Voltage Drift	$\Delta V/\Delta T$	I_O = 5mA		-	-1.0	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A =+25°C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 22V to 32V		-	57	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25°C		-	2.0	-	V
Output Resistance	r_O	f = 1KHz		-	19	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25°C		-	250	-	mA
Peak Current	I_{PK}	T_J=+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Change in V_O due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Electrical Characteristics (MC7824A)

(Refer to the test circuits. 0°C < T_J < 125°C, I_O =1A, V_I = 33V, C_I=0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25 °C		23.5	24	24.5	V
		I_O = 5mA to 1A, P_O ≤15W V_I = 27.3V to 38V		23	24	25	
Line Regulation (Note1)	Regline	V_I= 27V to 38V I_O = 500mA		-	18	240	mV
		V_I= 21V to 33V		-	6	240	
		T_J =+25 °C	V_I= 26.7V to 38V	-	18	240	
			V_I= 30V to 36V	-	6	120	
Load Regulation (Note1)	Regload	T_J =+25 °C I_O = 5mA to 1.5A		-	15	100	mV
		I_O = 5mA to 1.0A		-	15	100	
		I_O = 250mA to 750mA		-	7	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.2	6.0	mA
Quiescent Current Change	ΔI_Q	V_I = 27.3V to 38V, T_J =+25 °C		-	-	0.8	mA
		V_I = 27.3V to 38V, I_O = 500mA		-	-	0.8	
		I_O = 5mA to 1.0A		-	-	0.5	
Output Voltage Drift	$\Delta V/\Delta T$	I_O = 5mA		-	-1.5	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz T_A = 25 °C		-	10	-	μV/Vo
Ripple Rejection	RR	f = 120Hz, I_O = 500mA V_I = 28V to 38V		-	54	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2.0	-	V
Output Resistance	r_O	f = 1KHz		-	20	-	mΩ
Short Circuit Current	I_{SC}	V_I= 35V, T_A =+25 °C		-	250	-	mA
Peak Current	I_{PK}	T_J=+25 °C		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Change in VO due to heating effects must be taken into account separately. Pulse testing with low duty is used.

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Shenzhen Quark Technology Co. Ltd.
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Typical Perfomance Characteristics

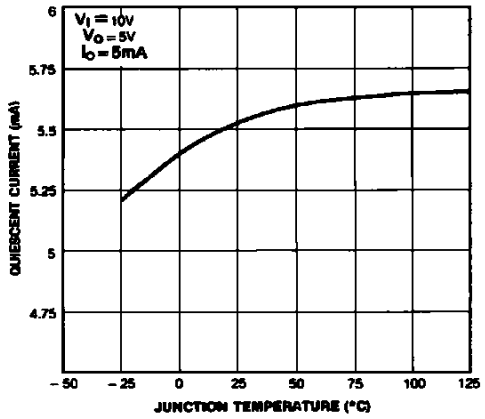


Figure 1. Quiescent Current

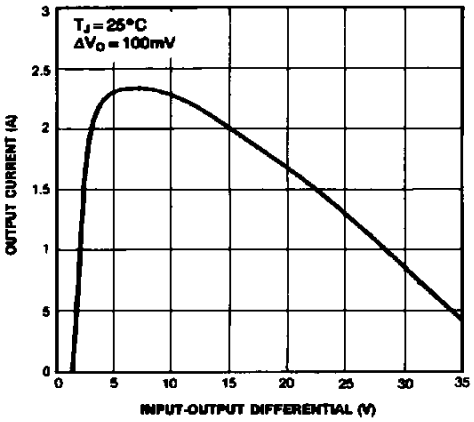


Figure 2. Peak Output Current

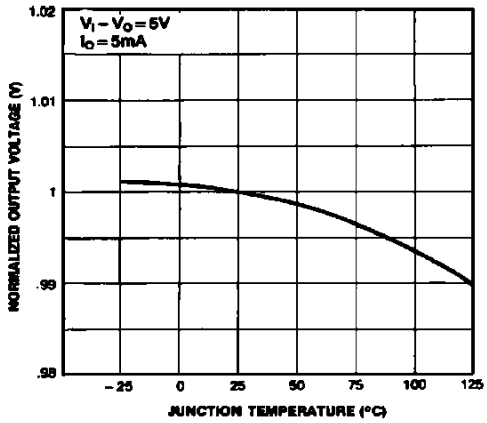


Figure 3. Output Voltage

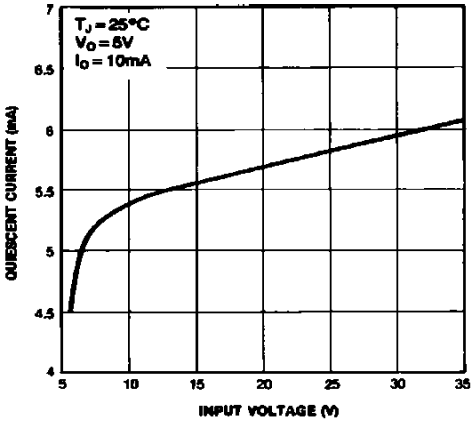


Figure 4. Quiescent Current

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Typical Applications

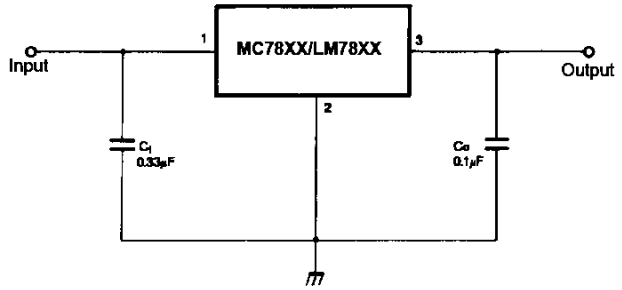


Figure 5. DC Parameters

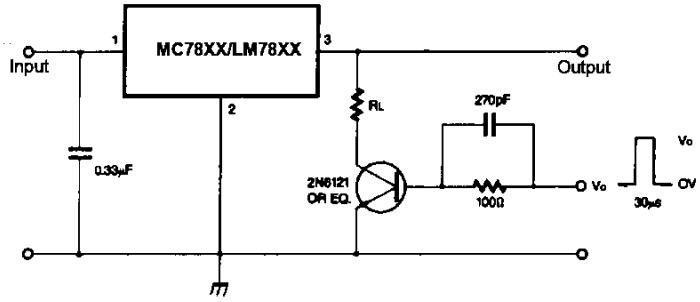


Figure 6. Load Regulation

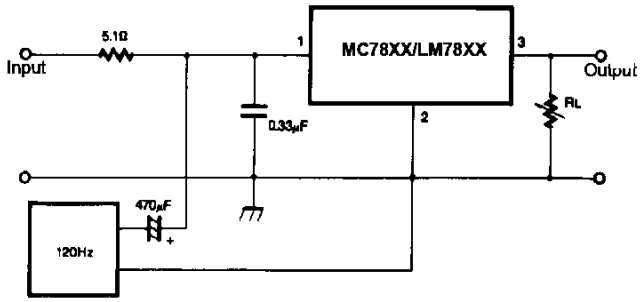


Figure 7. Ripple Rejection

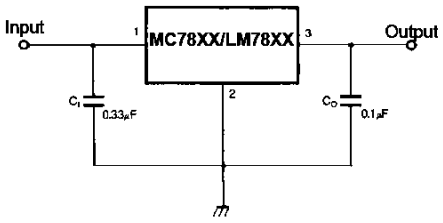
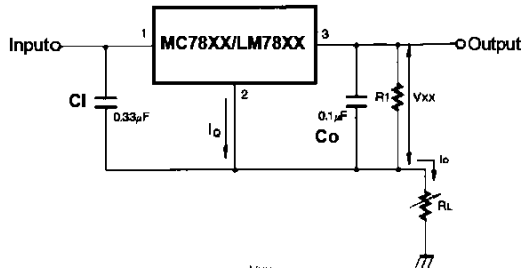


Figure 8. Fixed Output Regulator

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$$I_O = \frac{V_{XX}}{R_1} + I_Q$$

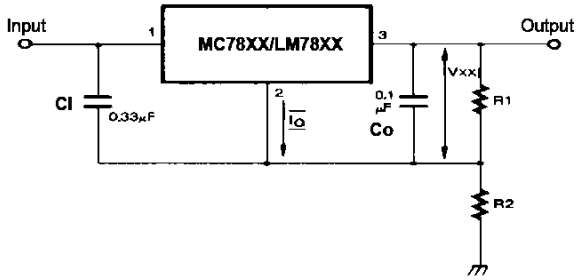
Figure 9. Constant Current Regulator

Notes:

(1) To specify an output voltage. substitute voltage value for "XX." A common ground is required between the input and the Output voltage. The input voltage must remain typically 2.0V above the output voltage even during the low point on the input ripple voltage.

(2) C_I is required if regulator is located an appreciable distance from power Supply filter.

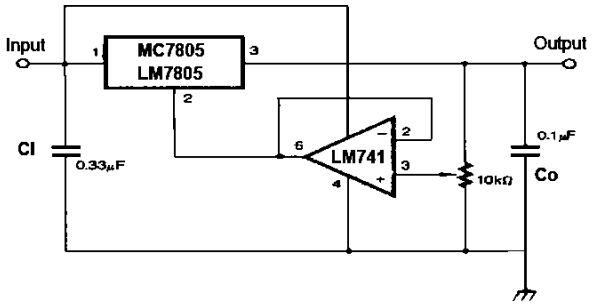
(3) C_O improves stability and transient response.



$$I_{RI} \geq 5IQ$$

$$V_O = V_{XX}(1+R_2/R_1)+I_QR_2$$

Figure 10. Circuit for Increasing Output Voltage



$$I_{RI} \geq 5\ I_Q$$

$$V_O = V_{XX}(1+R_2/R_1)+I_QR_2$$

Figure 11. Adjustable Output Regulator (7 to 30V)

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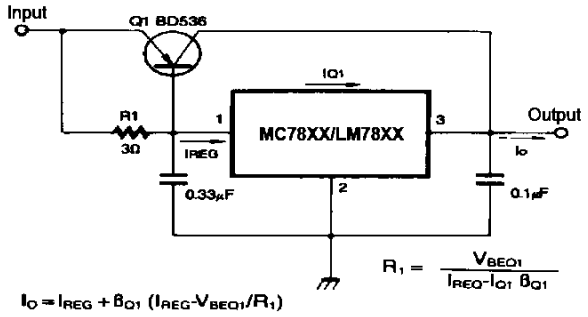


Figure 12. High Current Voltage Regulator

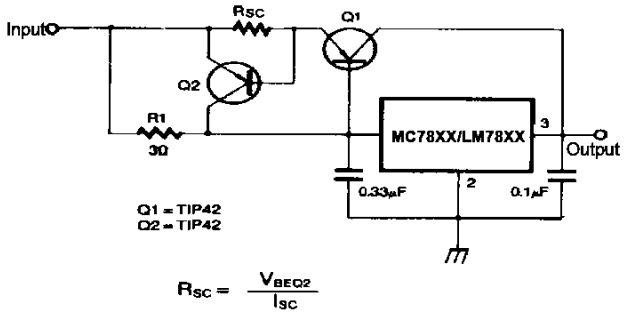


Figure 13. High Output Current with Short Circuit Protection

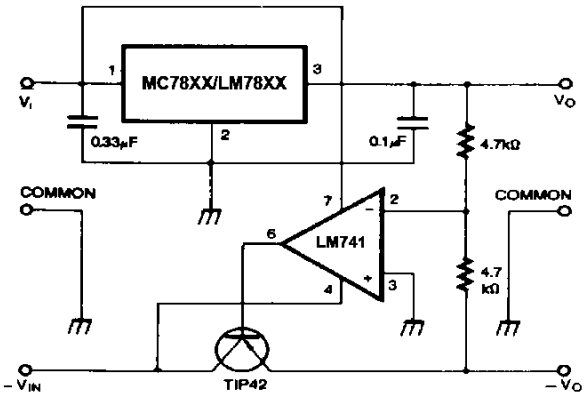


Figure 14. Tracking Voltage Regulator

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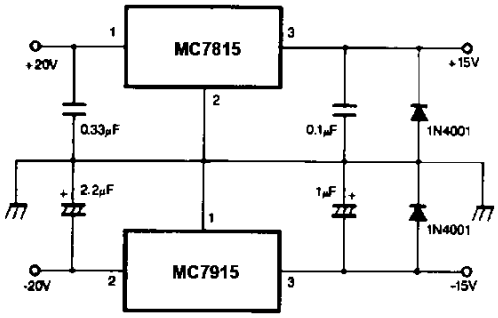


Figure 15. Split Power Supply (±15V-1A)

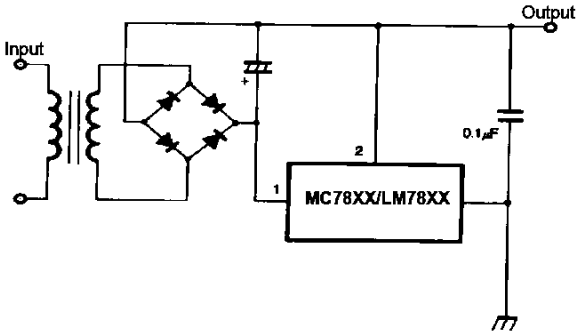


Figure 16. Negative Output Voltage Circuit

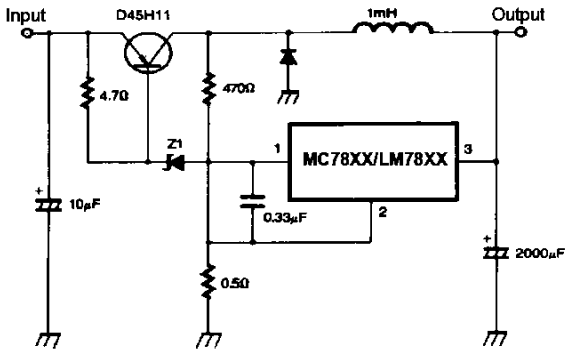


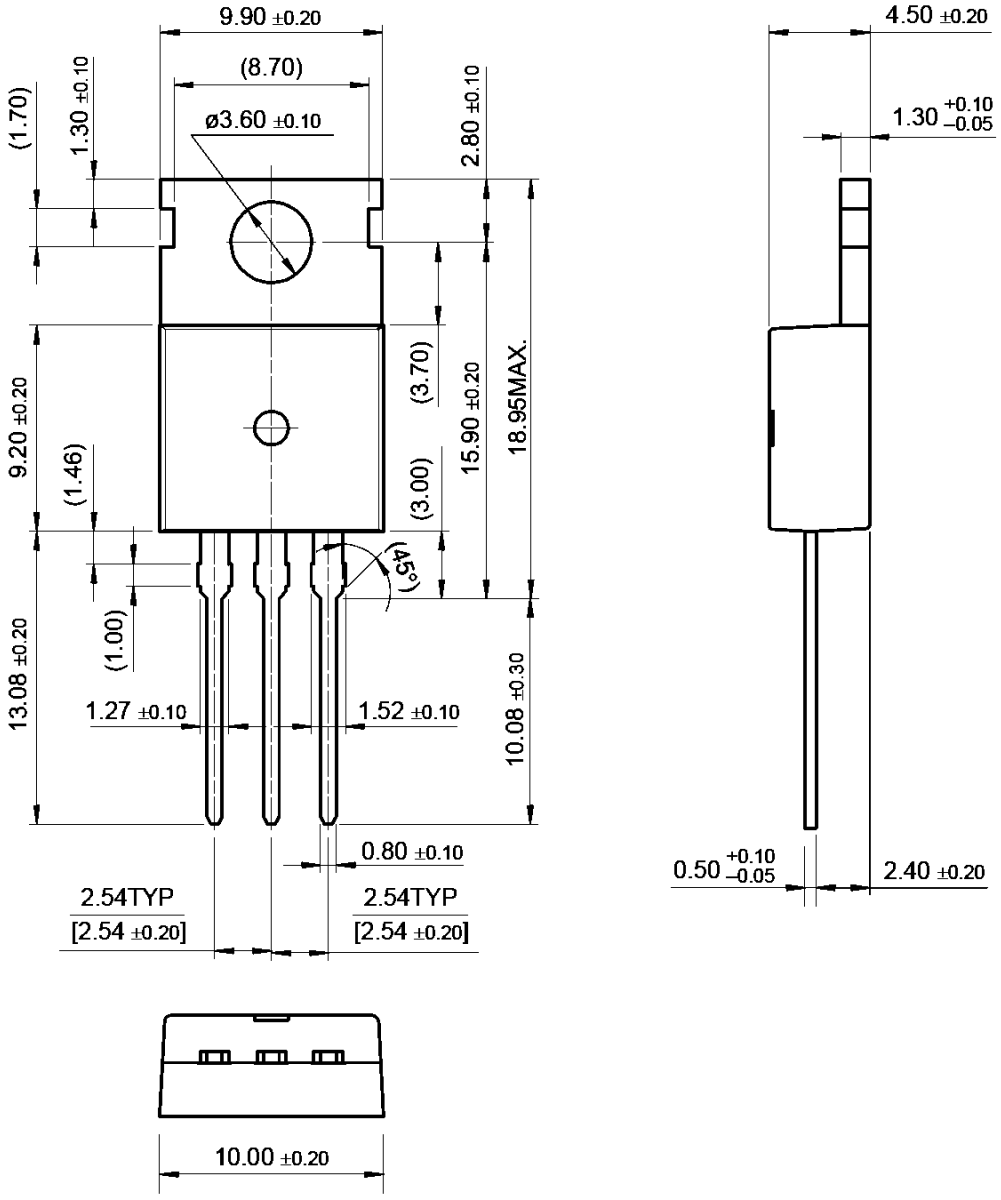
Figure 17. Switching Regulator

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Mechanical Dimensions

Package

TO-220

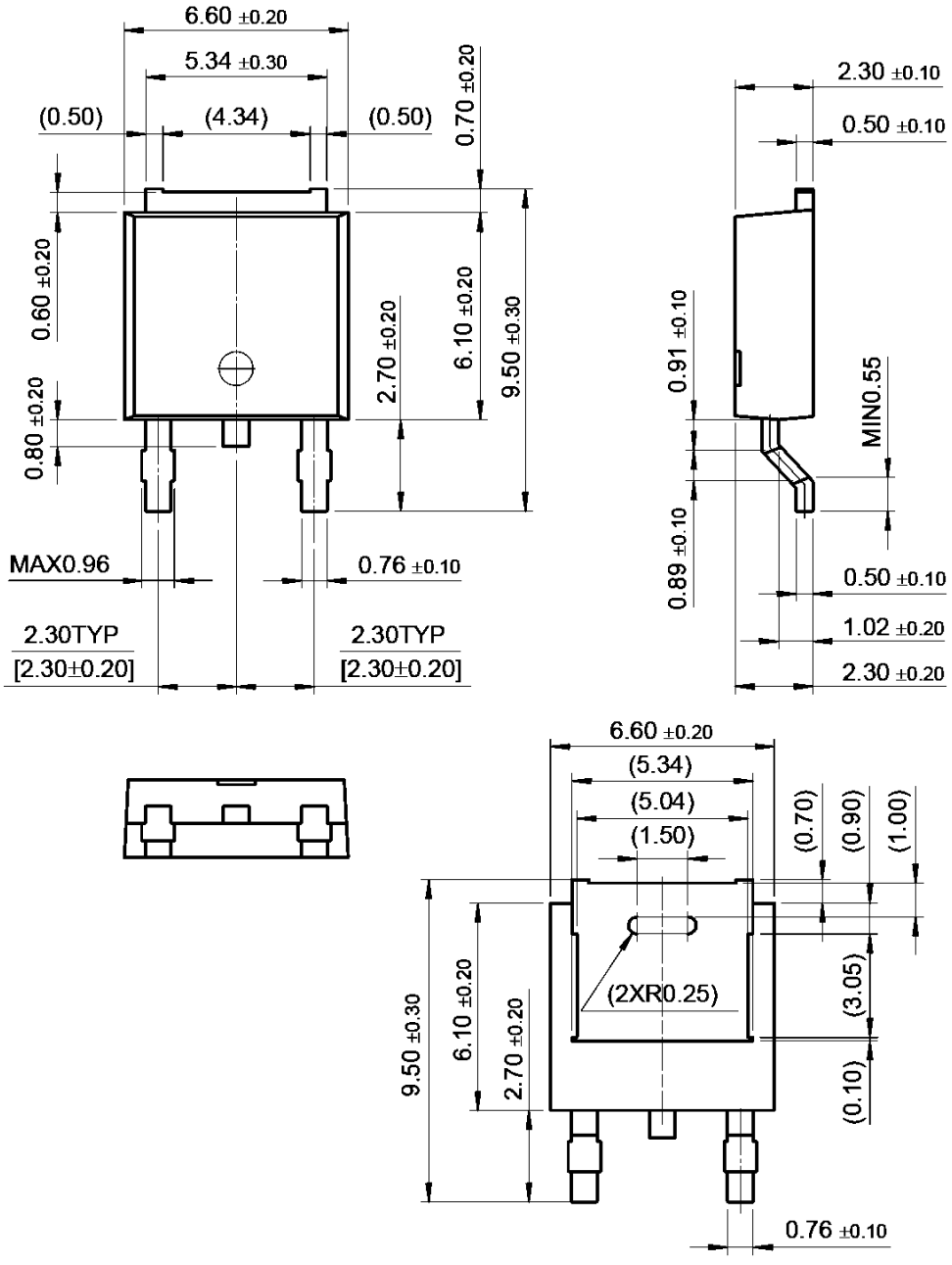


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Mechancal Dimensions (Continued)

Package

D-PAK



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Ordering Information

Product Number	Output Voltage Tolerance	Package	Operating Temperature
LM7805CT	±4%	TO-220	0 ~ + 125°C

Product Number	Output Voltage Tolerance	Package	Operating Temperature
MC7805CT	±4%	TO-220	0 ~ + 125°C
MC7806CT			
MC7808CT			
MC7809CT			
MC7810CT			
MC7812CT			
MC7815CT			
MC7818CT			
MC7824CT			
MC7805CDT		D-PAK	
MC7806CDT			
MC7808CDT			
MC7809CDT			
MC7810CDT			
MC7812CDT			
MC7805ACT	±2%	TO-220	
MC7806ACT			
MC7808ACT			
MC7809ACT			
MC7810ACT			
MC7812ACT			
MC7815ACT			
MC7818ACT			
MC7824ACT			

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IPR2025-00885 Page 0028

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Northern District of Ohio, Eastern Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
1:17-cv-02205	10/19/2017	for the Northern District of Ohio, Eastern Division

PLAINTIFF	DEFENDANT
The NOCO Company, Inc.	Shenzhen Anband Technology Co., Ltd.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	9,007,015	4/14/2015	The NOCO Company
2			
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16819831
Filing Date	2020-03-16
First Named Inventor	Jonathan Lewis NOOK
Art Unit	2859
Examiner Name	M. Baye DIAO
Attorney Docket Number	054985-000055-US-02-01

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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IPR2025-00885

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	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Jonathan Lewis NOOK
	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

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	49	D726109	S	2015-04-07	Nook ET AL.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16819831
	Filing Date	2020-03-16
	First Named Inventor	Jonathan Lewis NOOK
	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

	53	D746774	S	2016-01-05	Nook ET AL.	

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	1	20020041174	A1	2002-04-11	PURKEY	
	2	20040066168	A1	2004-04-08	GEORGE ET AL.	
	3	20040130298	A1	2004-07-08	KRIEGER ET AL.	
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	10	20110068734	A1	2011-03-24	WALDRON	
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	12	20120319487	A1	2012-12-20	SHAH	
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	23	20180342891	A1	2018-11-29	NOOK ET AL.	
	24	20180345803	A1	2018-12-06	NOOK ET AL.	
	25	20190308518	A1	2019-10-10	NOOK ET AL.	

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	1	2015258229	AU	A1	2016-01-28	THE NOCO COMPANY		
	2	2016269555	AU	B2	2017-01-05	THE NOCO COMPANY		
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	10	107852004	CN	A	2018-03-27	THE NOCO COMPANY		☒
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	Attorney Docket Number	054985-000055-US-02-01

	15	202009016260	DE	U1	2010-03-25	TSAI MING WEI		☐
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	25	2018536789	JP	A	2018-12-13	THE NOCO COMPANY		☒

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	Attorney Docket Number	054985-000055-US-02-01

	26	2004036714	WO	A1	2004-04-29	VECTOR PRODUCTS, INC.		☐
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	1	copy of the Petition for Inter Partes Review of US Patent No. 9,007,015; 49 pages; filed January 15, 2018.	
	2	copy of Report on the filing or determination of an action regarding a patent; U.S. Patent 9,007,015; issued on October 23, 2018; 1 page	
	3	copy of Report on the filing or determination of an action regarding a patent; U.S. Patent 9,007,015; issued on September 21, 2018; 1 page	

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	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

	4	copy of Report on the filing or determination of an action regarding a patent; U.S. Patent 9,007,015; issued on February 27, 2018; 1 page
	5	copy of Report on the filing or determination of an action regarding a patent; U.S. Patent 9,007,015; issued on December 5, 2017; 1 page
	6	PROJECTA; "2x22 Amp Hour High Performance Jumpstarter"; 2013; pages 1-20

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/William L. Klima/	Date (YYYY-MM-DD)	2020-07-23
Name/Print	William L. Klima	Registration Number	32422

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SHENZHEN CARKU TECHNOLOGY CO., LTD.,

Petitioner,

v.

THE NOCO COMPANY,

Patent Owner.

U.S. Patent No. 9,007,015

PETITION

for *Inter Partes* Review

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Statutes

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Regulations

37 C.F.R. §42.104(a) 93

37 C.F.R. §42.15(a) 97

37 C.F.R §42.100(b) 12

PETITIONER'S LIST OF EXHIBITS

Exhibit No.	Description
1001	U.S. Patent No. 9,007,015 ("the '015 patent)
1002	Declaration Of James L. Kirtley Jr., Ph.D.
1003	Prosecution History of Application No. 14/325,938 ("the '938 application")
1004	PTAB Decision Denying Institution of Inter Partes Review of the '015 patent in Case IPR2018-00503 ("Dongguan IPR")
1005	Special Master Report On Proposed Claim Construction For U.S. Patent No. 9,007,015 issued in NOCO Co. v. Shenzhen Dika Na'Er E-Commerce Co., Case No.1:17CV2282 (N.D. Ohio Jun. 28, 2018) accepted and adopted by United States District Court Judge Christopher A. Boyko, 2019 WL 1723358 ("Shenzhen Dika Order")
1006	U.S. Patent Application Publication No. 2013/0154543 ("Richardson")
1007	U.S. Patent No. 6,424,158 ("Klang")
1008	U.S. Patent No. 9,954,391 ("Lei")
1009	U.S. Patent Application Publication No. US 2004/0130298 ("Krieger")
1010	U.S. Patent No. 5,319,298 ("Wanzong")

1011	WO Publication No. 2010/129723 to Baxter ("Baxter");
1012	Carku Product Brochure for the Epower-20 jump starter product ("Epower-20 brochure")
1013	Carku Product Brochure for the Epower-21 jump starter product ("Epower-21 brochure")
1014	U.S. Patent No. 8,172,603 ("Richardet")
1015	MC78XX/LM78XX/MC78XXA 3-Terminal 1A Positive Voltage Regulator from Fairchild Semiconductor Corporation 2001 ("LM7805 Datasheet")
1016	Patent Owner The NOCO Company's Preliminary Response in the Dongguan IPR
1017	Memorandum Opinion and Order of United States District Court Judge Pamela A. Barker construing the disputed terms of claims 1, 9 and 19 of the '015 patent issued in The NOCO Co. v. SmarTech Products, Inc., Case No. 1:18-cv-2780 (N.D. Ohio April 16, 2020) ("SmarTech Order")
1018	Declaration Of Yingchun Wan

I. INTRODUCTION

1. Shenzhen Carku Technology Co., Ltd. ("Petitioner" or "Carku") petitions for *inter partes* review ("IPR") of claims 1-23 (the "Challenged Claims") of U.S. Patent No. 9,007,015 (the ""015 patent") (Ex. 1001) assigned to The NOCO Company ("Patent Owner"). This petition demonstrates that there is a reasonable likelihood that Petitioner will prevail on at least one of the Challenged Claims on the Grounds set forth herein.

II. BACKGROUND

A. The '015 patent

2. The '015 patent discloses an apparatus for jump starting a vehicle engine. Many such apparatus were known prior to the '015 patent's July 3, 2014 priority date. The '015 patent broadly claims conventional elements of jump starter apparatus such as an internal power supply, an output port, a microcontroller, a power switch, a vehicle battery isolation sensor, and a reverse polarity sensor. Ex. 1001, 8:6-23. The vehicle battery isolation sensor detects whether the jump starter apparatus is connected to the vehicle battery terminals (i.e., whether the vehicle battery is present or absent). Ex. 1001, 5:26-37, 41-46. The reverse polarity sensor ascertains whether the jump starter apparatus is connected to the vehicle battery with proper polarity (i.e., whether the negative and positive terminals of the

output port of the jump starter apparatus are connected to the correct respective terminals of the vehicle battery, or whether the connections are reversed.) Ex. 1001, 5:16-26, 39-41.

3. Both the vehicle battery isolation sensor and the reverse polarity sensor were used as safety features in conventional jump starter devices before the July 3, 2014 priority date of the '015 patent as will be discussed below.

4. The purported point of novelty of the '015 patent is that the vehicle battery isolation sensor is *separate* from the reverse polarity sensor, and that the microcontroller receives *distinct* signals from the two sensors and closes the power switch only when the sensors indicate that the vehicle battery is present and that the vehicle battery has been connected with a correct polarity. The purported novelty thus is that the claim requires *redundant* conventional components performing their conventional functions.[1] This should not be patentable. In any event, as discussed below, the redundancy is also disclosed in the prior art.

[1] Patent Owner discussed this purported point of novelty in its Preliminary Response in the Dongguan IPR: "Claim 1 of the '015 patent, therefore, has

5. The dependent claims of the '015 patent also cover concepts that were known before the '015 patent priority date. The concepts include other safety features such as circuitry preventing back charging and for detecting the temperature of the internal battery of the jump starter (claims 6-7). Other dependent claims cover convenience features such as a USB port for charging USB-chargeable devices, a flashlight, a visual alarm indicating an emergency situation, or visual indicators on the internal power supply capacity (claims 10, 12, 14, and 15). All these features were known before the priority date of the '015 patent. In fact, several claimed features including the USB port, flashlight, visual alarm, and battery capacity indicator features were disclosed by Carku to Jonathan Nook of Patent Owner NOCO, an inventor of the '015 patent, before the July 3, 2014 priority date of the '015 patent. Among other things, Carku sent an email to Nook on or about December 22, 2013 attaching a catalog of products offered

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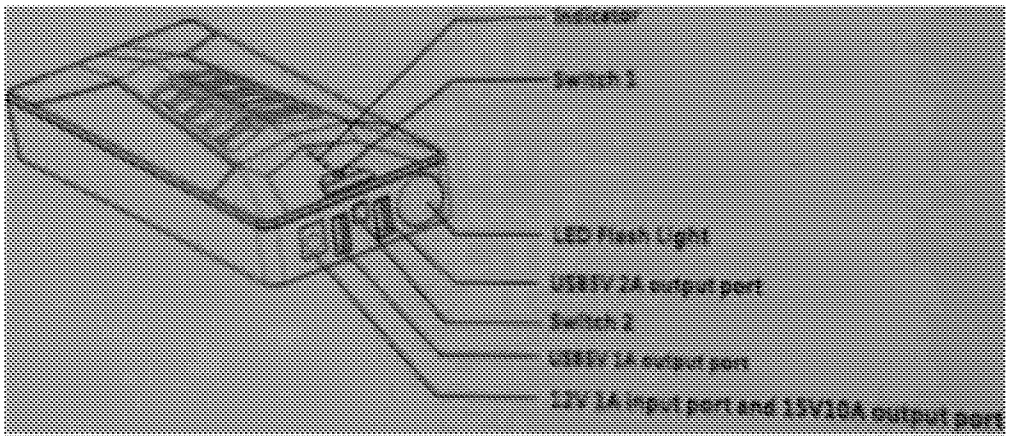
in essence a redundancy feature through which, unless the inputs from two separate sensors indicate that a battery is both present and connected with the proper polarity, the power switch will not be turned on, and the charging operation will never commence." Ex. 1016 at 4.

for sale from Carku. Ex. 1018 at 6. The catalog showed various available Carku jump starter products, including the product below, showing claimed features.



Ex. 1018 at 84

6. Carku also sent an email to Nook on March 5, 2014, enclosing Carku's brochure for the Epower-20B product also showing various claimed features. Ex. 1018 at 8.



Ex. 1018 at 33

7. The Patent Owner (with Nook listed as first inventor) later filed the patent application for the '015 patent claiming these features without disclosing Carku's prior art catalog or brochure to the examiner during prosecution, even though it was known to at least inventor Nook, and was likely the closest information he knew applying to several pending claims.

8. Other dependent claims in the '015 patent include widely known components such as lithium ion batteries or a plurality of such batteries as the power source (claims 2-3).

9. In short, none of the concepts in the Challenged Claims was new before July 3, 2014. These concepts were known before that date from at least Richardson, Klang, Lei, Wanzong, Krieger, Carku catalogs and brochures, and other references discussed in detail below.

B. Prosecution History of the '015 patent

10. The '015 patent issued from Application No. 14/325,938 ("'938 application") filed on July 8, 2014 as a continuation of PCT/US2014/045434 filed on July 3, 2014. Ex. 1001 at 1.

11. The '938 application was filed with a prioritized examination request granted on September 2, 2014. Ex. 1003 at 215.

12. An office action was issued on October 30, 2014. The examiner allowed claims 1-23, but rejected claims 24-26 as being anticipated by US2012/0091944, US2007/0285049, and US8,172,603. Ex. 1003 at 120. Applicant responded by cancelling claims 24-26. Ex. 1003 at 110.

13. Another office action was issued on December 10, 2014. The examiner rejected claims 1, 4-6, 8, 9, and 12-18 as anticipated by US2005/0110467 ("Thomason"). Claims 2, 3, 10, and 11 were rejected as unpatentable over Thomason and US2013/0241488; claims 7, 19, and 20 were rejected over Thomason and US6,362,599; and claims 21-23 were rejected over Thomason and US2007/0285049. Ex. 1003 at 48.

14. In response, the Patent Owner amended claim 1 to specify that the reverse polarity sensor is configured to "to provide an output signal indicating whether positive and negative terminals of said vehicle battery are

properly connected with said positive and negative polarity outputs of said output port." The claim was also amended to specify that the power switch "is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs." Additionally, the term "FET" relating to the power switch was deleted. Ex. 1003 at 37.

15. The examiner issued a Notice of Allowance on February 10, 2015. Ex. 1003 at 14. The '015 patent issued on April 14, 2015. Ex. 1001 at 1.

16. The'015 patent contains one independent claim (claim 1) and 22 dependent claims. Ex. 1001, 8:4-10:22.

III. SUMMARY OF CHALLENGES AND RELIEF REQUESTED

17. Petitioner asserts the following challenges supported by expert testimony of James L. Kirtley Jr. (Ex. 1002):

Ground	Reference(s)	Basis	Claims Challenged
1	Richardson	§102(a)	1, 7-9, 15, and 17-21
2	Richardson and Lei	§103	2, 3, 12-14, and 23
3	Richardson and Krieger	§103	4 and 5
4	Richardson and Wanzong	§103	6
5	Richardson and Baxter	§103	16
6	Richardson and the Epower-20 brochure or the Epower-21 brochure	§103	10-13
7	Richardson and Richardet	§103	22
8	Klang	§102(a)	1, 17, and 21
9	Klang and Krieger	§103	4 and 5
10	Klang and Richardet	§103	22
11	Klang and Lei	§103	23

18. Petitioner requests that the Board cancel claims 1-23 of the '015 patent because they are anticipated under 35 U.S.C. §102(a) and/or obvious under 35 U.S.C. §103 from the asserted prior art.

IV. PERSON OF ORDINARY SKILL IN THE ART

19. A person of ordinary skill in the art ("POSITA") in the relevant timeframe (before July 3, 2014) would have had a minimum of a bachelor's degree in electrical engineering or its equivalent and two years of experience in electrical engineering with some experience in design of battery charging systems. In lieu of a degree, a POSITA could be one whose equivalent accumulated knowledge and experience in the field of electrical engineering and specifically battery charging system design makes him or her a POSITA. Additional graduate education could substitute for professional experience, or significant experience in the field could substitute for formal education. Ex. 1002, ¶14.

V. CLAIM CONSTRUCTION

20. In an IPR, claim terms are given their "broadest reasonable construction in light of the specification of the patent in which it appears." *See* 37 C.F.R. §42.100(b). Under this broadest reasonable construction standard, claim terms generally are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

21. Petitioner proposes the constructions below.[2] All other claim terms should be given their plain and ordinary meaning.

22. Petitioner's claim constructions are the same as the constructions made in the Shenzhen Dika Order (Ex. 1005 at 14-15) and the SmarTech Order (Ex. 1017 at 20-31).

[2] Because standards applied during IPR are different than those in litigation, Petitioner reserves all rights to advocate additional and/or different claim interpretations in any litigation or any other proceeding in accordance with the claim construction standards in such proceedings. Petitioner further reserves the right to assert that the Challenged Claims are invalid under provisions for which IPR is not available.

Term or Phrase	Construction
"reverse polarity sensor" (The SmarTech Order construed "reverse polarity sensor connected in circuit")	A reverse polarity sensor separate from the vehicle battery isolation sensor
"vehicle battery isolation sensor" (The SmarTech Order construed "vehicle battery isolation sensor connected in circuit")	A vehicle battery isolation sensor separate from the reverse polarity sensor
"input signals from said vehicle isolation sensor and said reverse polarity sensor"	Distinct input signals from said vehicle isolation sensor and said reverse polarity sensor, respectively
"output port"	Component through which power from an internal power supply is transmitted

VI. SPECIFIC GROUNDS FOR PETITION

A. Ground 1: Claims 1, 7-9, 15, and 17-21 are anticipated by Richardson

1. Overview of Richardson

23. Richardson is prior art under 35 U.S.C. §102(a) based on its June 20, 2013 publication date. Richardson was cited during prosecution of the '938 application, but was not the basis of any claim rejection.

24. Richardson discloses a portable supplemental power source or jump starter that provides "supplemental power to start internal combustion and turbine engines." Ex. 1006, ¶0002. It includes safety features such as a polarity protection circuit such that "only if the proper polarity is detected can the system operate." Ex. 1006, ¶0007. It also includes separate circuits for detecting the presence of a vehicle battery and whether the battery is connected with reverse polarity, temperature measurements of the internal battery, and other features that are more advanced than described in the '015 patent. Ex. 1002, ¶59.

2. Richardson anticipates Claim 1

25. Each limitation of claim 1 is disclosed by Richardson as discussed below.

(a) "Apparatus for jump starting a vehicle engine"

26. To the extent the preamble is limiting, Richardson discloses an apparatus for jump starting a vehicle engine. "The present invention relates to a portable power source for a motor vehicle and, more particularly, to a method and apparatus to provide supplemental power to start internal combustion and turbine engines." Ex. 1006, ¶0002. "The system includes one or more internal batteries and capacitors to provide the power to the battery of the vehicle to be jump started." Ex. 1006, ¶0007.

(b) "an internal power supply"

27. Richardson's apparatus includes "jump starter batteries" identified by "22" in FIG. 1 below as the internal power supply. "The system includes one or more internal batteries and capacitors to provide the power to the battery of the vehicle to be jump started." Ex. 1006, ¶0007. "A battery voltage sensor 20 monitors the voltage level of one or more jump starter batteries 22." Ex. 1006, ¶0016.

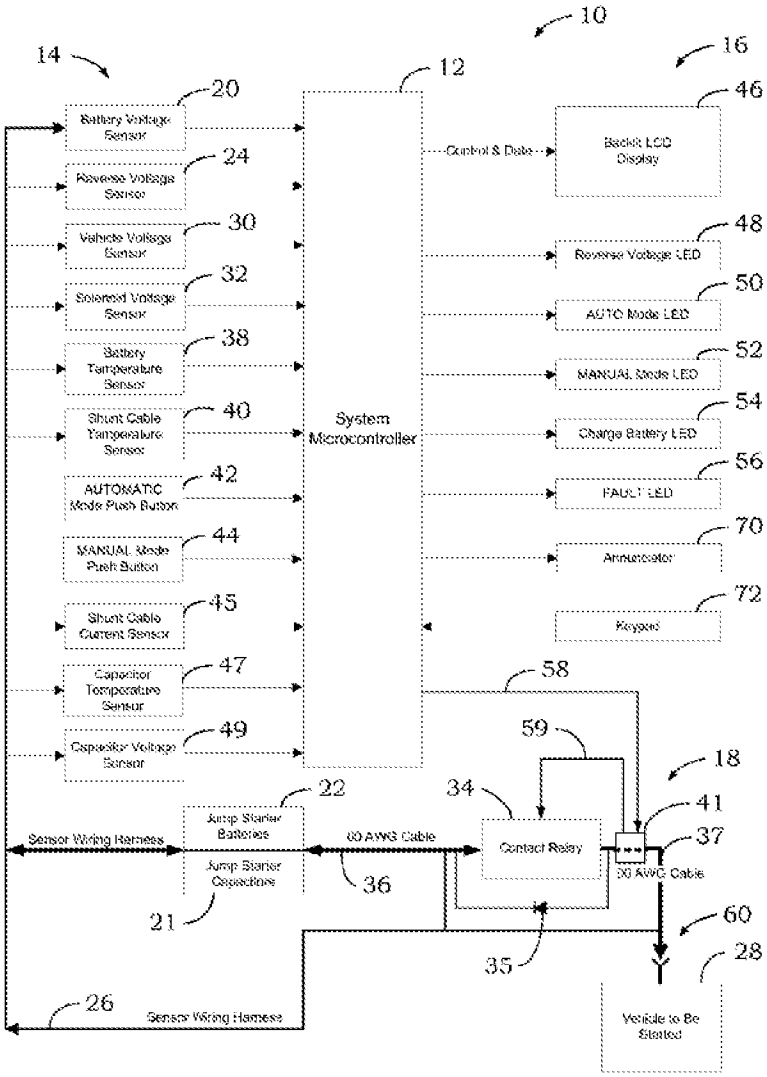


Fig. 1

Ex. 1006, FIG. 1

(c) **"an output port having positive and negative polarity outputs**."

28. "Output port" was previously construed in the Shenzhen Dika Order to mean "a component through which power from an internal power

supply is transmitted." Ex. 1005 at 15. Consistent with this construction, Richardson discloses an output port having the positive and negative polarity outputs through which power from the internal power supply is transmitted. Specifically, Richardson discloses conductive leads connected to jumper cables having positive and negative polarity outputs through which power from the internal power supply is transmitted. "A method and apparatus provides supplemental power to an engine. The method and apparatus includes a pair of conductive leads for connecting the supplemental power to an engine electrical system, one or more batteries connected in parallel with one or more capacitors, a relay connected to the conductive leads, a shunt cable connecting the batteries and capacitors to the relay and a processor for controlling the relay to selectively apply electrical power to the engine electrical system." Ex. 1006, Abstract. In addition, claim 1 of Richardson specifies "temporarily manually connecting conductive leads from said portable jump starter to the electrical system of the engine." Ex. 1006, Claim 1. Also, a "battery voltage sensor 20 monitors the voltage level of one or more jump starter batteries 22. A reverse voltage sensor 24 monitors the polarity of the jumper cables on line 26 which are connected to the vehicle's electrical system 28." Ex. 1006, ¶0016. FIG. 2C below shows jumper cables

60 with red (positive) and black (negative) clamps are connected to the output port (line 26) depicting positive and negative polarity outputs.

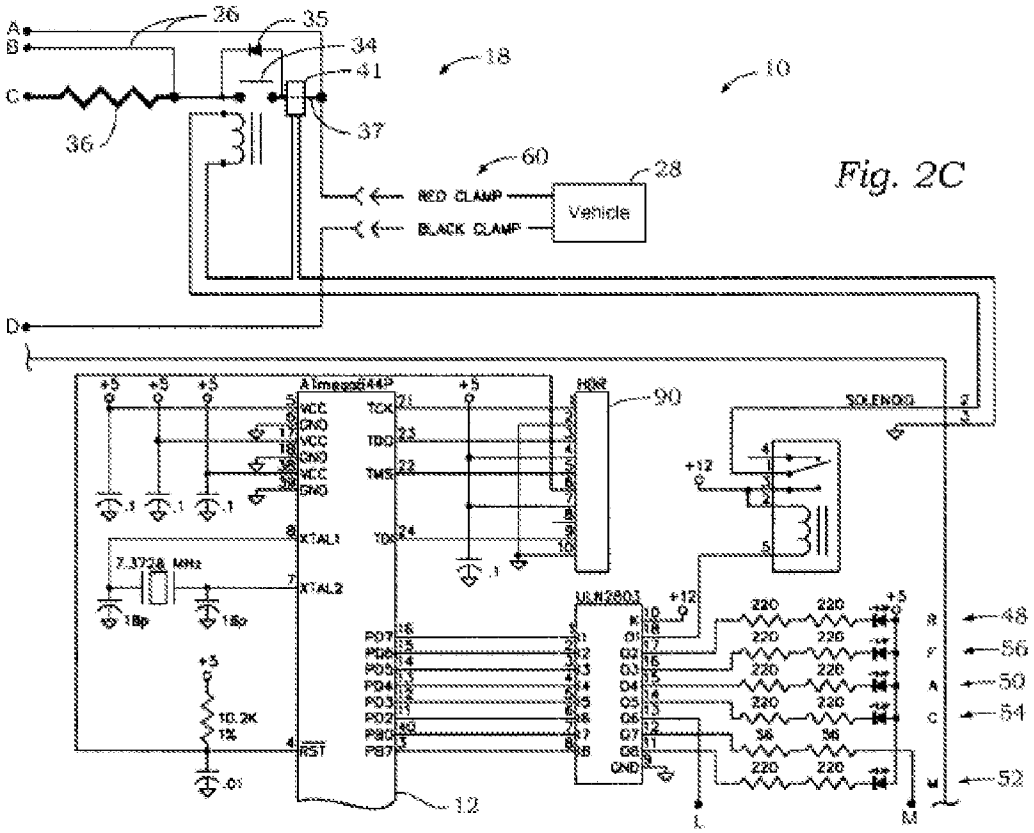


Fig. 2C

Ex. 1006, FIG. 2C.

(d) "a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs"

29. "Vehicle battery isolation sensor" was construed in the Shenzhen Dika Order to mean "a vehicle battery isolation sensor separate from the reverse polarity sensor." Ex. 1005 at 14. Richardson discloses a

vehicle battery isolation sensor consistent with this construction. Richardson discloses a "vehicle voltage sensor 30 monitors the voltage on line 37 (voltage of the vehicle)." Ex. 1006, ¶0016. Shown in FIG. 2C of Richardson below, the line 37 is connected in series with said positive and negative polarity outputs, such that the vehicle voltage sensor can detect presence of a vehicle battery connected between said positive and negative polarity outputs. Ex. 1002, ¶65.

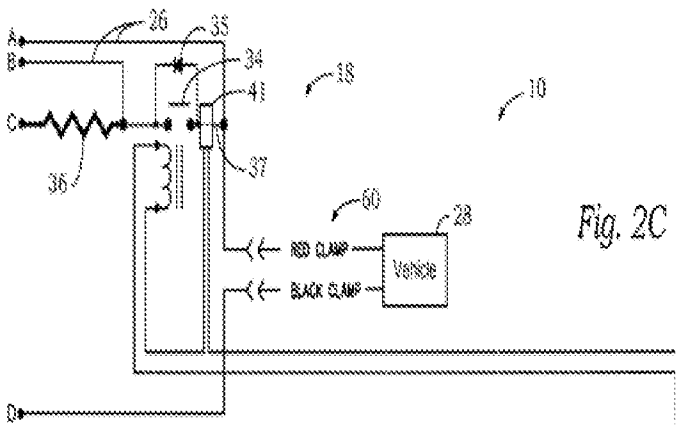
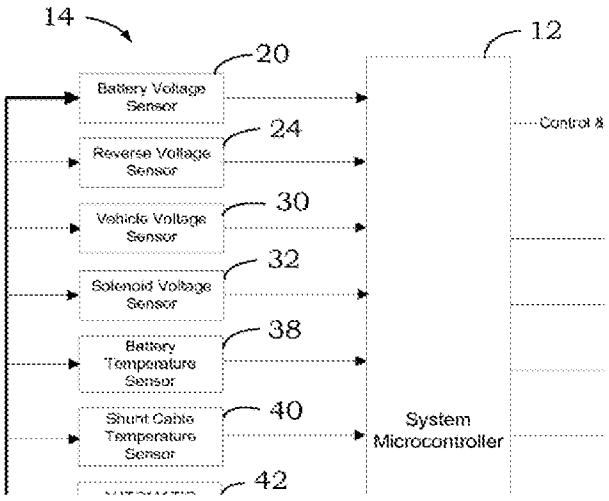


Fig. 2C

Ex. 1006, FIG. 2C

30. Also as shown in FIG. 1 of Richardson below, the vehicle voltage sensor 30 is separate from a reverse voltage sensor 24 (a reverse polarity sensor).

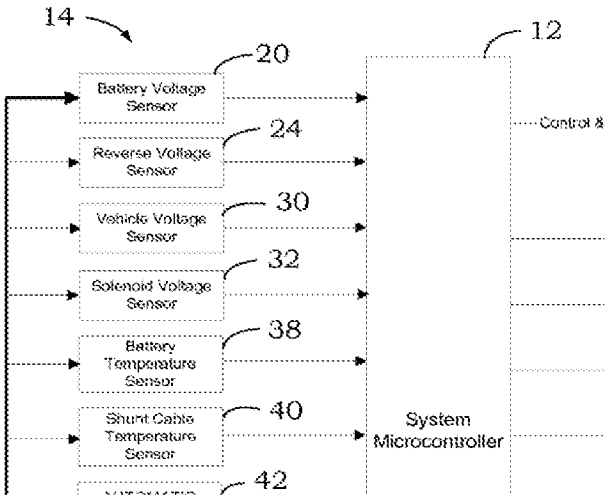


Ex. 1006, FIG. 1

> **(e) "a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port"**

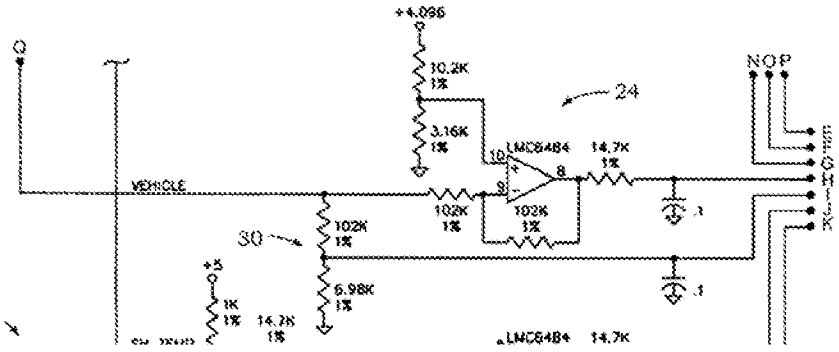
31. "Reverse polarity sensor" was construed in the Shenzhen Dika Order to mean a "reverse polarity sensor separate from the vehicle battery isolation sensor." Ex. 1005 at 14. Richardson discloses a reverse polarity sensor consistent with this construction.

32. As noted above, Richardson's FIG. 1 below shows a reverse polarity sensor, (reverse voltage sensor 24), which is separate from the vehicle battery isolation sensor (vehicle voltage sensor 30).



Ex. 1006, FIG. 1

33. More details on the vehicle sensing and reverse voltage sensing circuits are provided in Richardson's FIG. 2B below. The vehicle voltage sensor 30 places a signal on line 'I' using a voltage divider. The reverse voltage sensor 24 places a signal on line 'H' using an inverting operational amplifier (LM6484). Thus, the voltage sensor 30 and the reverse voltage sensor 24 comprise separate and distinct sensors. Ex. 1002, ¶68.



Ex. 1006, FIG. 2B

34. Richardson states the "reverse voltage sensor 24 monitors the polarity of the jumper cables on line 26 which are connected to the vehicle's electrical system 28." Ex. 1006, ¶0016. "A reverse voltage LED 48 is illuminated when the microprocessor 12 determines that a reverse voltage jumper cable voltage is detected by reverse voltage sensor 24." Ex. 1006, ¶0020. "If the system does not detect a battery charging voltage 212, once jumper cables 60 have been manually connected to the vehicle to be started 28, the voltage is measured by the reverse voltage sensor 24 to determine if the cables have been properly connected to the vehicle 214. If the voltage measured is significantly less than the voltage of the jump starter capacitors 21 and batteries 22, then a reverse polarity connection of the jumper cables to the vehicle is determined and an error flag is set and the event saved in non-volatile memory 216. A "Reverse Polarity" error message is displayed 218 on the LCD 46, and the reverse voltage LED 48 is illuminated 216." Richardson Ex. 1006, ¶0027.

(f) "a power switch connected between said internal power supply and said output port"

35. Richardson discloses a power switch connected between the internal power supply and the output port. In FIG. 1, Richardson discloses a contact relay 34 (power switch) connected between jump starter batteries 22

(internal power supply) and the leads (output port) connected to the vehicle to be started 28.

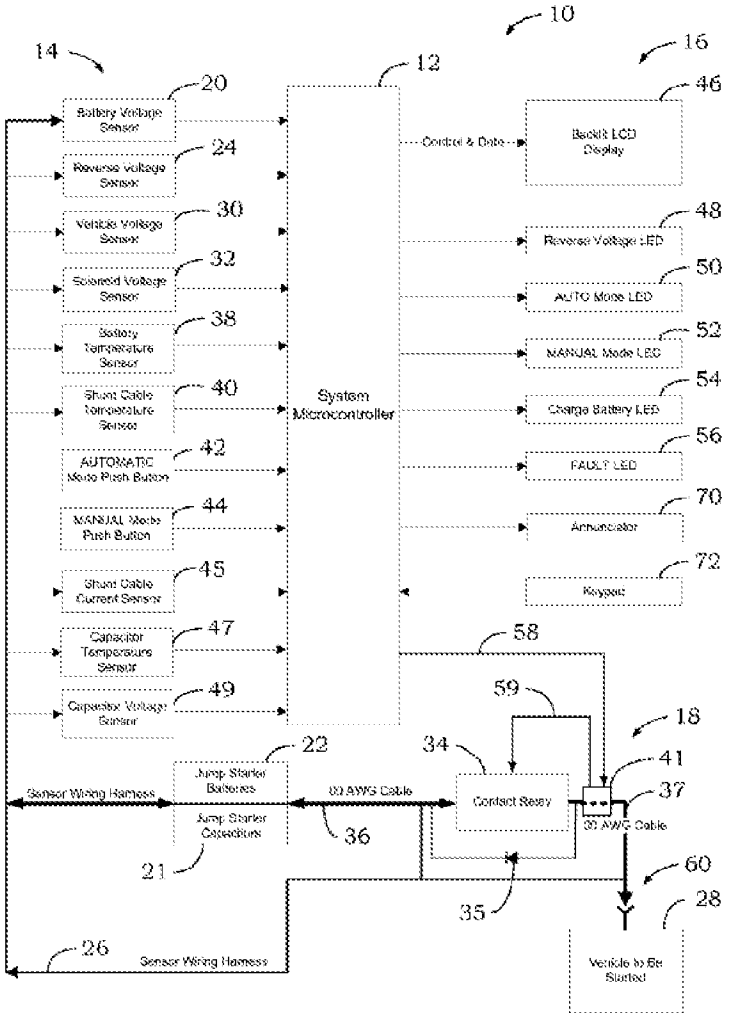
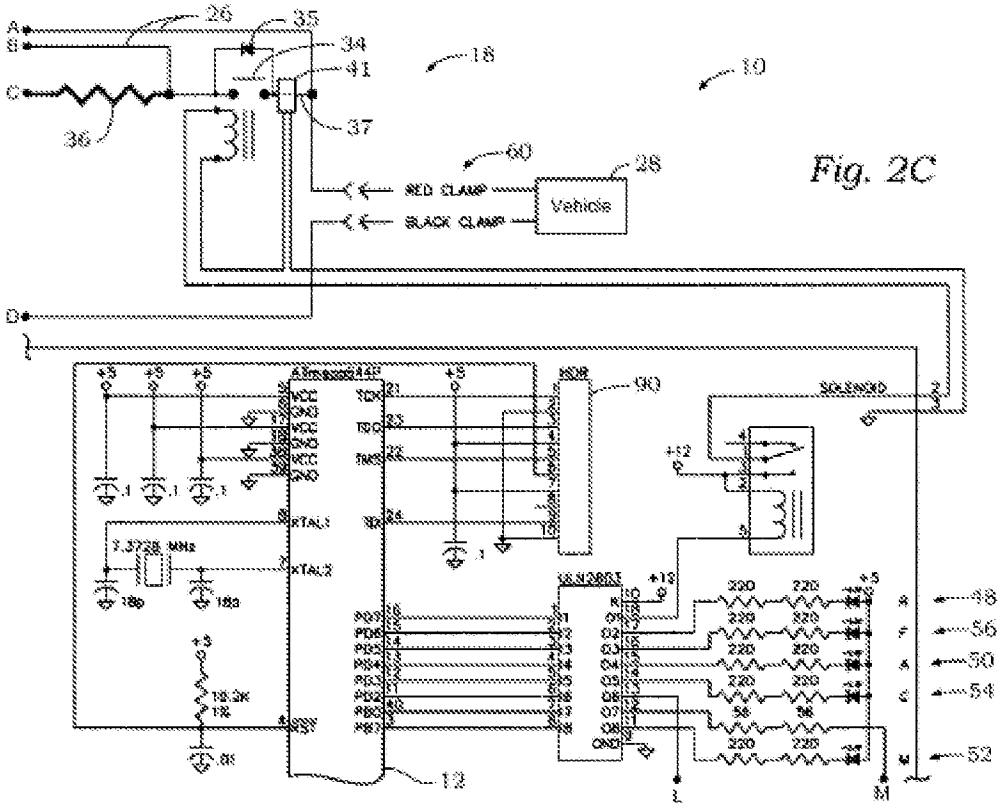


Fig. 1

Ex. 1006, FIG. 1

36. The power switch 34 is shown in more detail in FIG. 2C below.



Ex. 1006, FIG. 2C

37. "When the jump starter operation has been successfully initiated, the contact relay 34 is closed and the jump starter capacitors 21 and batteries 22 are connected to the starter system or batteries of the vehicle to be started 28. The contact relay 34 is opened when a successful start cycle has been completed, a start fault has occurred or the operator interrupts the jump starter cycle." Ex. 1006, ¶0021.

(g) "a microcontroller configured to receive input signals from said vehicle isolation sensor and said

reverse polarity sensor, and to provide an output signal to said power switch"

38. Richardson discloses a microcontroller receiving input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch. Richardson discloses a system microcontroller 12 in FIG. 1 below receiving input signals from the vehicle voltage sensor 30 (vehicle isolation sensor) and the reverse voltage sensor 24 (reverse polarity sensor) and providing output signals to the contact relay 34 (power switch). "Referring initially to FIG. 1, the portable supplemental power source (jump starter) of the present invention is generally indicated by reference numeral 10. Jump starter 10 includes a programmable microprocessor 12 which receives inputs 14 and produces informational outputs 16 and control outputs 18." Ex. 1006, ¶0014. (Richardson uses "microprocessor 12" interchangeably with "microcontroller 12".)

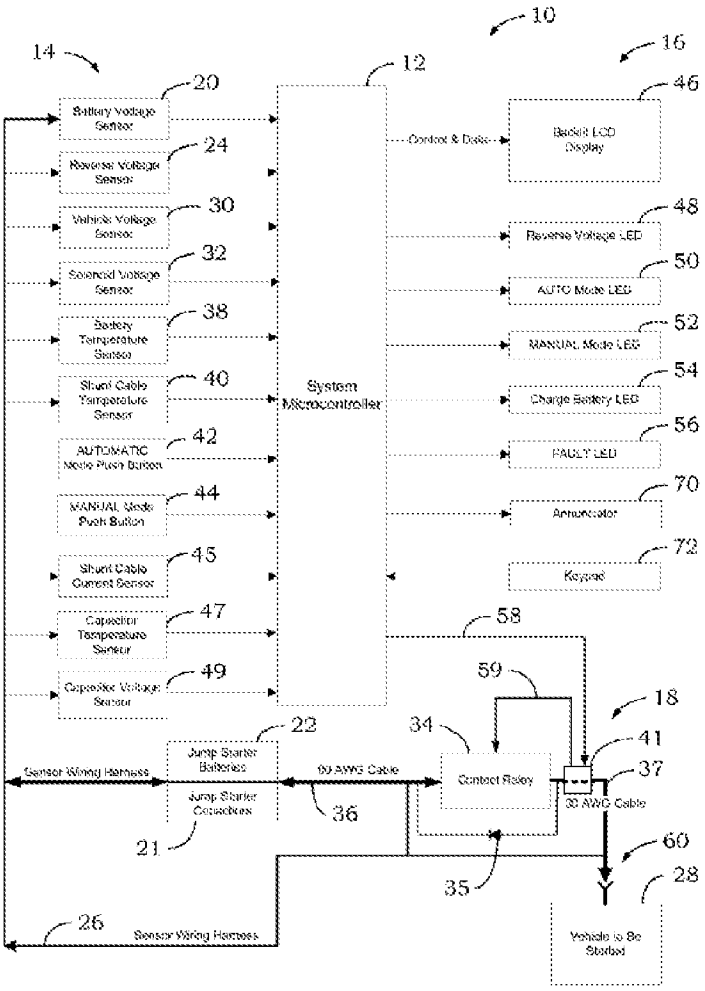


Fig. 1

Ex. 1006, FIG. 1

39. The phrase "input signals from said vehicle isolation sensor and said reverse polarity sensor" was construed in the Shenzhen Dika Order to mean "distinct input signals from said vehicle isolation sensor and said reverse polarity sensor, respectively." Ex. 1005 at 14. Richardson's FIG. 1 shows distinct input signals received by the microcontroller 12 from the

vehicle voltage sensor 30 and the reverse voltage sensor 24 consistent with this construction.

> **(h) "[a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch] such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs"**

40. As discussed below, Richardson discloses turning on the power switch to cause the internal power supply to be connected to the output port in response to signals from the sensors indicating (1) the presence of a vehicle battery at the output port and (2) proper polarity connection of positive and negative terminals of the vehicle battery with the positive and negative polarity outputs. Richardson also discloses the power switch is *not* turned on when signals from the sensors indicate either the absence of a

vehicle battery at the output port or an improper polarity connection of the vehicle battery.

41. Richardson discloses in FIGS. 3-8 "flow charts of the processing steps of the portable power source of the present invention." Ex. 1006, ¶0010. This sequence of steps involves several checks performed by the microcontroller before turning on the power switch to jump start the vehicle. As discussed below, these checks include detecting (1) the presence of a vehicle battery at said output port and (2) proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs. Ex. 1002, ¶76.

42. Richardson discloses the reverse voltage sensor 24 detecting whether jumper cables that have been manually connected to the vehicle battery have been properly connected or if there is a reverse connection. Richardson discloses that the power switch for charging the vehicle battery cannot be turned on unless there is a proper polarity connection of the cables. Referring to FIG. 3, Richardson states:

> If the system does not detect a battery charging voltage 212, once jumper cables 60 have been manually connected to the vehicle to be started 28, the voltage is measured by the reverse voltage sensor 24 to determine if

the cables have been properly connected to the vehicle 214. If the voltage measured is significantly less than the voltage of the jump starter capacitors 21 and batteries 22, then a reverse polarity connection of the jumper cables to the vehicle is determined and an error flag is set and the event saved in non-volatile memory 216. A "Reverse Polarity" error message is displayed 218 on the LCD 46, and the reverse voltage LED 48 is illuminated 216. Any further jump starter action by the operator is ignored until the reverse polarity condition is corrected 220, at which point processing returns to the start of the main processing loop 210. Ex. 1006, ¶0027.

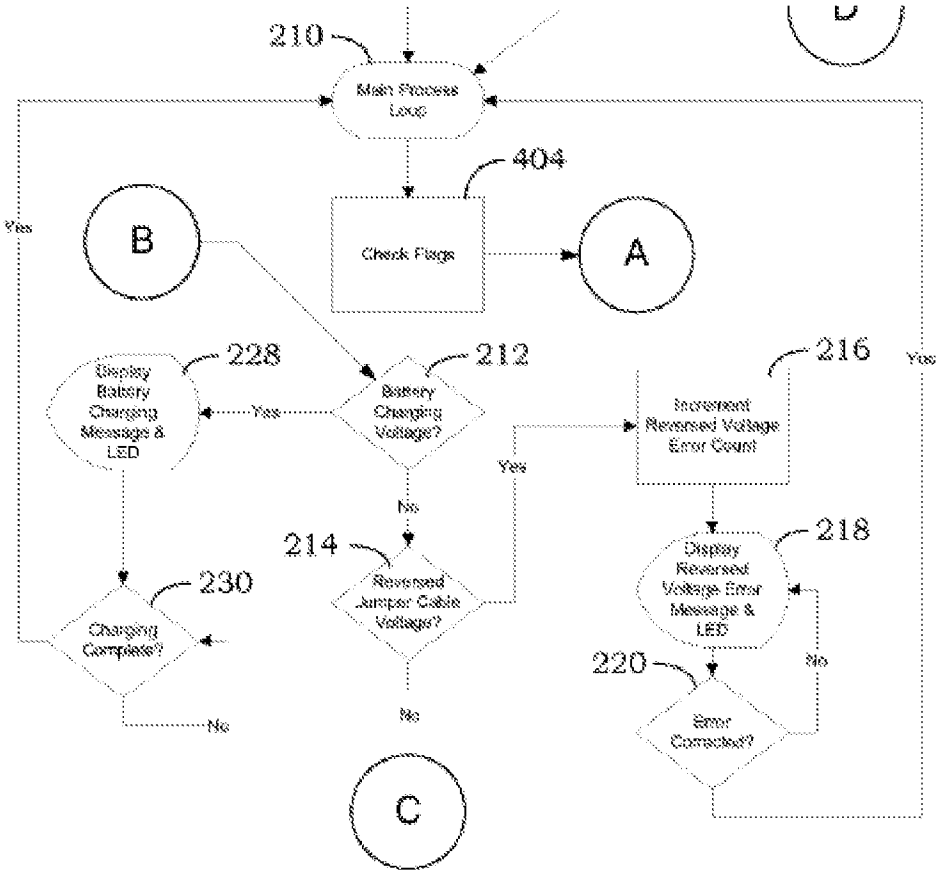


Fig. 3

Ex. 1006, FIG. 3

43. Additionally, as discussed below, in a separate sequence of steps, Richardson discloses detecting the presence of a vehicle battery at the output port before turning on the power switch to jump start the vehicle. Specifically, Richardson discloses detecting the presence of the vehicle battery by detecting the voltage of the battery to determine whether the

starter voltage of the jump starter apparatus configured by the operator is consistent with the voltage of the vehicle, depicted in FIG. 5 below.

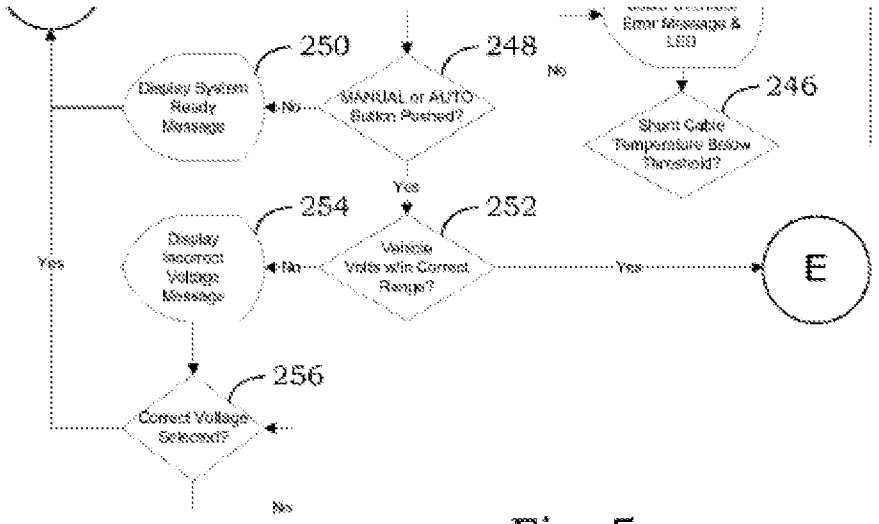


Fig. 5

Ex. 1006, FIG. 5

44. Richardson discloses that the starter voltage of the jump starter apparatus can be configured by the operator "for 12, 18, 24, 30, 36, 42 or 48 volts, for example." Ex. 1006, ¶0034. Richardson discloses a vehicle voltage sensor 30 that "monitors the voltage on line 37 (voltage of the vehicle)" for detecting the voltage of the vehicle to be started. Ex. 1006, ¶0016. "If one of the push buttons 42 or 44 has been selected, the system will compare the operator-configured starter voltage against the voltage of the vehicle to be started 28. ... If the difference between the voltage selected and the voltage measured is not within a predetermined range and tolerance 252, a "Wrong

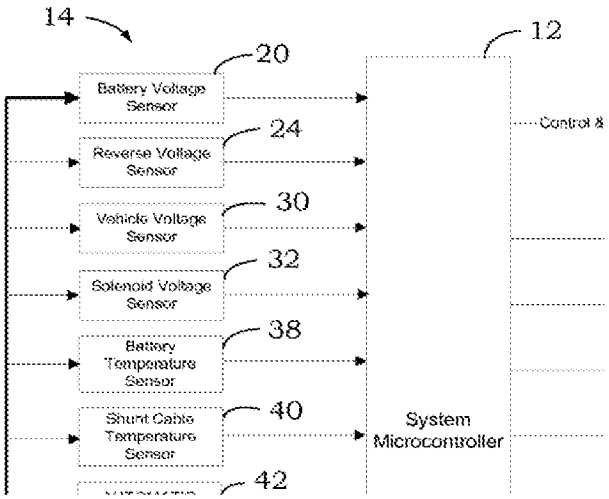
Selector Volts" message is displayed 254 on the LCD 46 and further operation is prohibited until the correct voltage is selected 256 at which point processing returns to the main processing loop 210." Ex. 1006, ¶0034. In other words, Richardson discloses that if a vehicle battery with a particular voltage that matches an operator-configured starter voltage is not detected by the vehicle voltage sensor 30, then the charging process cannot occur.

45. The process of sensing the voltage of the vehicle battery by the vehicle voltage sensor 30 necessarily involves detecting the presence or absence of the vehicle battery since a reading of zero volts would indicate the absence of a battery. The system microcontroller turns on the power switch only if the battery were present and furthermore within a particular range (which has to be greater than zero since the operator-configured starter voltage will always be some positive number greater than zero). Thus, the system microcontroller does not turn the power switch on in the absence of a battery. And the system microcontroller turns the power switch on only when a battery is present and the voltage measured is furthermore within a predetermined range and tolerance (which will be true at least some of the time). Ex. 1002, ¶80.

46. Thus, Richardson discloses that the power switch is turned on to cause the internal power supply to be connected to the output port in response to *distinct* signals from the sensors indicating (1) the presence of a vehicle battery at the output port and (2) proper polarity connection of positive and negative terminals of the vehicle battery with said positive and negative polarity outputs. Richardson also discloses that the power switch is *not* turned on when signals from said sensors indicate either the absence of a vehicle battery at the output port or an improper polarity connection of the vehicle battery.

3. Richardson anticipates Claim 7

47. Claim 7 depends from claim 1, and requires "a temperature sensor configured to detect temperature of said internal power supply and to provide a temperature signal to said microcontroller." Richardson meets this requirement. "A battery temperature sensor 38 monitors the temperature of the jump starter's batteries 22 to detect overheating due to excess current draw from the batteries during jump starting." Ex. 1006, ¶0017. The battery temperature sensor 38 provides a temperature signal to the microcontroller 12 depicted in FIG. 1 below.

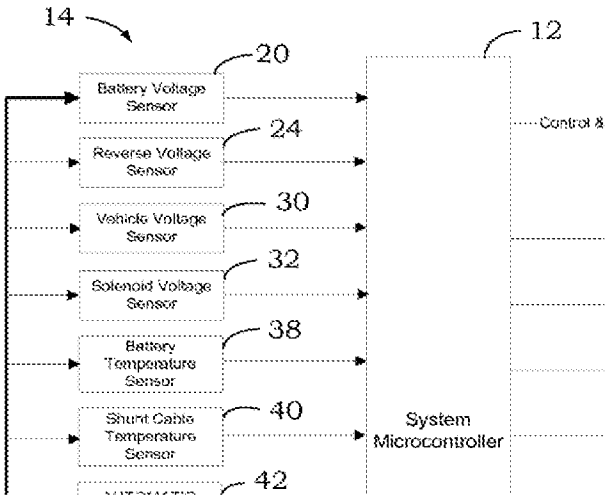


Ex. 1006, FIG. 1

4. Richardson anticipates Claim 8

48. Claim 8 depends from claim 1, and requires "a voltage measurement circuit configured to measure output voltage of said internal power supply and to provide a voltage measurement signal to said microcontroller." Richardson meets this limitation.

49. Richardson discloses "[a] battery voltage sensor 20 monitors the voltage level of one or more jump starter batteries 22." Ex. 1006, ¶0016. The battery voltage sensor 20 provides a voltage measurement signal to the microcontroller 12 depicted in FIG. 1, a portion of which is reproduced below.



Ex. 1006, FIG. 1

5. Richardson anticipates Claim 9

50. Claim 9 depends from claim 1, and requires "a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus." Richardson meets this limitation.

51. As explained by Professor Kirtley in his declaration, voltage regulators have been essential components in practically every electronic device having electronic components like operational amplifiers or microcontrollers well before the July 3, 2014 priority date of the '015 patent. Ex. 1002, ¶90. A voltage regulator stabilizes the DC voltages used by processors and other elements in electronic devices. Without a voltage regulator, the voltage variation from drawing current from the internal

battery could impair operation of the electronics in the device. Hence, practically every electronic appliance includes a voltage regulator. A POSITA would have known to use a voltage regulator to stabilize the power supplied to the processor and other active components. Ex. 1002, ¶90.

52. Richardson has a voltage regulator. Although not specifically discussed in the specification, the voltage regulator is clearly shown in FIG. 2A below. Ex. 1002, ¶91. The voltage regulator is identified in the figure as "LM7805", which is a commonly used five-volt regulator that provides power to the internal components (microprocessor, operational amplifiers, etc.) of the charging apparatus. Shown in FIG. 2A below, the voltage regulator component LM7805 is connected with several other components and provides +5 volts to a terminal labeled "+5", a voltage level appropriate to provide operating power to internal components of the apparatus. As is customary in this sort of circuit diagram, power supply leads are often not shown, but other +5 connections appear in FIGS. 2C and 2D. These are supplied by the LM7805 of FIG. 2A. Ex. 1002, ¶91.

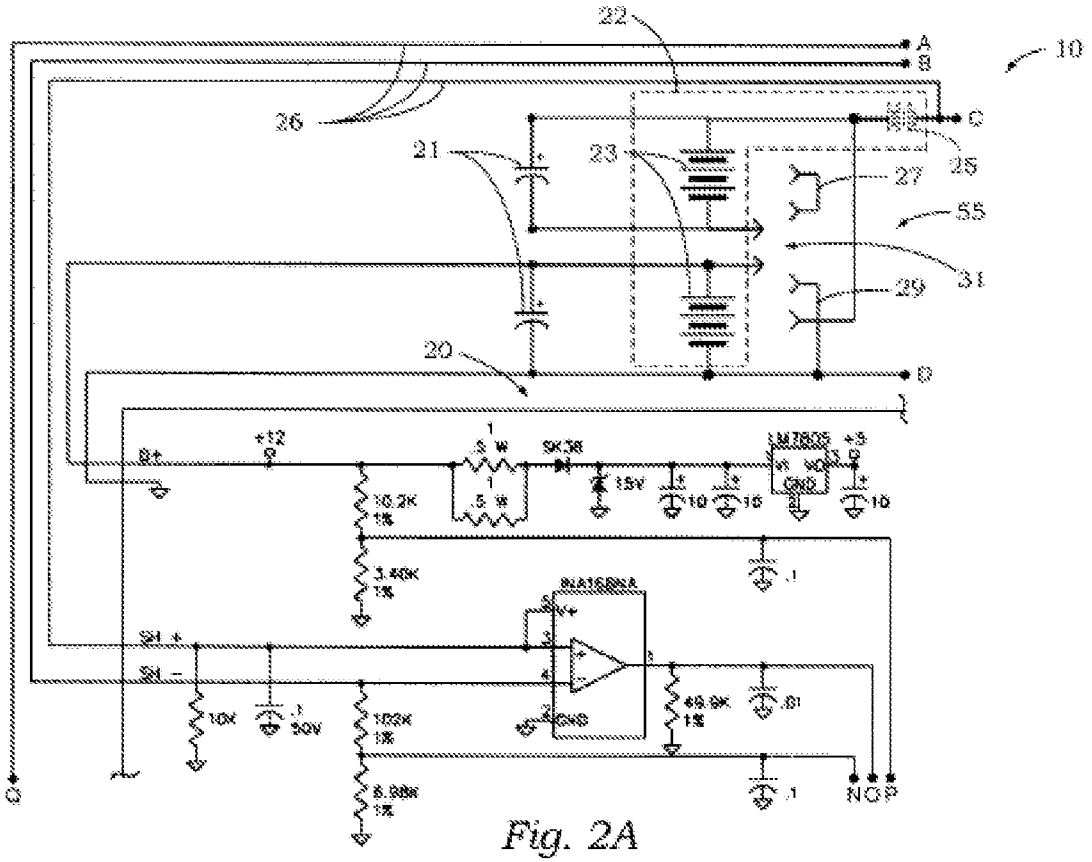


Fig. 2A

Ex. 1006, FIG. 2A

53. The LM7805 component is a well-known voltage regulator. An exemplary datasheet of an LM7805 voltage regulator from Fairchild Semiconductor Corporation (https://pdf1.alldatasheet.com/datasheet-pdf/view/82833/FAIRCHILD/LM7805.html) titled "MC78XX/LM78XX/MC78XXA 3-Terminal 1A Positive Voltage Regulator" (Ex. 1015) has a 2001 copyright date, which is before the priority date of the '015 patent. Ex. 1002, ¶92.

54. Voltage regulators like the LM7805 are also used in circuits of the other prior art references discussed herein. Lei discloses use of a voltage regulator identified as a component "7805" in the FIG. 2 circuit diagram of its smart battery detection system. Ex. 1008, FIG. 2. Ex. 1002, ¶93.

6. Richardson anticipates Claim 15

55. Claim 15 depends from claim 1, and requires "a plurality of visual indicators configured to display remaining capacity status of said internal power supply." Richardson meets this limitation.

56. Richardson discloses a plurality of visual indicators (LED 54 and LCD 46) to indicate to a user battery capacity. "If the voltage level of the system batteries 22 measured by the voltage sensor 30 is equal to a state of charge of eighty percent or more below a fully charged voltage level 222, an error flag is set and the event recorded in memory 224. The charge battery LED 54 is illuminated and the LCD 46 displays a "Charge Battery" message 225." Ex. 1006, ¶0028. Thus, the two visual indicators (LED 54 and LCD 46) in Richardson display remaining capacity status of the internal power supply (in this case, a charge of eighty percent or more below a fully charged voltage level).

7. Richardson anticipates Claim 17

57. Claim 17 depends from claim 1, and requires "a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity." Richardson meets the limitation.

58. Richardson discloses "[a] "Reverse Polarity" error message is displayed 218 on the LCD 46, and the reverse voltage LED 48 is illuminated 216. Any further jump starter action by the operator is ignored until the reverse polarity condition is corrected 220, at which point processing returns to the start of the main processing loop 210." Ex. 1006, ¶0027. Thus, the "Reverse Polarity" error message on the LCD 46 and illuminated LED 48 warn a user when a vehicle battery is connected with reverse polarity, prompting the user to correct the connection.

8. Richardson anticipates Claim 18

59. Claim 18 depends from claim 1, and requires "separate visual indicators configured to display the power on status of the apparatus, and the jump start boost power status of power supplied to said output port." Richardson meets these limitations.

60. Richardson discloses a visual indicator to display the power on status of the apparatus, specifically an LCD 46 that shows a start message (the power on status) when the jump starter is powered on. "Referring to

FIGS. 2A, 2B, 2C, 2D and 3-8, when the jump starter 10 is initially powered on 200, the microcontroller 12 initializes the hardware, reads all system parameters and variables, and initializes the interrupt service routine 202 (See FIG. 8). All stored performance history is read from the onboard, non-volatile memory 204 and a start message is displayed 206 on the LCD display 46." Ex. 1006, ¶0022. The start message on the LCD is a visual indicator displaying the power on status.

61. Additionally, Richardson discloses a separate visual indicator displaying the jump start boost power status of power supplied to the output port. "If the voltage level of the jump starter batteries 22 drop below a value of twenty percent of the normal level, a charge battery LED 54 is illuminated." Ex. 1006, ¶0020.

9. Richardson anticipates Claim 19

62. Claim 19 depends from claim 1, and requires "a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect presence of a vehicle battery." Richardson meets these limitations.

63. Richardson discloses a manual override mode that can be used if the presence of the vehicle battery cannot be detected. "The unit 10 also

includes automatic 42 and manual 44 pushbutton inputs to accept user input to select either automatic or manual operation." Ex. 1006, ¶0017. "If in manual mode, the jump starter 10 may be used when the battery voltage of the vehicle is below 10 volts, or if the vehicle's battery is not connected." Ex. 1006, ¶0049.

10. Richardson anticipates Claim 20

64. Claim 20 depends from claim 19, and requires that "the microcontroller is configured to detect actuation of said manual override switch for at least a predetermined period of time before activation of said manual override mode." Richardson meets all these limitations. "If manual mode is selected 258, "Manual" is displayed 332 on the LCD 46, the system will prompt the operator to press the manual button 44 again. If the manual button 44 is pressed a second time 334, then the system checks the number of start attempts 266. If the maximum number of start attempts has been exceeded 266, an over start attempt error count is incremented 336, a "Cool Down Unit" message is displayed 338 on the LCD 46, and the system waits for five minutes for the system to cool 340. Once the cool down time has expired, processing returns to the main processing loop 210. If the total start attempts have not exceeded the limit 266, the processing continues at block 268 as described above." Ex. 1006, ¶0047.

11. Richardson anticipates Claim 21

65. Claim 21 depends from claim 1, and requires that "further comprising a jumper cable device including a plug configured to plug into said output port, a pair of cables integrated with the plug at one respective end thereof and being configured to be connected to terminals of a battery at another respective end thereof." Richardson meets all these limitations.

66. FIG. 2C of Richardson shows jumper cables 60 having red and black clamps connected to a vehicle 28. The figure shows electrical symbols depicting a plug/socket connection of the jumper cables 60 to the output port.

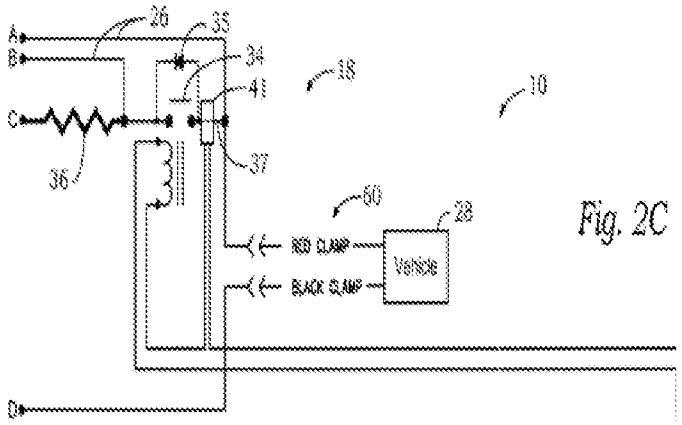


Fig. 2C

Ex. 1006, FIG. 2C

B. Ground 2: Claims 2, 3, 12-14, and 23 would have been obvious from Richardson and Lei

67. Claims 2, 3, 12-14, and 23 would have been obvious from Richardson and Lei. Lei, which is assigned to Carku, was not cited in the '015 patent. Lei is prior art under 35 U.S.C. §102(a) because it has a PCT filing date of November 8, 2013.

68. Lei discloses an emergency power source for jump starting a vehicle engine. "The emergency power source is convenient for charging, can output a heavy current for starting an automobile." Ex. 1008, Abstract. Like Richardson, Lei discloses jump starter with a power switch, a vehicle battery isolation sensor, a reverse polarity sensor, and a microcontroller. Ex. 1008, 7:67–8:1, 2:42-45, 8:36-44, 6:30-40. Lei discloses certain features that would have been obvious for a POSITA to incorporate into the jump starter disclosed in Richardson. A POSITA would recognize that the improvements provided by these features in Lei would improve the device of Richardson in the same way given the similarity of the devices.

1. Claims 2 and 3 would have been obvious from Richardson and Lei

69. Claims 2 and 3 depend from claims 1 and 2, respectively. Claim 2 requires that "said internal power supply comprises a lithium ion battery."

Claim 3 requires "said lithium ion battery comprises a battery pack of multiple lithium ion batteries."

70. Lei meets all these limitations. Lei states the "emergency power source uses lithium-ion batteries as its battery pack." Ex. 1008, 6:50-51. "In certain embodiments, the battery pack consists of lithium-ion batteries connected in series or parallel." Ex. 1008, 2:22-23.

71. Richardson discloses "one or more batteries connected in parallel with one or more capacitors" in a jump starter. Ex. 1006, Abstract. While Richardson does not explicitly state that the batteries are *lithium-ion* batteries, use of such batteries would have been obvious. A POSITA would have been particularly motivated to use lithium-ion batteries because Lei disclosed several specific benefits of using lithium-ion batteries in jump starter devices: "The emergency power source uses lithium-ion batteries as its battery pack, which has the characteristics of light weight, small size, durability, high instantaneous discharge current and rechargeability, which is capable of supplying a high current for starting a vehicle." Ex. 1008, 5:15-21. This teaching would have provided motivation to a POSITA to use lithium-ion batteries in Richardson. Ex. 1002, ¶120.

2. Claims 12 and 13 would have been obvious from Richardson and Lei

72. Claims 12 and 13 depend from claims 1 and 12, respectively.

73. Claim 12 requires that "a flashlight circuit configured to provide a source of light to a user." Claim 13 requires "said source of light is at least one LED." Lei meets these limitations.

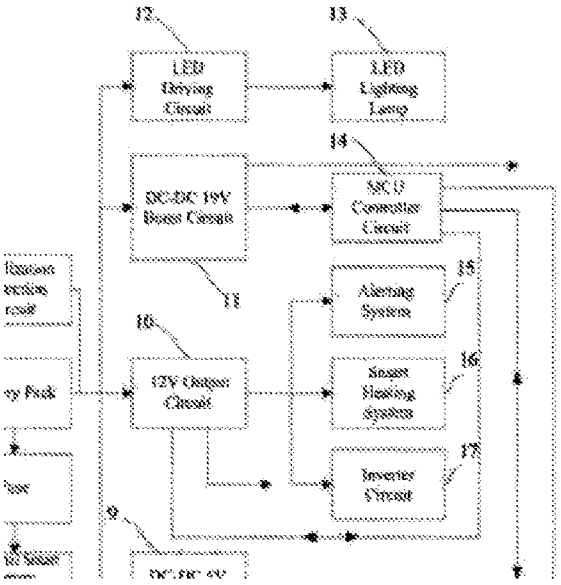
74. Lei discloses a flashlight circuit where the source of light is an LED. Referring to FIG. 1, Lei discloses "an output terminal of the LED driving circuit 12 is connected to a LED lighting lamp 13." Ex. 1008, 6:36-38. Lei explains that the "LED lighting lamp may provide outdoor lighting." Ex. 1008, 5:32-33.

75. A POSITA would have been motivated to incorporate a flashlight circuit having an LED light source in Richardson's jump starter to provide outdoor lighting for the user, as suggested by Lei.

3. Claim 14 would have been obvious from Richardson and Lei

76. Claim 14 depends from claim 13, and requires that "said microcontroller is configured to control said at least one LED to provide a visual alarm indicating an emergency situation." Lei meets this limitation. "An output terminal of the DC-DC 12V output circuit 10 is connected to an alerting system 15 for transmitting an alerting signal. .... A start button of the

alerting system 15 can be pressed by the user when he or she is lost or some condition occurs. The alerting system 15 may notice people around for help by lighting the indicator light or transmitting sounds with the alerting system 15." Ex. 1008, 7:3-13. Shown in FIG. 1 of Lei, the alerting system 15 is operably coupled to the MCU controller circuit 14.



Ex. 1008, FIG. 1

77. A POSITA would have been motivated to incorporate a visual alarm feature indicating an emergency situation controlled by the microcontroller in Richardson's jump starter as a safety feature for the user, as suggested by Lei. Ex. 1002, ¶128.

4. Claim 23 would have been obvious from Richardson and Lei

78. Claim 23 depends from claim 21, and requires that "said output port and said plug are dimensioned so that the plug will fit into the output port only in one specific orientation." Lei meets this limitation.

79. Lei discloses a jumper cable device having a plug that fits into the output port only in one specific orientation. "The external smart battery detection system 6 includes a red power source clip and a black power source clip for connecting with an external battery, ..., the red and black power source clips are connected to the battery pack through an anti-reverse connector connected to the positive and negative electrodes of the battery pack 4 or conducting wires welded to the positive and negative electrodes of the battery pack 4. If the red and black power source clips are connected to an insertable anti-reverse connector such that the voltage identifying system is connected to the red and black power source clips." Ex. 1008, 7:65–8:35. The insertable anti-reverse connector disclosed by Lei comprises a plug that can fit into the output port only in the correct orientation, not a reversed connection.

80. A POSITA would have been motivated to incorporate the insertable anti-reverse connector disclosed by Lei in Richardson's jump

starter to avoid a reverse connection, as suggested by Lei, for safe operation and convenience. Ex. 1002, ¶132.

C. Ground 3: Claims 4 and 5 would have been obvious from Richardson and Krieger

81. Claims 4 and 5 would have been obvious from the combination of Richardson and Krieger.

82. Krieger, (prior art under 35 U.S.C. §102(a)), discloses a jump starter including a battery, a semiconductor switch, a polarity sensing circuit, and a microprocessor for activating the semiconductor switch to enable a current flow between the boosting battery and the depleted battery. Ex. 1009, ¶0016.

83. Krieger was cited during prosecution of the '938 application, but was not the basis of any rejections by Examiner.

84. Krieger was considered by the PTAB in the Dongguan IPR (Ex. 1004). There, the PTAB denied institution of the IPR stating that the petitioner did not show that Krieger activated a power switch based on two distinct signals from the sensors in connection with claim 1. Without addressing whether this conclusion is correct, this Petition relies on Krieger for teaching the limitations of claims 4 and 5, not claim 1. Further, as to claim 5, the PTAB stated that the Dongguan Petition failed to explain

Krieger teaching "a vehicle isolation sensor comprising an optically coupled isolator phototransistor." Ex. 1004 at 16. The analysis below explains how Krieger suggests both the vehicle isolation sensor and the reverse polarity sensor comprise optically coupled isolator phototransistors.

85. Richardson and Krieger both disclose portable jump starters for vehicle engines. Their devices are similar in function and include the same basic components. A POSITA would recognize that the improvements provided by these features in Krieger would improve the device of Richardson in the same way given the similarity of the devices.

1. Claim 4 would have been obvious from Richardson and Krieger

86. Claim 4 depends from claim 1, and requires that "said power switch comprises a plurality of FETs in parallel."

87. Krieger discloses a power switch comprising a plurality of FETs in parallel. "The switch 12 is preferable a solid state device, such as a transistor, diode, field effect transistor (FET), etc. FIG. 1 represents the switch 12 as a number FETs 12a-12d connected in parallel with each other." Ex. 1009, ¶0030.

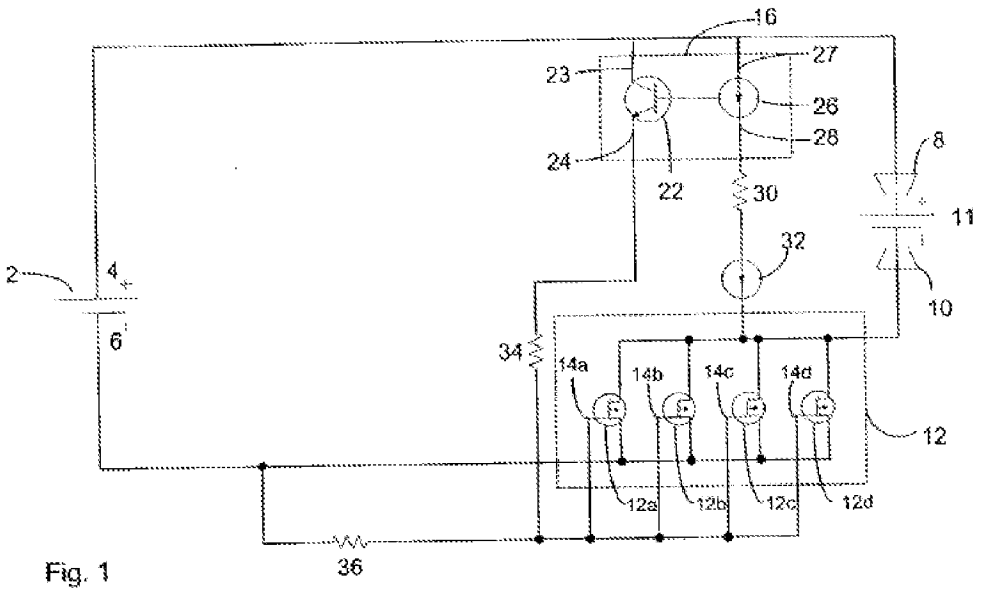


Fig. 1

Ex. 1009, FIG. 1

88. Krieger says by using a solid state switch comprising FETs, "[t]here is no need for any mechanical or electro-mechanical devices, as the FETs are the current handling devices." Ex. 1009, ¶0033. Substituting a relay switch in Richardson's jump starter with a solid state switch comprising a plurality of FETs would have been obvious to a POSITA to avoid or reduce electro-mechanical components, as suggested by Krieger. Ex. 1002, ¶144.

2. Claim 5 would have been obvious from Richardson and Krieger

89. Claim 5 depends from claim 1, and requires "said vehicle isolation sensor and reverse polarity sensor comprise optically coupled isolator phototransistors."

90. Krieger discloses a vehicle isolation sensor and reverse polarity sensor comprising of an optically coupled isolator phototransistor. "In the embodiment shown in FIG. 1, the polarity sensing circuit comprises an opto-isolator 16. The opto-isolator 16 comprises a phototransistor 22 and a light emitting diode (LED) 26." Ex. 1009, ¶0032.

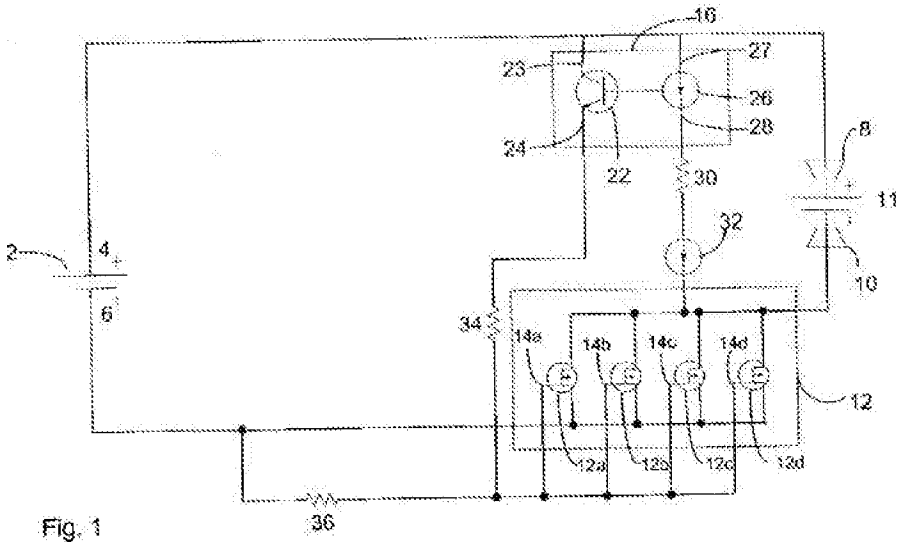


Fig. 1

Ex. 1009, FIG. 1

91. Krieger uses the opto-isolator 16 to perform the functions of both the vehicle isolation sensor and reverse polarity sensor. Krieger explains operation of the opto-isolator as follows:

> During operation of the battery booster device depicted in FIG. 1, the FETs 12 a-12 d are initially held in a non-conducting state via resistor 36. The opto-isolator 16 only turns on when it is properly biased as a result of a correct polarity connection being made between the boosting battery 2 and the depleted battery 11. When the LED 26 is properly biased, phototransistor 22 in the opto-isolator 16 turns on. Current flow through phototransistor 22 biases the control electrodes of the FETs 12 a-12 d into a conducting state, enabling current flow through the FETs 12 a-12 d to the depleted battery 11. Ex. 1009, ¶0033.

92. Krieger's opto-isolator 16 only turns on when it is properly biased "as a result of a correct polarity connection being made between the boosting battery 2 and the depleted battery 11." Ex. 1009, ¶0033. By detecting the correct connection of the depleted battery 11, Krieger also necessarily detects that the depleted battery 11 is present. Thus, Krieger discloses that an opto-isolator can perform the functions of both the vehicle isolation sensor and reverse polarity sensor. It would therefore be obvious to a POSITA to use one opto-isolator to sense the presence of a vehicle battery

and a correct polarity connection, or two opto-isolators if a POSITA wanted to use one for battery detection and another for correct polarity connection, e.g., for redundancy.

93. A POSITA would be particularly motivated to use opto-couplers of the type discloses by Krieger for sensing the presence of a vehicle battery and a correct polarity connection because the opto-coupler used in Krieger is an inherently digital device that can be preferable over using analog inputs to the system microcontroller, which may be subject to tests to determine if the vehicle battery is present or reversed. A POSITA would be motivated to simplify the system by using an optical coupler for one or both sensing functions, e.g., to provide a compact, packaged jump starter. Ex. 1002, ¶150.

D. Ground 4: Claim 6 would have been obvious from Richardson and Wanzong

94. Claim 6 depends from claim 1, and requires that "a plurality of power diodes coupled between said output port and said internal power supply to prevent back-charging of said internal power supply from an electrical system connected to said output port." Claim 6 would have been obvious from Richardson and Wanzong.

95. Wanzong (prior art under 35 U.S.C. §102(a)) was not cited in the '015 patent.

96. Richardson and Wanzong both relate to vehicle batteries. Richardson discloses monitoring the voltage of the vehicle battery and providing supplemental power to the battery. Ex. 1006, ¶0007. Wanzong discloses a battery maintainer and charger apparatus for batteries for vehicles, including "automobile or motorized vehicle not driven on a regular basis." Ex. 1010, 2:59-67. Like Richardson, Wanzong discloses safety features to protect the vehicle batteries and the operators of the charging devices, including a reverse polarity sensor. Ex. 1010, Abstract.

97. Wanzong discloses an "isolation diode 160", which acts as the power diodes to prevent back-charging of said internal power supply from an electrical system connected to said output port. Shown in FIG. 1 below, the isolation sensor 160 is between the output port (output terminals 170 and 180) of the charger apparatus and the internal power supply (transformer 20/ full wave bridge rectifier 30/ main capacitor 40). Ex. 1010, 4:10-20; 4:45-53. While the storage battery 150 is being charged, "[c]harging current for the battery will pass through the isolation transistor 110 and out through the final isolating diode 160 to the storage battery 150 under charge." Ex. 1010,

12:15-18. The isolation sensor 160 acts as the power diodes to prevent back-charging of said internal power supply from the storage battery 150.

> When a storage battery 150 containing more than 6 cells is connected to the terminals 170 and 180, the voltage regulator integrated circuit 70 will modulate off the main power transistor 90, current will cease to flow from the voltage regulator integrated circuit to the storage battery 150 and the final isolating diode 160 will be reverse biased and block current flow from the storage battery 150 to the present invention. Ex. 1010, 13:1-10.

98. While Wanzong shows a single isolating diode 160 in the schematic diagram of FIG. 1. It would be understood by a POSITA that a plurality of isolating diodes could be arranged in parallel to handle higher current flow. Ex. 1002, ¶160.

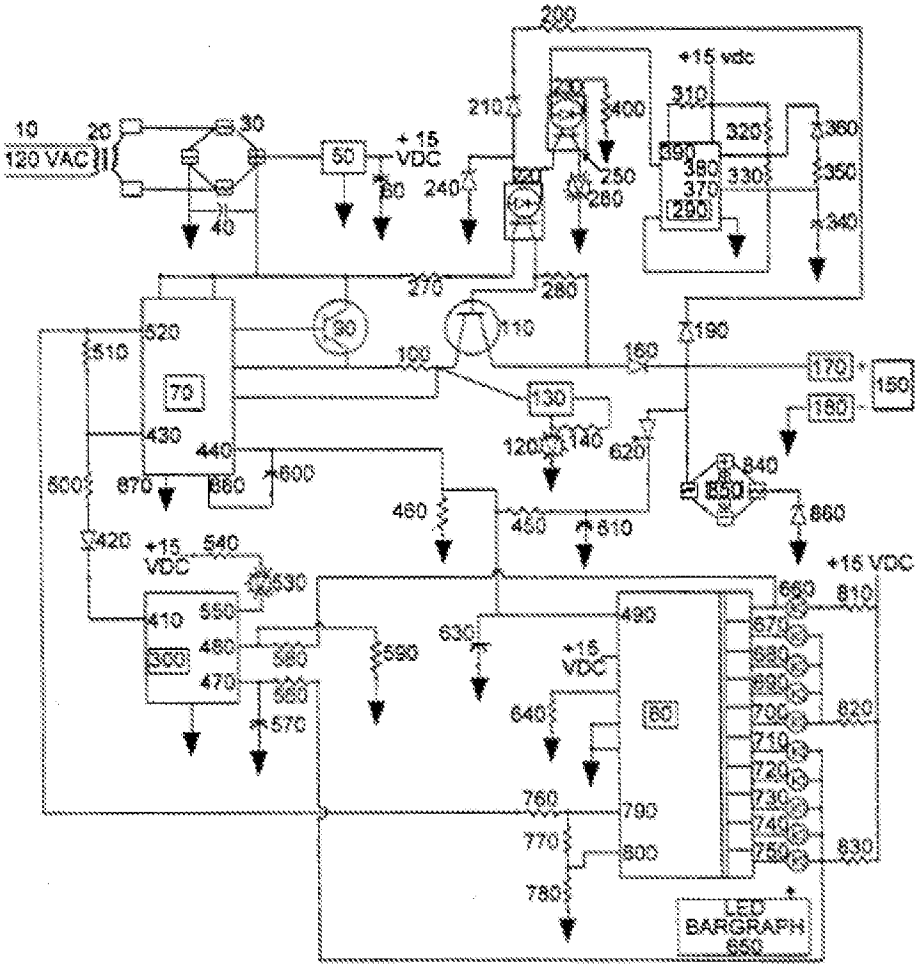


Fig. 1

Ex. 1010, FIG. 1

99. Incorporating Wanzong's isolating diode 160 in Richardson would have been obvious to of a POSITA to prevent back-charging of the charging circuit during or after the charging process. A POSITA would have been motivated to use an isolating diode 160 to prevent damage to the charging circuit. Ex. 1002, ¶161.

E. Ground 5: Claim 16 would have been obvious from Richardson and Baxter

100. Claim 16 depends from claim 15, and requires that "said plurality of visual indicators comprises a plurality of LEDs providing output light of different colors."

101. Claim 16 would have been obvious from the combination of Richardson and Baxter.

102. Baxter (prior art under 35 U.S.C. §102(a)) is not cited in the '015 patent. A related patent (US8199024) was cited during prosecution of the '938 application, but was not used in any claim rejection.

103. Baxter was before the PTAB in the Dongguan IPR. Ex. 1004. In that case, the petitioner relied on Baxter in combination with two other references for challenging claims 7 and 16. The PTAB did not substantively address the obviousness of claim 16 based on Baxter.

104. Richardson and Baxter are both directed to portable jump starters for vehicle engines. Baxter discloses a safety circuit for battery charging systems that can be incorporated into batteries and jumper cables. Ex. 1011, 1:4-5.

105. Using LEDs providing output light of different colors to indicate different conditions is plainly obvious by itself. Baxter states the

"microcontroller 26 can activate a green LED as a signal of proper connection .... Alternatively, a red LED might be activated if an improper connection is detected." Ex. 1011, 10:24-31. Different color LEDs are also used to indicate other conditions, e.g., if the cable clamps accidentally are touching. Ex. 1011, 12:18-29.

106. It would be obvious to a POSITA to incorporate LEDs providing output light of different colors in the Richardson device to indicate various conditions, including the capacity status of the internal power supply, since using lights of different colors enables users to readily view particular conditions clearly and easily. Ex. 1002, ¶170.

F. Ground 6: Claims 10-13 would have been obvious from Richardson and the Epower-20 brochure or the Epower-21 brochure

107. Claims 10-13 would have been obvious from Richardson and the Epower-20 brochure (Ex. 1012) or the Epower-21 brochure (Ex.1013).

108. The Epower-20 brochure provides technical details of Carku's EPower-20 Multifunction Jump Starter. The Epower-21 brochure similarly provides technical details of Carku's EPower-21 Multifunction Jump Starter. Both brochures were distributed to attendees of the 115th China Import and Export Fair 2014 in Guangzhou, China ("2014 Canton Fair"), one of the

largest trade shows in the world, on April 15 - May 5, 2014. Ex. 1018 at 2. The Epower-20 and Epower-21 jump starters and their brochures were on display and publically accessible to all attendees during the entire period of the 2014 Canton Fair at Carku's booth at the fair. *Id*. The booth was easily accessible to all attendees. *Id.* Carku's staff handed out the brochures and encouraged visitors to take the brochures. *Id*. The brochures are therefore printed publications available to the public before the July 3, 2014 effective filing date of the '015 patent, and thus prior art under 35 U.S.C. §102(a).

109. The brochures were not cited in the '015 patent.

110. Richardson and the brochures all disclose portable jump starters for vehicle engines. For instance, the Epower-20 brochure shows packaging below specifying "Carku Multifunction Jump Starter E-Power-20B." The Epower-20 brochure similarly specifies "Carku Multi-Function Jump Starter."



Ex. 1012 at 1

1. Claim 10 would have been obvious from Richardson and the Epower-20 brochure or the Epower-21 brochure

111. Claim 10 depends from claim 1, and requires that "a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device."

112. The Epower-20 brochure shows two USB output ports at the front of the device below.

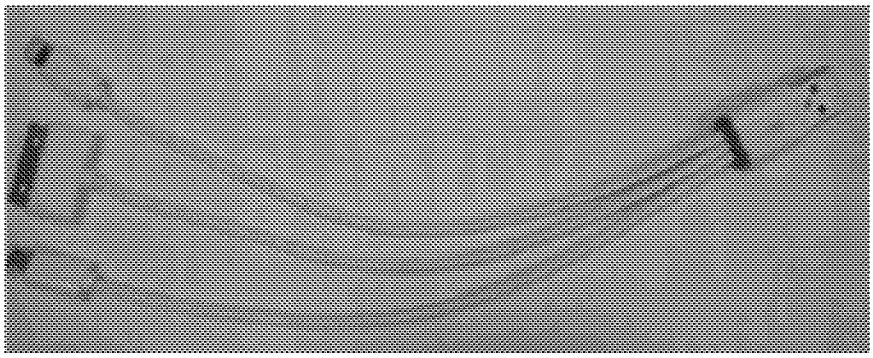


Ex. 1012 at 1.

113. The "Specification" of the Epower-20 brochure states the "Output" includes "5V/2A, 5V/1A ---mobile phone, tablet PC, other digital devices." A POSITA would understand that the 5V/2A and 5V/1A outputs described and shown are USB outputs for charging mobile phones and other devices. Ex. 1002, ¶78.

114. Additionally, the Epower-20 brochure discloses a "3-in-1 Mobile Phone Cable" accessory below with "Micro USB, iPhone4, iPhone5" outputs. The right end of the cable is a USB plug, which a POSITA would understand is plugged into a USB port shown above. Ex. 1012, ¶184. The

other end of the cable includes the "Micro USB, iPhone4, iPhone5" outputs described in the brochure.



Ex. 1012 at 1.

115. The Epower-21 brochure similarly discloses USB output ports.

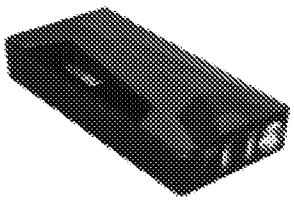
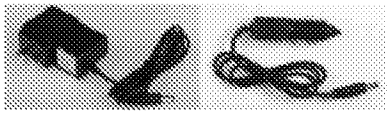
116. The USB output ports allow users to charge USB-chargeable devices like cell phones. It would have been obvious to a POSITA to incorporate USB output ports in Richardson as a convenience feature allowing users to also charge electronic devices.

2. Claim 11 would have been obvious from Richardson and the Epower-20 brochure or the Epower-21 brochure

117. Claim 11 depends from claim 1, and requires that "a USB charging port configured to provide charging power from an external power source to said internal power supply."

118. As discussed above, the Epower-20 and Epower-21 brochures disclose jump starters with USB output ports to charge other devices. Ex. 1012 at 1 and Ex. 1013 at 1.

119. Neither reference explicitly discloses a USB charging port providing charging power from an external power source to an internal power supply. The Epower-20 brochure shows below a "14V 1A" "Input" port for charging the jump starter with a "Home charger" ("Input: AC/100V-240V, Output: DC/14V1A").

Specification		
Description of goods	Fast car charger	
Battery Capacity	37Wh(7500mAh)	
Dimension	155*74*31.5mm	
Weight	330g	
Output	5V/2A、5V/1A ~~mobile phone, tablet PC, other digital devices 15V/1A ~~car fast charge	
Input	14V/1A	
Operation Temp.	-20℃~60℃/-4℉~140℉	
Time to charge car battery	About 8minutes in fully discharge	
Standard Accessories		
1pc Home charger	Input: AC/100V-240V 、Output: DC/14V1A	
1pc Car charger	Input / Output: DC 15V10A	
1pc User Manual		
		

Ex. 1012 at 1

120. The Epower-21 brochure makes a similar disclosure.

121. Thus, the Epower-20 and Epower-21 brochures disclose a "charging port configured to provide charging power from an external power source to said internal power supply." Ex. 1012 at 1. Ex. 1013 at 1. Further, the brochures disclose a USB port incorporated in the devices to provide charging power to other electronic devices like cell phones as explained above. Ex. 1012 at 1. It would be readily apparent from the references that a USB port, which is simply a different physical plug and socket combination from the round plug and socket used in the Epower-20 and 21 products, could also be incorporated into portable jump starters in place of or in addition to the 14V 1 A input port to charge the internal batteries of jump starter devices. A POSITA would be motivated to provide such a USB charging port to provide the added convenience to users of using another commonly used power input for charging the jump starter device. Ex. 1002, ¶190.

3. Claims 12-13 would have been obvious from Richardson and the Epower-20 brochure or the Epower-21 brochure

122. Claims 12 and 13 depend from claims 1 and 12, respectively.

123. Claim 12 requires "a flashlight circuit configured to provide a source of light to a user." Claim 13 specifies "said source of light is at least one LED."

124. The Epower-20 and Epower-21 brochures show a flashlight at the front of the devices in the pictures below.



Ex. 1012 at 1



Ex. 1013 at 1

125. The Epower-20 brochure also shows the flashlight in operation.



Ex. 1012 at 1

126. It would be obvious for a POSITA to use an LED lamp in the flashlight as LED lamps have high energy efficiency. Ex. 1002, ¶195.

127. A POSITA would have been motivated to incorporate a flashlight circuit having an LED light source in Richardson to provide lighting for the user, as suggested by the brochures.

G. Ground 7: Claim 22 would have been obvious from Richardson and Richardet

128. Claim 22 depends from claim 21, and requires that "said jumper cable device further comprises a pair of ring terminals configured to respectively connect said pair of cables at said another end thereof with one

of a battery terminal and a battery terminal clamp." Richardet meets this limitation.

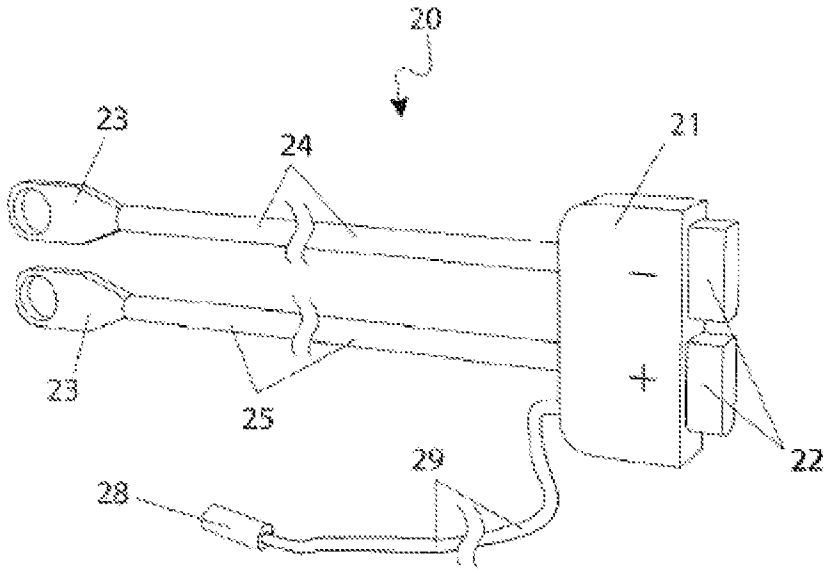
129. Richardet (prior art under 35 U.S.C. §102(a)) generally relates to electrical connectors for car batteries. Ex. 1014, 1:60-65.

130. Richardet was cited during prosecution of the '938 application. The Examiner rejected claims 24-26 as anticipated by Richardet. Instead of disputing the rejection, the applicant simply canceled claims 24-26.

131. Richardson and Richardet both relate to jump starting vehicle engines. Ex. 1014, 2:33-36. Richardet discloses "means to provide a battery terminal connection which provides secure and stable connection to a motor vehicle battery or the like adaptable to a variety of common scenarios and which is simple and quick for an average user." Ex. 1014, 1:60-65. As discussed below, Richardet discloses certain features that would have been obvious for a POSITA to incorporate into the jump starter disclosed in Richardson.

132. FIG. 2a of Richardet below discloses a "battery connector assembly 20 comprises a first fastener 21, a pair of battery ring terminals 23, a negative battery cable 24, a positive battery cable 25, and an accessory connector 28. The battery ring terminals 23 provide an attachment means

thereto a positive battery terminal 120 and a negative battery terminal 130 thereon a primary battery 100 (see FIG. 3)." Ex. 1014, 4:57-63. Thus, Richardet discloses a pair of ring terminals 23 to connect a pair of cables 24, 25 with battery terminals 120 and 130.



Ex. 1014, FIG. 2a

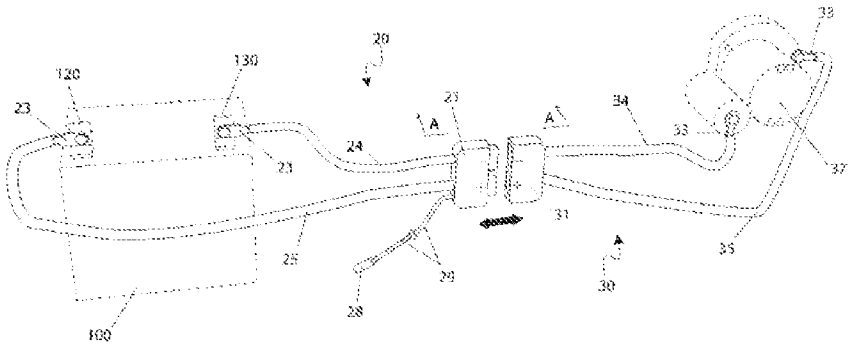


Fig. 3

Ex. 1013, FIG. 3

133. Richardet discloses that its cable systems "provide a battery terminal connection which provides secure and stable connection to a motor vehicle battery or the like adaptable to a variety of common scenarios and which is simple and quick for an average user." Ex. 1014, 1:59-65. Combining Richardet's cable system with ring terminals in Richardson would have been obvious to a POSITA as another advantageous way of connecting cabling to a battery. A POSITA would have been particularly motivated to use Richardet's cabling system to provide a secure and stable connection to a vehicle battery in a simple and quick way for an average user, as suggested by Richardet. Ex. 1002, ¶204.

H. Ground 8: Claims 1, 17, and 21 are anticipated by Klang

134. Klang (issued July 23, 2002) is prior art under 35 U.S.C. §102(a). Klang is not cited in the '015 patent.

135. Klang is "directed to a battery charging system and method that rapidly recharges batteries based on an interactive charging procedure." Ex. 1007, 4:67-5:2. It includes "safety features which minimize, if not eliminate, safety issues as regards both users and as to the test units themselves." Ex. 1007, 2:61-63. In particular, the system includes a voltage sensor that detects the presence of a battery and a reverse polarity sensor that detects whether the battery is connected with reverse polarity. Ex. 1007, 8:55-65.

1. Klang anticipates Claim 1

(a) "Apparatus for jump starting a vehicle engine"

136. The preamble of claim 1 does not limit the claim because (1) the preamble only describes an intended use (jump starting a vehicle engine) for the structure recited in the claim's body, (2) the preamble does not impose any structural requirements beyond those provided in the claim's body, (3) no arguments relying on "jump starting a vehicle engine" were made during prosecution to overcome prior art, and (4) "jump starting a vehicle engine" does not supply antecedent basis for any term in any claim.

See, e.g., *Arctic Cat Inc. v. GEP Power Products, Inc.*, No. 18-1520 (Fed. Cir. 2019.

137. To the extent the preamble is limiting, Klang discloses systems for rapidly charging vehicle batteries. "A more specific object of this invention lies in the provision of a diagnostic test unit which includes an interactive charging unit capable of rapidly and reliably recharging lead-acid batteries." Ex. 1007, 2:64-67. Klang discloses charging stand-alone batteries and in-vehicle batteries. Ex. 1007, 7:31-37.

138. While Klang does not explicitly state jump starting a vehicle engine, a POSITA would recognize that jump starter devices and devices for rapidly charging batteries like Klang function in a similar way and would both involve similar components and safety features. Ex. 1002, ¶210.

(b) "an internal power supply"

139. Klang discloses an internal power supply in FIGS. 1 and 4. "Turning to the drawings and referring first to FIG. 1, a diagnostic tester and charging system 10 according to the invention comprises a system controller 12, a variable programmable DC power supply and load 14, DC sensors 24, conducting cables 18 and a battery 16. The system controller 12 is coupled

to the power supply 14 and includes control circuitry for regulating the output of the power supply 14." Ex. 1007, 5:9-17.

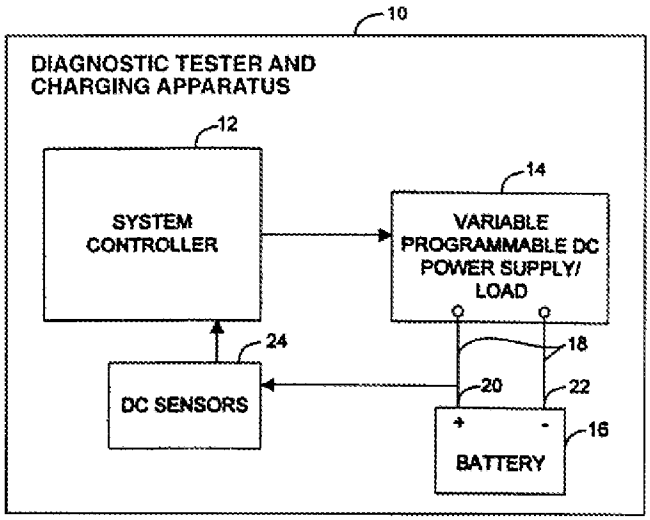


FIG._1

Ex. 1007, FIG. 1

140. Klang also states "[a]s shown in FIG. 4, the variable programmable DC power supply and load 14 includes a DC power supply 52 and a variable load 54. According to the invention, the power supply 14 is capable of providing an electrical charge output at either a variable voltage level or a variable current level (or both)." Ex. 1007, 6:48-53.

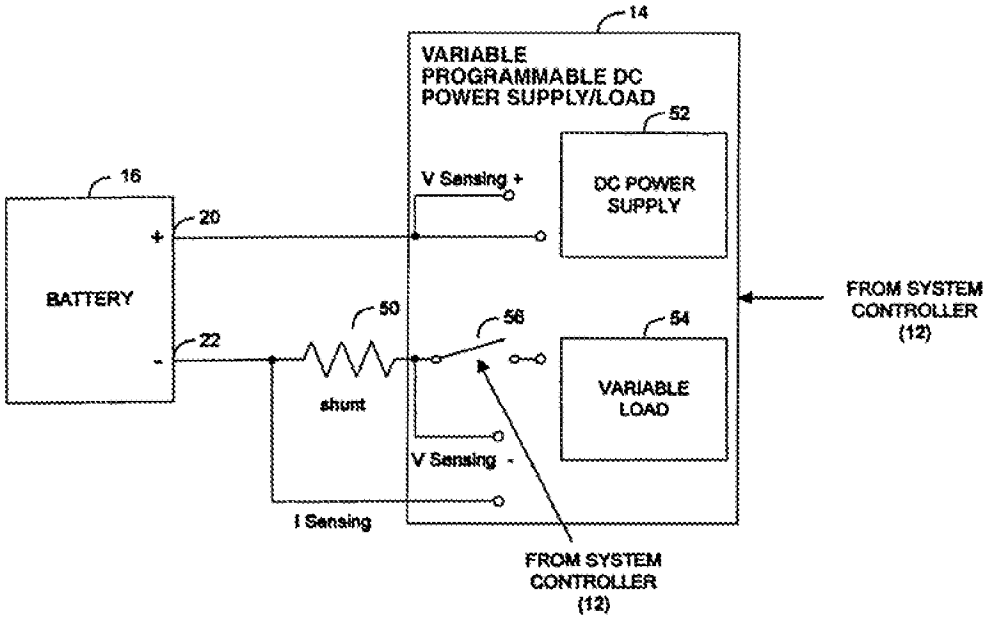


FIG._4

Ex. 1007, FIG. 4

(c) "an output port having positive and negative polarity outputs"

141. "Output port" means "a component through which power from an internal power supply is transmitted." Ex. 1005 at 15. Consistent with this construction, Klang discloses an output port having the positive and negative polarity outputs through which power from the internal power supply is transmitted. Specifically, referring to FIG. 1, Klang states "[t]he power supply and load 14 are coupled in a conventional manner to a battery 16 using conducting cables 18 which link the power supply and load 14 to the charging terminals 20, 22 of the battery 16." Ex. 1007, 5:17-19.

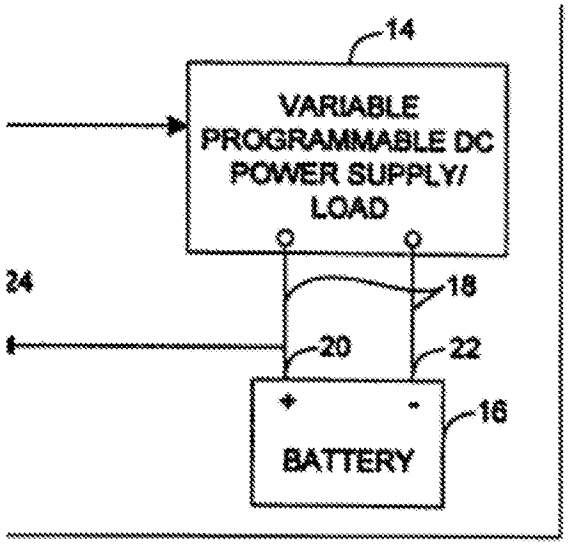


FIG._1

Ex. 1007, FIG. 1

(d) "a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs"

142. "Vehicle battery isolation sensor" means "a vehicle battery isolation sensor separate from the reverse polarity sensor." Ex. 1005 at 14. Consistent with this construction, Klang discloses a vehicle battery isolation sensor that is separate from a reverse polarity sensor and connected in circuit with the positive and negative polarity outputs, and detects presence of a vehicle battery connected between the positive and negative polarity outputs. Klang discloses a voltage sensor 46 shown in FIG. 3 connected in circuit with

the positive and negative polarity outputs of the output port (the leads 18 connected to the charging terminals 20, 22 of the battery 16). "As represented in FIG. 3, the exemplary diagnostic tester and charger is comprised of four DC sensors: a charging current sensor 42, a discharging current sensor 44, a voltage sensor 46, and a reverse polarity sensor 48. As illustrated, the voltage sensor 46 is connected in a conventional manner to measure the voltage across the terminals 20, 22 of the battery 16. The voltage across the battery terminals is read and attenuated by a voltage attenuator in order to match the input range of the analog-to-digital converters 38 residing in the system controller 12. The voltage sensor 46 is selected so as to be sensitive enough to reflect critical voltage changes with 0.01V accuracy." Ex. 1007, 6:8-19.

143. The voltage sensor 46 detects the presence of the battery 16 by detecting whether it is connected. "If the OCV is greater than −0.5V, at step 148, the OCV is compared to an extremely low voltage to determine whether a battery is connected." Ex. 1007, 8:55-58.

144. FIG. 3 of Klang shows the vehicle voltage sensor 46 as separate from a reverse polarity sensor 48.

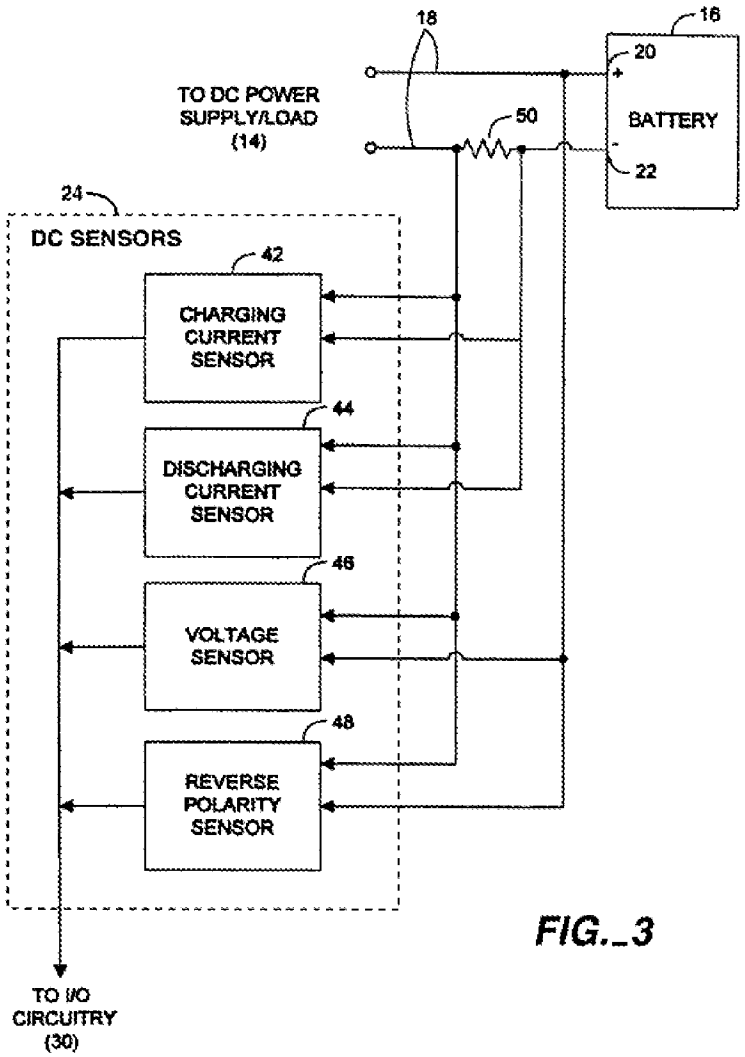


FIG._3

Ex. 1007, FIG. 3

(e) "a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port"

145. "Reverse polarity sensor" means a "reverse polarity sensor separate from the vehicle battery isolation sensor." Ex. 1005 at 14. Consistent with this construction, Klang discloses a reverse polarity sensor that is separate from a vehicle battery isolation sensor and is connected in circuit with the positive and negative polarity outputs, and detects polarity of a vehicle battery connected between the positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with the positive and negative polarity outputs of the output port.

146. Referring to FIG. 3, Klang states: "[t]he reverse polarity sensor 48, connected in a like manner across the battery terminals 20, 22, senses negative voltage indicating that the battery leads are connected backwards." Ex. 1007, 6:20-23. Klang's reverse polarity sensor provides an output signal (sensed negative voltage) indicating whether the battery has a proper polarity connection. Klang states: "[i]f the start button has not been pressed, at step 144, the OCV [battery open circuit voltage] is compared to a low negative voltage to determine whether the conducting cables 18 are properly connected to the battery 16. If the OCV is less than −0.5V, the method

proceeds at step 146 to notify the operator that the leads are reversed." Ex. 1007, 8:55-60.

147. FIG. 3 shows the reverse polarity sensor 48 of Klang as separate from the vehicle battery isolation sensor (the voltage sensor 46).

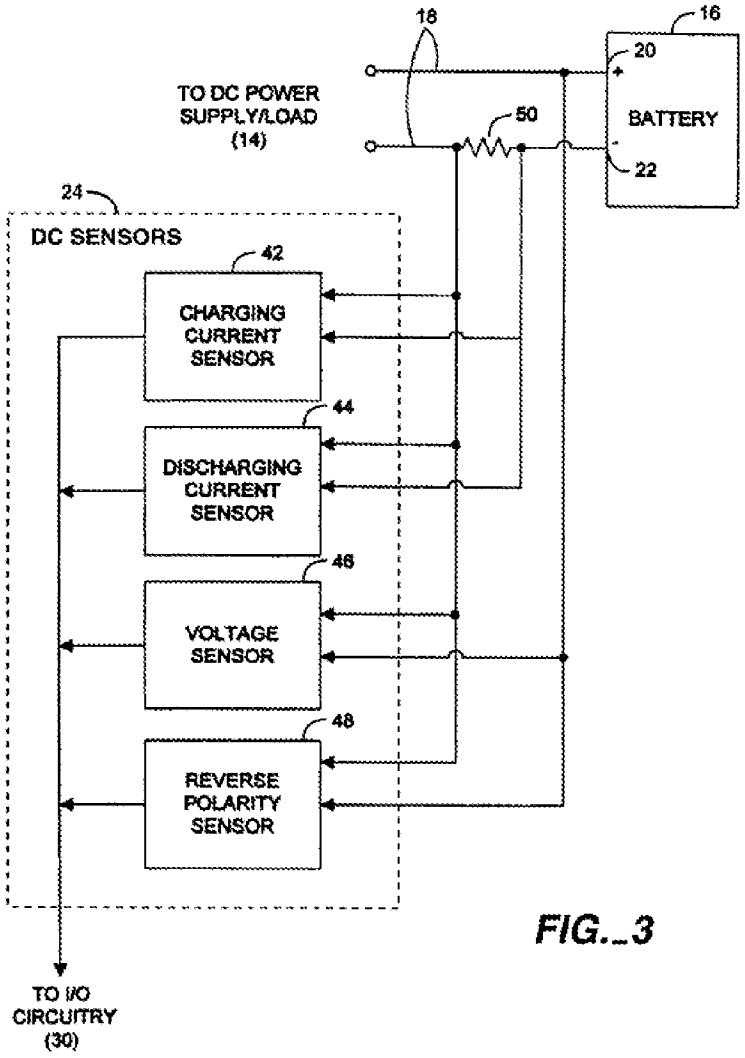


FIG._3

Ex. 1007, FIG. 3

(f) "a power switch connected between said internal power supply and said output port"

148. Klang discloses a power switch connected between the internal power supply and the output port. In FIG. 4 below, Klang discloses a switch 56 connected between the power supply 52 and the leads (output port) connected to the battery 16.

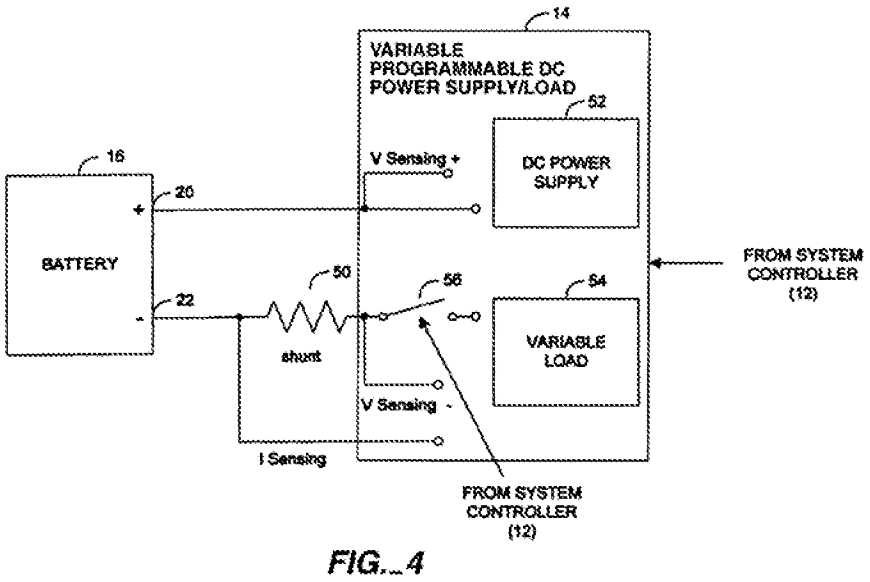


FIG._4

Ex. 1007, FIG. 4

149. Klang explains: "[d]uring the diagnostic test or charge, the system controller 12 may control means 56 such as a relay, a switch or the like to automatically connect the battery 16 to the circuit. For example, the switch 56 is open while measuring the open circuit voltage of the system. Conversely, the switch 56 is closed allowing current to flow across a shunt resistor 50 to

enable charging, discharging and current measurements to be taken." Ex. 1007, 7:7-14.

(g) "a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch"

150. Klang discloses a microcontroller receiving input signals from the vehicle isolation sensor and the reverse polarity sensor, and to provide an output signal to the power switch. Klang discloses a controller 12 in FIG. 1 receiving input signals from DC sensors 24 (which includes the voltage sensor 46 (a vehicle isolation sensor) and the reverse polarity sensor 48) and providing output signals to the variable programmable DC power supply/load 14 (containing the switch 56 in FIG. 4).

> Turning to the drawings and referring first to FIG. 1, a diagnostic tester and charging system 10 according to the invention comprises a system controller 12, a variable programmable DC power supply and load 14, DC sensors 24, conducting cables 18 and a battery 16. The system controller 12 is coupled to the power supply 14 and includes control circuitry for regulating the output of the power supply 14. The power supply and load 14 are coupled in a conventional manner to a battery 16 using conducting cables 18 which link the power supply and load 14 to the charging terminals 20, 22

of the battery 16. Depending on the amount of charge to be conveyed, the conducting cables 18 may comprise heavy-gauge copper wires or cabling compliant with National Electrical Code requirements. The DC sensors, which sense current and voltage across the battery terminals 20, 22, return the values thereof to the system controller 12 to which they are coupled. Ex. 1007, 5:10-25.

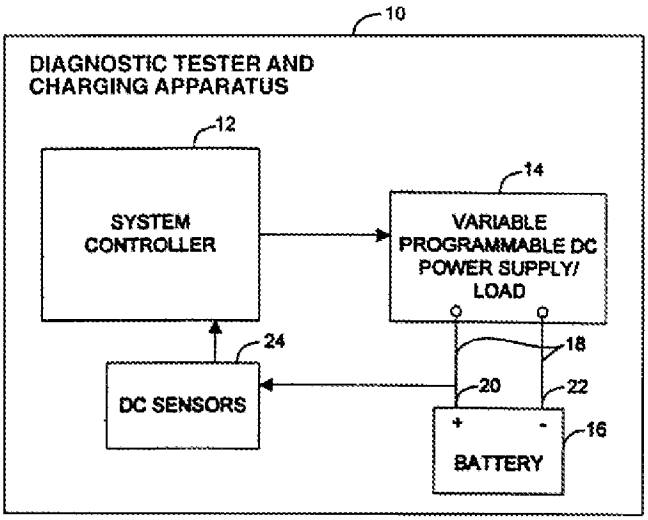


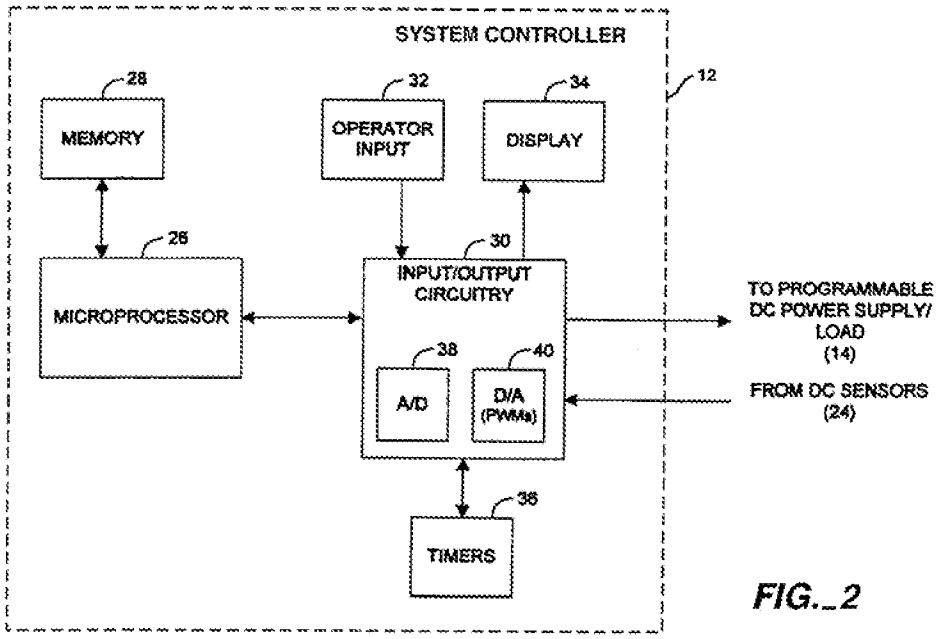
FIG._1

Ex. 1007, FIG. 1

151. Referring to FIG. 2, Klang states:

Shown in FIG. 2, the system controller 12 comprises a microprocessor 26, a memory 28, and input/output (I/O) circuitry 30 connected in a conventional manner. The memory 28 is comprised of random access memory (RAM), read-only memory (ROM) and the like. The I/O circuitry 30 is coupled to an operator input 32 that comprises the means

to input relevant operator commands and data, such as the rated CCA (Cold Cranking Amps) of the battery. The I/O circuitry 30 is also coupled to a display 34 that comprises the means to display relevant output messages, such as messages informing the operator on the status of diagnostic testing or charging, or messages prompting the operator to enter commands or data. The I/O circuitry 30 is further coupled to the power supply and load 14 and comprises the means to send commands originating in the microprocessor 26 to the power supply and load 14 and to send messages originating in the power supply and load 14 to the microprocessor 26. Ex. 1007, 5:27-44.



Ex. 1007, FIG. 2

152. "Input signals from said vehicle isolation sensor and said reverse polarity sensor" means "distinct input signals from said vehicle isolation sensor and said reverse polarity sensor, respectively." Ex. 1004 at 14. Consistent with this construction, FIG. 3 of Klang shows distinct input signals sent to I/O circuitry 30 of the controller 12 from the voltage sensor 46 and the reverse polarity sensor 48.

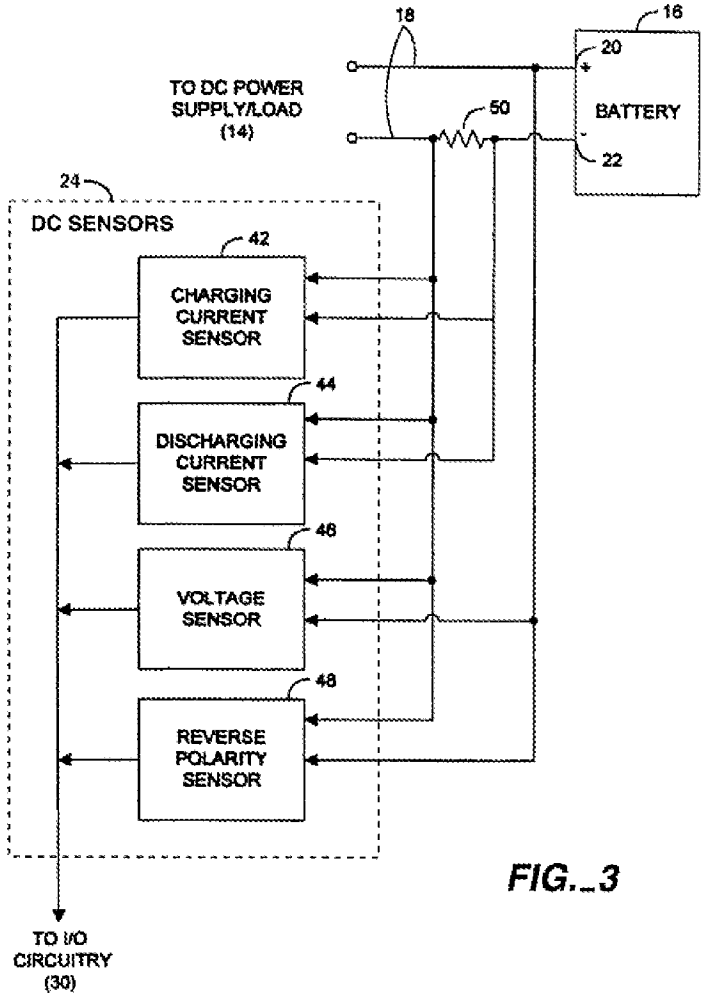


FIG._3

Ex. 1007, FIG. 3

(h) "[a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch] such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs"

153. Klang discloses the power switch being turned on to cause the internal power supply to be connected to the output port in response to signals from the sensors indicating (1) the presence of a vehicle battery at said output port and (2) proper polarity connection of positive and negative terminals of said vehicle battery with the positive and negative polarity outputs. Klang also discloses that the power switch is *not* turned on when signals from the sensors indicate either the absence of a vehicle battery at the output port or improper polarity connection of positive and negative terminals of the vehicle battery.

154. Klang discloses in FIG. 5 "a logic flow diagram illustrating the steps involved in performing the diagnostic battery test and battery charge

procedures according to the present invention." Ex. 1007, 4:10-13. Klang states "FIG. 6 is a logic flow diagram illustrating the particular steps involved in starting up the diagnostic tester and charging system." Ex. 1007, 4:14-16.

155. Klang states: "FIG. 5 illustrates the overall procedure used to implement the current invention. The exemplary testing/charging procedure begins in step 100 by connecting, in a conventional manner, the lead-acid battery to the diagnostic unit as illustrated in FIGS. 1-4. In step 102, the start-up procedure is invoked wherein proper connection of the battery to the diagnostic unit is verified, critical data is input by the operator via appropriate buttons and keys, and the voltage is measured." Ex. 1007, 7:49-57. (This "start-up" process is further described in FIG. 6 as discussed below.) Once the start-up process has been successfully completed and other steps such as checking if the battery is bad have been performed, the battery is charged. "If the battery is not judged "bad," however, at step 114 the charger will be turned on and the battery will be charged and checked in accordance with the rapid interactive stepping procedure at step 116." Ex. 1007, 8:5-8.

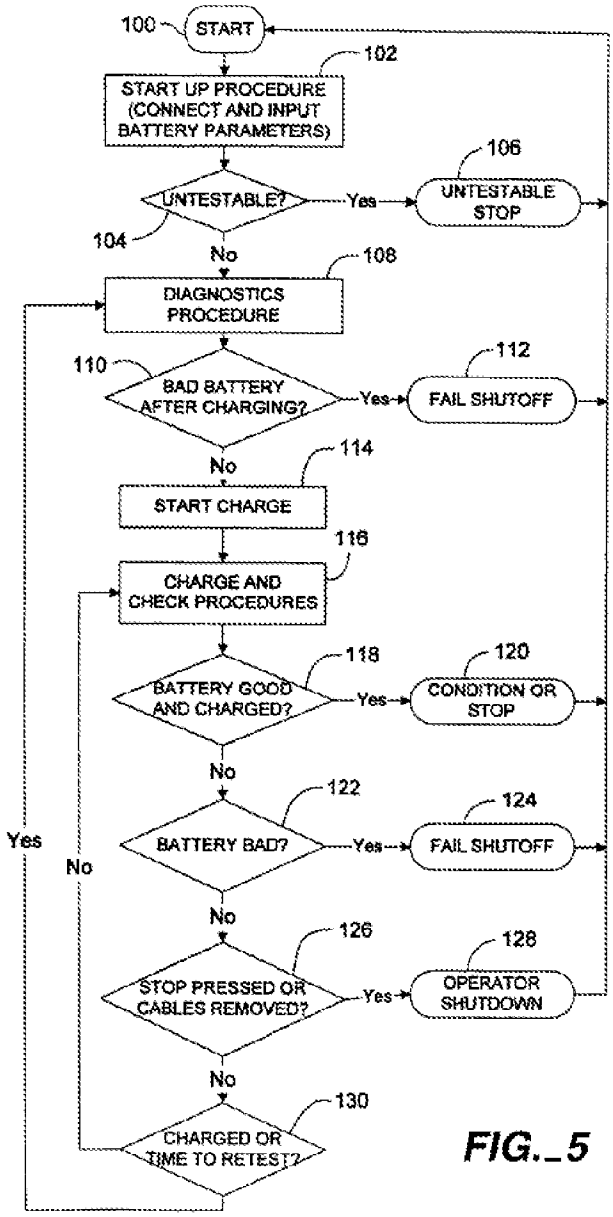
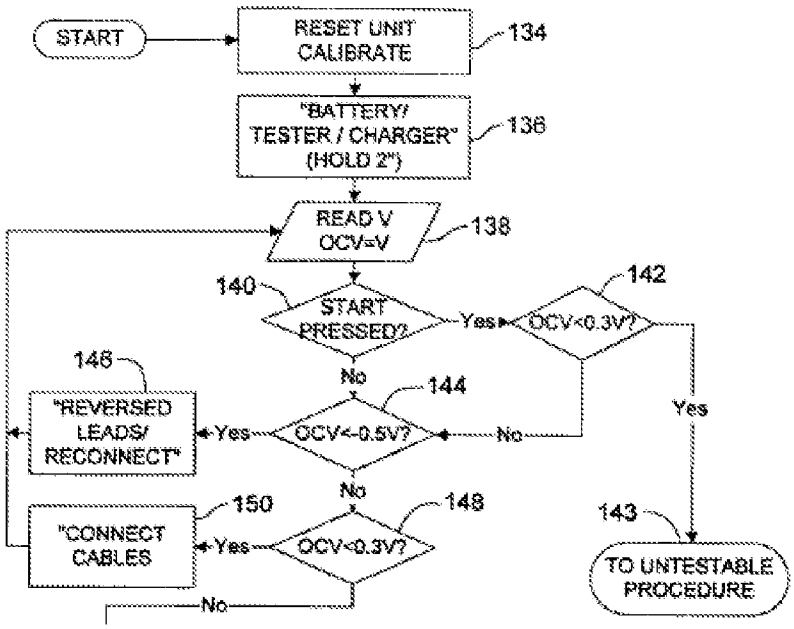


FIG._5

Ex. 1007, FIG. 5

156. FIG. 6 depicts the start-up process, which includes detecting (1) the presence of a vehicle battery at the output port and (2) proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.



Ex. 1007, FIG. 6

157. Klang states:

After the short delay, at step 138 the diagnostic tester measures the battery open circuit voltage (OCV) with a switch 56 such that the voltage sensor 46 and reverse polarity sensor 48 read the voltage across the battery terminals 20, 22 without any load or charge. In all, steps 138 through 150 determine whether the battery to be tested is properly connected to the diagnostic unit. For example, at step 140, the diagnostic unit determines if the operator has pressed the start button. If the start button has been pressed, at step 142, the OCV is compared to an extremely low voltage to determine whether the battery is testable. If the battery's OCV is

> less than 0.3V, the method proceeds at step 143 to run the untestable procedure which notifies the operator that the battery is untestable. (See FIG. 17). If the start button has not been pressed, at step 144, the OCV is compared to a low negative voltage to determine whether the conducting cables 18 are properly connected to the battery 16. If the OCV is less than −0.5V, the method proceeds at step 146 to notify the operator that the leads are reversed. If the OCV is greater than −0.5V, at step 148, the OCV is compared to an extremely low voltage to determine whether a battery is connected. If the OCV is less than 0.3V, indicating that a battery is not connected, the method proceeds at step 150 to display a message instructing the operator to connect the cables. Ex. 1007, 8:41-65.

158. Thus, Klang discloses unless the voltage measurement made by the voltage sensor 46 at step 148 indicates the presence of the battery (i.e., it is connected) and the voltage measurement made by the reverse polarity sensor 48 at step 144 indicates that the battery is connected with proper polarity, the charging process cannot occur, i.e., the power switch cannot be turned on. Ex. 1002, ¶230.

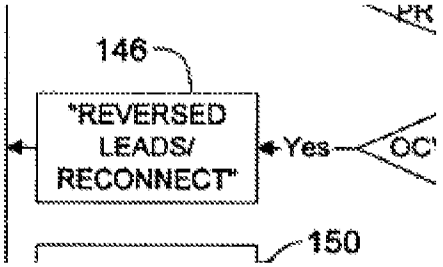
2. Klang anticipates Claim 17

159. Claim 17 depends from claim 1, and requires "a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity."

160. Klang states "[i]f the start button has not been pressed, at step 144, the OCV is compared to a low negative voltage to determine whether the conducting cables 18 are properly connected to the battery 16. If the OCV is less than −0.5V, the method proceeds at step 146 to notify the operator that the leads are reversed." Ex. 1007, 8:55-60. Thus, Klang warns a user when a vehicle battery is connected with reverse polarity. A visual indicator provides this warning. Klang discloses outputting messages on a display 34. "The I/O circuitry 30 is also coupled to a display 34 that comprises the means to display relevant output messages, such as messages informing the operator on the status of diagnostic testing or charging, or messages prompting the operator to enter commands or data." Ex. 1007, 5:34-39.

161. Regarding FIG. 6, Klang states: "the method proceeds at step 146 to notify the operator that the leads are reversed." Ex. 1007, 8:59-60. Step 146 in the figure identifies text ("REVERSED LEADS / RECONNECT") in quotations, which indicates that the text is displayed to

the operator. Thus, Klang discloses a visual indicator warning a user when a vehicle battery is connected with reverse polarity, as recited in claim 17.

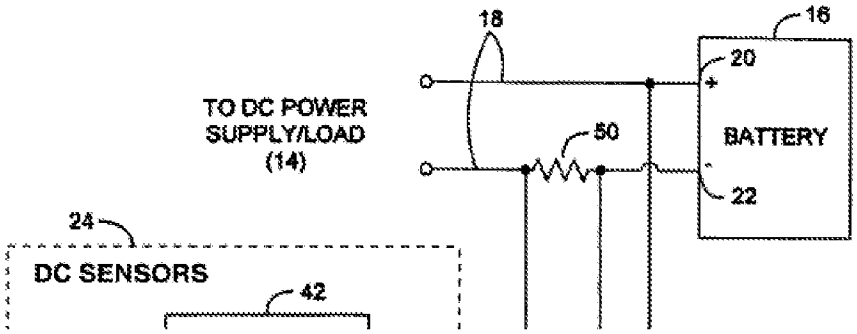


Ex. 1007, FIG. 6

3. Klang anticipates Claim 21

162. Claim 21 depends from claim 1, and requires "a jumper cable device including a plug configured to plug into said output port, a pair of cables integrated with the plug at one respective end thereof and being configured to be connected to terminals of a battery at another respective end thereof." Klang meets this limitation.

163. Klang's FIG. 3 shows a cable 18 connected between DC power supply/load 14 and battery 16. "The power supply and load 14 are coupled in a conventional manner to a battery 16 using conducting cables 18 which link the power supply and load 14 to the charging terminals 20, 22 of the battery 16. Depending on the amount of charge to be conveyed, the conducting cables 18 may comprise heavy-gauge copper wires or cabling compliant with National Electrical Code requirements." Ex. 1007, 5:17-23.



Ex. 1007, FIG. 3

I. Ground 9: Claims 4 and 5 would have been obvious from Klang and Krieger

164. Claims 4 and 5 would have been obvious from Klang and Krieger.

165. Klang and Krieger both relate to depleted vehicle batteries. Krieger discloses a portable jump starter for a vehicle with a depleted battery. Klang discloses rapidly charging depleted vehicle batteries. Klang and Krieger are similar in function and both include a power source, cable clamps for connecting the output ports to a vehicle battery, sensors for detecting the presence of a vehicle battery and reverse polarity connections, a power switch, and a microcontroller for actuating the power switch in response to signals from the sensors. A POSITA would recognize that the improvements provided by features in Krieger would improve Klang's device. Ex. 1002, ¶240.

1. Claim 4 would have been obvious from Klang and Krieger

166. Claim 4 depends from claim 1, and requires "said power switch comprises a plurality of FETs in parallel."

167. Please refer to the discussion of Krieger and claim 4 in ¶¶87-88 of Ground 3.

168. Substituting the switch in Klang's battery charger with Krieger's solid state switch comprising a plurality of FETs in parallel would have been obvious. A POSITA would have been particularly motivated to use the solid state switch comprising a plurality of FETs in Klang's apparatus to avoid or reduce electro-mechanical components, as suggested by Krieger.

2. Claim 5 would have been obvious from Klang and Krieger

169. Claim 5 depends from claim 1, and requires "said vehicle isolation sensor and reverse polarity sensor comprise optically coupled isolator phototransistors." Please refer to the discussion of Krieger and claim 5 in ¶¶90-93 of Ground 3 above.

170. A POSITA would be particularly motivated to use opto-couplers of the type discloses by Krieger for sensing the presence of a vehicle battery and a correct polarity connection because Krieger's opto-

coupler is an inherently digital device, giving a '1' or a '0' output. This can be preferable over analog inputs to the microcontroller, which may be subject to tests to determine if the vehicle battery is present or reversed. A POSITA would be motivated to simplify Klang by using an optical coupler for one or both sensing functions to, e.g., provide a more compact battery charger.

J. Ground 10: Claim 22 would have been obvious from Klang and Richardet

171. Klang and Richardet both disclose charging vehicle batteries. Ex. 1014, 2:33-36. Richardet discloses "means to provide a battery terminal connection which provides secure and stable connection to a motor vehicle battery or the like adaptable to a variety of common scenarios and which is simple and quick for an average user." Ex. 1014, 1:60-65.

172. Claim 22 depends from claim 21, and requires that "said jumper cable device further comprises a pair of ring terminals configured to respectively connect said pair of cables at said another end thereof with one of a battery terminal and a battery terminal clamp."

173. Please refer to the discussion of the teachings of Richardet and claim 22 in ¶¶ 128-133 of Ground 7 above.

174. Combining Richardet's cable system with ring terminals in Klang's battery charger would have been obvious to a POSITA to provide a secure and stable connection to a motor vehicle battery in a way that is simple and quick for an average user, as suggested by Richardet.

K. Ground 11: Claim 23 would have been obvious from Klang and Lei

175. Claim 23 depends from claim 21, and requires "said output port and said plug are dimensioned so that the plug will fit into the output port only in one specific orientation." Claims 23 would have been obvious from Klang and Lei.

176. Klang relates to rapidly charging vehicle batteries. Ex. 1007, Abstract. Klang and Lei both disclose conducting cables for connecting the output ports of the devices to a vehicle battery. Ex. 1007, 5:15-19.

177. Please refer to the discussion of Lei and claim 23 in ¶¶79-80 of Ground 7 above.

178. A POSITA would have been motivated to incorporate the insertable anti-reverse connector disclosed by Lei in Klang's battery charging system for safety or convenience for the user.

VII. CONCLUSION

179. Claims 1-23 of the '015 patent are therefore unpatentable. Petitioner requests institution of an IPR to cancel those claims.

VIII. CERTIFICATION OF GROUND FOR STANDING

180. Petitioner certifies pursuant to 37 C.F.R. §42.104(a) that the patent for which review is sought is available for IPR and that Petitioner is not barred or estopped from requesting an IPR challenging the patent claims on the grounds identified in this Petition.

IX. MANDATORY NOTICES

A. Real Party in Interest

181. Shenzhen Carku Technology Co., Ltd., a company based in China, is the real party-in-interest ("RPI") and is the only party currently directing, controlling, and funding this IPR.

B. Related Matters

182. The '015 patent (Ex. 1001) has been asserted by the NOCO Company in the following litigations:

- Shenzhen Anband Technology Co., Ltd., No. 1:17-cv-02205 (N.D. Ohio), filed on October 19, 2017 (default judgment entered August 6, 2018; motion to enforce default judgment filed March 16, 2020)

- SZ Jingxinghui Electronics Technology Co., Ltd., No. 1:17-cv-02208 (N.D.Ohio), filed on October 19, 2017 (default judgment entered July 27, 2018)
- Shenzhen ChangXinYang Technology Co. Ltd., No. 1-17-cv-02209 (N.D. Ohio), filed on October 19, 2017 (pending)
- Shenzhen Valuelink ECommerce Co., Ltd., No. 1-17-cv-02210 (N.D. Ohio), filed October 19, 2017 (pending)
- Shenzhen Dika Na'er E-Commerce Co., Ltd., No. 1-17-cv-02282 (N.D. Ohio) filed on October 30, 2017 (stipulation for dismissal with prejudice, pursuant to Rule 41(a)(1)(A)(ii) of the Federal Rules of Civil Procedure, filed January 9, 2020)
- Halo2Cloud, LLC, and QVC, Inc., No. 1:18-cv-01423 (D. Del.), filed on September 9, 2018 (notice of voluntary dismissal with prejudice, filed December 3, 2018)
- SmarTech Products, Inc., No. 1:18-cv-2789 (N.D. Ohio), filed November 30, 2018 (pending)
- Shenzhen Lianfa Tong Technology Co., Ltd.; Shenzhen Bi Te Yi Technology Co., LTD; and Shenzhen Mediatek Tong Technology Co., Ltd. l, No. 1:19-cv-01855 (N.D. Ohio), filed August 14, 2019 (pending)

- Sictec Instruments Company Limited, No. 1:19-cv-01856 (N.D. Ohio), filed August 14, 2019 (notice of dismissal under FRCP 41(a)(1) without prejudice, file March 13, 2020)
- TII Trading Inc., et al., No., 2:19-cv-07127 (C.D.Cal.) filed August 15, 2019 (pending)
- Sunvalleytek International, Inc., No. 5:19-cv-04907 (N.D. Cal.), filed August 15, 2019 (pending)
- Deltona Transformer Corporation, No. 6:20-cv-00050 (M.D.Fla.), filed January 9, 2020 (pending)
- Medcursor, Inc., No. 2:20-cv-01358 (S.D. Ohio), filed March 13, 2020 (pending)
- Nekteck, Inc., No. 2:20-cv-01356 (S.D. Ohio), filed March 13, 2020 (pending)

183. Petitioner may have sold at least some of the accused products allegedly sold by the defendants named in the following cases, but Petitioner was not served in any manner (via the Hague Convention or otherwise) with a complaint alleging infringement of the '015 patent: Noco Company Inc. v. Shenzhen Anband Technology Co., Ltd. (case no. 1:17-cv-02205, N.D.

Ohio); Jingxinghui Electronics Technology Co., Ltd. case (case no. 1:17-cv-02208, N.D. Ohio); Sunvalleytek International, Inc. case (case no. 5:19-cv-04907, N.D. Cal.); the Sictec Instruments Company Limited case (case no. 1:19-cv-01856, N.D. Ohio); the Halo2Cloud, LLC, and QVC, Inc., case (case no. 1:18-cv-01423, D. Del.); the Medcursor, Inc. case (case no. 2:20-cv-01358, S.D. Ohio;) and the Nekteck, Inc. case (case no. 2:20-cv-01356, S.D. Ohio).

184. Additionally, claims 1-21 and 23 of the '015 patent were previously challenged by Dongguan Juxing Power Co., Ltd., in Dongguan Juxing Power Co., Ltd. v. the NOCO Company, IPR2018-00503 (P.T.A.B.), filed January 15, 2018, with a Decision Denying Institution issued on July 11, 2018.

C. Lead and Back-up Counsel

Lead Counsel: Philip C. Swain (Reg. No. 32,376)

Back-up Counsel: Rajesh Vallabh (Reg. No. 35,761)

Yichen Cao, Ph.D. (Reg. No. 73,489)

Petitioner agrees to accept service by email.

D. Service Information

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Telephone number: 617-832-1000

Facsimile number: 617-832-7000

E. Fee for *Inter Partes* Review (37 C.F.R. §42.103)

185. The Director is authorized to charge the fee specified by 37 C.F.R. §42.15(a) and any other required fees to Deposit Account No. 06-1448.

Respectfully submitted,

Dated: May 14, 2020

/Philip C. Swain/
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Email: pcs@foleyhoag.com

Counsel for Shenzhen Carku Technology Co., Ltd.

CERTIFICATE OF COMPLIANCE

This Petition complies with the type-volume limitations of 37 C.F.R. §42.24(a)(1)(i) because, according to the "word count" function of Microsoft Word 2016, the Petition contains 13,988 words, excluding the parts of the Petition exempted from the word count by 37 C.F.R. §42.24(a)(1).

/Philip C. Swain/
Philip C. Swain, Reg. No. 32,376

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§42.6(e)(4) and 42.105, the undersigned certifies that on this date, a true and correct copy of this document (Petition for IPR), and every Exhibit filed with this document, was served by Federal Express overnight service on the current correspondence address of record for U.S. Patent No. 9,007,015:

Vorys, Sater, Seymour and Pease LLP

1909 K St., NW, 9th Floor

Washington DC 20006-1152

Dated: May 14, 2020

/Philip C. Swain/
Philip C. Swain, Reg. No. 32,376

AO 120 (Rev. 08/10)

TO:	Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Northern District of Ohio, Eastern Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
1:17-cv-02282	10/30/2017	for the Northern District of Ohio, Eastern Division

PLAINTIFF	DEFENDANT
The NOCO Company, Inc.	Shenzhen Dika Na'er E-Commerce Co., Ltd.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	9,007,015	4/14/2015	The NOCO Company
2			
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

IN THE UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF FLORIDA
ORLANDO DIVISION

THE NOCO COMPANY, an Ohio corporation, Plaintiff, v. DELTONA TRANSFORMER CORPORATION, a Florida Corporation. and DELTRAN USA, LLC, a Florida Limited Liability Company Defendants.	Case 6:20-cv-00050-PGB-GJK

DEFENDANT DELTRAN USA, LLC'S INVALIDITY CONTENTIONS

Defendant Deltran USA, LLC ("Deltran") submits its Invalidity Contentions ("Invalidity Contentions") with respect to United States Patent No. 9,007,015 ("the '015 Patent"). Pursuant to the Case Management and Scheduling Order in this action (Doc. 30 at 3-4) and this Court's order dated May 7, 2020 (Doc. 38), Deltran's "Disclosure of Non-Infringement and Invalidity Contentions" are due no later than May 13, 2020. This document contains Deltran's Invalidity Contentions. The Non-Infringement Contentions are contained in a separate document served herewith.

On April 6, 2020, Plaintiff The NOCO Company, Inc. ("NOCO" or "Plaintiff") served its Disclosure of Infringement Contentions ("Infringement Contentions"). In those contentions,

NOCO asserted infringement of claims 1-3, 9-13, 15, 17, and 19 of the '015 Patent (the "Asserted Claims").

The Asserted Claims are invalid because they are anticipated or rendered obvious under 35 U.S.C. §§ 102 and 103; are not enabled and/or lack written description under 35 U.S.C. § 112(a); and/or are indefinite under 35 U.S.C. § 112(b).

These Invalidity Contentions reflect Deltran's knowledge, thinking, and contentions as of the date of service. The disclosures are based upon Deltran's current knowledge, information, or belief. Discovery and Deltran's search for prior art are ongoing and are expected to include additional patents and printed publications as well as prior art products, some details of which are in the possession, custody, and control of Plaintiff and third parties. Expert discovery has not yet begun. Furthermore, Deltran has received limited documents from NOCO and minimal third-party discovery. Additionally, to the extent the Court's claim construction renders additional prior art relevant to invalidity, Deltran reserves the right to supplement these contentions.

The parties have not exchanged proposed claim constructions, and the Court has not issued a claim construction ruling. Deltran's contentions are based in part on the implied claim constructions in NOCO's Infringement Contentions against Deltran. Deltran's reliance on NOCO's Infringement Contentions does not mean that Deltran agrees with NOCO's contentions or implied constructions. Rather, Deltran has attempted to disclose the invalidating prior art and other grounds for invalidity of which they are currently aware based on their understanding of the scope of NOCO's contentions. Nothing in Deltran's Invalidity Contentions should be presumed to represent Deltran's position regarding the construction of

any claim terms except to the extent the terms identified as indefinite are not capable of construction. Deltran's positions in its Invalidity Contentions do not constitute any concession by Deltran for purposes of infringement. *See, e.g.*, *Vanmoor v. Wal-Mart Stores, Inc.*, 201 F.3d 1363, 1366 (Fed. Cir. 2000).

In addition, Deltran's identification of prior art disclosures that anticipate or render obvious a particular claim limitation is not an admission that the claim limitation satisfies the requirements of 35 U.S.C. § 112. Where Deltran asserts that an asserted claim is invalid under 35 U.S.C. § 112, Deltran nonetheless has provided prior art disclosures that anticipate or render obvious the Asserted Claim on the assumption that NOCO will contend the claim is definite.

Deltran reserves the right to present additional items of prior art under 35 U.S.C. § 102, or § 103 located during the course of discovery or further investigation. In addition, Deltran reserves the right to assert further grounds of invalidity under 35 U.S.C. §§ 102 and 103 to the extent that discovery or further investigation yields information forming the bases for such invalidity. Deltran further reserves the right to modify and supplement, without prejudice, their Invalidity Contentions in response to any findings as to the priority date(s) of the Asserted Claims; the Court's construction of the Asserted Claims; positions otherwise taken by NOCO or their expert(s) concerning claim construction, infringement, equivalents, or invalidity issues; or any amendment by NOCO of their Infringement Contentions, in accordance with the Federal Rules of Civil Procedure and other applicable rules and statutes.

I. PRIOR ART

Subject to the reservations above, Deltran identifies each item of prior art presently known that anticipates or renders obvious the Asserted Claims. The patents/applications,

publications, and systems identified are also relevant for their showing of the state of the art and reasons and motivations for making improvements, additions, and combinations.

A. Prior Art Patents

Deltran identifies the patents and published applications set forth below as prior art references, each of which anticipates or renders obvious (alone or in combination with other references) one or more of the Asserted Claims of the patents-in-suit under 35 U.S.C. § 102 or § 103. Prior art patents and applications included in these contentions may be related (such as a divisional, continuation, continuation-in-part, parent, or child) to earlier- or later-filed patents or publications, may have counterparts filed in other jurisdictions, or may incorporate (or be incorporated by) other patents or publications by reference. The listed patents and applications are intended to be representative of those other patents or publications to the extent they exist and includes all earlier published and/or filed related and/or incorporated references disclosed in those documents. Deltran accordingly reserves the right to modify, amend, or supplement these contentions with those related patents or patent applications, as well as other prior art references, upon further investigation.

Table 1 – Prior Art Patents/Publications

Country of Origin	Number	First Named Inventor	Title	Effective Prior Art Date	Issue/ Publication Date
U.S.	2015/0137740	Allos	System and Method for Mobile Charging	11/13/2013*	5/21/2015
WO	2012/080996	Tracy	A JUMP STARTER	12/16/2010*	6/21/2012
U.S.	2005/0116688	YIN	Power source with an anti-reverse connection and	11/28/2003*	6/2/2005

Country of Origin	Number	First Named Inventor	Title	Effective Prior Art Date	Issue/ Publication Date
			short circuit protection circuit for starting motor vehicles		
U.S.	2006/0220610	Solberg	Power management controller	4/5/2005	10/5/2006
EP	0 616 409	Herbert	Portable electrical power supply	9/21/1994	9/21/1994
U.S.	2004/0239290	Krieger	Combination jump starter and high frequency charger	3/21/2003*	12/2/2004
U.S.	2003/0141845	Krieger	High frequency battery charger and method of operating same	1/25/2002*	7/31/2003
U.S.	6,822,425	Krieger	High frequency battery charger and method of operating same	1/25/2002*	11/23/2004
U.S.	2014/0368155	Chen	Smart vehicle rescue battery apparatus	6/18/2013	12/18/2014
U.S.	2006/0176011	Lui	Battery charger with polarity switching capability	2/7/2005	8/10/2006
U.S.	2001/0025618	Kelling	Capacitive remote vehicle starter	3/24/2000*	10/4/2001
U.S.	6,679,212	Kelling	Capacitive remote vehicle starter	3/24/2000*	1/20/2004
U.S.	2014/0084844	Weflen	Self-contained automotive battery booster system	9/23/2013*	3/27/2014
U.S.	9,809,183	Weflen	Self-contained automotive battery booster system	9/23/2013*	11/7/2017
U.S.	2004/0150373	Chan	Vehicle jump starter with polarity compensation	1/30/2003	8/5/2004

Country of Origin	Number	First Named Inventor	Title	Effective Prior Art Date	Issue/ Publication Date
U.S.	2012/0025766	Reade	Charging Apparatus and Portable Power Supply	7/27/2010*	2/2/2012
U.S.	9,153,978	Reade	Charging Apparatus and Portable Power Supply	7/27/2010*	10/6/2015
U.S.	2006/0244412	Bonzer	Automotive jump-starter with polarity detection, current routing circuitry and lighted cable connection pairs	5/2/2005	11/2/2006
U.S.	6,759,833	Chen	Charger capable of switching polarity	5/6/2003	7/6/2004
U.S.	3,590,357	Reid	Battery booster	11/5/1969	6/29/1971
U.S.	5,194,799	Tomant-schger	Booster battery assembly	3/11/1991	3/16/1993
U.S.	2014/0210399	Urschel	Portable electric power source for aircraft	1/25/2013	7/31/2014
U.S.	3,638,108	Channing	Method of testing an automobile battery and electrical system while in circuit, using a booster battery	4/28/1969	1/25/1972
WO	2012/036556	Eidsvig	Device for charging of rechargeable batteries	9/13/2010*	3/22/2012**
U.S.	2015/0306964	Wang	Automobile charger	4/28/2014*	10/29/2015
U.S.	9,525,297	Wang	Automobile charger	4/28/2014*	12/20/2016
WO	2011/113734	Reichow	On-board electrical system for a vehicle	3/13/2010*	9/22/2011**

Country of Origin	Number	First Named Inventor	Title	Effective Prior Art Date	Issue/ Publication Date
U.S.	2013/0162029	Reichow	On-board electrical system for a vehicle	3/13/2010*	6/27/2013
U.S.	9,243,601	Reichow	On-board electrical system for a vehicle	3/13/2010*	1/26/2016
U.S.	6,650,086	Chang	Automatic detecting and switching vehicle charger	11/26/2002	11/18/2003
U.S.	6,147,471	Hunter	Single-point direct current connector	10/1/1999	11/14/2000
U.S.	2004/0130298	Krieger	Microprocessor controlled booster apparatus with polarity protection	2/19/2002*	7/8/2004
U.S.	7,345,450	Krieger	Microprocessor controlled booster apparatus with polarity protection	2/19/2002*	3/18/2008
U.S.	2002/0041174	Purkey	Apparatus for providing supplemental power to an electrical system and related methods	10/10/2000*	4/11/2002
U.S.	6,426,606	Purkey	Apparatus for providing supplemental power to an electrical system and related methods	10/10/2000*	7/30/2002
U.S.	6,344,733	Crass	Portable jump-starting battery pack with charge monitoring system	1/31/2000*	2/5/2002
U.S.	5,281,904	Tomkins	Multi mode cordless battery charger	9/29/1992	1/25/1994
U.S.	2015/0054336	Liu	Mobile power bank	8/23/2013*	2/26/2015

Country of Origin	Number	First Named Inventor	Title	Effective Prior Art Date	Issue/ Publication Date
U.S.	9,506,446	Liu	Mobile power bank	8/23/2013*	11/29/2016
WO	2014/106407	Lei	Emergency power source	1/7/2013*	10/7/2014**
U.S.	2015/0340907	Lei	Emergency power source	1/7/2013*	11/26/2014
U.S.	9,954,391	Lei	Emergency power source	1/7/2013*	4/24/2018
U.S.	2008/0143290	Chavakula	Multi-Power Charger and Battery Backup System	12/19/2006	7/19/2008
U.S.	7,893,657	Chavakula	Multi-Power Charger and Battery Backup System	12/19/2006	2/22/2011
U.S.	2011/0175461	Tinaphong	Method and apparatus for harvesting energy	1/7/2010	7/21/2011
U.S.	8,362,745	Tinaphong	Method and apparatus for harvesting energy	1/7/2010	1/29/2013
USB Implementers Forum, Inc.			Battery Charging Specification, Revision 1.1	4/15/2009	4/15/2009

* The date shown is the date the U.S. or WIPO patent document is effective as prior art pursuant to 35 U.S.C. §102(d)(2). The document is also effective as prior art at least as of its actual filing date in the U.S. pursuant to 35 U.S.C. §102(d)(1).

** The date shown is the publication date of the WIPO patent document. The document is also effective as prior art at least as its actual filing date in the U.S. pursuant to 35 U.S.C. §102(d)(1).

C. Prior Art Offered for Sale or Publicly Used or Known

Deltran identifies products and systems (collectively "Product Prior Art") that were publicly known, in public use, offered for sale, sold, and/or invented in the U.S. (and not abandoned, suppressed, or concealed) prior to the purported effective filing date of the patents-

in-suit and/or prior to the alleged invention date of the claimed inventions. This Public Prior Art anticipates or renders obvious (alone or in combination with other references) one or more of the Asserted Claims of the patents-in-suit under 35 U.S.C. §§ 102(a), (b), (e), (g), and/or § 103(a).

Most notably, one of the accused products, the Battery Tender® Portable Power Pack, is a private label product based on a lithium ion battery jump starter that was publicly known and used and on sale prior to the priority date of the '015 patent. Accordingly, to the extent that NOCO is able to establish that such product infringes the '015 patent, NOCO admits, as a matter of law, that such product anticipates the '015 patent.

In addition, Deltran is currently investigating the dates of conception and reduction to practice of such Public Prior Art and when such Public Prior Art was first known or used by others. There were dozens of portable jump starters on the market prior to the priority date of the '015 patent, and others launched in the United States at approximately the same time as the '015 patent. Deltran is still investigating these prior art products and intends to seek third-party discovery as appropriate during the course of this litigation. Additionally, the Court's claim construction may cause additional prior art products to be invalidating. In the course of their investigation, Deltran may identify additional prior art documents describing these products and systems that may also anticipate and/or render obvious the one or more Asserted Claims of the patents-in-suit as invalidating printed publications. Deltran accordingly reserves the right to modify, amend, or supplement these contentions with those products, as well as other prior art references, upon further investigation. At present, Deltran identifies the following products as invalidating prior art.

Table 2 – Product Prior Art

Item Offered for Sale or Publicly Used or Known	Date Offered for Sale or Became Publicly Used or Known[1]	Identity of Person Offering for Sale or Making Use or Making
MICRO-START/PPS	As late as July 29, 2013	Antigravity Batteries
E-Power	As late as April 15, 2013	Carku
Battery Tender Power Pack	Prior to July 3, 2014	Carku/Deltran USA LLC
PowerAll	As late as March 26, 2014	Gryphon Mobile Electronics LLC
Electromate 400	As late as 2013	Black & Decker

[1] Deltran will further develop the facts as to the dates these products were offered for sale or became publicly used or known as discovery progresses.

II. INVALIDITY UNDER 35 U.S.C. §§ 102 AND 103

The '015 Patent also is invalid as anticipated under 35 U.S.C. §§ 102(a), (b), or (e) or rendered obvious under 35 U.S.C. § 103, as set forth below.[2] The '015 Patent, under NOCO's apparent understanding of the Asserted Claims in their Infringement Contentions, generally recite, with regard to claim 1, an apparatus for jump starting a vehicle that includes an internal power supply, an output port, a vehicle battery isolation sensor, a reverse polarity sensor, a power switch, and a microcontroller. *See* '015 Patent at 8:4-37 (claim 1). The vehicle battery isolation sensor is configured to detect the presence of a vehicle battery connected between the positive and negative polarity outputs of the output port. *Id.* at 8:9-12. The reverse polarity sensor is configured to detect the polarity of the vehicle batter and to provide an output signal indicating whether the battery is properly connected with the positive and negative outputs. *Id.* at 8:13-20. The microcontroller is configured to receive signals from the vehicle battery isolation and reverse polarity sensors and to output a signal to the power switch such that the power switch is turned on when the signals indicate the presence of a battery and proper polarity and is turned off when the signals do not indicate the presence of a batter or improper polarity. *Id.* at 8:21-37. The claims dependent on claim 1 recite limitations on the internal power source (claims 2-3), other well-known limitations regarding individual internal components (claims 4-9), USB ports (claims 10-11), various limitations regarding a light source (claims 12-18), a manual override switch (claims 19-20), and cable terminals (claims

[2] To the extent the Court disagrees with Deltrans's non-infringement, § 112 lack of written description and § 112 indefiniteness positions, the obviousness and anticipation positions, if considered inconsistent, are offered in the alternative.

21-23). *See Id.* at 8:38-10:22. NOCO did not "invent" any of these features. Rather, the '015 Patent merely combines prior art elements according to known methods to yield predictable results and therefore are invalid for obviousness.

Accordingly, to the extent the references disclosed in Tables 1 and 2 above are found not to anticipate the '015 Patent, they render the Asserted Claims obvious under 35 U.S.C. § 103 either alone or in combination with the knowledge of a person of ordinary skill in the art or each other. It would have been obvious to the person of ordinary skill in the art as of the purported effective filing date of the '015 Patent to combine the various references cited herein so as to practice the Asserted Claims. The prior-art items render the claim obvious because, as discussed above, the missing feature was known to persons skilled in the art in the field at the time, and could have been added by those persons to the device or method disclosed by the prior art, and adding that known feature would yield predictable results, so that the subject matter of the claim as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art. *See KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007).

The motivation to combine comes from many sources, including the prior art (specific and as a whole), common knowledge, common sense, predictability, expectations, industry trends, design incentives or need, market demand or pressure, market forces, obviousness to try, the nature of the problem faced, or knowledge possessed by a person of ordinary skill. Deltran reserves the right to rely on the knowledge of those skilled in the art, the testimony of expert witnesses, or other prior art, to show that it would have been obvious to include the allegedly missing limitation and to explain the motivation to combine the prior art elements.

The combinations that render the Asserted Claim obvious are identified in the claim charts attached as Charts A (publications) and B (products)[3] (collectively, "Invalidity Charts") and listed in Table 4 below. These Invalidity Charts identify where specifically in each item of prior art each element of the Asserted Claims is found. Each Invalidity Chart identifies by citation the disclosures within the prior art reference(s) that teach the relevant claim elements, limitations, or rationale supporting the combination(s). The inclusion of certain exemplary combinations in these Invalidity Charts does not exclude other combinations. The combinations are not meant to be exhaustive. The discussions in the charts are only exemplary and not an exhaustive discussion of everywhere in the cited referenced where the claim element can be found or obviated. Deltran contends that it would have been obvious to a person of ordinary skill in the art to combine any of the various references cited herein so as to practice the Asserted Claim. Deltran reserves the right to identify additional specific combinations as well as to detail and explain such combinations. Deltran further reserves the right to amend or otherwise modify this disclosure if and when further relevant information is provided by NOCO or other circumstances change.

Table 3 – Invalidity Charts

Chart No.	References	§102 or 103
1	U.S. 2015/0137740 Allos and/or WO 2012/080996 Tracy and/or	§102 – claims 1-3, 9-13, 15, 17, and 19

[3] Included in the Products chart are certain documents that also qualify as publications – e.g., brochures, websites, advertisements, etc., and so their inclusion in the products chart should not lead to the inference that they only qualify as "on sale" prior art but rather may also qualify as published or public prior art as well.

	U.S. 2005/0116688 YIN and/or U.S. 2006/0220610 Solberg and/or EP 0 616 409 Herbert and/or U.S. 2004/0130298 (issued as US 7,345,450) Krieger and/or U.S. 2004/0239290 Krieger and/or U.S. 2003/0141845 Krieger and/or U.S. 2007/0285049 to Krieger and/or U.S. 2014/0368155 Chen and/or U.S. 2006/0176011 Lui and/or U.S. 2001/0025618(issued as US 6,679,212) Kelling and/or U.S. 2014/0084844 (issued as US 9,809,183) Weflen and/or U.S. 2004/0150373 Chan and/or U.S. 2012/0025766 (issued as US 9,153,978) Reade and/or U.S. 2006/0244412 Bonzer and/or U.S. 6,759,833 Chen and/or U.S. 3,590,357 Reid and/or U.S. 5,194,799 Tomantschger and/or U.S. 2014/0210399 Urschel and/or U.S. 3,638,108 Channing and/or WO 2012/036556 Eidsvig and/or U.S. 2015/0306964 (issued as US 9,525,297) Wang and/or WO 2011/113734 (issued as US 9,243,601) Reichow and/or U.S. 6,650,086 Chang and/or U.S. 6,147,471 Hunter and/or U.S. 2002/0041174 (issued as US 6,426,606) Purkey and/or U.S. 6,344,733 Crass and/or U.S. 5,281,904 Tomkins and/or U.S. 2015/0054336 (issued as US 9,506,446) Liu and/or U.S. 2015/0340907 (issued as US 9,954,391) Lei and/or U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula and/or U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong and/or USB Implementers Forum, Inc.	§103 – claims 1-3, 9-13, 15, 17, and 19

2	Antigravity Batteries MICRO-START/PPS and/or Carku E-Power and/or Deltran Battery Tender Power Pack and/or Gryphon Mobile Electronics LLC PowerAll and/or Black & Decker Electromate 400	§102 – claims 1-3, 9-13, 15, 17, and 19 §103 – claims 1-3, 9-13, 15, 17, and 19
	U.S. 2015/0137740 Allos alone (§102) or in combination (§103) with knowledge of a POSA and/or one or more of U.S. 2005/0116688 Yin, U.S. 2004/0239290 Krieger, U.S. 2007/0285049 Krieger, U.S. 2012/0025766 (issued as US 9,153,978) Reade, U.S. 2006/0244412 Bonzer, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2015/0340907 (issued as US 9,954,391) Lei, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	§102 – claims 1-3, 9, 15, 17, 19 §103 – claims 10-13
	U.S. 2005/0116688 Yin alone (§102) or in combination (§103) with knowledge of a POSA and/or one or more of WO 2012/080996 A1 Tracey, U.S. 2005/0116688 Yin, U.S. 2006/0220610 Solberg, EP 0 616 409 Herbert, U.S. 2004/0239290 Krieger, U.S. 2003/0141845 Krieger, U.S. 2004/0130298 (issued as US 7,345,450) Krieger, U.S. 2007/0285049 Krieger, U.S. 2012/0025766 (issued as US 9,153,978) Reade, U.S. 2006/0244412 Bonzer, U.S. 3,590,357 Reid, U.S. 5,194,799 Tomantschger, U.S. 2014/0210399 Urschel, U.S. 3,638,108 Channing, WO 2012/036556 Eidsvig, U.S. 2015/0306964 (issued as US 9,525,297) Wang, WO 2011/113734 (issued as US 9,243,601) Reichow, U.S. 6,650,086 Chang, U.S. 2002/0041174 (issued as US 6,426,606) Purkey, U.S. 6,344,733 Crass, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2015/0340907 (issued as US 9,954,391) Lei, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	§102 – claims 1, 12, 17 §103 – claims 2, 3, 9-11, 13, 15, 19

	U.S. 2006/0220610 Solberg alone (§102) or in combination (§103) with knowledge of a POSA and/or one or more of WO 2012/080996 A1 Tracey, U.S. 2005/0116688 Yin, EP 0 616 409 Herbert, U.S. 2004/0239290 Krieger, U.S. 2003/0141845 Krieger, U.S. 2004/0130298 (issued as US 7,345,450) Krieger, U.S. 2007/0285049 Krieger, U.S. 2012/0025766 (issued as US 9,153,978) Reade, U.S. 2006/0244412 Bonzer, U.S. 3,590,357 Reid, U.S. 5,194,799 Tomantschger, U.S. 2014/0210399 Urschel, U.S. 3,638,108 Channing, WO 2012/036556 Eidsvig, U.S. 2015/0306964 (issued as US 9,525,297) Wang, WO 2011/113734 (issued as US 9,243,601) Reichow, U.S. 6,650,086 Chang, U.S. 2002/0041174 (issued as US 6,426,606) Purkey, U.S. 6,344,733 Crass, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2015/0340907 (issued as US 9,954,391) Lei, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	§102 – claims 1, 9, 17, 19 §103 – claims 2, 3, 10-13, 15
	U.S. 2004/0239290 Krieger alone (§102) or in combination (§103) with knowledge of a POSA and/or one or more of U.S. 2015/0137740 Allos, WO 2012/080996 A1 Tracey, U.S. 2006/0220610 Solberg, EP 0 616 409 Herbert, U.S. 2007/0285049 Krieger, U.S. 2012/0025766 (issued as US 9,153,978) Reade, U.S. 2006/0244412 Bonzer, U.S. 3,638,108 Channing, U.S. 2015/0306964 (issued as US 9,525,297) Wang, U.S. 2002/0041174 (issued as US 6,426,606) Purkey, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2015/0340907 (issued as US 9,954,391) Lei, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	§102 – claims 1, 3, 11, 12, 15, 17, 19 §103 – claims 2, 9, 10-13
	U.S. 2004/0130298 (issued as US 7,345,450) Krieger alone (§102) or in combination (§103) with knowledge	§102 – claims 1, 3, 15, 17

	of a POSA and/or one or more of U.S. 2015/0137740 Allos, WO 2012/080996 A1 Tracey, U.S. 2005/0116688 Yin, U.S. 2006/0220610 Solberg, EP 0 616 409 Herbert, U.S. 2004/0239290 Krieger, U.S. 2003/0141845 Krieger, U.S. 2007/0285049 Krieger, U.S. 2012/0025766 (issued as US 9,153,978) Reade, U.S. 2006/0244412 Bonzer, U.S. 3,590,357 Reid, U.S. 5,194,799 Tomantschger, U.S. 3,638,108 Channing, U.S. 2015/0306964 (issued as US 9,525,297) Wang, WO 2011/113734 (issued as US 9,243,601) Reichow, U.S. 6,650,086 Chang, U.S. 2002/0041174 (issued as US 6,426,606) Purkey, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2015/0340907 (issued as US 9,954,391) Lei, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	§103 – claims 2, 9-13, 19
	U.S. 2007/0285049 Krieger alone (§102) or in combination (§103) with knowledge of a POSA and/or one or more of U.S. 2015/0137740 Allos, WO 2012/080996 A1 Tracey, U.S. 2005/0116688 Yin, U.S. 2004/0239290 Krieger, U.S. 2006/0244412 Bonzer, U.S. 2014/0210399 Urschel, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2015/0340907 (issued as US 9,954,391) Lei, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	§102 – claims 1, 3, 9, 10, 15, 17, 19 §103 – claims 2, 11-13
	U.S. 2004/0150373 Chan alone (§102) or in combination (§103) with knowledge of a POSA and/or one or more of U.S. 2015/0137740 Allos, WO 2012/080996 A1 Tracey, U.S. 2005/0116688 Yin, U.S. 2006/0220610 Solberg, EP 0 616 409 Herbert, U.S. 2004/0239290 Krieger, U.S. 2003/0141845 Krieger, U.S. 2004/0130298 (issued as US 7,345,450) Krieger, U.S. 2007/0285049 Krieger, U.S. 2001/0025618 (issued as US 6,679,212) Kelling, U.S. 2014/0084844 (issued as	§102 – claim 1 §103 – claims 2, 3, 9-13, 15, 17, 19

	US 9,809,183) Weflen, U.S. 2012/0025766 (issued as US 9,153,978) Reade, U.S. 2006/0244412 Bonzer, U.S. 3,590,357 Reid, U.S. 5,194,799 Tomantschger, U.S. 2014/0210399 Urschel, U.S. 3,638,108 Channing, WO 2012/036556 Eidsvig, U.S. 2015/0306964 (issued as US 9,525,297) Wang, WO 2011/113734 (issued as US 9,243,601) Reichow, U.S. 6,650,086 Chang, U.S. 2002/0041174 (issued as US 6,426,606) Purkey, U.S. 6,344,733 Crass, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2015/0340907 (issued as US 9,954,391) Lei, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	
	U.S. 2015/0306964 (issued as US 9,525,297) Wang alone (§102) or in combination (§103) with knowledge of a POSA and/or one or more of U.S. 2015/0137740 Allos, WO 2012/080996 A1 Tracey, U.S. 2004/0239290 Krieger, U.S. 2004/0130298 (issued as US 7,345,450) Krieger, U.S. 2007/0285049 Krieger, U.S. 2001/0025618 (issued as US 6,679,212) Kelling, U.S. 2014/0084844 (issued as US 9,809,183) Weflen, U.S. 2012/0025766 (issued as US 9,153,978) Reade, U.S. 2006/0244412 Bonzer, U.S. 3,590,357 Reid, U.S. 5,194,799 Tomantschger, U.S. 2014/0210399 Urschel, WO 2011/113734 (issued as US 9,243,601) Reichow, U.S. 6,650,086 Chang, U.S. 2002/0041174 (issued as US 6,426,606) Purkey, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2015/0340907 (issued as US 9,954,391) Lei, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	§102 – claims 1, 9, 15 §103 – claims 2, 3, 10-13, 17, 19
	U.S. 2015/0340907 (issued as US 9,954,391) Lei alone (§102) or in combination (§103) with knowledge of a POSA and/or one or more of U.S. 2015/0137740 Allos, WO 2012/080996 A1 Tracey, U.S. 2006/0220610	§102 – claims 1, 2, 9, 12, 13, 15, 17 §103 – claims 3, 10, 11, 19

	Solberg, U.S. 2004/0239290 Krieger, U.S. 2007/0285049 Krieger, U.S. 2012/0025766 (issued as US 9,153,978) Reade, U.S. 3,590,357 Reid, U.S. 5,194,799 Tomantschger, U.S. 3,638,108 Channing, WO 2011/113734 (issued as US 9,243,601) Reichow, U.S. 6,650,086 Chang, U.S. 2002/0041174 (issued as US 6,426,606) Purkey, U.S. 2015/0054336 (issued as US 9,506,446) Xinfang, U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula, U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong, USB Implementers Forum, Inc., Antigravity Batteries MICRO-START/PPS, Carku E-Power, Deltran Battery Tender Power Pack, Gryphon Mobile Electronics LLC PowerAll, Black & Decker Electromate 400	

While Deltran has identified citations in the references for the claim limitations, each and every disclosure of the same limitation in the same reference is not necessarily identified. In an effort to focus the issues, Deltran cites only portions of the references, even when a reference may contain additional support for or disclosure of a particular claim element. Where Deltran cites a particular figure, table, or image relating to a prior art reference, the citation should be understood to encompass any text referring or relating to the directly cited material, in addition to the directly cited material itself. Similarly, where a cited portion of text refers to a figure, table, or image, the citation should be understood to include the figure as well.

Deltran's reference to a prior art apparatus in these contentions should be interpreted as a reference to the product itself and any corresponding patents, publications, or product literature cited in these contentions that relates to the cited apparatus. In addition, Deltran may rely on other documents or things that have not yet been located to support their contentions regarding such prior art apparatuses that are referenced in these contentions. Any physical

embodiments of the references described in the Invalidity Charts that were publicly available during the relevant time period also constitute prior art.

For any claim limitation that NOCO alleges is not disclosed in a particular prior art reference, Deltran reserves the right to assert that such limitation is inherent, that the limitation would have been obvious to one of ordinary skill in the art at the relevant time, or that the limitation is disclosed in one or more prior art references that individually or in combination would have rendered the asserted claim obvious.

Deltran further reserves the right to identify and rely on additional art or teachings within the cited art. Unless otherwise stated, it should be presumed that Deltran intends to rely upon each reference in its entirety to the extent relevant or appropriate, including references cited in or referenced within the prior art identified below.

The prior art references produced by Deltran reflect the "state of the art" as of the purported effective filing date of the '015 Patent or the alleged invention date of the Asserted Claims. These references illustrate the scope and content of the prior art, the knowledge of those skilled in the relevant field, as well as the motivations of skilled persons to modify and combine known systems and components during the relevant time period. Persons of ordinary skill in the art read a prior art reference as a whole, and in the context of other publications and literature. Accordingly, Deltran may rely on uncited portions of the prior art references and on other publications and expert testimony to provide context, and as aids to understanding and interpreting the portions of references that are cited. Deltran may also rely on uncited portions of the prior art references, other publications, and the testimony of experts to establish that a

person of ordinary skill in the art would have been motivated to modify or combine certain of the cited references so as to render the claims obvious.

III. INVALIDITY BASED ON 35 U.S.C. § 112

The Asserted Claims are invalid under 35 U.S.C. § 112, first paragraph, for lack of written description and/or enablement, and second paragraph, for failing to particularly point out and distinctly claim the subject matter that the applicants regard as their invention. Deltran's invalidity contentions under 35 U.S.C. § 112 are set forth below.

In making these contentions, Deltran is not necessarily proposing a specific level of ordinary skill in the art, and these contentions are based at least in part on what NOCO may contend is the level of ordinary skill in the art. Deltran does not concede that NOCO's contentions as to the level of ordinary skill in the art are proper and may contest any such contentions. Deltran further reserve the right to modify and supplement, without prejudice, their Invalidity Contentions in light of positions taken by NOCO or their expert witness(es) concerning claim construction, infringement, equivalents or invalidity issues, or claim construction positions adopted by the Court.

Indefiniteness

The Asserted Claims are invalid as indefinite because they do not "particularly point[] out and distinctly claim[] the subject matter." 35 U.S.C. § 112(b). A patent is indefinite "if its claims, read in light of the specification delineating the patent, and the prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention." *Nautilus, Inc. v. Biosig Instruments, Inc.*, 134 S. Ct. 2120, 2124 (2014).

For example, the following claim terms are not reasonably certain and are nowhere defined or explained with specificity in the '015 Patent or prosecution history:

Claim	**Element**	**Reason for invalidity under 35 U.S.C. § 112, ¶ 1**
1	vehicle isolation sensor	This term lacks antecedent basis.
1	signals from said sensors	It is not possible to discern with reasonable certainty which signals are referred to because there is no recited signal from the vehicle isolation sensor

As a result, the claims fail to reasonably apprise those skilled in the art as to their scope when read in light of the specification, rendering the limits of the patent unknown.

V. DOCUMENT PRODUCTION

In connection with their disclosure of these contentions, Deltran also produces documents.

Dated: May 13, 2020

Respectfully submitted,

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CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on May 13, 2020, a true and correct copy of the foregoing document is being served via e-mail on counsel for Plaintiff, as follows:

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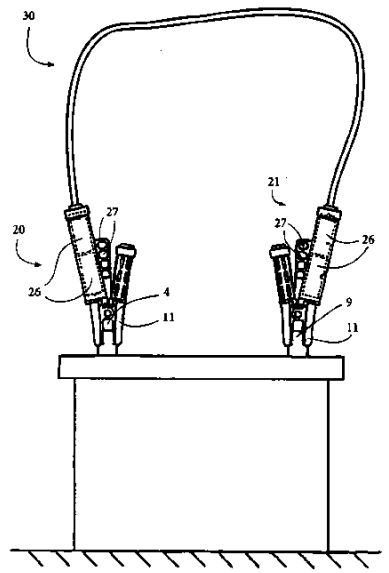
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Exhibit 1. Printed Publications

Claim No.	Claim	Printed Publications
1[PRE]	Apparatus for jump starting a vehicle engine, comprising:	To the extent the preamble is limiting, the following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, the limitation: **WO 2012/080996 A1 to Tracey et al.** Abstract ("A jump starter (1, 30, 50) for a flat battery, such as a vehicle battery…."); 1:7 ("This invention relates to a jump starter system for a battery, especially a vehicle battery."); 2:1-2 ("According to the invention, there is provided a jump starter for a battery such as a vehicle battery…."; 5:7-9 ("Referring to Figs. 1 and 2 there is illustrated a jump starter system 1 according to the invention. The jump starter system comprises a first crocodile clip 2 having a first handle 3 for connection to one terminal 4 of a flat vehicle battery 5."); Figure 2. 5/10  Fig.5

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Claim No.	Claim	Printed Publications
		U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger ¶3 [1:22-25] ("It is well known that when an engine of an automobile is not able to be started due to insufficient electric power, a battery of the automobile can be jump started by power from a battery of another automobile or from a battery in a booster device to thereby start the engine."); ¶9 [2:8-11] ("There is therefore a need for a self-contained jump starter system that can be used as a jump starter, tester, and diagnostic system for a vehicle to assist in performing vehicle diagnostics and minor vehicle repairs."); ¶35 [6:45-47] ("Once a proper polarity connection is made between the batteries, the depleted battery 11 is charged or the vehicle is jump started."); ¶43 [8:40-42] ("Referring now to FIG. 5, an example of a microprocessor controlled jump starter system according to an embodiment of the invention is described. The microprocessor 60 can be programmed to perform essentially all of the control functions needed for operation of the jump starter."); ¶49 [9:47-51] ("The microprocessor 60 may also be used to conduct a test of an alternator of a vehicle. When the alternator of a vehicle is working properly, the voltage level of the depleted battery 11 rises rapidly immediately after the battery is jump-started.") **U.S. 2003/0141845 [Issued as U.S. 6,822,425] to Krieger** ¶5 ("Dual-mode battery chargers currently exist. When operated in a first mode, the battery charger delivers a high current output for a short duration of time. This short duration, high current can be used to **jump-start a vehicle with a dead battery**.); ¶22 ("However, the boost circuit is adapted provide a high current that can be used to jump-start a vehicle with a depleted battery."); ¶41 ("The boost circuit 16 is used to provide a high current boost that can be used to jump-start a vehicle with a dead battery."); ¶48 ("Referring again to FIG. 1, boost circuit 16 is now described. Boost circuit 16 provides a high current pulse that can be used to jump-start a dead battery.") **U.S. 2004/0239290 to Krieger**

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Claim No.	Claim	Printed Publications
		Abstract ("A portable jump starter/charger combination includes a housing and a jump starter battery enclosed within the housing for providing a first DC output. A battery charger is also enclosed within the housing and provides a second DC output. A function selector switch has a first input coupled to the first DC output of the jump starter battery, a second input coupled to the second DC output of the charger and an output coupled to battery cables. The function selector switch is operative to selectively connect one of the first and second inputs to the output of the function selector for either jump starting a vehicle with a dead battery or charging the dead battery through the pair of battery cables."); ¶4 ("There are a number of portable jump starters for vehicles having a dead starter battery. Such units provide the ability to jump-start a motor when another vehicle's battery is not available to the motorist. Portable jump starters usually have an internal battery which is used to jump start the vehicle."); ¶24 ("This combination of the functionalities of a jump starter and a charger provides a motorist with the ability, not only to jump-start a vehicle with a dead battery, but also to charge the battery with the same cables used for jump-starting.") **U.S. 2007/0285049 to Krieger** ¶13 ("A **power source 20**, for example a battery, such as a sealed lead acid battery, a nickel cadmium battery, a nickel metal hydride battery or the like, may be disposed in the housing 10 (FIG. 3). The **battery 20** may be adapted to provide DC power for a variety of applications."); ¶17 ("The battery 20 may also be used to provide jumpstarting power for vehicles such as cars, RVs, and the like, which cannot start due to a depleted vehicle battery.") **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** Abstract ("An apparatus for providing power, the apparatus having a housing; a battery module positioned inside of the housing, the battery module having: a battery, a battery circuit board coupled to the battery and an ignition output port coupled to the battery circuit board; a circuit board positioned inside of the housing

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Claim No.	Claim	Printed Publications
		and coupled to the battery module, the circuit board having: a charge module, a discharge module, a lighting module and a control module coupled to the charge module, the discharge module and the lighting module; a light source coupled to the circuit board; and wherein the apparatus is configured to provide sufficient power to **jump start a vehicle**."); ¶2 [1:19-23] ("The present invention relates to mobile power technology and, more particularly, to a mobile power bank capable of charging electronic devices, jump starting an ignition system of a vehicle with a weak or dead battery, and operating as a flashlight."); ¶6 [1:45-49] ("The present invention according to an embodiment provides a mobile power bank, vehicle ignition system jump starter, and a flashlight. The mobile power bank is capable of jump starting a vehicle by providing power for a vehicle ignition and starter motor."); ¶7 [1:62-63] ("The apparatus is configured to provide sufficient power to jump start a vehicle."); ¶12 [2:65-3:6] ("The apparatus further comprises: a light source coupled to the circuit board; a charging port coupled to the charging module; at least one Universal Serial Bus interface coupled to the discharge module; and a Light Emitting Diode indicator module coupled to the circuit board and configured to indicate a charge level of the battery; wherein the apparatus is configured to provide sufficient power to jump start a vehicle at a voltage higher than about 13.6 volts."); ¶26 [4:5-7] ("If the vehicle battery power is low, the mobile power bank 10 can be used to jump start the ignition.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶5 ("An objective of the present invention is to provide an emergency power source, which is easy to be recharged, to output a high current for starting a vehicle and accurately control the outputting of high current."); ¶7 ("Input terminals of the battery pack are connected to output terminals of a charging circuit and a solar panel input circuit, output terminals of the battery pack are connected to a high current outputting circuit for outputting a high current used for starting a vehicle, and an external smart battery detection system is connected between the battery pack and the high current outputting circuit."); ¶20 ("The emergency power source of the present invention uses lithium-ion batteries as its battery pack, which have

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Claim No.	Claim	Printed Publications
		characteristics of light weight, small size, durability, high instantaneous discharging current and rechargeability, which can meet the demand of high current for starting a vehicle."); ¶26 ("As shown in FIGS. 1 to 3, an emergency power source includes a housing having at its inside a battery pack 4 for storing electric energy. Input terminals of the battery pack 4 are connected to output terminals of a charging circuit 1 and a solar panel input circuit 2, output terminals of the battery pack 4 are connected to a high current outputting circuit 7 for outputting a high current used for starting a vehicle, and an external smart battery detection system 6 is connected between the battery pack 4 and the high current outputting circuit 7."); ¶27 ("The emergency power source uses lithium-ion batteries as its battery pack, which has the characteristics of light weight, small size, durability, high instantaneous discharge current and rechargeability, which is capable of supplying a high current for starting a vehicle."); ¶31 ("The high current outputting circuit 7 has an output voltage of 12V DC or 24V DC, and an instantaneous current ranging from 100 A to 600 A, which can be used as a starting power source for vehicles in emergency.") **U.S. 2005/0116688 to Yin** ¶1 ("The present invention relates to a power source for starting motor vehicles and more particularly pertains to a power source with a circuit for protecting against reverse polarity connection and short circuit of the battery clamps during jump starting of a motor vehicle's engine."); ¶2 ("The present invention relates to a power source for starting motor vehicles and more particularly pertains to a power source with a circuit for protecting against reverse polarity connection and short circuit of the battery clamps during jump starting of a motor vehicle's engine."); ¶19 ("Power source with an anti-reverse connection and short circuit protection circuit for starting motor vehicles according to the present invention is hereinafter described with reference to FIGS. 1 to 3.") **U.S. 2014/0368155 to Chen**

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Claim No.	Claim	Printed Publications
		¶4 ("The vehicle rescue battery is used to connect to the vehicle battery to start the vehicle engine urgently if the power of the vehicle battery is not enough to start the vehicle engine (for example, the vehicle engine has not been started for a long time)."); ¶17 ("FIG. 1 shows a block diagram of the smart vehicle rescue battery apparatus of the present invention. A smart vehicle rescue battery apparatus 10 is applied to a vehicle battery 20. The smart vehicle rescue battery apparatus 10 is used to connect to the vehicle battery 20 to start a vehicle engine (not shown in FIG. 1) if the power of the vehicle battery 20 is not enough to start the vehicle engine.") **U.S. 2015/0137740 to Allos** ¶10 ("The mobile charging system 100 further includes at least two types of circuits, including a jump start and boost circuit 104, and the charging circuit 106. The jumpstart and boost circuit 104 may be employed to provide an immediate jumpstart to a battery."); *see also* U.S. Provisional Patent Application 61/903,779 at 2-3. **U.S. 2006/0220610 to Solberg** ¶2 ("The inventions relate to charging systems, and more particularly, to energy delivery systems that are capable of delivering current to a vehicle."); ¶5 ("When a battery is dead or weakened, it is sometimes necessary to recharge the battery to a level that can be used to start a vehicle. One common way of recharging a battery is by jumping it with another battery. To jump a battery, a second battery is connected in parallel with the dead or weakened battery."); ¶19 ("A portable charging system is capable of sourcing power to start a vehicle and support other vehicle systems."); ¶44 ("The term charging is intended to broadly encompass mechanisms and methods that source a current and/or voltage that is capable of starting a vehicle as well as other mechanisms and methods that may supplement another power source within or coupled to a vehicle.") The following references also disclose, teach, or suggest this element:

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Claim No.	Claim	Printed Publications
		EP 0 616 409 to Herbert, e.g., at ¶¶17, 36-37; U.S. 2001/0025618 to Kelling, e.g., at ¶22; U.S. 2014/0084844 to Weflen, e.g., at ¶49; U.S. 2004/0150373 to Chan, e.g., at ¶¶1, 19, 21; U.S. 2006/0244412 to Bonzer, e.g., at ¶4; U.S. 6,759,833 to Chen, e.g., at 1:11-23; U.S. 3,590,357 to Reid, e.g., at 1:4-35; U.S. 5,194,799 to Tomantschger, e.g., at 1:5-21; U.S. 6,650,086 Chang; e.g., at 1:12-19; U.S. 6,147,471 to Hunter, e.g., at 1:62-67; U.S. 2002/0041174 to Purkey, e.g., at ¶46; U.S. 6,344,733 to Crass, e.g., at 2:24-41; U.S. 5,281,904 to Tomkins, e.g., at 2:63-3:7
1[A]	an internal power supply;	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **WO 2012/080996 A1 to Tracey et al.** Abstract ("The clips are interconnected (10, 28, 53) and **on-board starter batteries (15, 26)** are provided along the interconnecting cable (10) and/or at least one of the clips (20, 21). The **on-board starter battery (15, 26)** may comprise a lithium iron phosphate battery.") 2:10-14 ("an **on-board starter battery** means provided along the interconnection means and/or adjacent at least one of the clips"); 5:12-14 ("In the invention there is an **on-board starter battery** which comprises a plurality of interconnected batteries 15 which may be of the lithium iron phosphate type.") **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** ¶28 [5:11-15] ("FIG. 1 illustrates a battery booster device including a polarity protection circuit according to an exemplary embodiment of the invention. A **boosting battery 2** with a positive terminal 4 and a negative terminal 6 is provided in the booster device.") **U.S. 2004/0239290 to Krieger** ¶4 ("There are a number of portable jump starters for vehicles having a dead starter battery. Such units provide the ability to jump-start a motor when another vehicle's battery is not available to the motorist. Portable jump starters usually have an

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Claim No.	Claim	Printed Publications
		internal battery which is used to jump start the vehicle."); ¶6 ("Further, the known devices do not take advantage of their **internal battery** in addressing other possible needs of a motorist."); ¶8 ("In an exemplary embodiment, a portable jump starter/charger apparatus is provided that comprises: a housing; an **internal battery**, housed inside the housing; a pair of jumper cables coupled to the **internal battery**; and a function selector switch operative to switch between jump starting an external battery with the pair of jumper cables, and charging an external battery with the pair of jumper cables."); ¶17 ("The DC input 302 is coupled to the jump starter circuit 304, and can charge the **internal battery 308** of the jump starter circuit 304 directly. The **internal battery 308** can also be charged by the high frequency charger 306."); ¶18 ("The jump starter circuit of the present invention may include a polarity protection circuit (not shown) that can be electrically coupled to the depleted battery and to the **internal battery 308**. The polarity protection circuit can prevent current flow between the batteries unless a proper polarity connection is achieved, i.e. the positive terminal of the **internal battery** is connected to the positive terminal of the depleted battery and the negative terminal of the **internal battery** is connected to the negative terminal of the depleted battery.") **U.S. 2007/0285049 to Krieger** ¶13 ("A **power source 20**, for example a battery, such as a sealed lead acid battery, a nickel cadmium battery, a nickel metal hydride battery or the like, may be disposed in the housing 10 (FIG. 3). The **battery 20** may be adapted to provide DC power for a variety of applications."); ¶17 ("The battery 20 may also be used to provide jumpstarting power for vehicles such as cars, RVs, and the like, which cannot start due to a depleted vehicle battery.") **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** Abstract ("An apparatus for providing power, the apparatus having a housing; a battery module positioned inside of the housing, the battery module having: a battery, a battery circuit board coupled to the battery and an ignition output port

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		coupled to the battery circuit board; a circuit board positioned inside of the housing and coupled to the battery module, the circuit board having: a charge module, a discharge module, a lighting module and a control module coupled to the charge module, the discharge module and the lighting module; a light source coupled to the circuit board; and wherein the apparatus is configured to provide sufficient power to jump start a vehicle."); ¶7 [1:50-55] ("Accordingly, the present invention according to an embodiment is directed to an apparatus for providing power comprising: a housing; a battery module positioned inside of the housing, the battery module further comprising: a battery, a battery circuit board coupled to the battery and an ignition output port coupled to the battery circuit board."); ¶27 [4:8-14] ("The mobile power bank 10 includes a housing 12, a control circuit board 14, and a battery module 16. The housing 12 comprises an upper cover 18 and a base cover 20. The upper cover 18 is coupled to the base cover 20 to form an enclosed, storage space. The control circuit board 14 and the battery module 16 may be accommodated and fixed inside the storage space.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶7 ("An emergency power source has a housing. The housing has at its inside a **batter[y] pack** for storing electric energy. Input terminals of the **battery pack** are connected to output terminals of a charging circuit and a solar panel input circuit, output terminals of the **battery pack** are connected to a high current outputting circuit for outputting a high current used for starting a vehicle, and an external smart battery detection system is connected between the **battery pack** and the high current outputting circuit."); ¶8 ("In certain embodiments, the battery pack consists of lithium-ion batteries connected in series or parallel, each battery having a positive electrode made of lithium iron phosphate, lithium cobalt oxide, nickel cobalt manganese ternary lithium or lithium manganate and a negative electrode made of artificial or natural graphite, the output terminal of the battery pack is further connected to a multipath DC-DC voltage regulator circuit and a LED driving circuit, each path of the DC-DC voltage regulator circuit is connected to a MCU controller circuit, and the MCU controller circuit is further connected to a smart LED electric

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		quantity display system for displaying the electric quantity of the emergency power source, an output terminal of the LED driving circuit is connected to a LED lighting lamp, and an equalization protection circuit is connected in parallel with the battery pack for protecting the battery pack."); ¶26 ("As shown in FIGS. 1 to 3, an emergency power source includes a housing having at its inside a **battery pack 4** for storing electric energy. Input terminals of the **battery pack 4** are connected to output terminals of a charging circuit 1 and a solar panel input circuit 2, output terminals of the **battery pack 4** are connected to a high current outputting circuit 7 for outputting a high current used for starting a vehicle, and an external smart battery detection system 6 is connected between the **battery pack 4** and the high current outputting circuit 7.") **U.S. 2005/0116688 to Yin** ¶5 ("To attain this, the power source of the present invention generally comprises a rechargeable battery, a flash light circuit, a positive battery clamp which is connected via a normally open contact relay to the positive terminal of the rechargeable battery, a negative battery clamp which is connected to the negative terminal of the rechargeable battery, and a circuit for protecting against reverse polarity connection and short circuit of the battery clamps …"); ¶20 ("As illustrated in FIG. 1, the power source with an anti-reverse connection and short circuit protection circuit for starting motor vehicles generally comprises a charging circuit, **an internal rechargeable battery B**, a circuit for protecting against reverse polarity connection and short circuit of the battery clamps, a flash light circuit, an electricity testing circuit, an inverting circuit, a fluorescent tube circuit, a light L and an air pump M. Save for the circuit for protecting against reverse polarity connection and short circuit of the battery clamps and the flash light circuit, the other circuits are connected in ways similar to those of the current power sources for starting vehicles in the marketplace."); ¶26 ("The power source provides electric power via the first diode D1 to the first relay JD1, thereby energizing the first relay JD1 and connecting the rechargeable battery B with the vehicle's battery to start the

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		vehicle."); ¶28 ("The rechargeable battery B provides power to the flash light circuit making the light L1 to flash.") **U.S. 2014/0368155 to Chen** ¶7 ("The smart vehicle rescue battery apparatus includes **a battery unit** …"); ¶8 ("Moreover, the battery unit is a storage battery."); ¶18 ("The smart vehicle rescue battery apparatus 10 includes **a battery unit 102** …"); ¶23 ("Moreover, the battery unit 102 is a storage battery.") **U.S. 2015/0137740 to Allos** ¶9 ("Coupled to the housing may be a **rechargeable source of energy 105**, which is in many cases a **plurality of battery cells** which may be charged, e.g., from a wall or other outlet source."); ¶16 ("The batteries may be lead acid, absorption glass mat (AGM), lithium ion, or the equivalent …"); *see also* U.S. Provisional Patent Application 61/903,779 at 1-2. **U.S. 2015/0306964 [issued as U.S. 9,525,297] to Wang** ¶5 ("To achieve the purpose described above, the present disclosure provides the following technical solutions: a novel automobile charger comprises a direct current power supply …"); ¶23 ("Refer to FIG. 1, a novel automobile charger comprises a **direct current power supply**, wherein the positive pole of the direct current power supply is connected with one end or lead of the DC to DC module, one end of the battery voltage detection module and one end of the load module simultaneously, while the negative pole of the direct current voltage is connected with the other end of the DC to DC module, one end of the microcontroller, one end of the automobile start control module and the other end of the battery voltage detection module simultaneously.") **U.S. 2006/0220610 to Solberg**

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		¶20 ("…a plurality of **boost modules 108 and 110**."); ¶21 ("The link may connect one or more of the outputs of the **boost modules 108 and 110** to an input of the receiver 120."); ¶24 ("In FIG. 1, the boost modules 108 and 110 are separate active energy storage elements. The energy storage elements may deliver current that is proportional to the rate of change of the voltage they store. A first boost module 108 may deliver a substantially smaller amount of current than the second boost module I 10. When the boost modules 108 and 110 are delivering current during a common time period, some second boost modules 110 may deliver a substantially larger current than some first boost modules 108. In some charging systems, the second boost module 110 delivers a boost current that is almost twice the boost current or greater than twice the boost current delivered by the first boost module 108."); ¶30 ("In FIG. 2, the first and second boost modules 208 and 210 comprise separate active circuit elements (e.g., capacitors or ultra capacitors) that store charge.") The following references also disclose, teach, or suggest this element: EP 0 616 409 to Herbert, e.g., at ¶¶36-37; U.S. 2006/0176011 to Lui, e.g., at ¶34; U.S. 2001/0025618 to Kelling, e.g., at ¶16; U.S. 2014/0084844 to Weflen, e.g., ¶¶21-22; U.S. 2004/0150373 to Chan, e.g., at ¶17; U.S. 2012/0025766 to Reade, e.g., at ¶¶31-32; U.S. 2006/0244412 to Bonzer, e.g., at ¶21; U.S. 6,759,833 to Chen, e.g., at 2:21-34; U.S. 3,590,357 to Reid, e.g., at 1:36-54; U.S. 5,194,799 to Tomantschger, e.g., at 6:37-55; U.S. 2014/0210399 to Urschel, e.g., at ¶30; U.S. 3,638,108 to Channing, e.g., at 3:25-31; U.S. 6,650,086 Chang; e.g., at 3:16-18; U.S. 6,344,733 to Crass, e.g., at 2:42-58; U.S. 5,281,904 to Tomkins, e.g., at 3:13-25
1[B]	an output port having positive and negative polarity outputs;	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** ¶28 [5:15-21] ("The positive terminal 4 of the boosting battery 2 is coupled to one of a pair of alligator clamps 8, 10 to be connected to a battery to be charged 11

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		(depleted battery) via a wire or battery cable. The negative terminal 6 of the boosting battery 2 is connected to the other of the alligator clamps 8, 10 to be connected to the battery to be charged 11 via a wire or battery cable.") **U.S. 2003/0141845 [Issued as U.S. 6,822,425] to Krieger** ¶64 ("Typically, the battery charger includes **a pair of clamps 60, 61** for connection to the positive terminal and the negative terminal, respectively, of the battery to be charged 21. A polarity detection circuit detects the polarity of the connection of **clamps 60, 61** and provides a signal to the microprocessor 50. In response to the signal from polarity detection circuit, the microprocessor controls the operation of the battery charger to supply power to the battery 21 or indicate an incorrect polarity accordingly.") **U.S. 2004/0239290 to Krieger** ¶5 ("However, this patent teaches jumpstarting the vehicle through a set of jumper cables, and charging the dead vehicle battery from a DC output that presumably requires a separate set of cables connected between the DC output and the terminals of the dead battery."); ¶14 ("The jump starter/charger also has two conventional jumper cables, including a positive jumper cable 106 and a negative jumper cable (not visible) in FIG. 1. The positive and negative cables are selectively coupled to the jump starting circuit and the charging circuit.") **U.S. 2007/0285049 to Krieger** ¶16 ("The jump starter therefore may include a set of jumper cables 16 that may be used to connect the battery 20 in the housing 10 to the depleted vehicle battery. Such jumper cables 16 are well known to those of ordinary skill in the art."); ¶17 ("The jumper cables may be detachable from the housing. An end of the jumper cables may include a plug 17 that may be received in the housing 10 to connect the cables to the internal battery 20. At an end of the cables 16 opposite the plug 17

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		there may be a pair of clamps 24 for connecting to the depleted battery. The housing 10 may also include clips or holsters for the jumper cables 16. The housing 10 may also be provided with pins, guides, compartments or the like in order to allow a user to wrap the jump starter cables 16 for storage, thus keeping the cables neat and accessible.") **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** ¶7 [1:50-55] ("Accordingly, the present invention according to an embodiment is directed to an apparatus for providing power comprising: a housing; a battery module positioned inside of the housing, the battery module further comprising: a battery, a battery circuit board coupled to the battery and **an ignition output port** coupled to the battery circuit board."); ¶8 [1:64-2:4] ("In an embodiment, the **ignition output port** outputs power at a voltage higher than about 13.6 volts. The ignition output port may further comprise a positive and negative barrel jack. The battery may comprise a lithium iron phosphate battery cell or a lithium cobalt oxide battery cell. Optionally, the battery circuit board is configured to boost battery voltage output to the ignition output board to above about 13.6 volts."); ¶11 [2:40-43] ("Optionally, the apparatus further comprises a vehicle ignition cable having a first end coupleable to the ignition output port and a second end coupleable to terminals of a vehicle battery."); ¶13 [3:10-13]("Optionally, the apparatus further comprises a vehicle ignition cable having a first end coupleable to the **ignition output port** and a second end coupleable to terminals of a vehicle battery."); ¶34 [5:6-9] ("In an embodiment, the battery module 16 includes battery cells 42, a battery circuit board 44, an ignition output port 46, and a connecting ribbon cable 48."); ¶38 [5:52-61] ("The output of the battery cell 42 is provided to the vehicle's ignition via a vehicle ignition cable (not shown) coupleable to the ignition output port 46. In an embodiment, the vehicle ignition cable has a first end with a connector configured to fit into the ignition output port 46 and a second end with positive and negative connectors, such as clamps or clips, that are connectable to vehicle battery terminals. **The output port 46 may be a positive and negative barrel socket.** In an embodiment, the mobile power bank of the present invention is

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		provided in a kit with the vehicle ignition cable."); ¶55 [8:49-56] ("In an embodiment, sidewalls of the upper cover 18 have openings adjacent to the flashlight 28, the charging port 34, the USB interfaces 38, 40, the LED indicator module 32, and the ignition output port 46. The openings allow the flashlight 28 and LED indication lights of the LED indicator module 32 to emit light outside of the housing 12 and allow external devices and adaptors access to the charging port 34, the USB interfaces 38, 40 and the ignition output port 46.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶7 ("Input terminals of the battery pack are connected to output terminals of a charging circuit and a solar panel input circuit, output terminals of the battery pack are connected to a high current outputting circuit for outputting a high current used for starting a vehicle, and an external smart battery detection system is connected between the battery pack and the high current outputting circuit."); ¶9 ("In certain embodiments, the external smart battery detection system includes a red power source clip and a black power source clip for connecting with an external battery, a relay switchable between an ON state and an OFF state according to a detection signal, a voltage identifying system for identifying the voltage of an external lead-acid battery or a lithium-ion starting battery, and a current identifying system for identifying a current flowing through an external starting circuit, two terminals of a coil of the relay are connected to the voltage identifying system, an input terminal of the relay is connected to the current identifying system, an output terminal of the relay is connected to the high current outputting circuit, **the red and black power source clips are connected to the positive and negative electrodes of the battery pack** through an reverse-insertion-proof connector or welded wires, the voltage identifying system is connected to the red and black power source clips, the relay is a 12V or 24V relay with a rating current ranging from 20 A to 300 A and 4 to 6 pins, the external smart battery detection system is either disposed outside the emergency power source and connected to the emergency power source through a reverse-insertion-proof connector, or disposed inside the emergency power source while the red and black power source clips is disposed outside the emergency

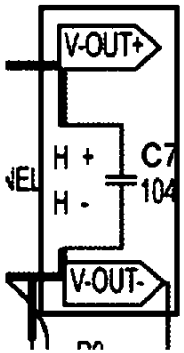
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		power."); ¶26 ("Input terminals of the battery pack 4 are connected to output terminals of a charging circuit 1 and a solar panel input circuit 2, output terminals of the battery pack 4 are connected to a high current outputting circuit 7 for outputting a high current used for starting a vehicle, and an external smart battery detection system 6 is connected between the battery pack 4 and the high current outputting circuit 7."); ¶29 ("The external smart battery detection system 6 includes a red power source clip and a black power source clip for connecting with an external battery, a relay switchable between an ON state and an OFF state according to a detection signal, a voltage identifying system for identifying the voltage of an external lead-acid battery or a lithium-ion starting battery, and a current identifying system for identifying a current flowing through an external starting circuit. The voltage identifying system is connected between two terminals of a coil of the relay, an input terminal of the relay is connected to the current identifying system, an output terminal of the relay is connected to the high current outputting circuit 7, **the red and black power source clips are connected to the battery pack through an anti-reverse connector connected to the positive and negative electrodes of the battery pack 4 or conducting wires welded to the positive and negative electrodes of the battery pack 4**.") **U.S. 2005/0116688 to Yin** ¶2 ("A power source generally comprises a battery and **two battery clamps which are connected to the positive and negative terminals of the battery respectively**."); ¶5 ("… a positive battery clamp which is connected via a normally open contact relay to the positive terminal of the rechargeable battery, a negative battery clamp which is connected to the negative terminal of the rechargeable battery …"); ¶21 ("As illustrated in FIG. 2, the positive terminal of the rechargeable battery B is connected via a normally open contact relay JD1 to one part of the positive battery clamp 1. The negative terminal of the rechargeable battery B is connected to one part of the negative battery clamp."); Figure 3 **U.S. 2014/0368155 to Chen**

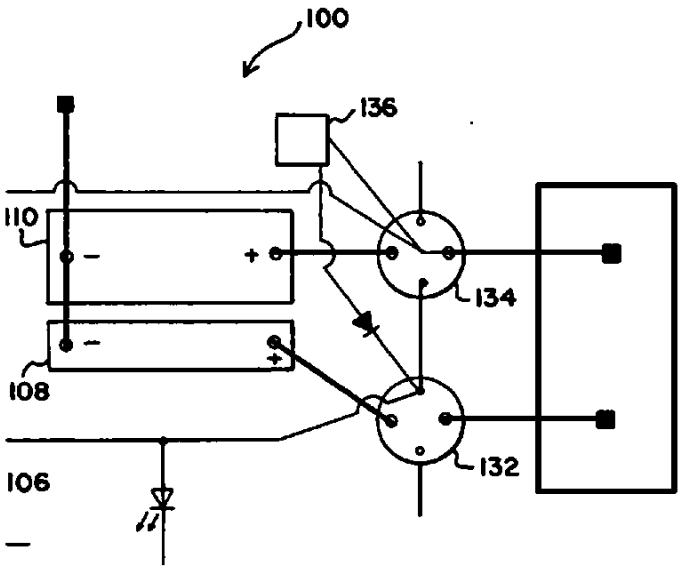
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		¶19 ("The first switch unit 104 is **electrically connected** to the battery unit 102 and the vehicle battery A. The second switch unit 106 is **electrically connected** to the battery unit 102, the first switch unit 104 and **the vehicle battery 20**. The third switch unit 108 is **electrically connected** to the battery unit 102, the first switch unit 104 and the **vehicle battery 20**. The fourth switch unit 110 is **electrically connected** to the battery unit 102, the second switch unit 106, the third switch unit 108 and the **vehicle battery 20**."); ¶21 ("The control unit 112 is configured to turn on the first switch unit 104 and the fourth switch unit 110 and turn off the second switch unit 106 and the third switch unit 108, when the polarity of a contact connecting the first switch unit 104, the third switch unit 108 and the vehicle battery 20 is judged to be **a positive pole** and when the polarity of a contact connecting the second switch unit 106, the fourth switch unit 110 and the vehicle battery 20 is judged to be **a negative pole**."); ¶22 ("The control unit 112 is configured to turn on the first switch unit 104 and the fourth switch unit 110 and turn off the second switch unit 106 and the third switch unit 108, when the polarity of a contact connecting the first switch unit 104, the third switch unit 108 and the vehicle battery 20 is judged to be **a positive pole** and when the polarity of a contact connecting the second switch unit 106, the fourth switch unit 110 and the vehicle battery 20 is judged to be **a negative pole**.") **U.S. 2015/0137740 to Allos** ¶17 ("The mobile charging system may be connected to the electrical system of that vehicle via battery cables 18 and 19 and clamped onto each terminal of a dead battery."); *see also* U.S. Provisional Patent Application 61/903,779 at 2. **U.S. 2015/0306964 [issued as U.S. 9,525,297] to Wang** ¶23 ("Refer to FIG. 1, a novel automobile charger comprises a direct current power supply, wherein the positive pole of the direct current power supply is connected with one end or lead of the DC to DC module, one end of the battery voltage

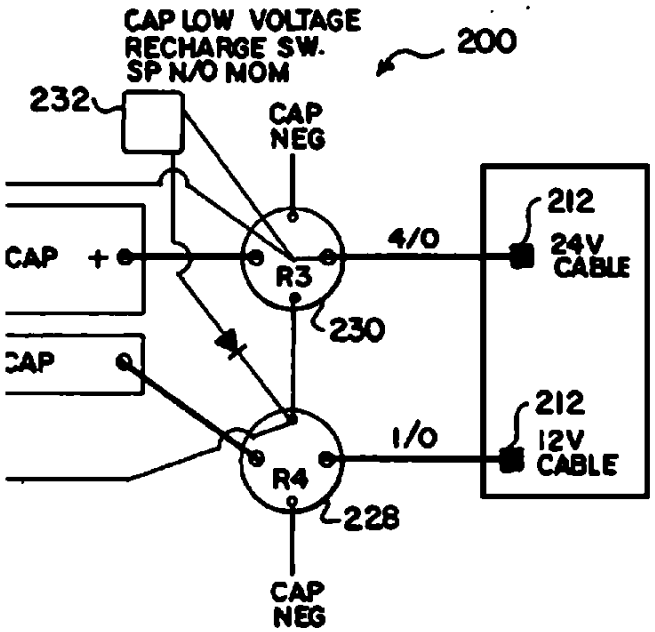
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		detection module and one end of the load module simultaneously, while the negative pole of the direct current voltage is connected with the other end of the DC to DC module, one end of the microcontroller, one end of the automobile start control module and the other end of the battery voltage detection module simultaneously. A third end of the DC to DC module is connected with the other end of the microcontroller, and the other three ends of the microcontroller are connected with the third end of the battery voltage detection module, the other end of the automobile start control module and one end of the load detection module respectively, wherein the other end of the load detection module is connected with the third end of the automobile start control module and the other end of the load module simultaneously; the load module which comprises the automobile storage battery and the automobile engine is located on the end of the load module.")  Figure 2 **U.S. 2006/0220610 to Solberg** ¶32 ("At act 504, the operator couples the charging cables to a vehicle. The connection may comprise connecting one or both output cables to separate or common elements of the vehicle's battery or electrical system."); ¶36 ("At act 604, the operator couples the charging cables to a vehicle. The connection may comprise connecting one or both output cables to separate or common elements of the

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		vehicle's battery or electrical system."); ¶40 ("At act 702, the operator couples the charging cables to a vehicle. The connection may comprise connecting one or both output cables to separate or common elements of the vehicle's battery or electrical system.")  Figure 1

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		 Figure 2 The following references also disclose, teach, or suggest this element: EP 0 616 409 to Herbert, e.g., at ¶¶31, 41-44; U.S. 2014/0084844 to Weflen, e.g., ¶23; U.S. 2004/0150373 to Chan, e.g., at ¶17
1[C]	a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs;	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** ¶44 [8:48-53] ("By way of a **feedback circuit or other means**, the microprocessor 60 can monitor the voltage and/or current being supplied to the depleted battery 11 from the booster battery 2, the voltage and/or current of the battery 11 and can

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		detect short circuits or other faults, as described in more de tail below."); ¶48 [9:33-38] ("Microprocessor 60 can be programmed to detect if clamps 8, 10 are connected to a battery or have been disconnected. To perform the detection, the microprocessor 60 deactivates the switch 12 into a non-conducting state. **Via the feedback circuit or other means**, the microprocessor **detects whether clamps 8,10 are connected to a battery**.") **U.S. 2003/0141845 [Issued as U.S. 6,822,425] to Krieger** ¶67 ("Once a correct polarity connection has been established, the transistor 72 may remain on even after clamps 60, 61 are disconnected from the battery 21. The disconnected clamps are thus still powered-up. Therefore, **a means for detecting the presence of a battery at the clamps may be provided**. The microprocessor 50 can be programmed to detect when the clamps 60, 61 have been disconnected and, in response, turn transistor 72 off. **A voltage divider comprised of resistors 74 and 76 is provided for this purpose**. The voltage divider divides the voltage across the clamps 60, 61 and provides a portion of this voltage to the microprocessor 50. When the clamps are disconnected from the battery 21, the voltage across the clamps 60, 61 will greatly increase. The voltage provided by the **voltage divider** will also increase in a corresponding manner. When the voltage provided to the microprocessor 50 exceeds a selected amount, for example, 18 volts, the microprocessor 50 detects that the clamps 60, 61 have been disconnected and immediately turns off transistors 69 and 70, which turns off transistor 72. Various resistors, such as resistor 78, may also be included in the circuit."); ¶68 ("According to another embodiment of the invention, the **means for detecting the presence of a battery** at the clamps may **detect the presence of a current flowing through the clamps 60, 61**, instead of, or in addition to the voltage across the clamps. The presence of a current flowing through the clamps 60, 61 may indicate whether the clamps 60, 61 are connected to a battery. A current flows through the clamps when they are connected to a battery and no current should flow through the clamps when they are not connected to a battery. The microprocessor 50 is adapted to detect the current flowing through the clamps 60, 61. **When no current is detected**, the

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		microprocessor 50 detects that the clamps 60, 61 have been disconnected and immediately turns off transistors 69 and 70, which turns off transistor 72."); ¶76 ("If the charge complete flag is not set, the process proceeds to step 134 (in FIG. 7) and detects if a battery is connected to the charger. This check can prevent current from being supplied from the battery charger unless a battery is connected to the battery charger, preventing a, potentially hazardous situation. The **means for detecting the presence of a battery** at the clamps discussed above in connection with FIG. 5 can be perform this check.") **U.S. 2004/0239290 to Krieger** ¶16 ("An example of a high-frequency charger that may be used to implement the present invention is described in U.S. patent application Ser. No. 10/270,391, entitled "A High Frequency Battery Charger and Method of Operating Same," commonly owned by the Assignee of the present application and the disclosure of which is incorporated herein by reference in its entirety."); ¶18 ("An example of a jump starter that may be used to implement the present invention is described in U.S. patent application Ser. No. 10/315,061 entitled "Microprocessor Controlled Jump Starter System With Polarity Protection," commonly owned by the Assignee of the present application and the disclosure of which is incorporated herein by reference in its entirety. The jump starter circuit of the present invention may include a polarity protection circuit (not shown) that can be electrically coupled to the depleted battery and to the internal battery 308. The polarity protection circuit can prevent current flow between the batteries unless a proper polarity connection is achieved, i.e. the positive terminal of the internal battery is connected to the positive terminal of the depleted battery and the negative terminal of the internal battery is connected to the negative terminal of the depleted battery. The above-mentioned U.S. patent application Ser. No. 10/315,061 describes a polarity protection circuit that may be used to implement this aspect of the described embodiment.")¶19 ("Both the jump starter 304 and the high frequency charger 306 have their own **internal diagnostics** (not shown, but described and illustrated in the above mentioned applications incorporated herein by reference) that check, for example,

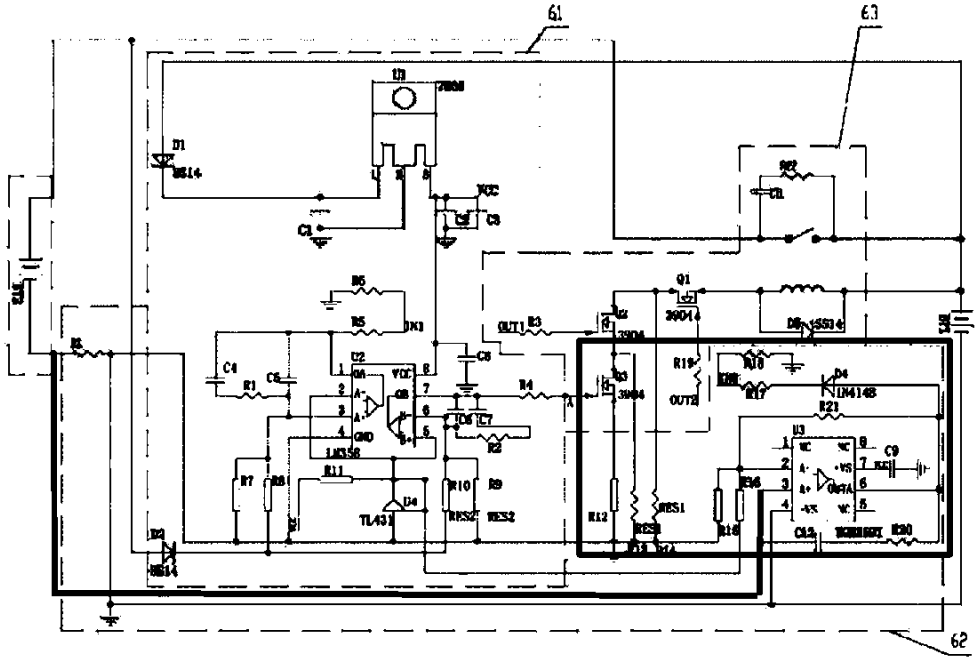
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		the status of the internal and/or depleted battery and whether the jumper cables are correctly attached to the external battery. The diagnostics can generate error codes which the microprocessor 312 can display on display 208 to notify the user of an error.") **U.S. 2007/0285049 to Krieger** ¶16 ("For example, a booster apparatus as described in U.S. patent application Ser. No. 10/315,061, which is incorporated herein by reference, may be provided.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶9 ("…a **current identifying system for identifying a current flowing through an external starting circuit**."); ¶17 ("In certain embodiments, a circuit of the current identifying system includes: a high-accuracy operational amplifier U3 whose model is SGM8591, resistors R12, R13, R14, R15, R16, R17, R18, R20, R21 and RS, capacitors C9 and C12, a switching diode D4 whose model is IN4148; and wherein pin 1 of U3 is floating, pin 2 of U3 is connected with a terminal of R16, a terminal of R15 and a terminal of R21, pin 3 of U3 is connected with a terminal of C12, a terminal of RS, and a negative electrode of BT2, pin 4 of U3 is grounded with a negative electrode of BT1 and the other terminal of RS, pin 5 of U3 is floating, pin 6 of U3 is connected with a terminal of R20, the other terminal of R21 and a positive electrode of D4, the other terminal of R20 is connected to the other terminal of C12, pin 7 of U3 is connected with terminal VCC and a terminal of C9, the other terminal of C9 is grounded, pin 8 of U3 is floating, a negative electrode of D4 is connected to a terminal of R17, the other terminal of R17 is connected with a terminal of R18 and terminal IN2, the other terminal of R18 is grounded, the other terminal of R15 is connected with a terminal of R12, a terminal of R13, and a terminal of R14."); ¶32 ("FIGS. 2 and 3 show a circuit diagram of the external smart battery detection system 6. BT1 is a rechargeable battery, which is the battery pack 4 in FIG. 1, and BT2 is a vehicle battery to be charged."); ¶33 ("Specifically, a circuit 62 of the current identifying system includes: a high-accuracy operational

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		amplifier U3 whose model is SGM8591, resistors R12, R13, R14, R15, R16, R17, R18, R20, R21 and RS, capacitors C9 and C12, a switching diode D4 whose model is IN4148; and wherein pin 1 of U3 is floating, pin 2 of U3 is connected with a terminal of R16, a terminal of R15 and a terminal of R21, pin 3 of U3 is connected with a terminal of C12, a terminal of RS, and a negative electrode of BT2, pin 4 of U3 is grounded with a negative electrode of BT1 and the other terminal of RS, pin 5 of U3 is floating, pin 6 of U3 is connected with a terminal of R20, the other terminal of R21 and a positive electrode of D4, the other terminal of R20 is connected to the other terminal of C12, pin 7 of U3 is connected with terminal VCC and a terminal of C9, the other terminal of C9 is grounded, pin 8 of U3 is floating, a negative electrode of D4 is connected to a terminal of R17, the other terminal of R17 is connected with a terminal of R18 and terminal IN2, the other terminal of R18 is grounded, the other terminal of R15 is connected with a terminal of R12, a terminal of R13, and a terminal of R14."

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		 Fig. 2 Figure 2 ¶36 ("When the emergency power source is disconnected from the external rechargeable battery, or the current is smaller than the preset current value, R15 and R16 in the **circuit 62 of the current identifying system** provide a detection signal to U3. Then U3 sends an output signal to the MCU controller chip according to the detection signal, based on which the MCU controller chip may determine the ON or OFF state of the circuit to make proper instructions.") **U.S. 2005/0116688 to Yin** ¶21 ("The circuit for protecting against reverse polarity connection and short circuit of the battery clamps comprises two relays JD1, JD2 and at least two diodes D1, D2; **one terminal of the wire coils of the first relay JD1** and the second relay JD2

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		are connected to the positive battery clamp 1; the other terminal of the wire coil of the **first relay JD1 is connected to the positive terminal of the first diode D1** and the negative terminal of the first diode D1 is connected to the negative battery clamp; the other terminal of the wire coil of the second relay JD2 is connected to the negative terminal of the second diode D2 and the positive terminal of the second diode D2 is connected to the negative battery clamp."); ¶23 ("As illustrated in FIGS. 2 and 3, a conducting wire 2 is disposed on one part of the positive battery clamp 1. The **conducting wire 2 is connected via the wire coil of the first relay JD1** and the **first diode D1** with the negative battery clamp."); ¶24 ("In normal situations, the battery clamps have no electricity and this prevents short circuit of the battery clamps. When the battery clamps are connected to the vehicle's battery, the polarity detecting circuit will detect the polarity automatically and if the polarity is correct, the circuit will **allow the first relay JD1 to conduct electricity** and thus connect the circuit of the rechargeable battery B and the vehicle's battery to start the vehicle."); ¶26 ("The power source **provides electric power via the first diode D1 to the first relay JD1**, thereby **energizing the first relay JD1** and connecting the rechargeable battery B with the vehicle's battery to start the vehicle."); ¶27 ("After starting the vehicle, the operator removes the battery clamps from the vehicle's battery. The two parts 11, 12 of the positive battery clamp 1 will be instantly separated and this will **cause the first relay JD1 to be in an off state** and even if the two parts 11, 12 contact each other again, the first relay JD1 will remain in an off state and short circuit will not occur in the rechargeable battery B and so the rechargeable battery B will not burnt out.") **U.S. 2015/0137740 to Allos** ¶22 ("When the mobile charging system is correctly connected to a vehicle with a discharged battery, the green warning light 10 will illuminate, indicating proper connection. Component 18 with circuit C16 will have positive voltage and component 19 with circuit C1 will have negative voltage. C16 and C1 circuits are monitored by component 20 (forward polarity sense circuit), and this component includes three resistors with ratio values biased for low voltage detection. When

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		circuit C16 voltage value is 2 or more volts more positive than circuit C1, **the operational amplifier L2722 will conduct and switch its output circuit C25 to 12V positive to energize component 21 (Relay 3)**. When relay 3 N.O. (normally open) contacts are closed, 12V power from circuit C14 will connect with circuit C24 to **turn green light on** in component 10, indicating the correct and safe hook-up of the mobile charging system."); *see also* U.S. Provisional Patent Application 61/903,779 at 2. **U.S. 2015/0306964 [issued as U.S. 9,525,297] to Wang** ¶5 ("A third end of the DC to DC module is connected with the other end of the microcontroller, and the other three ends of the microcontroller are connected with the third end of the battery voltage detection module, the other end of the automobile start control module and one end of the **load detection module** respectively, wherein the other end of the **load detection module** is connected with the third end of the automobile start control module and the other end of the load module simultaneously; the load module which comprises the automobile storage battery and the automobile engine is located on the end of the load module."); ¶6 ("the **load detection module** which comprises the automobile storage battery or the automobile engine **detects whether the load module is correctly connected**."); ¶23 ("A third end of the DC to DC module is connected with the other end of the microcontroller, and the other three ends of the microcontroller are connected with the third end of the battery voltage detection module, the other end of the automobile start control module and one end of the **load detection module** respectively, wherein the other end of the **load detection module** is connected with the third end of the automobile start control module and the other end of the load module simultaneously; the load module which comprises the automobile storage battery and the automobile engine is located on the end of the load module."); ¶24 ("… two ends of the automobile storage battery are in parallel connection with the capacitor C7, resistors R9, 10, a capacitor C6 and a resistor R13 to form **the load detection module** together …");¶25 ("The battery voltage detection module conducts the measurement of the batter voltage, and the automobile start control

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		module conducts the power supply or the power outage for the load module through the microcontroller, wherein **the load detection module detects whether the load module is correctly connected**."); ¶26 ("The microcontroller in the present disclosure determines whether the automobile storage battery is connected with the automobile engine through the load detection module, wherein the automobile start control model is automatically activated and the battery starts to supply power to the load module when the load is correctly connected; the automobile start control model is automatically deactivated and the battery stops supplying power to the load module when assuming that the load is not connected or the positive and negative polarities are reversely connected."); Figure 2 **U.S. 2006/0220610 to Solberg** ¶23 ("With or without input and output isolation (e.g., such as through **an opt-coupler**), the control module 104 monitors an output of the charging system 100 and compares it against a fixed or a programmable voltage level or voltage range. When the voltage equals or rises above the voltage level or falls within the voltage range, the control module 104 activates the second switch 130 that couples one or more of the boost modules 108 and 110 to the outputs of the charging system 100."); ¶29 ("The output of the charging system 200 is monitored by **a voltage and/or current monitoring circuit** within the controller 204. Voltage and/or current monitored at the output interface 212 are compared against a fixed or programmed reference. When the output exceeds the reference, a control signal activates the second, third, and fourth relays 224, 228, and 230.") The following references also disclose, teach, or suggest this element: EP 0 616 409 to Herbert, e.g., at ¶¶37; U.S. 2004/0150373 to Chan, e.g., at ¶¶17-21; U.S. 2012/0025766 to Reade, e.g., at ¶¶79, 103, 138, 154; U.S. 2006/0244412 to Bonzer, e.g., at Fig. 3; U.S. 6,759,833 to Chen, e.g., at 2:36-43; WO 2012/036556 to Eidsvig, e.g., at 5:12-15; U.S. 2002/0041174 to Purkey, e.g., at ¶62
1[D]	a reverse polarity sensor connected in circuit with said positive and	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation:

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	negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port;	**WO 2012/080996 A1 to Tracey et al.** 3:19-20 ("In one embodiment, the protection means comprises a circuit to short gate current to ground in the event of accidental reverse polarity connection."); 6:23-24 ("An integrated circuit IC1 is connected via a resistor R2 to the positive lead 103 and is connected to the negative lead 105 via reverse polarity indicator (LED1)."); 6:28-29 ("The circuit of the jump starter circuit 100 protects from voltage mismatch, reverse polarity, short circuit, over-discharge, and over-use."); 8:16-29 ("The circuit also protects against accidental reverse polarity connection. Should the operator inadvertently connect the jump starter circuit 100 backwards to the vehicle battery (i.e. positive clamp 4 to negative terminal and vice versa), the system offers two levels of protection. The first level is passive. As the MOSFETS Ql through Q3 are non-conductive, no current flow takes place upon connection. This eliminates any potentially dangerous and destructive electrical arcing at the vehicle battery terminals. Such arcing conditions have been linked with the destruction of modern vehicle electronic controls. Secondly, current from the vehicle battery flows via the resistor R2, reverse polarity indicator LED1 and the input side of the semiconductor photo-relay type TLP222 (IC1) thus illuminating LED1 and the input photo LED in IC1 . Even if the vehicle battery is severely discharged, the current requirement of IC1 is very small and will in most cases be less than 5 mA. Should the user ignore the reverse polarity indicator LED1 and depress SWl , MOSFET gate current is shunted to ground via an output MOSFET in IC 1 thus preventing the successful triggering of Q1 -Q3 and damage to the vehicle or to the jump starter 1.") **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** Abstract ("A polarity protection circuit for a battery booster device is provided. … The polarity protection circuit is electrically connected to the battery to be charged and to the boosting battery. The polarity protection circuit prevents current flow between the batteries unless proper polarity is achieved."); ¶2 [1:15-18] ("The present invention relates to a booster device used for boosting a depleted battery and

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		in particular to microprocessor control of the booster apparatus and a polarity protection circuit."); ¶10 [2:25-28] ("The polarity protection circuit is electrically connected to the battery to be charged (depleted battery) and to a boosting battery or other power source. The polarity protection circuit prevents current flow between the batteries unless proper polarity is achieved."); ¶11 [2:40-44] ("As mention above, a polarity protection circuit is provided in the booster device and prevents current flow between the batteries unless a proper polarity connection between the two batteries is achieved."); ¶31 [5:22-30] ("The switch 12 is activated by a polarity sensing circuit 16 to allow current flow from the boosting battery 2 to the depleted battery 11. The polarity sensing circuit 16 is coupled to the boosting battery 2 and to the depleted battery 11 when the clamps 8, 10 are connected to the depleted battery 11. The polarity sensing circuit 16 senses the polarity of the connection between the boosting battery 2 and the depleted battery 11 and provides a signal indicating the state of the connection. The signal from the polarity sensing circuit 16 is provided to the switch 12. When a proper polarity connection is signaled, the switch 12 completes the boosting circuit and permits current flow to the depleted battery 11."); ¶45 [8:60-66] ("Opto-isolator 16 is coupled to clamps 8, 10 via resistor 62 such that LED 26 is forward biased when a correct polarity connection between the boosting battery 2 and the depleted battery 11 is made. When forward biased, LED 26 turns on phototransistor 22. The collector 23 of the phototransistor 22 is coupled to a supply voltage via internal circuitry in the microprocessor 60. When the phototransistor 22 is on, **a first signal** of a first voltage is present at the collector 23 and is sensed by the microprocessor 60. When the phototransistor 22 is off, **a second signal** of a second voltage is present at the collector 23 and is sensed by the microprocessor 60.") **U.S. 2003/0141845 [Issued as U.S. 6,822,425] to Krieger** ¶63 ("Additional **polarity and short-circuit protection circuitry** can also be provided, as shown in the embodiment of FIG. 5. FIG. 5 is a partial schematic diagram of a battery charger showing only the short circuit and polarity protection elements to simplify the understanding of this embodiment. The other elements of

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		the battery charger can be included as shown in FIGS. 1, 3, and 4."); ¶64 ("In this embodiment, the battery charger is provided with a **polarity detection circuit**. Only when the polarity detection circuit detects that the battery has been connected to the battery charger with correct polarity is power supplied to the battery. Typically, the battery charger includes a pair of clamps 60, 61 for connection to the positive terminal and the negative terminal, respectively, of the battery to be charged 21. A **polarity detection circuit detects the polarity of the connection of clamps 60, 61 and provides a signal to the microprocessor 50**. In response to the signal from polarity detection circuit, the microprocessor controls the operation of the battery charger to supply power to the battery 21 or indicate an incorrect polarity accordingly."); ¶65 ("In the embodiment illustrated in FIG. 5, the polarity detection circuit includes an **opto-isolator 62 connected to clamps 60, 61 and to microprocessor 50**. The opto-isolator includes a light-emitting diode (LED) 63 and a phototransistor 65. When the battery 21 is connected with correct polarity, clamp 60 is connected to the positive terminal and clamp 61 is connected to the negative terminal of the battery 21. LED 63 is then forward biased and turns on phototransistor 65. When the phototransistor 65 is turned on, it provides a logic high signal to a pin a4 of the microprocessor 50. The logic high signal indicates to the microprocessor 50 that a correct polarity connection has been made. Connecting clamp 60 to the negative terminal of battery 21 reverse biases the LED 63, and no signal is provided to the microprocessor 50.") **U.S. 2004/0239290 to Krieger** ¶18 ("An example of a jump starter that may be used to implement the present invention is described in U.S. patent application Ser. No. 10/315,061 entitled "Microprocessor Controlled Jump Starter System With Polarity Protection," commonly owned by the Assignee of the present application and the disclosure of which is incorporated herein by reference in its entirety. The jump starter circuit of the present invention may include **a polarity protection circuit** (not shown) that can be electrically coupled to the depleted battery and to the internal battery 308. The **polarity protection circuit** can prevent current flow between the batteries

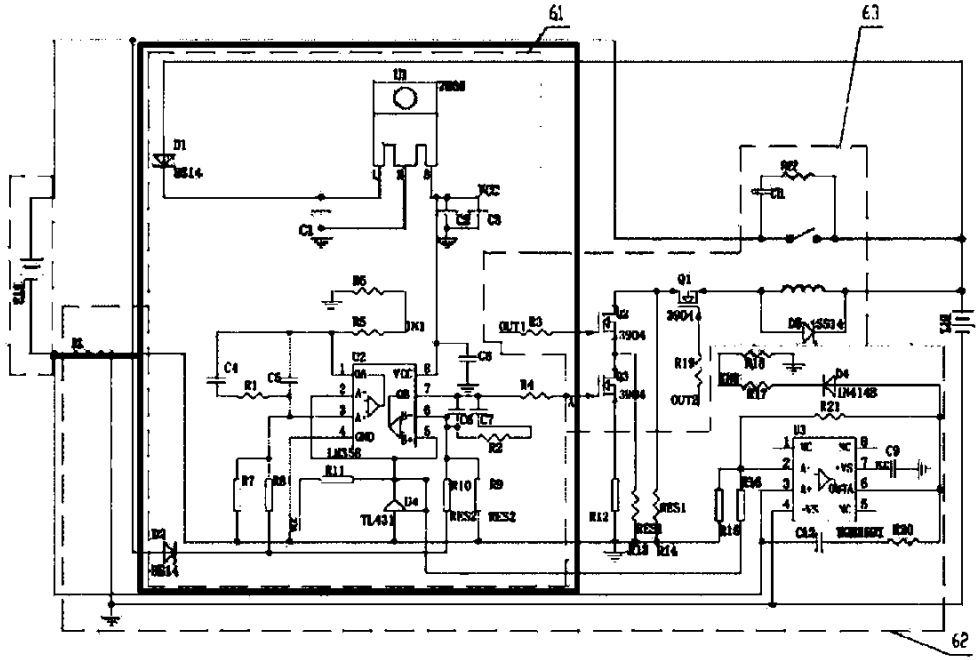
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		unless a proper polarity connection is achieved, i.e. the positive terminal of the internal battery is connected to the positive terminal of the depleted battery and the negative terminal of the internal battery is connected to the negative terminal of the depleted battery. The above-mentioned **U.S. patent application Ser. No. 10/315,061 describes a polarity protection circuit** that may be used to implement this aspect of the described embodiment.") **U.S. 2007/0285049 to Krieger** ¶16 ("The jump starter therefore may include a set of jumper cables 16 that may be used to connect the battery 20 in the housing 10 to the depleted vehicle battery. Such jumper cables 16 are well known to those of ordinary skill in the art. For example, **a booster apparatus as described in U.S. patent application Ser. No. 10/315,061**, which is incorporated herein by reference, may be provided.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶9 ("… a **voltage identifying system** for identifying the voltage of an external lead-acid battery or a lithium-ion starting battery."); ¶30 ("When the red and black power source clips are respectively connected to the positive and negative electrodes of the external battery, **if the connection is correct, a feedback voltage displayed by the voltage identifying system is positive, otherwise the feedback voltage is negative**."); ¶34 ("Specifically, the **circuit 61** of the voltage identifying system includes: a dual operational amplifier U2 whose model is LM358, a three-terminal voltage regulator circuit U1 whose model is a 7805, resistors R1, R2, R4, R5, R6, R7, R8, R9, R10 and R11, capacitors C1, C2, C3, C4, C5, C6, C7 and C8, schottky diodes D1 and D2 whose model are SS14, and a three-terminal adjustable shunt voltage reference U4 whose model is TL431; and wherein pin 1 of U2 is connected with a terminal of R5, a terminal of C5 and a terminal of C4, the other terminal of R5 is connected with a terminal of R6 and terminal IN1, the other terminal of R6 is grounded, pin 2 of U2 is connected to pin 5 of U2, a terminal of R11, a negative electrode of U4, a reference electrode of U4, and the other terminal of R16, the

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		other terminal of R11 is connected to terminal VCC, pin 3 of U2 is connected with the other terminal of C5, a terminal of R1, a terminal of R7 and a terminal of R8, the other terminal of R1 is connected to the other terminal of C4, pin 4 of U2 is grounded with the other terminal of R7, a positive electrode of U4 and a terminal of R9, the other terminal of R8 is connected with a negative electrode of D2 and a terminal of R10, a positive electrode of D2 is connected to a positive electrode of BT2, pin 6 of U2 is connected with the other terminal of R10, the other terminal of R9, a terminal of C6 and a terminal of R2, pin 7 of U2 is connected with the other terminal of C6, a terminal of C7 and a terminal of R4, the other terminal of R4 is connected to node A, the other terminal of C7 is connected to the other terminal of R2, pin 8 of U2 is connected with a terminal of C8, a terminal of C2, a terminal of C3, pin 3 of U1 and terminal VCC, the other terminal of C8 is grounded, the other terminal of C2 is grounded with the other terminal of C3, pin 1 of U1 is connected with a terminal of C1 and a negative electrode of D1, pin 2 of U1 is grounded with the other terminal of C1, a positive electrode of D1 is connected to the positive electrode of BT1."); ¶36 ("When the preset voltage value is 8.1V and the output voltage value is smaller than the preset value, R7 and R8 of the **circuit 61** of **the voltage identifying system may provide a detection signal** to U2, and U2 may send an output signal to terminal IN1 according to the detection signal. Then the MCU controller chip further controls the control switch Q2 in the circuit 63 of the relay according to the signal from terminal IN1. When the output voltage is bigger than a preset value, which may be 12.6V in the invention, R9 and R10 of the circuit 61 of the voltage identifying system may provide a detection signal to U2, and U2 may send a signal according to the detection signal to control the control switch Q3 in the circuit 63 of the relay.")

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		 Fig 2 Figure 2 **U.S. 2005/0116688 to Yin** ¶24 ("High current relays and **polarity detecting circuit** are used in the present invention. In normal situations, the battery clamps have no electricity and this prevents short circuit of the battery clamps. When the battery clamps are connected to the vehicle's battery, **the polarity detecting circuit will detect the polarity automatically and if the polarity is correct, the circuit will allow the first relay JD1 to conduct electricity and thus connect the circuit of the rechargeable battery B and the vehicle's battery** to start the vehicle. If the polarity is detected to be reversely connected, the circuit will maintain the first relay JD1 in an off state and the rechargeable battery B and the vehicle's battery are not connected and so the vehicle's battery will not be burnt out owing to the reverse polarity connection.");

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		¶25 ("When the battery clamps are not connected with the vehicle's battery, the first relay JD1 has no voltage and is in an off state and the battery clamps have no electricity. This can prevent danger caused by short circuit of the battery clamps."); ¶26 ("When the battery clamps and the vehicle's battery are connected with the correct polarity, **the second diode D2 is reversely biased**, the second relay JD2 is in an off state, the light L1 does not flash and the buzzer BU does not sound. The **power source provides electric power via the first diode D1** to the first relay JD1, thereby energizing the first relay JD1 and connecting the rechargeable battery B with the vehicle's battery to start the vehicle."); ¶28 ("When the two battery clamps are reversely connected to the two terminals of vehicle's battery, **the first diode D1 is in a reversed close state** in the circuit of the first relay JD1 and so the **first relay JD1 remains in an off state**, which leads to the disconnection of the rechargeable battery B and the vehicle's battery, thereby eliminating the risks of incurring high current and sparks. Simultaneously, the vehicle's battery provides power to the second relay JD2 and the buzzer BU via **the second diode D2, thereby energizing the second relay JD2 and making the buzzer BU to sound**. The rechargeable battery B provides power to the flash light circuit making the light L1 to flash.") **U.S. 2014/0368155 to Chen** ¶18 ("… a voltage polarity detection unit 114 …"); ¶19 ("The voltage polarity detection unit 114 is electrically connected to the first switch unit 104, the second switch unit 106, the third switch unit 108, the fourth switch unit 110, the vehicle battery 20 and the control unit 112."); ¶20 ("The voltage polarity detection unit 114 is configured to detect the voltage polarity of the vehicle battery 20 and inform the control unit 112."); ¶23 ("The voltage polarity detection unit 114 is, for examples but not limited to, a microprocessor, a microcontroller, or a voltage polarity detection apparatus having electronic components.") **U.S. 2015/0137740 to Allos**

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		¶45 ("This reverse source of voltage originates from the vehicle battery. Component 13 is a **reverse polarity sense circuit** that uses circuit C1 and C16 for input signals. It also uses circuit C14 from fuse No.5 for a 12 voltpower source that originates from battery 2a."); ¶46 ("The **reverse polarity sense circuit 13** includes in one implementation three resistors with ratio values biased for low voltage, e.g., approximately negative 2 volts or greater at circuit C16. An operational amplifier L2722 may be configured as a voltage comparator. This component will output positive 12 volts through circuit C23 when its negative input is more negative than its positive input with approximately 2 volts or greater. This only occurs in reverse polarity connection to vehicle battery."); ¶47 ("The **reverse polarity sense circuit** is designed and configured in this manner to have the ability to detect reverse polarity condition even if the vehicle battery is discharged from 12 volts to as low as 2 volts."); ¶48 ("Once the **reverse polarity sense circuit** detects reverse polarity, it will conduct current and switch output circuit C23 to positive 12 volts energizing component 14 relay 1 that will **result in the enabling of the reverse polarity protection feature of the mobile charging system**, and the **disabling of the boost cycle power source to component 11**."); *see also* U.S. Provisional Patent Application 61/903,779 at 2, 5. **U.S. 2015/0306964 [issued as U.S. 9,525,297] to Wang** ¶5 ("A third end of the DC to DC module is connected with the other end of the microcontroller, and the other three ends of the microcontroller are connected with the third end of the battery voltage detection module, the other end of the automobile start control module and one end of the **load detection module** respectively, wherein the other end of the **load detection module** is connected with the third end of the automobile start control module and the other end of the load module simultaneously; the load module which comprises the automobile storage battery and the automobile engine is located on the end of the load module."); ¶6 ("the **load detection module** which comprises the automobile storage battery or the automobile engine **detects whether the load module is correctly connected**."); ¶23 ("A third end of the DC to DC module is connected with the other end of the

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		microcontroller, and the other three ends of the microcontroller are connected with the third end of the battery voltage detection module, the other end of the automobile start control module and one end of the **load detection module** respectively, wherein the other end of the **load detection module** is connected with the third end of the automobile start control module and the other end of the load module simultaneously; the load module which comprises the automobile storage battery and the automobile engine is located on the end of the load module."); ¶24 ("… two ends of the automobile storage battery are in parallel connection with the capacitor C7, resistors R9, 10, a capacitor C6 and a resistor R13 to form **the load detection module** together …");¶25 ("The battery voltage detection module conducts the measurement of the batter voltage, and the automobile start control module conducts the power supply or the power outage for the load module through the microcontroller, wherein **the load detection module detects whether the load module is correctly connected**."); ¶26 ("The microcontroller in the present disclosure determines whether the automobile storage battery is connected with the automobile engine through the load detection module, wherein the automobile start control model is automatically activated and the battery starts to supply power to the load module when the load is correctly connected; the automobile start control model is automatically deactivated and the battery stops supplying power to the load module when assuming that the load is not connected or the positive and negative polarities are reversely connected."); Figure 2 **U.S. 2006/0220610 to Solberg** ¶23 ("When the voltage equals or rises above the voltage level or falls within the voltage range, the control module 104 activates the second switch 130 that couples one or more of the boost modules 108 and 110 to the outputs of the charging system 100. When the control module 104 detects a reverse polarity, the second switch 130 is deactivated effectively shutting down the charging system 100."); ¶29 ("When a reverse polarity connection is detected, the control signal does not flow from the controller 204, which deactivates the second relay 224 and shuts down the charging system 200.")

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		The following references also disclose, teach, or suggest this element: EP 0 616 409 to Herbert, e.g., at ¶38; U.S. 2006/0176011 to Lui, e.g., at ¶6; U.S. 2001/0025618 to Kelling, e.g., at ¶17; U.S. 2014/0084844 to Weflen, e.g., at ¶14; U.S. 2004/0150373 to Chan, e.g., at ¶3; U.S. 2012/0025766 to Reade, e.g., at ¶161; U.S. 2006/0244412 to Bonzer, e.g., at ¶13; U.S. 6,759,833 to Chen, e.g., at 1:34-44; U.S. 3,590,357 to Reid, e.g., at 3:61-4:62; Fig. 2; U.S. 5,194,799 to Tomantschger, e.g., at 5:24-33, 6:51-55; 2014/0210399 to Urschel, e.g., at ¶38; U.S. 3,638,108 to Channing, e.g., at 3:14-45; WO 2012/036556 to Eidsvig, e.g., at 7:25-26; U.S. 2013/0162029 to Reichow, e.g., at ¶24; U.S. 2002/0041174 to Purkey, e.g., at ¶20; U.S. 5,281,904 to Tomkins, e.g., at 3:60-4:4
1[E]	a power switch connected between said internal power supply and said output port; and	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **WO 2012/080996 A1 to Tracey et al.** 3:8-11 ("In one embodiment, the control circuit further comprises a **switch** in the negative lead which is turned on for use. In one embodiment, the switch is a solid state switch. In one embodiment, the **switch comprises a MOSFET switch**. In one embodiment, the switch is an SCR. In one embodiment, there is a plurality of switches arranged in parallel."); 6:24-26 ("Also, a manual contact switch 115 (SW1) is connected on one side to the positive lead 3, and on the other to a Zener diode ZD1, a resistor Rl, in turn linked with a bank of MOSFET switches Ql, Q2, and Q3."); 7:8-11: ("The battery 102 positive terminal is also connected to the momentary action single pole normally open **switch SW1 115**. This **switch**, the Zener diode ZD1 , the resistor Rl and Metal Oxide Semiconductor Field Effect Transistors (MOSFETS) Ql to Q3 comprise the power-switching and over-discharge elements."); 7: 13-20 ("To activate the jump-starter system it must be connected to a vehicle battery by means of the positive and negative jaws 56 linked to the conductors 104 and 106. The **activation switch 115 (SW1)** is then briefly depressed. This switch may be located at any convenient location of the housing[.] Current flows from the battery (BAT) via ZD1 and Rl to the gates of International

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		Rectifier IRF 1324s MOSFETS (or alternates) Ql, Q2 and Q3 via their respective gate resistors R4, R5 and R6. Capacitor C1 is also charged. Once a Vgs of 10V is applied to the MOSFETS Ql, Q2, and Q3 they begin conducting from drain to source with a very low ON state resistance, typically about 0.00033 Ohms for three parallel connected parts."); 8:5-7 ("When the voltage across C1 drops below the gate threshold voltage of the MOSFETS, they will rapidly come out of conduction and switch off the output.") **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** ¶29 [5:22-30] ("A switch 12 is coupled to one of the wires or battery cables to be connected to the depleted battery 11. The switch 12 is activated to complete a boosting circuit between the boosting battery 2 and the depleted battery 11 only when a correct polarity connection between the batteries is attained. In the embodiment shown, the switch 12 is arranged between the negative terminal 6 of the boosting battery 2 and the alligator clamp 10 intended to be connected to the negative terminal of the depleted battery 11.") **U.S. 2003/0141845 [Issued as U.S. 6,822,425] to Krieger** ¶66 ("**Transistor 72 acts as a switch to connect battery 21 to the charger circuit.** Only when switch 72 is closed will transistor 69 complete the connection between the battery charger and the battery 21. The opening and closing of transistor 72 is controlled via transistors 69 and 70. A control electrode of transistor 69 receives the control signal from the microprocessor. When the control signal is received, transistor 69 turns on, which, in turn, turns on transistor 70. Current flow through transistor 70 activates a control electrode for transistor 72 and turns transistor 72 on, completing the circuit between the charger circuit and battery 21. Only when the control signal is provided to transistor 69 is it possible for transistor 72 to be turned on.") **U.S. 2004/0239290 to Krieger**

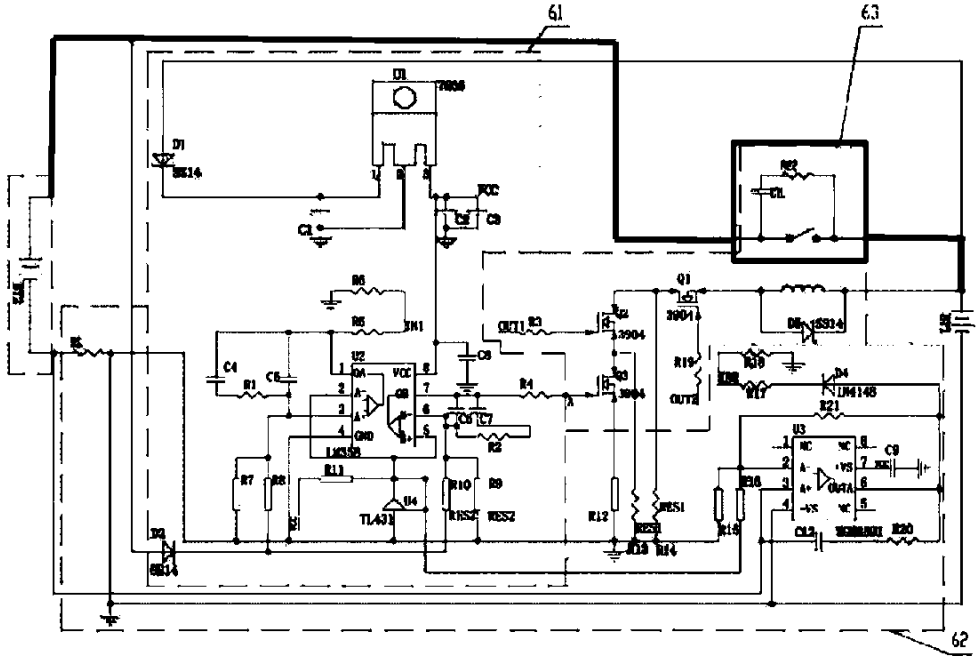
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		¶18 ("An example of a jump starter that may be used to implement the present invention is described in U.S. patent application Ser. No. 10/315,061 entitled "Microprocessor Controlled Jump Starter System With Polarity Protection," commonly owned by the Assignee of the present application and the disclosure of which is incorporated herein by reference in its entirety. The jump starter circuit of the present invention may include a polarity protection circuit (not shown) **that can be electrically coupled to the depleted battery and to the internal battery 308**. The polarity protection circuit can **prevent current flow between the batteries unless a proper polarity connection is achieved**, i.e. the positive terminal of the internal battery is connected to the positive terminal of the depleted battery and the negative terminal of the internal battery is connected to the negative terminal of the depleted battery. The above-mentioned **U.S. patent application Ser. No. 10/315,061 describes a polarity protection circuit** that may be used to implement this aspect of the described embodiment."); ¶20 ("Both the jump starter 304 and the high frequency charger 306 may be coupled to the function selector switch 110. The function selector switch 110 may be either a manually operated or an automatoically operated [sic]. The function selector switch 110 that is automatically operated may be controlled by the microprocessor controller 312 or other suitable controller. The function selector switch 110 may be used to selectively connect the jumper cables to the output of the jump starter 304 and the output of the high frequency charger 306. Thus, both the jump starter 304 and the high frequency charger 306 use the same set of jumper cables 316.") **U.S. 2007/0285049 to Krieger** ¶16 ("For example, a booster apparatus as described in U.S. patent application Ser. No. 10/315,061, which is incorporated herein by reference, may be provided.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei**

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		¶29 ("The external smart battery detection system 6 includes a red power source clip and a black power source clip for connecting with an external battery, a **relay** switchable between an ON state and an OFF state according to a detection signal …"); ¶30 ("When the red and black power source clips are respectively connected to the positive and negative electrodes of the external battery, if the connection is correct, a feedback voltage displayed by the voltage identifying system is positive, otherwise the feedback voltage is negative. The positive feedback voltage ranges from value a of 6 to 24 V to value b of 9 to 30 V, and a is smaller than b. If the connection is reverse, the **relay does not work**, and the high current outputting circuit 7 may be cut off."); ¶31 ("In this invention, when the feedback voltage ranges from value a to value b and is of a positive value, the coil of the **relay receives a voltage signal so that its contact is closed** and **its output terminal is coupled to the high current outputting circuit 7**, and the emergency power source starts to power an external device with a high current."); ¶35 ("…a negative electrode of D5 is connected with the other terminal of the coil of the relay, a terminal of a normally open contact of the relay, a terminal of R22, and a positive electrode of BT1, the other terminal of R22 is connected to a terminal of C11, the other terminal of C11 is connected with a terminal of the normally open contact of the relay and a positive electrode of BT2..")

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		 Fig. 2 Figure 2 **U.S. 2005/0116688 to Yin** ¶26 ("The power source **provides electric power via the first diode D1 to the first relay JD1**, thereby **energizing the first relay JD1** and connecting the rechargeable battery B with the vehicle's battery to start the vehicle."); ¶27 ("After starting the vehicle, the operator removes the battery clamps from the vehicle's battery. The two parts 11, 12 of the positive battery clamp 1 will be instantly separated and this will **cause the first relay JD1 to be in an off state** and even if the two parts 11, 12 contact each other again, the first relay JD1 will remain in an off state and short circuit will not occur in the rechargeable battery B and so the rechargeable battery B will not burnt out.")

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		U.S. 2014/0368155 to Chen ¶7 ("The first switch unit is electrically connected to the battery unit and the vehicle battery. The second switch unit is electrically connected to the battery unit, the first switch unit and the vehicle battery. The third switch unit is electrically connected to the battery unit, the first switch unit and the vehicle battery. The fourth switch unit is electrically connected to the battery unit, the second switch unit, the third switch unit and the vehicle battery."); ¶18 ("The smart vehicle rescue battery apparatus 10 includes a battery unit 102, a first switch unit 104, a second switch unit 106, a third switch unit 108, a fourth switch unit 110, a control unit 112, a voltage polarity detection unit 114 and a charging unit 116.") **U.S. 2015/0137740 to Allos** ¶27 ("During the boost function, component 15 is also energized, closing internal contacts and transferring 12V power from C14 to C21, for the purpose of energizing contactor 17 N.C.to break open internal contacts that will disconnect circuit C20 from C16. **Component 17 acts as an isolator between the boost function and charging function of the MCS**. It is also energized during reverse polarity conditions."); ¶41 ("Current flows through the meter to circuit C20 and then to component 17 contactor N.C. **When component 17 is de-energized, current flows through it from circuit C20 to circuit C16 and then to component 18 to the vehicle battery**."); ¶42 ("**Component 17 acts as an isolator between charging and boost cycles**. As such, the same is de-energized during a charging cycle of the mobile charging system, and energized during jump start or "boost" function and during reverse polarity detection condition. During the charging cycle of the mobile charging system, the voltage output will vary between 13.8 to 14.3 volts, depending on the condition of the vehicle discharged battery."); ¶50 ("Component 15 may be de-energized during a reverse polarity condition and may act as an interrupt during boost cycle. When circuit C21 has +12 Volts it will **energize component 17** (Normally Closed) Contactor resulting in a circuit **break between circuit C16**

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		vehicle battery and circuit C20 that controls the mobile charging system output, thus providing protection to amp meter 8 and fuse box 4 and other internal mobile charging system components. In addition, it also prevents the mobile charging system boost and charge functions from causing electrical damage to the weak or discharged vehicle battery and electrical system by isolating the same from the mobile charging system internal power source."); *see also* U.S. Provisional Patent Application 61/903,779 at 3, 5. **U.S. 2015/0306964 [issued as U.S. 9,525,297] to Wang** ¶6 ("… the **automobile start control module** conducts the power supply or the power outage for the load module through the microcontroller …"); ¶11 ("As a further solution of the present disclosure that: the automobile start control module is the electronic switch."); ¶ 23 ("Refer to FIG. 1, a novel automobile charger comprises a direct current power supply, wherein the positive pole of the direct current power supply is connected with one end or lead of the DC to DC module, one end of the battery voltage detection module and one end of the load module simultaneously, while the negative pole of the direct current voltage is connected with the other end of the DC to DC module, one end of the microcontroller, one end of the **automobile start control module** and the other end of the battery voltage detection module simultaneously. A third end of the DC to DC module is connected with the other end of the microcontroller, and the other three ends of the microcontroller are connected with the third end of the battery voltage detection module, the other end of the **automobile start control module** and one end of the load detection module respectively, wherein the other end of the load detection module is connected with the third end of the **automobile start control module** and the other end of the load module simultaneously; the load module which comprises the automobile storage battery and the automobile engine is located on the end of the load module."); ¶24 ("a Drive port of the **automobile start control module** is connected with the automobile engine and one end of a resistor R14 simultaneously, wherein the other end of the resistor R14 is grounded."); ¶25 ("the **automobile start control module** conducts the power supply or the power outage for the load module

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		through the microcontroller"); ¶26 ("The microcontroller in the present disclosure determines whether the automobile storage battery is connected with the automobile engine through the load detection module, wherein the **automobile start control model** [sic] is **automatically activated and the battery starts to supply power to the load module** when the load is correctly connected; the **automobile start control model** [sic] is **automatically deactivated and the battery stops supplying power to the load module** when assuming that the load is not connected or the positive and negative polarities are reversely connected. In the standby mode, the microcontroller closes all outputs when the battery voltage is lower than 9V, and recovers the normal operation only when the battery voltage is larger than 10V; the automobile engine will generate the normal voltage to recharge the battery after the automobile starts, whereas the **automobile start control module** is deactivated immediately once the recharging voltage is larger than the voltage before that battery starts the power supply, to protect the battery from damages caused by charging with the normal voltage; the automobile start control module is the electronic switch, which can prevent the load from being reversely connected and recharging of the normal voltage, thus protecting the battery and prolonging lifespan."); ¶27 ("The automobile engine will generate abnormal voltage to recharge the direct current power supply after the automobile starts, and the **automobile start control module** is deactivated immediately once the recharging voltage is larger than the voltage before the direct current power supply starts the power supply, to protect the direct current power supply from damages caused by charging with normal voltage charge.") **U.S. 2006/0220610 to Solberg** ¶23 ("A control module 104 coupled to an output of charging system 100 and the **second switch 130 controls the states of the second, third, and fourth switches 130, 132, and 134**. With or without input and output isolation (e.g., such as through an opt-coupler), the control module 104 monitors an output of the charging system 100 and compares it against a fixed or a programmable voltage level or voltage range. When the voltage equals or rises above the voltage level or falls within the

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		voltage range, the control module 104 **activates the second switch 130** that couples one or more of the boost modules 108 and 110 to the outputs of the charging system 100. When the control module 104 detects a reverse polarity, the **second switch 130 is deactivated** effectively shutting down the charging system 100."); ¶29 ("The output of the charging system 200 is monitored by a voltage and/or current monitoring circuit within the controller 204. Voltage and/or current monitored at the output interface 212 are compared against a fixed or programmed reference. When the output exceeds the reference, **a control signal activates the second, third, and fourth relays 224, 228, and 230**. When a reverse polarity connection is detected, the control signal does not flow from the controller 204, which **deactivates the second relay 224** and shuts down the charging system 200. Analog gauges, digital, or light emitting diode displays 302 (as shown in FIG. 3) may provide a reverse polarity warning. A speaker or piezoelectric elements 302 may provide an audible warning to the user of a reverse polarity connection.") The following references also disclose, teach, or suggest this element: EP 0 616 409 to Herbert, e.g., at ¶¶30; U.S. 2006/0176011 to Lui, e.g., at ¶40; U.S. 2001/0025618 to Kelling, e.g., at ¶17; U.S. 2004/0150373 to Chan, e.g., at ¶¶12; U.S. 2006/0244412 to Bonzer, e.g., at ¶21-22; U.S. 6,759,833 to Chen, e.g., at 1:34-43; U.S. 5,194,799 to Tomantschger, e.g., at 6:37-55; U.S. 2014/0210399 to Urschel, e.g., at ¶40; U.S. 3,638,108 to Channing, e.g., at 6:35-46; U.S. 2013/0162029 to Reichow, e.g., at ¶24; U.S. 6,650,086 Chang; e.g., at 4:41-62; U.S. 2002/0041174 to Purkey, e.g., at ¶21; U.S. 6,344,733 to Crass, e.g., at 2:42-58; U.S. 5,281,904 to Tomkins, e.g., at 3:26-38
1[F]	a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **<u>WO 2012/080996 A1 to Tracey et al.</u>** 6:23-26 ("An integrated circuit IC1 is connected via a resistor R2 to the positive lead 103 and is connected to the negative lead 105 via reverse polarity indicator (LED1). Also, a manual contact switch 115 (SW1) is connected on one side to the

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	to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.	positive lead 3, and on the other to a Zener diode ZD1 , a resistor Rl , in turn linked with a bank of MOSFET switches Ql , Q2, and Q3."); 7:13-20: ("To activate the jump-starter system it must be connected to a vehicle battery by means of the positive and negative jaws 56 linked to the conductors 104 and 106. The activation switch 1 15 (SW1) is then briefly depressed. This switch may be located at any convenient location of the housing Current flows from the battery (BAT) via ZD1 and Rl to the gates of International Rectifier IRF 1324s MOSFETS (or alternates) Ql , Q2 and Q3 via their respective gate resistors R4, R5 and R6. Capacitor CI is also charged. Once a Vgs of 10V is applied to the MOSFETS Ql , Q2, and Q3 they begin conducting from drain to source with a very low ON state resistance, typically about 0.00033 Ohms for three parallel connected parts."); 8:22-26 ("Secondly, current from the vehicle battery flows via the resistor R2, reverse polarity indicator LED1 and the input side of the semiconductor photo-relay type TLP222 (IC1) thus illuminating LED1 and the input photo LED in IC1 . Even if the vehicle battery is severely discharged, the current requirement of IC1 is very small and will in most cases be less than 5 mA.") **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** ¶12 [2:45-46] ("In a further embodiment, the battery booster device may also comprise a **microprocessor**. The **microprocessor** can be used as part of a polarity protection circuit."); ¶43 [8:40-44] ("Referring now to FIG. 5, an example of a microprocessor controlled jump starter system according to an embodiment of the invention is described. The **microprocessor 60 can be programmed to perform essentially all of the control functions needed for operation of the jump starter**."); ¶44 [8:48-53] ("By way of a feedback circuit or other means, the microprocessor 60 can monitor the voltage and/or current being supplied to the depleted battery 11 from the booster battery 2, the voltage and/or current of the battery 11 and can detect short circuits or other faults, as described in more de tail [sic] below."); ¶45 [8:59-9:10] ("In this embodiment, **microprocessor 60 is used to control the switch 12**. Opto-isolator 16 is coupled to clamps 8, 10 via resistor 62 such that LED 26 is forward biased when a correct polarity connection between the

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		boosting battery 2 and the depleted battery 11 is made. When forward biased, LED 26 turns on phototransistor 22. The collector 23 of the phototransistor 22 is coupled to a supply voltage via internal circuitry in the microprocessor 60. When the phototransistor 22 is on, a first signal of a first voltage is present at the collector 23 and is sensed by the microprocessor 60. When the phototransistor 22 is off, a second signal of a second voltage is present at the collector 23 and is sensed by the microprocessor 60. The **microprocessor 60 provides output signals to activate the switch 12** into a conducting state when it receives the first signal and provides an output signal to deactivate the switch 12 into a non-conducting state when it receives the second signal. Additionally, the **microprocessor can deactivate switch 12** to terminate the jump starting process when a fault is detected."); ¶46 [9:11-26] ("The output signals from the **microprocessor 60** to control switch 12 are provided to control electrodes 14 a-14 d of transistors 12 a-12 d, as shown in FIG. 5. The control electrodes 14 a-14 d of the transistors are electrically connected to the microprocessor 60 via a level translator 68. Microprocessors normally run on low voltages, e.g., 5 volts. A low voltage power supply is provided to the **microprocessor 60** from battery 2 via a voltage regulator 70. The low voltage output signals from the **microprocessor 60** should be translated to higher voltages before being supplied to the transistors 12 a-12 d. The level translator 68 translates the output voltage of the **microprocessor 60** to the higher levels that are needed to operate transistors 12 a-12 d. Accordingly, the output signals from the **microprocessor 60** are used by the level translator 68 to generate control signals for the control electrodes of the FETs."); ¶47 [9:27-32] ("If the polarity connections of clamps 8, 10 to the depleted battery 11 are not correct, the switch 12 remains off. The display 64 may be controlled by the microprocessor 60 to display a message indicating reverse polarity. The microprocessor 60 may additionally activate an alarm such as buzzer 72 in response to the incorrect polarity connection."); ¶48 [9:33-42] ("**Microprocessor 60 can be programmed to detect if clamps 8, 10 are connected to a battery or have been disconnected**. To perform the detection, the microprocessor 60 deactivates the switch 12 into a non-conducting state. Via the feedback circuit or other means, the microprocessor detects whether clamps 8,10 are connected to a battery. If no battery is present, the switch 12 is placed in a non-

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		conducting state, that is, all the FETs 12 a-12 d are placed in a non-conducting state. If a battery is present, the jump starting process continues.") **U.S. 2003/0141845 [Issued as U.S. 6,822,425] to Krieger** ¶57 ("The embodiment shown in FIG. 4 includes a **microprocessor** that controls many of the functions of the battery charger."); ¶58 ("In this embodiment, a **microprocessor 50 is coupled to switches 22, 24**, which may, for example, comprise FETS, and to the high frequency transformer portion 8."); ¶64 ("A polarity detection circuit detects the polarity of the connection of clamps 60, 61 and provides a signal to the microprocessor 50. In response to the signal from polarity detection circuit, the **microprocessor controls the operation of the battery charger to supply power to the battery 21 or indicate an incorrect polarity accordingly**."); ¶65 ("When the phototransistor 65 is turned on, it provides a logic high signal to a pin a4 of the **microprocessor 50**. The logic high signal indicates to the microprocessor 50 that a correct polarity connection has been made. Connecting clamp 60 to the negative terminal of battery 21 reverse biases the LED 63, and no signal is provided to the **microprocessor 50**."); ¶66 ("In response to the logic high signal, the **microprocessor 50 outputs a control signal to a control circuit for completing the connection between the battery charger and the battery 21**. Here, the control circuit includes a transistor 72 coupled between one of the clamps 60, 61 and the charger circuit. Transistor 72 acts as a switch to connect battery 21 to the charger circuit. Only when switch 72 is closed will transistor 69 complete the connection between the battery charger and the battery 21. The opening and closing of transistor 72 is controlled via transistors 69 and 70. **A control electrode of transistor 69 receives the control signal from the microprocessor**. When the control signal is received, transistor 69 turns on, which, in turn, turns on transistor 70. Current flow through transistor 70 activates a control electrode for transistor 72 and turns transistor 72 on, completing the circuit between the charger circuit and battery 21. **Only when the control signal is provided to transistor 69 is it possible for transistor 72 to be turned on.**"); ¶67 ("Once a correct polarity connection has been established, the transistor 72 may remain on even after clamps

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		60, 61 are disconnected from the battery 21. The disconnected clamps are thus still powered-up. Therefore, a **means for detecting the presence of a battery** at the clamps may be provided. The **microprocessor 50 can be programmed to detect when the clamps 60, 61 have been disconnected and, in response, turn transistor 72 off**. A voltage divider comprised of resistors 74 and 76 is provided for this purpose. The voltage divider divides the voltage across the clamps 60, 61 and provides a portion of this voltage to the microprocessor 50. When the clamps are disconnected from the battery 21, the voltage across the clamps 60, 61 will greatly increase. The voltage provided by the voltage divider will also increase in a corresponding manner. When the voltage provided to the **microprocessor 50** exceeds a selected amount, for example, 18 volts, the **microprocessor 50 detects that the clamps 60, 61 have been disconnected and immediately turns off transistors 69 and 70, which turns off transistor 72**. Various resistors, such as resistor 78, may also be included in the circuit."); ¶68 ("The presence of a current flowing through the clamps 60, 61 may indicate whether the clamps 60, 61 are connected to a battery. A current flows through the clamps when they are connected to a battery and no current should flow through the clamps when they are not connected to a battery. The **microprocessor 50 is adapted to detect the current flowing through the clamps 60, 61**. When no current is detected, the microprocessor 50 detects that the clamps 60, 61 have been disconnected and immediately turns off transistors 69 and 70, which turns off transistor 72.") **U.S. 2004/0239290 to Krieger** ¶16 ("An example of a high-frequency charger that may be used to implement the present invention is described in **U.S. patent application Ser. No. 10/270,391**, entitled "A High Frequency Battery Charger and Method of Operating Same," commonly owned by the Assignee of the present application and the disclosure of which is incorporated herein by reference in its entirety.") (incorporating U.S. 2003/0141845 [Issued as U.S. 6,822,425] to Krieger, e.g., at ¶57 ("The embodiment shown in FIG. 4 includes a **microprocessor** that controls many of the functions of the battery charger."); ¶58; ¶64; ¶65; ¶66; ¶67; ¶68); ¶17 ("A **microprocessor**,

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		described below, may be used to control the charging process.") (quoted above); ¶18 ("**An example of a jump starter that may be used to implement the present invention is described in U.S. patent application Ser. No. 10/315,061 entitled "Microprocessor Controlled Jump Starter System With Polarity Protection,"** commonly owned by the Assignee of the present application and the disclosure of which is incorporated herein by reference in its entirety. The jump starter circuit of the present invention may include a polarity protection circuit (not shown) that can be electrically coupled to the depleted battery and to the internal battery 308. The polarity protection circuit can prevent current flow between the batteries unless a proper polarity connection is achieved, i.e. the positive terminal of the internal battery is connected to the positive terminal of the depleted battery and the negative terminal of the internal battery is connected to the negative terminal of the depleted battery. The above-mentioned **U.S. patent application Ser. No. 10/315,061** describes a polarity protection circuit that may be used to implement this aspect of the described embodiment.") (incorporating U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger, e.g., at ¶12 [2:45-46] ("In a further embodiment, the battery booster device may also comprise a **microprocessor**. The **microprocessor** can be used as part of a polarity protection circuit."); ¶43; ¶44; ¶45; ¶46; ¶47; ¶48) (quoted above) **U.S. 2007/0285049 to Krieger** ¶14 ("Additionally, the battery 20 may provide power for a controller 14, such as a **microprocessor or other circuitry**, which may be used to **control the operation of the various components** described below that may be provided in the jump starter."); ¶16 ("For example, a booster apparatus as described in U.S. patent application Ser. No. 10/315,061, which is incorporated herein by reference, may be provided.") (incorporating U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger, e.g., at ¶12 [2:45-46] ("In a further embodiment, the battery booster device may also comprise a **microprocessor**. The **microprocessor** can be used as part of a polarity protection circuit."); ¶43; ¶44; ¶45; ¶46; ¶47; ¶48) (quoted above)

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		U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei ¶19 ("a MCU controller chip J1"); ¶26 ("The output terminals of the battery pack are further connected to a multipath DC-DC voltage regulator circuit and a LED driving circuit 12, each path of the DC-DC voltage regulator circuit is connected to a **MCU controller circuit 14** …"); ¶30 ("When the red and black power source clips are respectively connected to the positive and negative electrodes of the external battery, if the connection is correct, a feedback voltage displayed by the voltage identifying system is positive, otherwise the feedback voltage is negative. The positive feedback voltage ranges from value a of 6 to 24 V to value b of 9 to 30 V, and a is smaller than b. If the connection is reverse, the relay does not work, and the high current outputting circuit 7 may be cut off. 1f the external smart battery detection system 6 fails, to further ensure the safety of the emergency power source, in the circuit of the emergency power source of the invention, a disposable or recoverable fuse 5 is provided and is connected between the output terminals of the battery pack 4 and the external smart battery detection system 6."); ¶31 ("In this invention, when the feedback voltage ranges from value a to value b and is of a positive value, the coil of the relay receives a voltage signal so that its contact is closed and its output terminal is coupled to the high current outputting circuit 7, and the emergency power source starts to power an external device with a high current. At this time, the current identifying system detects the current flowing through the high current outputting circuit 7. 1f the current is lower than value c, which ranges from 0.1 A to 10 A, the voltage signal across the coil of the relay disappears, the contact is then open, thus its output terminal is disconnected from the high current outputting circuit 7 to stop powering the external device with the high current."); ¶36 ("When the emergency power source is disconnected from the external rechargeable battery, or the current is smaller than the preset current value, R15 and R16 in the circuit 62 of the current identifying system provide a detection signal to U3. Then U3 sends an output signal to the MCU controller chip according to the detection signal, **based on which the MCU controller chip may determine the ON or OFF state of the circuit to make proper instructions**. When the preset voltage value is 8.1V and the output voltage value is smaller than the preset value,

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		R7 and R8 of the circuit 61 of the voltage identifying system may provide a detection signal to U2, and U2 may send an output signal to terminal IN1 according to the detection signal. Then the **MCU controller chip further controls the control switch Q2** in the circuit 63 of the relay according to the signal from terminal IN1. When the output voltage is bigger than a preset value, which may be 12.6V in the invention, R9 and R10 of the circuit 61 of the voltage identifying system may provide a detection signal to U2, and U2 may send a signal according to the detection signal to control the control switch Q3 in the circuit 63 of the relay. In this invention, the circuit 61 of the voltage identifying system and the circuit 62 of the current identifying system co-operate to provide the signal to the MCU controller chip. **With the determination of the MCU controller chip, the switches Q1, Q2 and Q3 in the circuit 63 of the replay can be controlled to achieve charging and protecting**.") **U.S. 2005/0116688 to Yin** ¶24 ("High current relays and **polarity detecting circuit** are used in the present invention. In normal situations, the battery clamps have no electricity and this prevents short circuit of the battery clamps. When the battery clamps are connected to the vehicle's battery, **the polarity detecting circuit will detect the polarity automatically and if the polarity is correct, the circuit will allow the first relay JD1 to conduct electricity and thus connect the circuit of the rechargeable battery B and the vehicle's battery** to start the vehicle. If the polarity is detected to be reversely connected, the circuit will maintain the first relay JD1 in an off state and the rechargeable battery B and the vehicle's battery are not connected and so the vehicle's battery will not be burnt out owing to the reverse polarity connection."); ¶25 ("When the battery clamps are not connected with the vehicle's battery, the first relay JD1 has no voltage and is in an off state and the battery clamps have no electricity. This can prevent danger caused by short circuit of the battery clamps."); ¶26 ("When the battery clamps and the vehicle's battery are connected with the correct polarity, **the second diode D2 is reversely biased**, the second relay JD2 is in an off state, the light L1 does not flash and the buzzer BU does not sound. The

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		power source provides electric power via the first diode D1 to the first relay JD1, thereby energizing the first relay JD1 and connecting the rechargeable battery B with the vehicle's battery to start the vehicle."); ¶28 ("When the two battery clamps are reversely connected to the two terminals of vehicle's battery, **the first diode D1 is in a reversed close state** in the circuit of the first relay JD1 and so the **first relay JD1 remains in an off state**, which leads to the disconnection of the rechargeable battery B and the vehicle's battery, thereby eliminating the risks of incurring high current and sparks. Simultaneously, the vehicle's battery provides power to the second relay JD2 and the buzzer BU via **the second diode D2, thereby energizing the second relay JD2 and making the buzzer BU to sound**. The rechargeable battery B provides power to the flash light circuit making the light L1 to flash.") **U.S. 2014/0368155 to Chen** ¶7 ("The **control unit** is electrically connected to the first switch unit, the second switch unit, the third switch unit and the fourth switch unit. The voltage polarity detection unit is electrically connected to the first switch unit, the second switch unit, the third switch unit, the fourth switch unit, the vehicle battery and the control unit. The **voltage polarity detection unit** is configured to detect the voltage polarity of the vehicle battery and **inform the control unit**. The **control unit** is configured to **turn on the first switch unit and the fourth switch unit and turn off the second switch unit and the third switch unit**, when the polarity of a contact connecting the first switch unit, the third switch unit and the vehicle battery is judged to be a positive pole and when the polarity of a contact connecting the second switch unit, the fourth switch unit and the vehicle battery is judged to be a negative pole. The control unit is configured to **turn on the second switch unit and the third switch unit** and **turn off the first switch unit and the fourth switch unit**, when the polarity of the contact connecting the first switch unit, the third switch unit and the vehicle battery is judged to be the negative pole and when the polarity of the contact connecting the second switch unit, the fourth switch unit and the vehicle battery is judged to be the positive pole."); ¶13 ("Moreover, the control unit is, for examples but not limited to, a microprocessor, a **microcontroller**, or a

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		control circuit having an integrated circuit and electronic components."); ¶19 ("The **control unit 112** is electrically connected to the first switch unit 104, the second switch unit 106, the third switch unit 108, the fourth switch unit 110 and the voltage polarity detection unit 114. The voltage polarity detection unit 114 is electrically connected to the first switch unit 104, the second switch unit 106, the third switch unit 108, the fourth switch unit 110, the vehicle battery 20 and **the control unit 112**."); ¶20 ("The voltage polarity detection unit 114 is configured to detect the voltage polarity of the vehicle battery 20 and **inform the control unit 112**."); ¶21 ("The control unit 112 is configured to **turn on the first switch unit 104 and the fourth switch unit 110** and **turn off the second switch unit 106 and the third switch unit 108**, when the polarity of a contact connecting the first switch unit 104, the third switch unit 108 and the vehicle battery 20 is judged to be a positive pole and when the polarity of a contact connecting the second switch unit 106, the fourth switch unit 110 and the vehicle battery 20 is judged to be a negative pole."); ¶22 ("The control unit 112 is configured to **turn on the second switch unit 106 and the third switch unit 108** and **turn off the first switch unit 104 and the fourth switch unit 110**, when the polarity of the contact connecting the first switch unit 104, the third switch unit 108 and the vehicle battery 20 is judged to be the negative pole and when the polarity of the contact connecting the second switch unit 106, the fourth switch unit 110 and the vehicle battery 20 is judged to be the positive pole."); ¶23 ("The control unit 112 is, for examples but not limited to, a microprocessor, a **microcontroller**, or a control circuit having an integrated circuit and electronic components.") **U.S. 2015/0137740 to Allos** ¶11 ("In particular, it is noted that variations in values of voltages and currents may be employed in given implementations, and that certain circuit components may be combined in various ways or implemented with different circuitry, including **microprocessors**. Accordingly, equivalent circuit configurations are also intended to be encompassed by the scope of present principles."); ¶22 ("When the mobile charging system is correctly connected to a vehicle with a discharged battery, the

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		green warning light 10 will illuminate, indicating proper connection. Component 18 with circuit C16 will have positive voltage and component 19 with circuit C1 will have negative voltage. C16 and C1 circuits are monitored by component 20 (forward polarity sense circuit), and this component includes three resistors with ratio values biased for low voltage detection. When circuit C16 voltage value is 2 or more volts more positive than circuit C1, the operational amplifier L2722 will conduct and switch its output circuit C25 to 12V positive to energize component 21 (Relay 3). When relay 3 N.O. (normally open) contacts are closed, 12V power from circuit C14 will connect with circuit C24 to turn green light on in component 10, indicating the correct and safe hook-up of the mobile charging system."); ¶41 ("Current flows through the meter to circuit C20 and then to component 17 contactor N.C. When component 17 is de-energized, current flows through it from circuit C20 to circuit C16 and then to component 18 to the vehicle battery."); ¶48 ("Once the reverse polarity sense circuit detects reverse polarity, it will conduct current and switch output circuit C23 to positive 12 volts **energizing component 14 relay 1 that will result in the enabling of the reverse polarity protection feature** of the mobile charging system, and the disabling of the boost cycle power source to component 11."); ¶49 ("**When component 14 is energized, normally open relay 1 contacts will close**, connecting circuit C14 (+12V source) with circuit C18 that feeds component 10 (polarity indicator) red warning light and buzzer in the instrument panel to warn the technician of the incorrect connection of the mobile charging system to the vehicle battery. Circuit C18 also feeds component 15 (Normally Closed) relay 2 contacts that connect to circuit C21."); ¶50 ("**Component 15 may be de-energized during a reverse polarity condition and may act as an interrupt during boost cycle**. When circuit C21 has +12 Volts it will energize component 17 (Normally Closed) Contactor **resulting in a circuit break between circuit C16 vehicle battery and circuit C20 that controls the mobile charging system output**, thus providing protection to amp meter 8 and fuse box 4 and other internal mobile charging system components. In addition, it also prevents the mobile charging system boost and charge functions from causing electrical damage to the weak or discharged vehicle battery and electrical system by

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		isolating the same from the mobile charging system internal power source."); *see also* U.S. Provisional Patent Application 61/903,779 at 2, 4-5. **U.S. 2015/0306964 [issued as U.S. 9,525,297] to Wang** ¶6 ("As a further solution of the present disclosure that: the DC to DC module provides a stable voltage for the **microcontroller** which **collects relevant data to conduct the corresponding control**. The battery voltage detection module conducts the measurement of the batter[y] voltage, the automobile start control module conducts the power supply or the power outage for the load module through the **microcontroller**, and the load detection module which comprises the automobile storage battery or the automobile engine detects whether the load module is correctly connected."); ¶10 ("As a further solution of the present disclosure that: in the standby mode, the **microcontroller closes all outputs** when the voltage of the direct current power supply is lower than that of the state being able to supply power and then recovers when it is higher than that of the state being able to supply power."); ¶ 23 ("Refer to FIG. 1, a novel automobile charger comprises a direct current power supply, wherein the positive pole of the direct current power supply is connected with one end or lead of the DC to DC module, one end of the battery voltage detection module and one end of the load module simultaneously, while the negative pole of the direct current voltage is connected with the other end of the DC to DC module, one end of the **microcontroller**, one end of the automobile start control module and the other end of the battery voltage detection module simultaneously. A third end of the DC to DC module is connected with the other end of the **microcontroller**, and the other three ends of the microcontroller are connected with the third end of the battery voltage detection module, the other end of the automobile start control module and one end of the load detection module respectively, wherein the other end of the load detection module is connected with the third end of the automobile start control module and the other end of the load module simultaneously; the load module which comprises the automobile storage battery and the automobile engine is located on the end of the load module."); ¶25 ("The DC to DC module in the present disclosure provides

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		the stable voltage for the **microcontroller which collects relevant data** to conduct the corresponding control. The battery voltage detection module conducts the measurement of the batter voltage, and the **automobile start control module conducts the power supply or the power outage for the load module through the microcontroller**, wherein the load detection module detects whether the load module is correctly connected."); ¶26 ("**The microcontroller in the present disclosure determines whether the automobile storage battery is connected** with the automobile engine through the load detection module, wherein the **automobile start control model** [sic] is **automatically activated and the battery starts to supply power to the load module** when the load is correctly connected; the **automobile start control model** [sic] is **automatically deactivated and the battery stops supplying power to the load module** when assuming that the load is not connected or the positive and negative polarities are reversely connected. In the standby mode, the **microcontroller closes all outputs** when the battery voltage is lower than 9V, and recovers the normal operation only when the battery voltage is larger than 10V; the automobile engine will generate the normal voltage to recharge the battery after the automobile starts, whereas the automobile start control module is deactivated immediately once the recharging voltage is larger than the voltage before that battery starts the power supply, to protect the battery from damages caused by charging with the normal voltage; the automobile start control module is the electronic switch, which can prevent the load from being reversely connected and recharging of the normal voltage, thus protecting the battery and prolonging lifespan.") **U.S. 2006/0220610 to Solberg** ¶23 ("**A control module 104** coupled to an output of charging system 100 and the second switch 130 controls the states of the second, third, and fourth switches 130, 132, and 134. With or without input and output isolation (e.g., such as through an opt-coupler), the **control module 104 monitors an output of the charging system 100** and compares it against a fixed or a programmable voltage level or voltage range. When the voltage equals or rises above the voltage level or falls within the

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		voltage range, the **control module 104 activates the second switch 130** that couples one or more of the boost modules 108 and 110 to the outputs of the charging system 100. When the control module 104 detects a reverse polarity, **the second switch 130 is deactivated effectively shutting down the charging system 100**."); ¶29 ("The output of the charging system 200 is monitored by a voltage and/or current monitoring circuit within the **controller 204**. Voltage and/or current monitored at the output interface 212 are compared against a fixed or programmed reference. When the output exceeds the reference, **a control signal activates the second, third, and fourth relays 224, 228, and 230**. When a reverse polarity connection is detected, **the control signal does not flow from the controller 204, which deactivates the second relay 224 and shuts down the charging system 200**. Analog gauges, digital, or light emitting diode displays 302 (as shown in FIG. 3) may provide a reverse polarity warning. A speaker or piezoelectric elements 302 may provide an audible warning to the user of a reverse polarity connection.") The following references also disclose, teach, or suggest this element: U.S. 2006/0176011 to Lui, e.g., at ¶21; U.S. 2004/0150373 to Chan, e.g., at ¶¶17-21; U.S. 2006/0244412 to Bonzer, e.g., at ¶21-22; U.S. 2014/0210399 to Urschel, e.g., at ¶39; WO 2012/036556 to Eidsvig, e.g., at 3:25-26; 5:8-10; U.S. 2013/0162029 to Reichow, e.g., at ¶22-24; U.S. 6,650,086 Chang; e.g., at 3:9-15; U.S. 2002/0041174 to Purkey, e.g., at ¶57-61; U.S. 6,344,733 to Crass, e.g., at 2:42-3:37
2	The apparatus of claim 1, wherein said internal power supply comprises a lithium ion battery	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **WO 2012/080996 A1 to Tracey et al.** Abstract ("The on-board starter battery (15, 26) may comprise a **lithium iron phosphate battery**."); 2:13-14 ("In one embodiment, the on-board starter battery means comprises a lithium iron phosphate battery."); 5:12-15 ("In the invention there is an on-board starter battery which comprises a plurality of interconnected batteries 15 which may be of the **lithium iron phosphate type**. The battery cells

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		can be of either cylindrical, prismatic or pouch type. The voltage is between 3.2 and 3.7 V nominal and of **lithium iron chemistry**."); 5:33-6:3 ("The jump starter 50 comprises a first clip 51 and a second clip 52 interconnected by a power cable 53. The first clip 51 has a housing 55 for a battery of sufficient capacity to provide the full starting power, in this embodiment of the **lithium iron phosphate type**. Also, the first clip 51 comprises a pair of jaws 56 having finger grips 57 for pressing together for opening and closing."); 6:11-12 ("The jump starter 50 involves use of close-proximity high-power batteries of the **lithium iron phosphate type**."); 9:32-34 ("In a still further embodiment, referring to Fig. 12, a 4-cell **Lithium iron battery** is connected to a positive jump-starter clamp by means of a number of parallel connected positive thermal coefficient (PTC) type resettable fuses."); Claim 2 ("A jump starter as claimed in claim 1 , wherein the on-board starter battery means (1 , 26) comprises a **lithium iron phosphate battery**.") **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** ¶8 [1:67-2:1] ("The battery may comprise a **lithium iron phosphate** battery cell or a **lithium cobalt oxide** battery cell."); ¶35 5:12-27 ("In an embodiment of the present invention, the battery cell 42 is a **lithium iron phosphate** cell. In an additional embodiment, the battery cell 42 is a **lithium cobalt oxide** cell. Preferably, the output of the ignition output port's voltage is higher than about 13.6V. The voltage of the vehicle battery is generally less than about 13.6V and the output voltage of the ignition output port 46 is higher than 13.6V. The voltage differential can effectively prevent voltage reverse charging from the vehicle battery to the device 10 upon vehicle ignition start; thereby preventing reverse charging of the battery cell 42. Thus, the voltage differential protects the battery cell 42 and extends the life of the battery module 16. **Lithium iron phosphate and lithium cobalt oxide battery cells** have a large discharge capacity and may provide an output voltage higher than about 13.6V."); **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei**

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		¶8 ("In certain embodiments, the battery pack consists of **lithium-ion batteries** connected in series or parallel, each battery having a positive electrode made of lithium iron phosphate, lithium cobalt oxide, nickel cobalt manganese ternary lithium or lithium manganate and a negative electrode made of artificial or natural graphite …"); ¶20 ("The emergency power source of the present invention uses **lithium-ion batteries** as its battery pack, which have characteristics of light weight, small size, durability, high instantaneous discharging current and rechargeability, which can meet the demand of high current for starting a vehicle."); ¶26 ("Furthermore, the battery pack 4 consists of **lithium-ion batteries** connected in series or parallel, each having a positive electrode made of lithium iron phosphate, lithium cobalt oxide, nickel cobalt manganese ternary lithium or lithium manganate and a negative electrode made of artificial or natural graphite."); ¶27 ("The emergency power source uses lithium-ion batteries as its battery pack, which has the characteristics of light weight, small size, durability, high instantaneous discharge current and rechargeability, which is capable of supplying a high current for starting a vehicle.") **U.S. 2015/0137740 to Allos** ¶9 ("Coupled to the housing may be a **rechargeable source of energy 105**, which is in many cases a **plurality of battery cells** which may be charged, e.g., from a wall or other outlet source."); ¶16 ("The batteries may be lead acid, absorption glass mat (AGM), lithium ion, or the equivalent …"); *see also* U.S. Provisional Patent Application 61/903,779 at 1-2. The following references also disclose, teach, or suggest this element: U.S. 2014/0210399 to Urschel, e.g., at ¶57
3	The apparatus of claim 2, wherein said lithium ion battery comprises a battery pack of multiple lithium ion batteries.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **WO 2012/080996 A1 to Tracey et al.**

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		2:16-17 ("In one embodiment, there is a plurality of on-board starter batteries along the interconnection means."); 2:19-20 ("In one embodiment, the on-board starter battery means comprises a plurality of separate batteries which are electrically interconnected."); 5:12-13 ("In the invention there is an on-board starter battery which comprises a plurality of interconnected batteries 15 which may be of the lithium iron phosphate type."); 5:29-30 ("In this embodiment there are two batteries 26 housed within each handle 25, and finger- gripping features 27 are provided to aid user operation."); **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** ¶34 ("In an embodiment, the battery module 16 includes battery cells 42, a battery circuit board 44, an ignition output port 46, and a connecting ribbon cable 48. The battery cell 42 may have a multi-cell structure. In an embodiment of the present invention, the battery cell 42 has four battery cells.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶8 ("In certain embodiments, the battery pack consists of **lithium-ion batteries connected in series or parallel**, each battery having a positive electrode made of lithium iron phosphate, lithium cobalt oxide, nickel cobalt manganese ternary lithium or lithium manganate and a negative electrode made of artificial or natural graphite …"); ¶26 ("Furthermore, the battery pack 4 consists of **lithium-ion batteries connected in series or parallel**, each having a positive electrode made of lithium iron phosphate, lithium cobalt oxide, nickel cobalt manganese ternary lithium or lithium manganate and a negative electrode made of artificial or natural graphite.") **U.S. 2015/0137740 to Allos** ¶9 ("Coupled to the housing may be a **rechargeable source of energy 105**, which is in many cases a **plurality of battery cells** which may be charged, e.g., from a wall

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		or other outlet source."); ¶16 ("The batteries may be lead acid, absorption glass mat (AGM), lithium ion, or the equivalent …"); *see also* U.S. Provisional Patent Application 61/903,779 at 1-2. The following references also disclose, teach, or suggest this element: U.S. 2014/0210399 to Urschel, e.g., at ¶57
9	The apparatus of claim 1, further comprising a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** ¶46 [9:16-26] ("A low voltage power supply is provided to the microprocessor 60 from battery 2 via a voltage regulator 70. The low voltage output signals from the microprocessor 60 should be translated to higher voltages before being supplied to the transistors 12 a-12 d. The level translator 68 translates the output voltage of the microprocessor 60 to the higher levels that are needed to operate transistors 12 a-12 d. Accordingly, the output signals from the microprocessor 60 are used by the level translator 68 to generate control signals for the control electrodes of the FETs."); ¶52 [10:27-29] ("Voltage regulator 70 is coupled to the boosting battery 2 and the depleted battery 11 for detecting their charge levels."); ¶53 [10:30-43] ("In order to measure the charge level of the boosting battery 2, clamps 8, 10 should be disconnected from the depleted battery 11. The voltage regulator then produces a voltage proportional to the voltage of the boosting battery 2, and which is within the operating range of the microprocessor 60. The microprocessor 60 is programmed to detect when the voltage of the boosting battery 2 falls below a predetermined level, for example, about 80% of its rated value. The buzzer 72 or other device can then be activated to indicate to the operator that the charge of the boosting battery 2 is low and that it should be recharged. The booster system may be plugged into a standard 110/220-volt electrical outlet via a standard wall charger 82 to recharge the boosting battery 2."); ¶54 [10:44-54] ("In order to measure the voltage of the depleted battery 11, switch 12 between the boosting battery 2 and the depleted battery 11 should be in a non-conducting state. Microprocessor 60 can be controlled via operator input

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		from input device 66 to place switch 12 in a non-conducting state. Clamps 8, 10 are then connected to the depleted battery 11. The voltage regulator produces a voltage proportional to the voltage of the depleted battery 11. The microprocessor 60 receives this signal from the voltage regulator 70 and determines and displays the voltage of the depleted battery 11 on display 64.") **U.S. 2007/0285049 to Krieger** ¶14 ("In one embodiment, **a voltage regulator** optionally included may convert DC input power, for example from the battery 20, into a USB compatible 5V/500 mA DC power output. The **voltage regulator** may be a component of the power inverter 60. A charging port 19 for mobile telephones or other portable devices may also be provided. Additionally, the battery 20 may **provide power for a controller 14**, such as a microprocessor or other circuitry, which may be used to control the operation of the various components described below that may be provided in the jump starter.") **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** ¶42 ("In an embodiment, the discharge module 54 includes a constant current and constant voltage output circuit 66, a discharge module over-discharge protection circuit 68, and a discharge module power test circuit 70. The constant current and constant voltage output circuit 66 is coupled to the USB output module 36, so that the first USB interface 38 and the second USB interface 40 maintain a constant charging current and constant voltage.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶11 ("In certain embodiments, the DC-DC **voltage regulator circuit** includes a DC-DC 19V boost circuit having an output voltage of 19V, a DC-DC 12V output circuit having an output voltage of 12V, and a DC-DC 5V buck circuit having an output voltage of 5V."); ¶18 ("… a three-terminal **voltage regulator circuit U1** whose model is 7805 …"); ¶20 ("The battery pack of the emergency power source is also

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		connected to the **voltage regulator circuit** for outputting a variety of voltage levels …"); ¶26 ("The DC-DC **voltage regulator circuit** includes a DC-DC 19V boost circuit 11 of an output voltage of 19V, a DC-DC 12V output circuit 10 of an output voltage of 12V, and a DC-DC 5V buck circuit 9 of an output voltage of 5V."); ¶27 ("The battery pack of the emergency power source is also connected to the **voltage regulator circuit** for outputting a variety of voltage levels, and by connecting the output terminal of the respective path of the voltage regulator circuit to the MCU controller circuit, various outdoor power demands of mobile phones, computers, digital cameras, car playing pumps, car refrigerators, car cleaners, etc. can be satisfied."); ¶34 ("…a three-terminal **voltage regulator circuit U1** whose model is a 7805 …") **U.S. 2015/0137740 to Allos** ¶31 ("The mobile charging system may contain in one implementation **five primary components used to regulate the output voltage and current** to properly recharge a discharged vehicle battery, and these are components 3 a, 3 b, 5, 6 and 7. Components 3 a and 3 b are as noted above, e.g., switching regulator DC to DC converters. In one specific implementation the same are identical in model and part numbers, with the same electrical characteristics and specifications. Because of their configuration, they share the same inputs and outputs and are connected (wired) in parallel; therefore, the shared output current will max out at 40 amperes."); *see also* U.S. Provisional Patent Application 61/903,779 at 3. **U.S. 2015/0306964 [issued as U.S. 9,525,297] to Wang** ¶6 ("As a further solution of the present disclosure that: the **DC to DC module provides a stable voltage** for the microcontroller which collects relevant data to conduct the corresponding control."); ¶24 ("Refer to FIG. 2, the **DC to DC module** comprises a diode D1, a resistor R1, capacitor C1, a HT7530 voltage stabilizing tube, capacitors C2 and C3, wherein the positive pole of the diode D1 is connected with the positive pole of the battery, the negative pole of the diode D1 is connected

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		with one end of the capacitor C1 and an IN port of the HT7530 voltage stabilizing tube simultaneously through the resistor R1, and an OUT port of the HT7530 voltage stabilizing tube is connected with one end of the capacitor C2, one end of the capacitor C3 and a VDD port of the microcontroller U2, while the other end of the capacitor C1, the other end of the capacitor C2 and the other end of the capacitor C3 as well as a GND port of the HT7530 voltage stabilizing tube are grounded and connected with the negative pole of the battery simultaneously …"); ¶25 ("The **DC to DC module** in the present disclosure **provides the stable voltage** for the microcontroller which collects relevant data to conduct the corresponding control.") **U.S. 2006/0220610 to Solberg** ¶25 ("In other charging systems, a **current monitoring and limiting circuit** within the control module 104 may deactivate the second switch 130 to protect the user and charging system 100 against high current and/or **voltage** conditions."); ¶31 ("In other charging systems, a current and/or **voltage monitoring and limiting circuit** within the control module 104 may deactivate the second relay 224 to protect the user and charging system 200 against high current and/or **voltage** conditions.") The following references also disclose, teach, or suggest this element: EP 0 616 409 to Herbert, e.g., at ¶46; U.S. 3,638,108 to Channing, e.g., at 7:34-36; U.S. 2002/0041174 to Purkey, e.g., at ¶11-12, 58, 61, Fig. 6
10	The apparatus of claim 1, further comprising a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** ¶42 ("The discharge module 54 is connected to the USB (Universal Serial Bus) output module 36. In an embodiment, the discharge module 54 includes a constant current and constant voltage output circuit 66, a discharge module over-discharge protection circuit 68, and a discharge module power test circuit 70. The constant current and constant voltage output circuit 66 is coupled to the USB output module

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		36, so that the first USB interface 38 and the second USB interface 40 maintain a constant charging current and constant voltage."); ¶43 ("The discharge module over-discharge protection circuit 68 is used when the battery module 16 is supplying energy via the USB output module 36. The discharge module over-discharge protection circuit 68 prevents damage to the battery module and an external device charging via the USB output module 36 when the battery module's power output is below a predetermined threshold.") **U.S. 2007/0285049 to Krieger** ¶14 ("Several different types of DC power outlets may be provided. For example, **USB port 18** may be provided on the housing 10. The **USB port 18** may be used to provide a USB power supply. In one embodiment, a voltage regulator optionally included may convert DC input power, for example from the battery 20, into a USB compatible 5V/500 mA DC power output.") **U.S. 2013/0099736 to Roberts** ¶35 ("A USB port 114 allows for an external device 116 to be powered and/or charged by the battery charger if the external device 116 includes a USB compatible charging device 118. When inserted into the USB port 114, which is coupled to the auxiliary USB power supply 52 of FIG. 2, the USB charging device 118 conveys power from the USB port 114 to the external device 116. This allows a user to charge the vehicle battery 12 while simultaneously powering and/or charging a mobile telephone, hand-held computer, or any other external device. In a presently contemplated embodiment, the USB port 114 may convey electrical power rated up to approximately ten watts to the external device 116 (the power required to charge certain cellular, wireless or hand-held devices) through the USB charging device 118.") The following references also disclose, teach, or suggest this element: U.S. 2012/0025766 to Reade, e.g., at ¶25

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11	The apparatus of claim 1, further comprising a USB charging port configured to provide charging power from an external power source to said internal power supply.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **U.S. 2004/0239290 to Krieger** ¶17 ("In addition to the AC input plug 204, the apparatus may also have a DC input 302. The DC input 302 is coupled to the jump starter circuit 304, and can charge the internal battery 308 of the jump starter circuit 304 directly. The internal battery 308 can also be charged by the high frequency charger 306. A microprocessor, described below, may be used to control the charging process.") **U.S. 2015/0054336 [issued as U.S. 9,506,446] to Xinfang** ¶32 ("The charging port 34 may be an AC or DC charging port and is connectable to an external charging circuit adaptor for charging the battery module 16.") **U.S. 2008/0143290 [issued as U.S. 7,893,657] to Chakavula** ¶33 ("As described below (FIG. 10) the detection of the input source is automatic and governed by processor logic. When an input cable is used to connect either to an AC, DC or **USB**/Firewire source, the processor senses the type of power it receives and automatically converts that power to the type necessary to charge the portable unit that has been selected by the user based on the plug or bridge selected or by the power requirements of the portable unit that are selected by the user via the control panel."); ¶39 ("The MPC can automatically select which way to charge its internal rechargeable battery when either connected to an AC, DC, **USB**/Firewire, solar or hand crank method of charging its internal battery.") **U.S. 2011/0175461 [issued as U.S. 8,362,745] to Tinaphong** ¶39 ("As can be seen from FIG. 2, the energy harvesting circuit also includes a USB charger port or connector 24 for providing a connection to an external source of

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		voltage (preferably, about 5 volts DC), to charge the internal second storage device 18, which as will be explained is preferably a lithium polymer battery, using a lap top computer or other device connectable to the USB charger connector 24. The USB charger connector 24 has its +5 volt input pin connected to the connection between the output of the first stage DC-to-DC converter circuit 20 and the input of the second stage DC-to-DC converter circuit 22."); ¶40 ("The second stage DC-to-DC converter circuit 22 acts as a low drop out, step down voltage converter/regulator to convert the 4.5 volts from the first stage DC-to-DC converter circuit 20 (or the 5 volt DC signal provided on the USB charger connector 24 from an external source) to a 3.7 volt DC signal on the output of the second DC-to-DC converter circuit 22. This output voltage of the second stage DC-to-DC converter circuit 22 is provided to the positive side of a lithium polymer battery 18 forming part of the energy harvesting circuit, the negative side of the battery being preferably grounded. Preferably, the lithium polymer battery is a 3.7 volt, 1.5 amp battery which is used as a second storage device 18 which is charged by the rectified and DC-converted voltage generated by the energy harvesting circuit from the RF signal received by the antenna 2, or by an external DC power source connected to the USB charger connector 24." **USB Implementers Forum, Inc.** §1.4.8. ("A Portable Device is considered to be any USB or OTG device that is capable of operating from its own battery, and is also capable of drawing current from USB for purposes of operating and/or charging its battery.") The following references also disclose, teach, or suggest this element: U.S. 2015/0137740 to Allos at ¶9; EP 0 616 409 to Herbert at ¶32; U.S. 2004/0130298 (issued as US 7,345,450) Krieger at ¶53; U.S. 2007/0285049 to Krieger at ¶15; U.S. 2001/0025618(issued as US 6,679,212) to Kelling at ¶¶22-24; U.S. 2012/0025766 (issued as US 9,153,978) to Reade at ¶79; U.S. 2006/0244412 to Bonzer at ¶23; U.S. 5,194,799 to Tomantschger at 7:10-25; U.S. 2014/0210399 to Urschel at ¶¶27, 34-35; U.S. 2002/0041174 (issued as US 6,426,606) to Purkey at

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		Abstract, ¶26; U.S. 5,281,904 Tomkins at 5:18-22; U.S. 2015/0054336 [issued as U.S. 9,506,446] to Xinfang at ¶¶30-32; U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei at ¶¶5, 20
12	The apparatus of claim 1, further comprising a flashlight circuit configured to provide a source of light to a user.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **U.S. 2004/0239290 to Krieger** ¶23 ("The DC output 108 can be used to provide power to the built in air compressor 206, a **removable light 314** or any other type of accessory."); ¶24 ("The motorist can further inflate a tire, and **illuminate an area with the removable light**. The jump starter/charger of the present invention also allows the motorist to use AC appliances anywhere."). **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** ¶2 ("The present invention relates to mobile power technology and, more particularly, to a mobile power bank capable of charging electronic devices, jump starting an ignition system of a vehicle with a weak or dead battery, and operating as a **flashlight**."); ¶6 ("The present invention according to an embodiment provides a mobile power bank, vehicle ignition system jump starter, and a **flashlight**."); ¶26 ("The mobile power bank 10 functions as a mobile power bank, vehicle battery jump starter, and a flashlight."); ¶29 ("The second plate 24 may be provided with a master control button 26 and a **flashlight 28**. The **flashlight 28** and the master control button 26 may be positioned on opposite surfaces of the second plate 24. Preferably, the **flashlight 28** is placed adjacent to an edge of the base cover 20."); ¶44 ("The lighting module 56 is connected to the **flashlight 28**. In an embodiment, the lighting module 56 includes a lighting module over-discharge protection circuit 72 and a lighting module power test circuit 74. The lighting module over-discharge protection circuit 72 limits discharge of the battery module 16 to the flashlight 28 when the battery power output to the flashlight is below a predetermined threshold to protect the battery module and the flashlight. The lighting module power test

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		circuit 74 detects the battery module's power levels during illumination of the flashlight 28.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶8 ("… the MCU controller circuit is further connected to a smart LED electric quantity display system for displaying the electric quantity of the emergency power source, an output terminal of the LED driving circuit is connected to a LED lighting lamp …"); ¶20 ("The LED lighting lamp may provide outdoor lighting."); ¶26 ("the MCU controller circuit 14 is further connected to a smart LED electric quantity display system 8 for displaying the electric quantity of the emergency power source, an output terminal of the LED driving circuit 12 is connected to a LED lighting lamp 13"); ¶27 ("The LED lighting lamp may provide outdoor lighting.") **U.S. 2005/0116688 to Yin** ¶5 ("… a flash light circuit …"); ¶20 ("… a flash light circuit …"); ¶28 ("The rechargeable battery B provides power to the flash light circuit making the light L1 to flash.") **U.S. 2013/0099736 to Roberts** ¶33 ("FIG. 5 shows the LED 100 on the positive terminal clamp 16 in action. A user grasping the positive terminal clamp 16 depresses the switch 102 (covered by the user's hand) to activate the LED 100, illuminating a "+" marking (or other indicia) on the positive terminal 20 of the battery 12 in an otherwise dark region under the hood of a car. Applying the LED 100 to the positive terminal clamp 16 may be advantageous because the positive terminal clamp 16 is typically secured to the positive terminal 20 before the negative terminal clamp 18 is secured to the negative terminal 22 in order to make the connections necessary for charging a vehicle battery 10. In addition, disposing the LED 100 on the positive terminal clamp 16 adds a distinction to the positive terminal clamp 16, making it less likely to be

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		mistaken for the negative terminal clamp 18."); ¶34 ("A close up view of the positive terminal clamp 16 with the LED 100 illuminated is illustrated in FIG. 6. The LED 100 shines light from an outside edge of the clamp so that the illumination may not be obscured by the teeth 104 used to clamp directly onto the positive terminal 20. Positioning the LED 100 near the tip of the clamp allows a light path 106 to reach farther in the direction of the clamp tip than if it were positioned closer to the gripped region of the clamp.") The following references also disclose, teach, or suggest this element: U.S. 2004/0239290 to Krieger, e.g., at ¶23-24; U.S. 2006/0244412 to Bonzer, e.g., at ¶¶23-25; 5,194,799 to Tomantschger, e.g., at 4:17-26
13	The apparatus of claim 12, wherein said source of light is at least one LED.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶8 ("… the MCU controller circuit is further connected to a smart LED electric quantity display system for displaying the electric quantity of the emergency power source, an output terminal of the LED driving circuit is connected to a LED lighting lamp …"); ¶20 ("The LED lighting lamp may provide outdoor lighting."); ¶26 ("the MCU controller circuit 14 is further connected to a smart LED electric quantity display system 8 for displaying the electric quantity of the emergency power source, an output terminal of the LED driving circuit 12 is connected to a LED lighting lamp 13"); ¶27 ("The LED lighting lamp may provide outdoor lighting.") **U.S. 2013/0099736 to Roberts** ¶33 ("FIG. 5 shows the LED 100 on the positive terminal clamp 16 in action. A user grasping the positive terminal clamp 16 depresses the switch 102 (covered by the user's hand) to activate the LED 100, illuminating a "+" marking (or other indicia) on the positive terminal 20 of the battery 12 in an otherwise dark region under the hood of a car. Applying the LED 100 to the positive terminal clamp 16 may be

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		advantageous because the positive terminal clamp 16 is typically secured to the positive terminal 20 before the negative terminal clamp 18 is secured to the negative terminal 22 in order to make the connections necessary for charging a vehicle battery 10. In addition, disposing the LED 100 on the positive terminal clamp 16 adds a distinction to the positive terminal clamp 16, making it less likely to be mistaken for the negative terminal clamp 18."); ¶34 ("A close up view of the positive terminal clamp 16 with the LED 100 illuminated is illustrated in FIG. 6. The LED 100 shines light from an outside edge of the clamp so that the illumination may not be obscured by the teeth 104 used to clamp directly onto the positive terminal 20. Positioning the LED 100 near the tip of the clamp allows a light path 106 to reach farther in the direction of the clamp tip than if it were positioned closer to the gripped region of the clamp.") The following references also disclose, teach, or suggest this element: U.S. 2006/0244412 to Bonzer, e.g., at ¶24
15	The apparatus of claim 1, further comprising a plurality of visual indicators configured to display remaining capacity status of said internal power supply.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** ¶53 [10:30-43] ("In order to measure the charge level of the boosting battery 2, clamps 8, 10 should be disconnected from the depleted battery 11. The voltage regulator then produces a voltage proportional to the voltage of the boosting battery 2, and which is within the operating range of the microprocessor 60. The microprocessor 60 is programmed to detect when the voltage of the boosting battery 2 falls below a predetermined level, for example, about 80% of its rated value. The buzzer 72 or other device can then be activated to indicate to the operator that the charge of the boosting battery 2 is low and that it should be recharged. The booster system may be plugged into a standard 110/220-volt electrical outlet via a standard wall charger 82 to recharge the boosting battery 2.") **U.S. 2007/0285049 to Krieger**

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Claim No.	Claim	Printed Publications
		¶24 ("An on/off switch 58 may control the operation of the jump starter. A **set of indicator lights 64** may be provided to show **the status of the internal battery 20** or portable batteries being charged. The controller 14 may monitor the various components of the jump starter and show results on **a display**. The display may include, for example, a linear meter, a digital read out or a bar graph which may allow a user to monitor the operation of the jump starter, such as **the status on the internal battery**, the battery in a vehicle being jump started, or the portable batteries. **A battery gauge** such as a linear meter for a digital read out or a bar graph may be provided to display to the user **the status of the internal and/or the external battery** being charged. The **gauge** or read out may be provided on a front surface of the housing.") **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** ¶31 ("The LED **indicator module 32** may include a plurality of LED's. In an embodiment, the LED indicator module 32 has five LED's in the control circuit board 14, to indicate the available power and the charging status of the battery module 16."); ¶46 ("When the mobile power bank 10 is connected to an external power source for charging the battery module 16 via the charging port 34 and is in a charged state, the power test circuit 64 detects the battery capacity of the battery module 16 and activates the LED indicator module 32 for a battery charging indicator."); ¶47 ("For example, when the power test circuit 64 detects battery voltage of the battery module 16 is lower than about 10.8V, the control module 58 may control the LED indicator module 32 to stop all LED's from lighting up. When the detected battery voltage is greater than about 12.6V, the control module 58 may control the LED indicator module 32 so that one LED is lit and another LED is flashing. When the detected battery voltage is greater than about 13V, the control module 58 may control the LED indicator module 32 so that two LED's are lit and another LED is flashing."); ¶48 ("When the battery voltage is greater than about 13.2V, the control module 58 may control the LED indicator module 32 so that three LED's are lit and another LED is flashing. When the battery voltage is greater

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		than about 13.3V, the control module 58 may control the LED indicator module 32 so that four LED's are lit and another LED is flashing. When the battery voltage is equal to or greater than about 13.4V, the control module 58 may control the LED indicator module 32 so that all five LED are lit. As will be understood by one of skill in the art, the number of LED's controlled by the LED module 32 and battery charge indications may be varied."); ¶50 ("If the discharge module power test circuit 70 indicates there is no power load when the battery voltage of the battery module 16 is lower than about 10.8V, then the control module 58 may control the LED module 32 so that one LED is flashing; when the detected battery voltage is greater than about 12.6V, the control module can control the LED module so that one LED is lit; when the detected battery voltage is greater than about 13V, the control module may control the LED module so that two LED's are lit; when the detected battery voltage is greater than about 13.2V, the control module may control the LED module so that three LED's are lit; when the detected battery voltage is greater than about 13.3V, the control module may control the LED module so that four LED's are lit; when the detected battery voltage is equal to or greater than about 13.4V, the control module can control the LED module so that all five LED's are lit."); ¶51 ("If the master control button 26 is activated, and the control module 58 detects that the a power load is connected (for example, if a greater than 50 A power load current is detected, then a power load is considered to be connected), then the control module 58 may turn on the discharge module power test circuit 70 and the LED indicator module 32 to activate the discharged battery indicator. Specifically, when the detected voltage of the battery module 16 is equal to or lower than about 10.8V, the control module 58 may control the LED module 32 so that one LED is flashing; when the detected battery voltage is greater than about 12.6V, the control module can control the LED module 32 so that one LED is lit; when the detected battery voltage is greater than about 13V, the control module may control the LED module 32 so that two LED's are lit; when the detected battery voltage is greater than about 13.2V, the control module can control the LED module 32 so that three LED's are lit; when the detected battery voltage is greater than about 13.3V, the control module may control the LED module 32 so that four LEDs are lit; when the detected battery voltage is equal to or greater than about 13.4V, the control module

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Claim No.	Claim	Printed Publications
		can control the LED module 32 so that all five LED's are lit."); ¶52 ("As will be understood by one of skill in the art, the power bank system 10 may have a plurality of LED indicator modules. For example, there may be a first LED indicator module for indicating battery charge level and a second LED indicator module for indicating power output level. The plurality of LED indicator modules may be controlled by the control module 58 or by separate modules, such as the power charging module 52 and the discharge module 54.") **U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei** ¶8 ("… the MCU controller circuit is further connected to a smart LED electric quantity display system for displaying the electric quantity of the emergency power source …"); ¶26 ("… the MCU controller circuit 14 is further connected to a smart LED electric quantity display system 8 for displaying the electric quantity of the emergency power source …"); ¶27 ("Moreover, by a smart LED electric quantity display system 8, the power usage status of the battery pack 4 in the emergency power source can be detected in real time.") **U.S. 2015/0137740 to Allos** ¶17 ("When the 36 VDC battery pack is fully charged, charger 1 may be configured to automatically shut off and a green light may illuminate on **battery fuel gauge 9** when the test switch 20 is pressed, indicating that the mobile charging system is ready to be used."); *see also* U.S. Provisional Patent Application 61/903,779 at 2, 6-7. The following references also disclose, teach, or suggest this element: U.S. 2004/0239290 to Krieger, e.g., at ¶15; U.S. 2012/0025766 to Reade, e.g., at ¶95; U.S. 2006/0244412 to Bonzer, e.g., at ¶25; U.S. 2014/0210399 to Urschel, e.g., at ¶33; WO 2012/036556 to Eidsvig, e.g., at 7:5-14; U.S. 2002/0041174 to Purkey, e.g., at ¶59; U.S. 6,344,733 to Crass, e.g., at 3:16-22

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Claim No.	Claim	Printed Publications
17	The apparatus of claim 1, further comprising a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **WO 2012/080996 A1 to Tracey et al.** 6:23-24 ("An integrated circuit IC1 is connected via a resistor R2 to the positive lead 103 and is connected to the negative lead 105 via **reverse polarity indicator (LED1)**."); 8:22-25 ("Secondly, current from the vehicle battery flows via the resistor R2, reverse polarity indicator LED1 and the input side of the semiconductor photo-relay type TLP222 (lC1) thus illuminating LED1 and the input photo LED in IC1."); 10:1-4 ("A warning light emitting diode LED1 and its associated series limiting resistor are connected in parallel with the PTC devices. During normal engine starting operation the PTC devices are cold and exhibit a low resistance thus permitting normal current flow. As there is little voltage drop across the devices in this state, LED1 is extinguished."); 10:6-11 ("Should any of the following fault conditions occur: clamp short circuit, reverse connection to vehicle or incorrect voltage selection, then a larger than normal current flow will result causing the PTC devices to rapidly warm up and exhibit a high resistance thus limiting current flow to a very low level and preventing damage to the jump starter unit or the flat battery. As most of the battery (BAT1) voltage will now be developed across the PTC devices, LED1 is illuminated thus informing the user that a fault condition has occurred.") **U.S. 2004/0130298 [issued as U.S. 7,345,450] to Krieger** ¶38 [7:34-36] ("The indicator 40 may provide a visual or audio indication to a user that a proper polarity connection has or has not been established. The indicator 40 illustrated in FIG. 4 includes a resistor 41 and an LED 42."); ¶39 [7:53-57] ("If the alligator clamps 8, 10 are connected to depleted battery 11 with an incorrect polarity, LED 42 is forward biased and is illuminated indicating an incorrect connection.")

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Claim No.	Claim	Printed Publications
		U.S. 2015/0340907 [issued as U.S. 9,954,391] to Lei ¶10 ("In certain embodiments, when the red and black power source clips are respectively connected to the positive and negative electrodes of the external battery, if the connection is correct, a feedback voltage displayed by the voltage identifying system is positive, otherwise the feedback voltage is negative …"); ¶30 ("When the red and black power source clips are respectively connected to the positive and negative electrodes of the external battery, if the connection is correct, a feedback voltage displayed by the voltage identifying system is positive, otherwise the feedback voltage is negative.") **U.S. 2005/0116688 to Yin** ¶5 ("… a flash light circuit …"); ¶20 ("… a flash light circuit …"); ¶28 ("**When the two battery clamps are reversely connected to the two terminals of vehicle's battery**, the first diode D1 is in a reversed close state in the circuit of the first relay JD1 and so the first relay JD1 remains in an off state, which leads to the disconnection of the rechargeable battery B and the vehicle's battery, thereby eliminating the risks of incurring high current and sparks. Simultaneously, the vehicle's battery provides power to the second relay JD2 and the buzzer BU via the second diode D2, thereby energizing the second relay JD2 and making the buzzer BU to sound. **The rechargeable battery B provides power to the flash light circuit making the light L1 to flash**.") **U.S. 2015/0137740 to Allos** ¶5 ("The mobile charging system may include an indicator, e.g., **a green light indicator**, to alert the operator when the system is interfaced correctly to the vehicle."); ¶22 ("When the mobile charging system is correctly connected to a vehicle with a discharged battery, the **green warning light 10 will illuminate**, indicating proper connection. … When relay 3 N.O. (normally open) contacts are closed, 12V power from circuit C14 will connect with circuit C24 to **turn green**

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Claim No.	Claim	Printed Publications
		light on in component 10, indicating the correct and safe hook-up of the mobile charging system."); ¶49 ("When component 14 is energized, normally open relay 1 contacts will close, connecting circuit C14 (+12V source) with circuit C18 that feeds component 10 (polarity indicator) **red warning light and buzzer** in the instrument panel to warn the technician of the incorrect connection of the mobile charging system to the vehicle battery. Circuit C18 also feeds component 15 (Normally Closed) relay 2 contacts that connect to circuit C21."); *see also* U.S. Provisional Patent Application 61/903,779 at 1, 2, 5, 7. **U.S. 2006/0220610 to Solberg** ¶23 ("A **display** and a device that converts electric signals into sound may warn a user of a reverse polarity connection."); ¶29 ("Analog gauges, digital, or **light emitting diode displays 302** (as shown in FIG. 3) may provide a reverse polarity warning.") The following references also disclose, teach, or suggest this element: EP 0 616 409 to Herbert, e.g., at ¶37; U.S. 2004/0239290 to Krieger, e.g., at ¶15; U.S. 2003/0141845 to Krieger, e.g., at ¶64; U.S. 2001/0025618 to Kelling, e.g., at ¶17; U.S. 2014/0084844 to Weflen, e.g., at ¶15; U.S. 5,194,799 to Tomantschger, e.g., at 4:7-16; U.S. 2014/0210399 to Urschel, e.g., at ¶33; U.S. 3,638,108 to Channing, e.g., at 3:57-71; 5:63-71
19	The apparatus of claim 1, further comprising a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect presence of a vehicle battery.	The following prior art references alone or in combination suggest, teach, or anticipate, either in part or whole, this limitation: **WO 2012/080996 A1 to Tracey et al.** 3:13-17 ("In one embodiment, a gate of the switch is connected to the positive lead by a user-activated switch. In one embodiment, the user-activated switch is of the type for momentary closing. In one embodiment, the user-activated switch is connected to the gate via a diode, preferably a Zener diode. In one embodiment, the switch is solid state and is reverse biased to prevent current flow if a system to

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Claim No.	Claim	Printed Publications
		which the clamps are connected attempts to return charge."); 6:24-26 ("Also, a manual contact switch 115 (SW1) is connected on one side to the positive lead 3, and on the other to a Zener diode ZD1, a resistor Rl, in turn linked with a bank of MOSFET switches Ql, Q2, and Q3."); 7:8-11 ("The battery 102 positive terminal is also connected to the momentary action single pole normally open switch SW1 1 15. This switch, the Zener diode ZD1 , the resistor Rl and Metal Oxide Semiconductor Field Effect Transistors (MOSFETS) Ql to Q3 comprise the power-switching and over-discharge elements."); 7:13-15 ("To activate the jump-starter system it must be connected to a vehicle battery by means of the positive and negative jaws 56 linked to the conductors 104 and 106. The **activation switch 115** (SW1) is then briefly depressed."); 9:4-5 ("Unlike other jump starter protection circuits that require a vehicle battery to be present for correct operation, this jump starter circuit 100 can operate with a completely dead battery or none at all. However in this case, reverse polarity detection is not available.") **U.S. 2007/0285049 to Krieger** ¶24 ("An **on/off switch 58** may control the operation of the jump starter.") **U.S. 2015/0054336 [issued as US 9,506,446] to Xinfang** ¶11 ("In an embodiment, the circuit board further comprises a master control button and the housing further comprises a button cap positioned adjacent the master control button such that operation of the button cap causes operation of the master control button."); ¶29 ("The second plate 24 may be provided with a master control button 26 and a flashlight 28. The flashlight 28 and the master control button 26 may be positioned on opposite surfaces of the second plate 24. Preferably, the flashlight 28 is placed adjacent to an edge of the base cover 20. In an embodiment, the master control button 26 is operable in a direction parallel to the second plate 24. The upper cover 18 is provided with a button cap 30 in the corresponding position of the master control button 26. The button cap 30 may be operated by a user to press the master control button 26.")

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Claim No.	Claim	Printed Publications
		U.S. 2015/0137740 to Allos ¶24 ("The jump-start and boost functions can be activated with, e.g., a two-minute timer switch 11. The **switch dial** can be rotated manually clockwise and set up to a maximum time of 2 minutes (and thus other times are also possible).") **U.S. 2006/0220610 to Solberg** ¶38 ("An operator may couple one or more of the boost modules to the vehicle's battery or electrical system by activating **a mechanical or electromechanical switch**. When the switch is activated, the charging system couples the boost modules to the vehicle's battery or electric system for a predetermined period of time at act 614. If additional charging is needed, the operator may re-couple one or both of the boost modules to the vehicle's battery or charging system by re-activating switch.") The following references also disclose, teach, or suggest this element: U.S. 2004/0239290 to Krieger, e.g., at ¶14; U.S. 3,590,357 to Reid, e.g., at 4:38-49; U.S. 5,194,799 to Tomantschger, e.g., at 3:3-12; U.S. 3,638,108 to Channing, e.g., at 3:32-45; U.S. 2013/0162029 to Reichow, e.g., at ¶24; U.S. 6,650,086 Chang; e.g., at 4:63-5:9; U.S. 2002/0041174 to Purkey, e.g., at ¶60

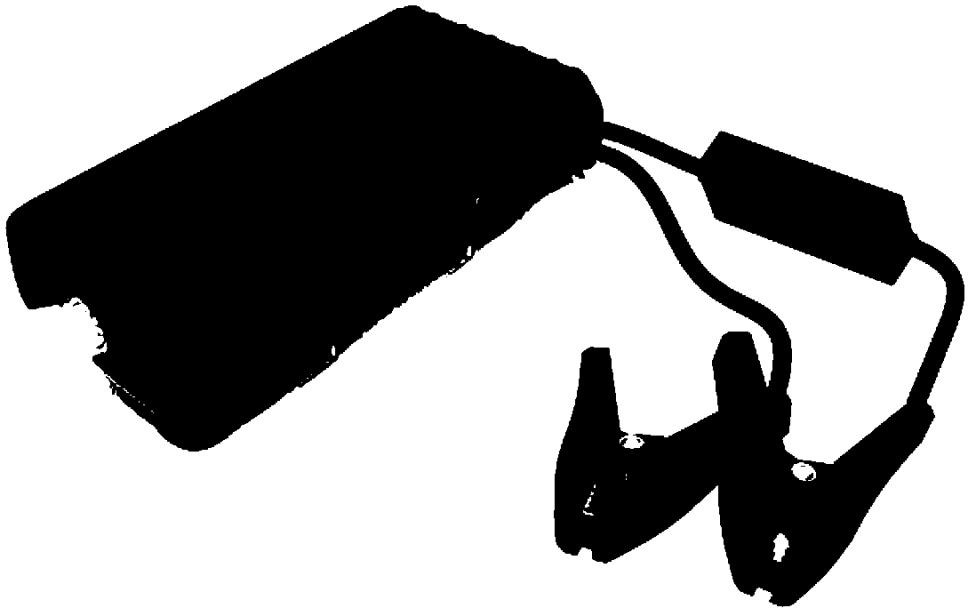
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Exhibit 2. Prior Art Products

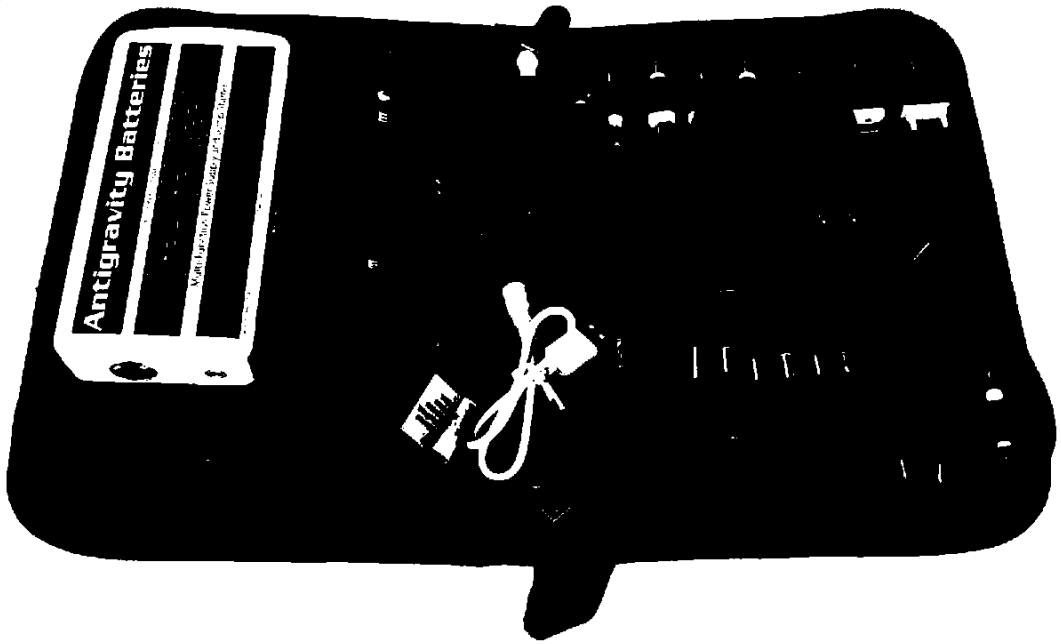
Deltran is currently investigating the dates of conception and reduction to practice of such Public Prior Art and when such Public Prior Art was first known or used by others. There were dozens of portable jump starters on the market prior to the priority date of the '015 patent, and others launched in the United States at approximately the same time as the '015 patent. Deltran is still investigating these prior art products and intends to seek third-party discovery as appropriate during the course of this litigation. Additionally, the Court's claim construction may cause additional prior art products to be invalidating. In the course of their investigation, Deltran may identify additional prior art documents describing these products and systems that may also anticipate and/or render obvious the one or more Asserted Claims of the patents-in-suit as invalidating printed publications. Deltran accordingly reserves the right to modify, amend, or supplement these contentions with those products, as well as other prior art references, upon further investigation.

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Claim No.	Claim	Prior Art Products
1	Apparatus for jump starting a vehicle engine, comprising:	**Gryphon Mobile Electronics Power All**  DELTRAN 0000558-59; See also PowerAll Website Dated January 20, 2014: https://web.archive.org/web/20140120001814/http://www.thepowerall.com/product.html (last visited May 6, 2020)

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		Antigravity Batteries Micro-Start  DELTRAN 0000544; DELTRAN 0000547; DELTRAN 0000548-554; DELTRAN 0000562-63 **Black & Decker Electromate 400**

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Claim No.	Claim	Prior Art Products
		
	an internal power supply;	**Gryphon Mobile Electronics Power All**

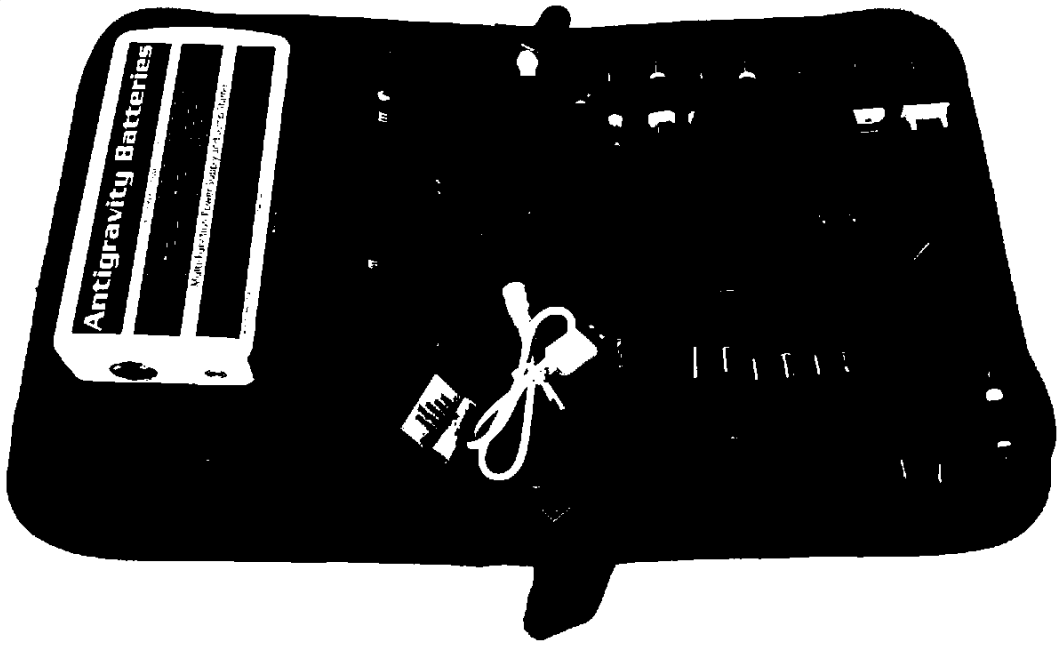
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Claim No.	Claim	Prior Art Products

Claim No.	Claim	Prior Art Products
		SPECIFICATIONS **MSRP: USD $139.95** **PBJS12000RD** • Battery Type: Lithium-Ion • Battery Capacity: 12,000 mAh • Battery Life Cycles: >500 • Outputs: 2 x 5V / 2.1A, 1 x 12V / 10A • Input: 12V / 1A • Jump Start Current: 200 - 400A • Dimensions: 165 x 75 x 30mm (6.5 x 2.9 x 1.2in) • LED Lifespan: 100,000 hours • LED Energy: 1w • LED Lumens: 86 Lm • Operating Temperatures: -20 to 140 Degrees • **Professional Grade Smart Jumper Cable w/Anti-Voltage Feedback Protection** • **Heavy-Duty Carrying Case Included** DELTRAN 0000558-59; See also PowerAll Website Dated January 20, 2014: https://web.archive.org/web/20140120001814/http://www.thepowerall.com/product.html (last visited May 6, 2020)

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Antigravity Batteries Micro-Start



The Micro-Start PPS (Personal Power Supply) is the world's smallest Jump Starter and Personal Power Supply (only 6" x 2-7/8" x 1"). The built-in Extreme Power Lithium battery can hold a charge for up to a year and not only will it jump-start any car, truck, motorcycle or powersports vehicle mulitple times, but also provides hours of backup power to all of your electronic devices. Weighing less than a pound (14 oz.) and small enough to fit in your pocket, you can take it with you anywhere and remain confident that you will be able to start your vehicle, make that important call, or power your child's PSP on that long trip in the car. It even has a built in flashlight with S.O.S patterns built in! Whatever you do, don't get stuck without back up power again....

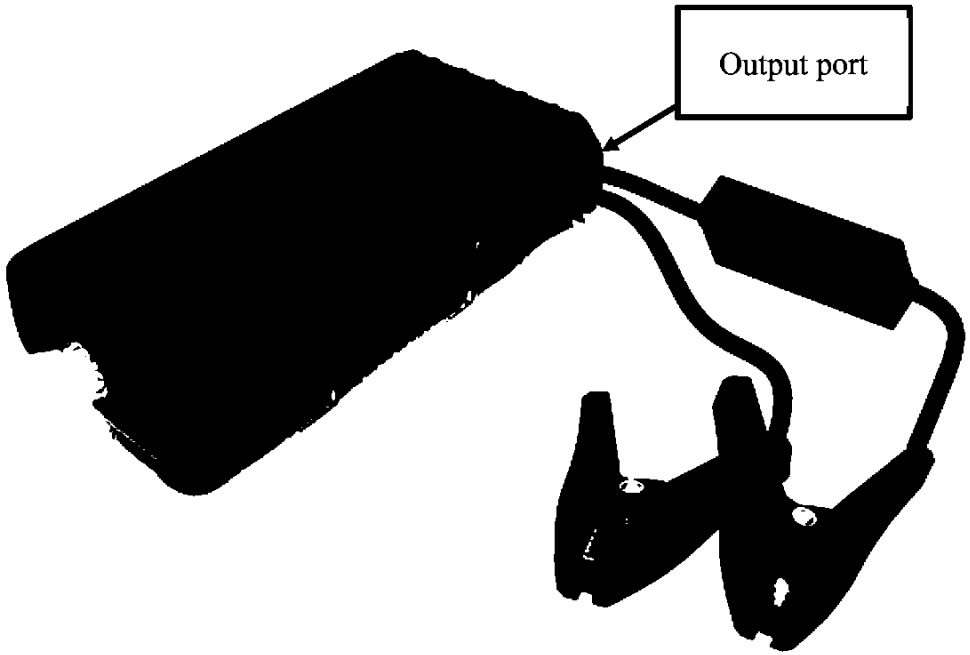
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Claim No.	Claim	Prior Art Products
		DELTRAN 0000544; DELTRAN 0000547; DELTRAN 0000548-554; DELTRAN 0000562-63 **Black & Decker Electromate 400** 

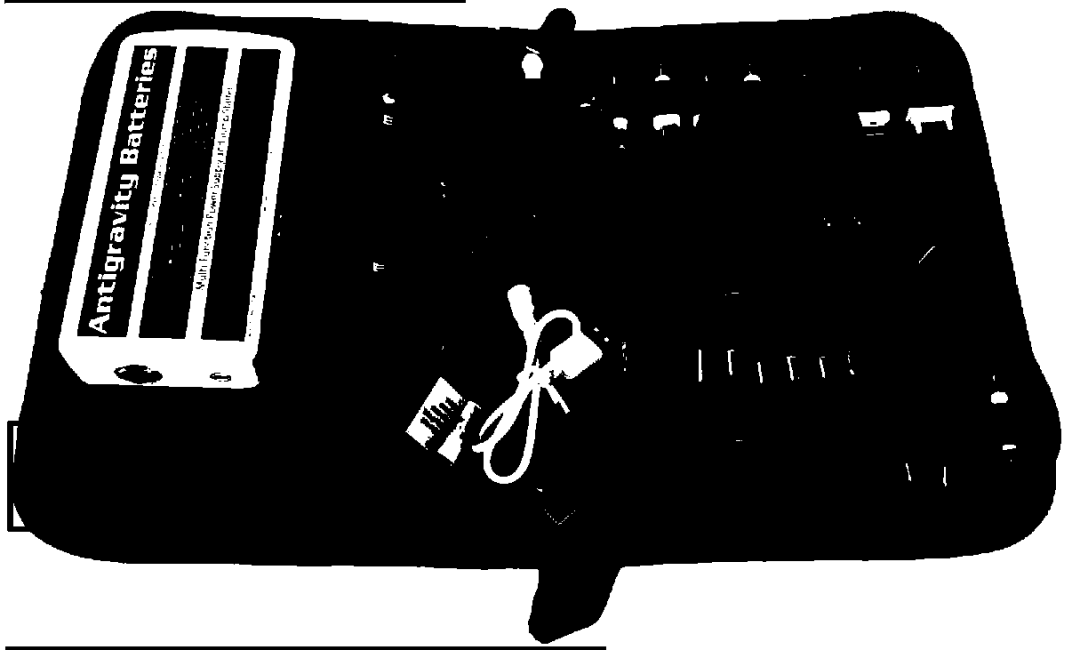
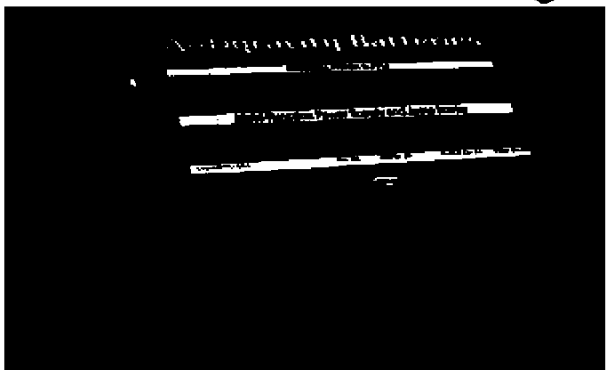
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Claim No.	Claim	Prior Art Products
		Technical Details Brand: BLACK+DECKER Model: VEC026BD Item Weight: 25 pounds Product Dimensions: 18 x 8 x 12 inches California residents: Click here for Proposition 65 warning Item model number: VEC026BD Batteries: 1 12V batteries required. (included) Discontinued by manufacturer: Yes Manufacturer Part Number: VEC026BD
	an output port having positive and negative polarity outputs;	**Gryphon Mobile Electronics Power All**

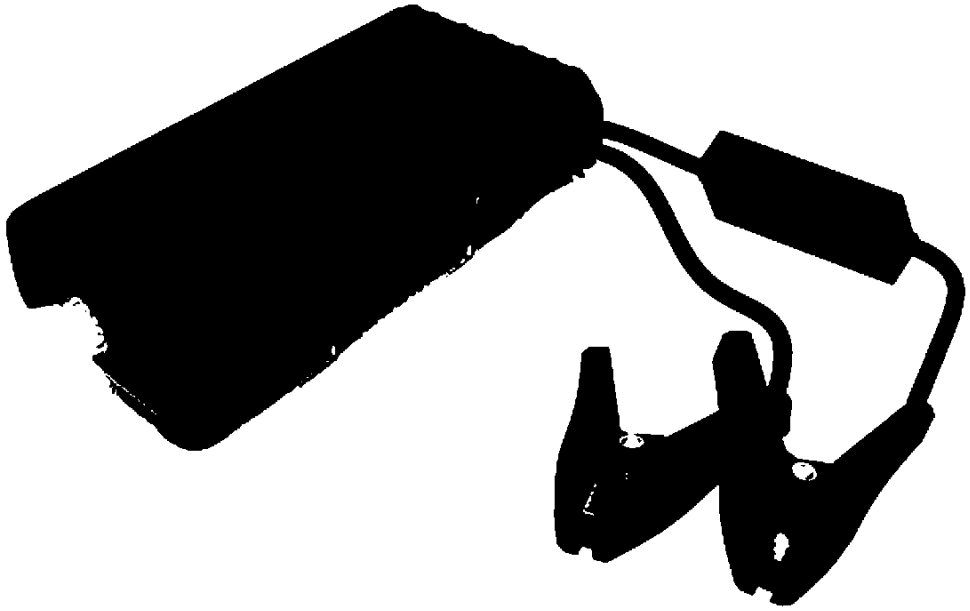
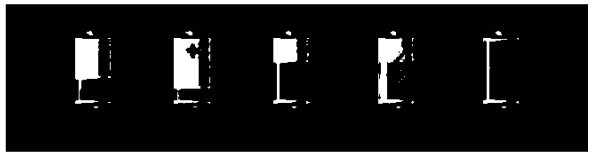
ADC EX1002
IPR2025-00885

Claim No.	Claim	Prior Art Products
		 DELTRAN 0000558-59; See also PowerAll Website Dated January 20, 2014: https://web.archive.org/web/20140120001814/http://www.thepowerall.com/product.html (last visited May 6, 2020)

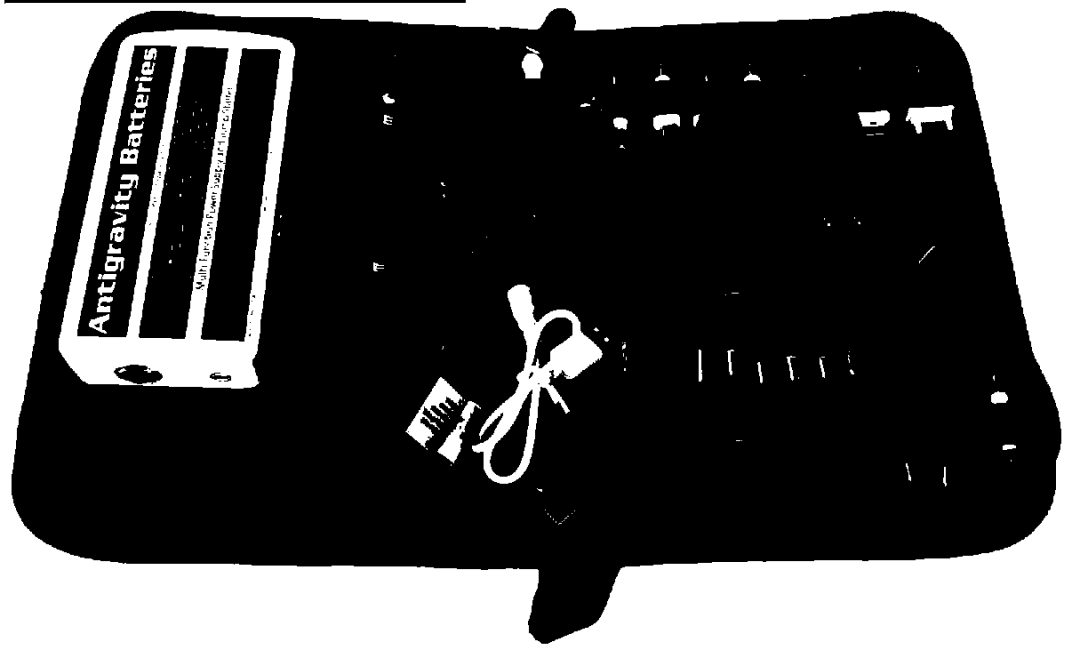
ADC EX1002
IPR2025-00885

Claim No.	Claim	Prior Art Products
		Antigravity Batteries Micro-Start   DELTRAN 0000544; DELTRAN 0000547; DELTRAN 0000548-554; DELTRAN 0000562-63

ADC EX1002
IPR2025-00885

Claim No.	Claim	Prior Art Products
	a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs;	**Gryphon Mobile Electronics Power All**   **SAFETY AND PROTECTION** An advanced device with safety and protection in mind. It has over current protection, short circuit protection, overload protection, over voltage protection, and over charge protection all built-in to ensure the safety of all your valuable devices and vehicles. DELTRAN 0000558-59; See also PowerAll Website Dated January 20, 2014: https://web.archive.org/web/20140120001814/http://www.thepowerall.com/product.html (last visited May 6, 2020)

ADC EX1002
IPR2025-00885

Claim No.	Claim	Prior Art Products
		Antigravity Batteries Micro-Start  DELTRAN 0000544; DELTRAN 0000547; DELTRAN 0000548-554; DELTRAN 0000562-63 "7. It has built-in over-charge and over-discharge protections for long battery life" (DELTRAN0000548, DELTRAN0000551, DELTRAN0000554)
	a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and	**Black & Decker Electromate 400**

ADC EX1002
IPR2025-00885

Claim No.	Claim	Prior Art Products
	negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port;	 ★★★☆☆ 179 ratings | 17 answered questions Currently unavailable. We don't know when or if this item will be back in stock. • 450 amps instantly jump-starts without the need of another vehicle • Built-in ultra-bright LED work light for emergency roadside assistance • Exclusive built-in 120 volt AC charger for use with ordinary household extension cord for recharging • Reverse hook-up warning alarm to prevent damage to vehicle or electronics • One year warranty

ADC EX1002
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Claim No.	Claim	Prior Art Products
		The Black & Decker Electromate 400 Portable Power Station/Jump-Starter/Compressor has 450 instant amps to start your car in the unlikely event that your battery goes dead. You can never count on finding someone to jump-start your car, even if you have a set of jumper cables. The Power Station/Jump-Starter/Compressor will alleviate this problem by giving you the power you need to do it yourself.  *Black & Decker's Electromate 400 is a powerful and compact tool to restart your vehicle. View larger.* **Ideal for Roadside Emergencies** When your car loses power, the Electromate 400 has enough power to both jump-start your vehicle and run emergency appliances such as portable lights, radios, cell phones, and small tools. The Electromate 400 is also ideal for non-emergency situations like tailgating parties, camping, power outages, and any other situation where no wall outlet is available. It comes equipped with one 120V AC power outlet and one 12V DC outlet, allowing you to charge and operate more than one appliance at once. **Inflates Tires, Sports Equipment, and More** There's also a built-in air compressor that allows you to inflate bicycle tires, sports equipment, and pool toys, but this compressor is also powerful enough to pump up the tires on your vehicle. **Other Features** The Electromate 400 also comes equipped with a built-in, ultra-bright LED work light for emergency roadside assistance and an exclusive, built-in 120-volt AC charger that plugs into any household outlet. Other features include a keyless on/off power safety switch, reverse hook-up warning alarm in case the jump-start cables are attached to the wrong terminals, vehicle alternator voltage check, and LED battery status indicator. **Rechargeable** This unit recharges easily from any household AC outlet or DC automobile cigarette-plug style outlet, so that it will be ready the next time you need it. **Warranty** Black & Decker offers a full 2-year warranty.  *The Electromate 400 comes equipped with an air compressor.*  *Power small appliances with the 120V AC and 12V DC outlets.*
	a power switch connected between said internal power supply and said output port; and	**Black & Decker Electromate 400**

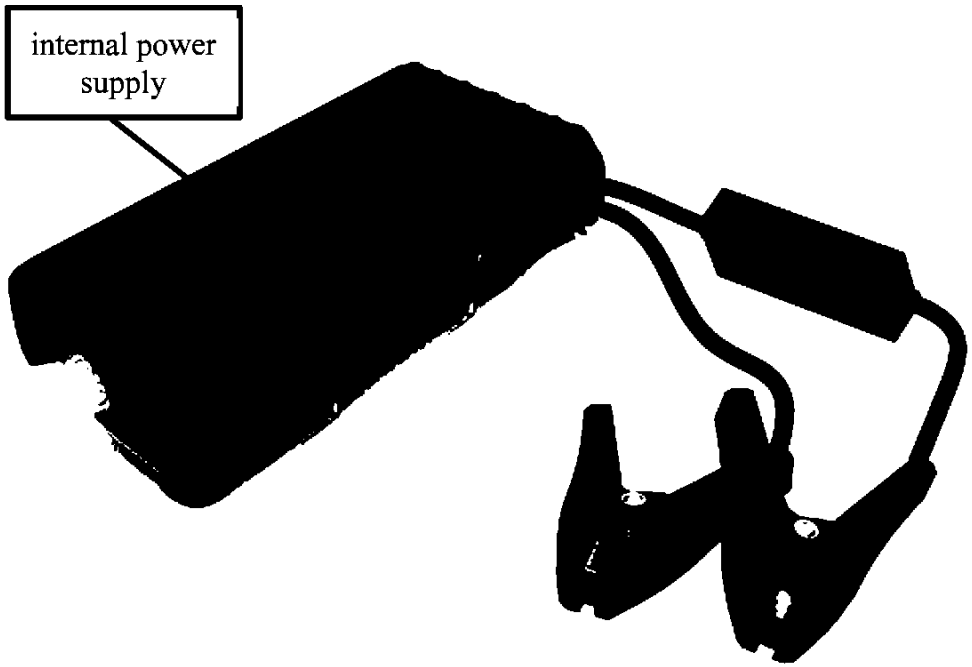
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Claim No.	Claim	Prior Art Products
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ADC EX1002
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Claim No.	Claim	Prior Art Products
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	a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive	

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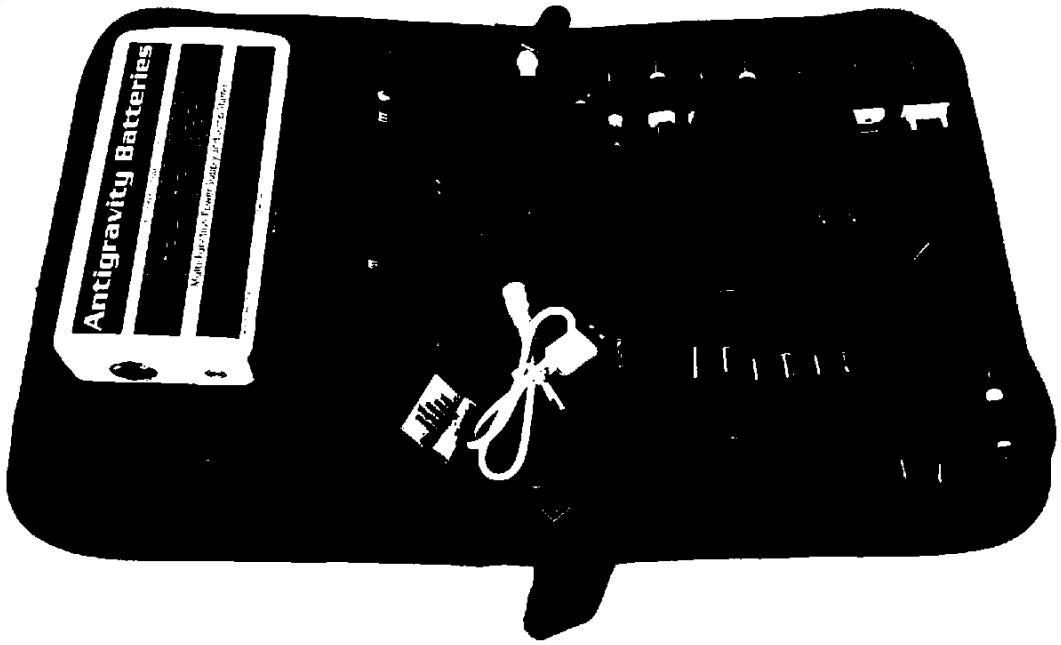
Claim No.	Claim	Prior Art Products
	and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.	
2	The apparatus of claim 1, wherein said internal power supply comprises a lithium ion battery	**Gryphon Mobile Electronics Power All** 

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Claim No.	Claim	Prior Art Products
		SPECIFICATIONS **MSRP: USD $139.95** **PBJS12000RD** • Battery Type: Lithium-Ion • Battery Capacity: 12,000 mAh • Battery Life Cycles: >500 • Outputs: 2 x 5V / 2.1A, 1 x 12V / 10A • Input: 12V / 1A • Jump Start Current: 200 - 400A • Dimensions: 165 x 75 x 30mm (6.5 x 2.9 x 1.2in) • LED Lifespan: 100,000 hours • LED Energy: 1w • LED Lumens: 86 Lm • Operating Temperatures: -20 to 140 Degrees • **Professional Grade Smart Jumper Cable w/Anti-Voltage Feedback Protection** • **Heavy-Duty Carrying Case Included** DELTRAN 0000558-59; See also PowerAll Website Dated January 20, 2014: https://web.archive.org/web/20140120001814/http://www.thepowerall.com/product.html (last visited May 6, 2020)

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Antigravity Batteries Micro-Start

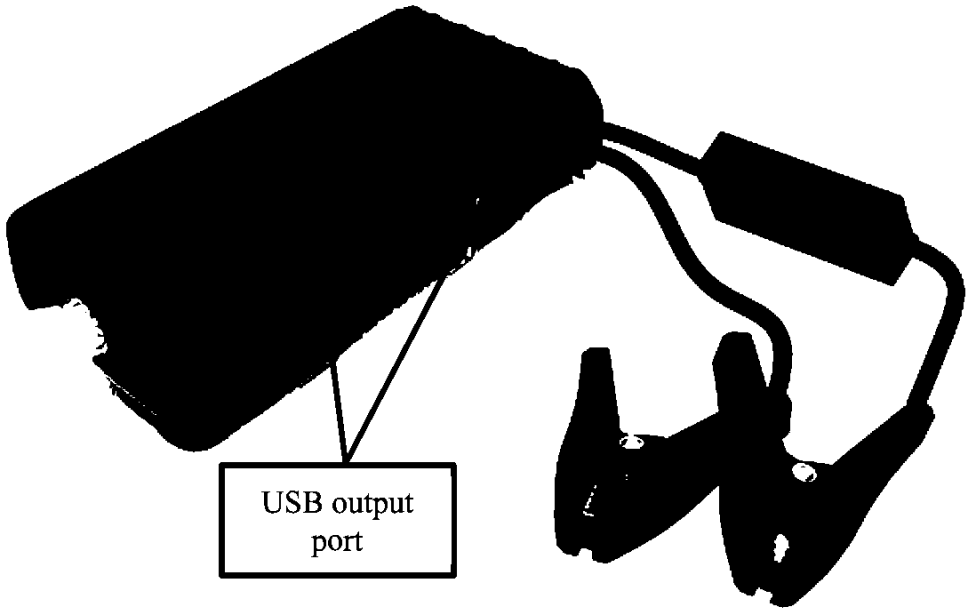


The Micro-Start PPS (Personal Power Supply) is the world's smallest Jump Starter and Personal Power Supply (only 6" x 2-7/8" x 1"). The built-in Extreme Power Lithium battery can hold a charge for up to a year and not only will it jump-start any car, truck, motorcycle or powersports vehicle mulitple times, but also provides hours of backup power to all of your electronic devices. Weighing less than a pound (14 oz.) and small enough to fit in your pocket, you can take it with you anywhere and remain confident that you will be able to start your vehicle, make that important call, or power your child's PSP on that long trip in the car. It even has a built in flashlight with S.O.S patterns built in! Whatever you do, don't get stuck without back up power again....

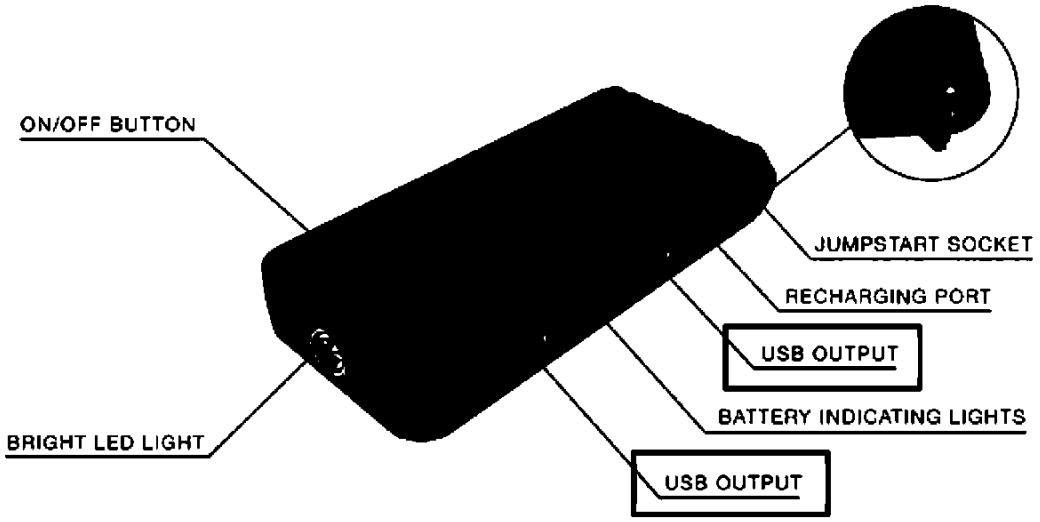
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Claim No.	Claim	Prior Art Products
		DELTRAN 0000544; DELTRAN 0000547; DELTRAN 0000548-554; DELTRAN 0000562-63
3	The apparatus of claim 2, wherein said lithium ion battery comprises a battery pack of multiple lithium ion batteries.	
9	The apparatus of claim 1, further comprising a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus.	
10	The apparatus of claim 1, further comprising a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device.	**Gryphon Mobile Electronics Power All**

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Claim No.	Claim	Prior Art Products
		

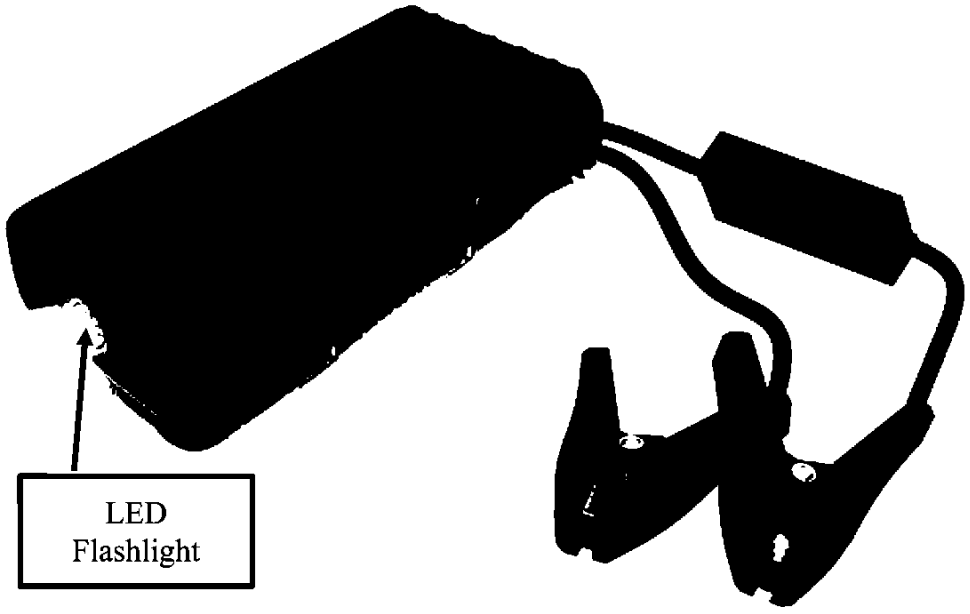
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Claim No.	Claim	Prior Art Products
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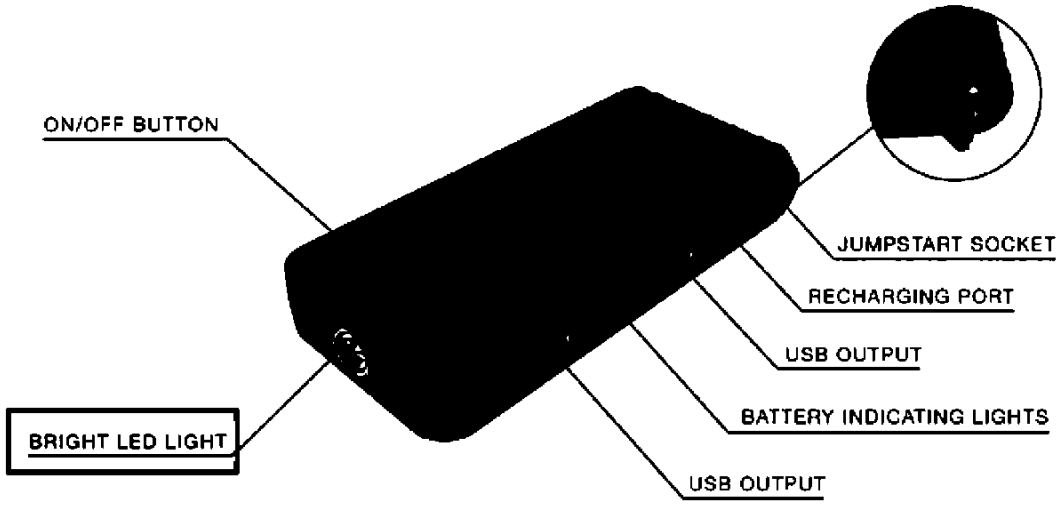
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Antigravity Batteries Micro-Start

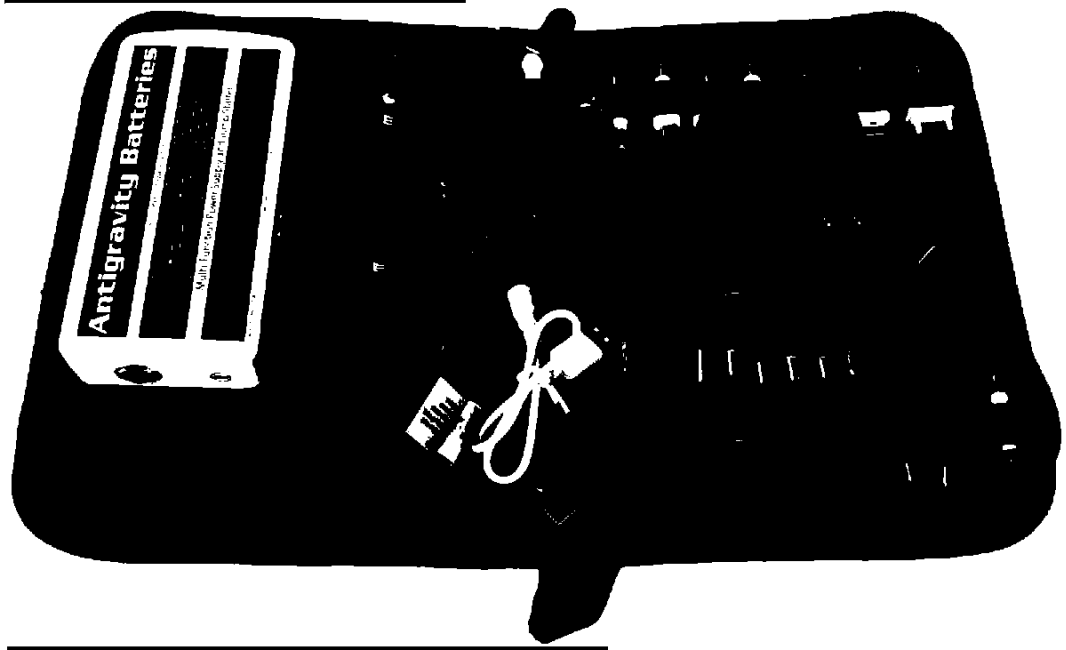
DELTRAN 0000544; DELTRAN 0000547; DELTRAN 0000548-554; DELTRAN 0000562-63

Claim No.	Claim	Prior Art Products
11	The apparatus of claim 1, further comprising a USB charging port configured to provide charging power from an external power source to said internal power supply.	
12	The apparatus of claim 1, further comprising a flashlight circuit configured to provide a source of light to a user.	**Gryphon Mobile Electronics Power All** 

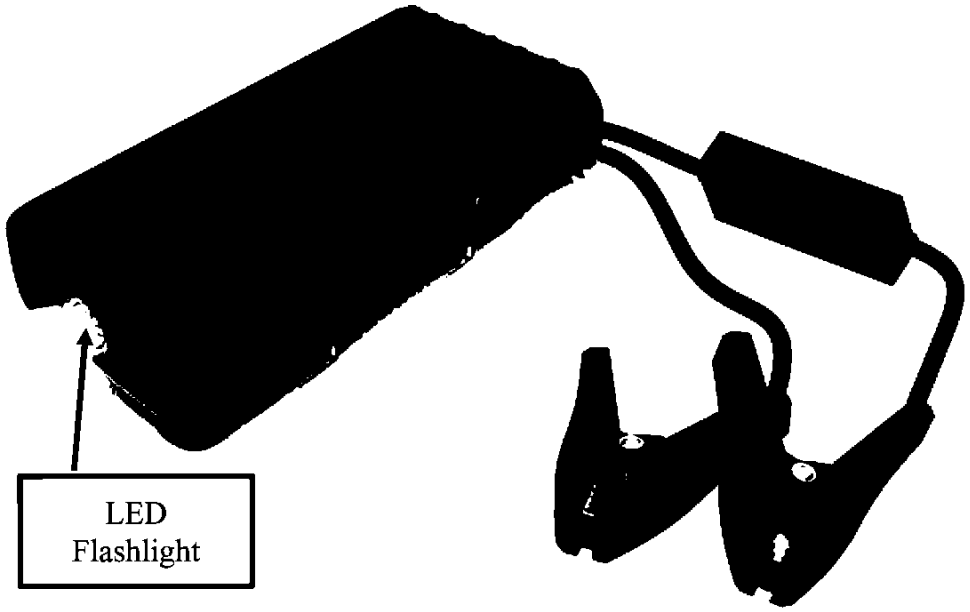
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Claim No.	Claim	Prior Art Products
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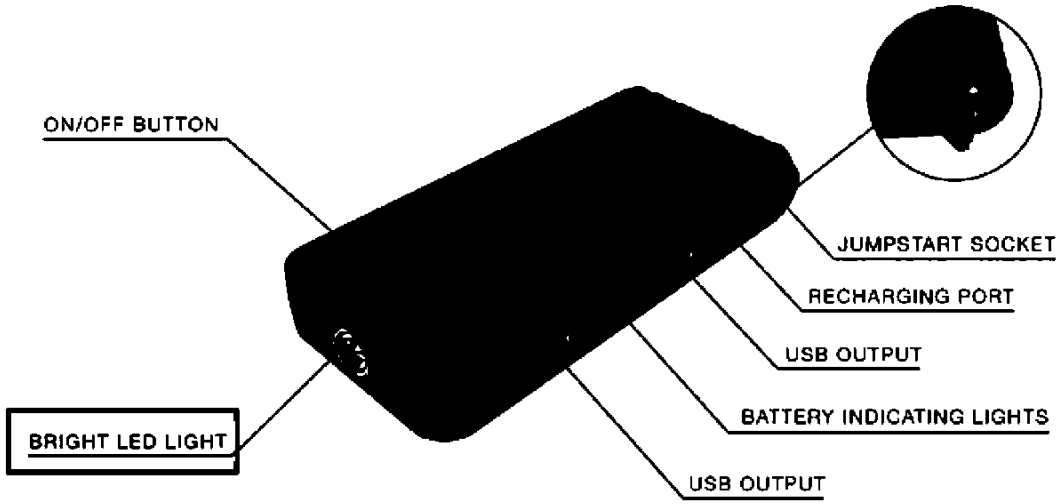
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Claim No.	Claim	Prior Art Products
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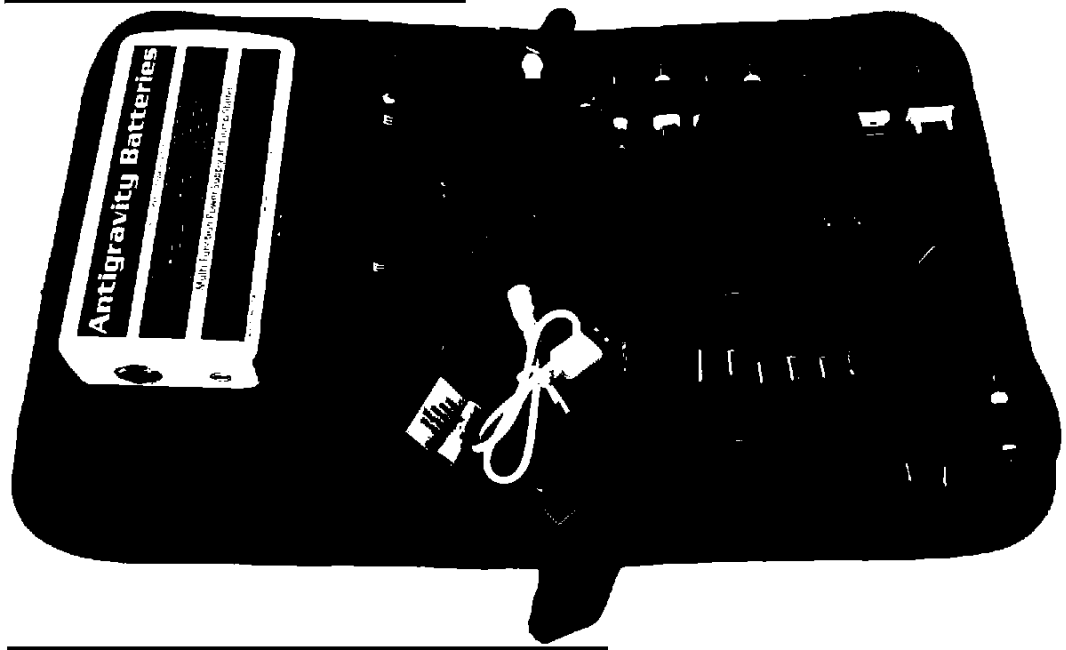
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Claim No.	Claim	Prior Art Products
13	The apparatus of claim 12, wherein said source of light is at least one LED.	**Gryphon Mobile Electronics Power All** 

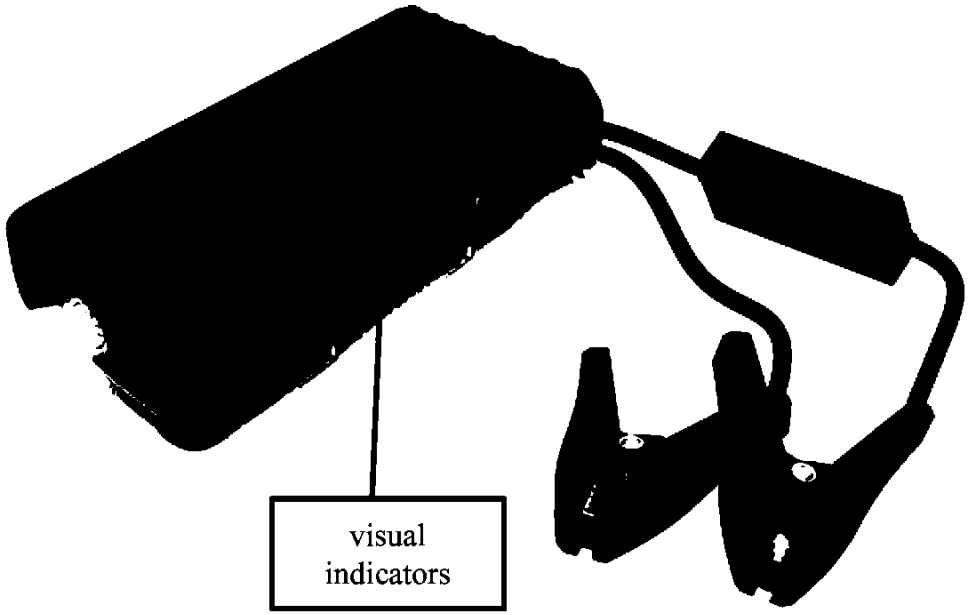
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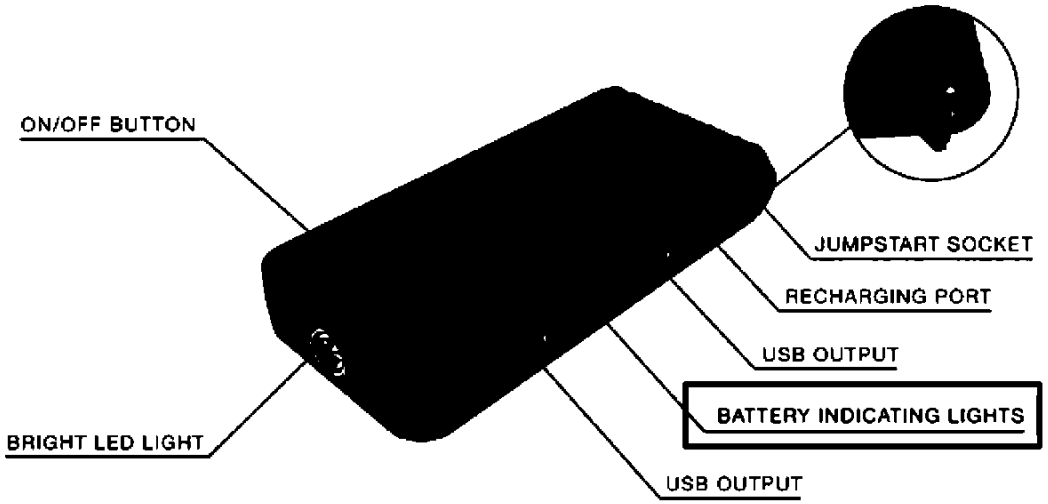
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Claim No.	Claim	Prior Art Products
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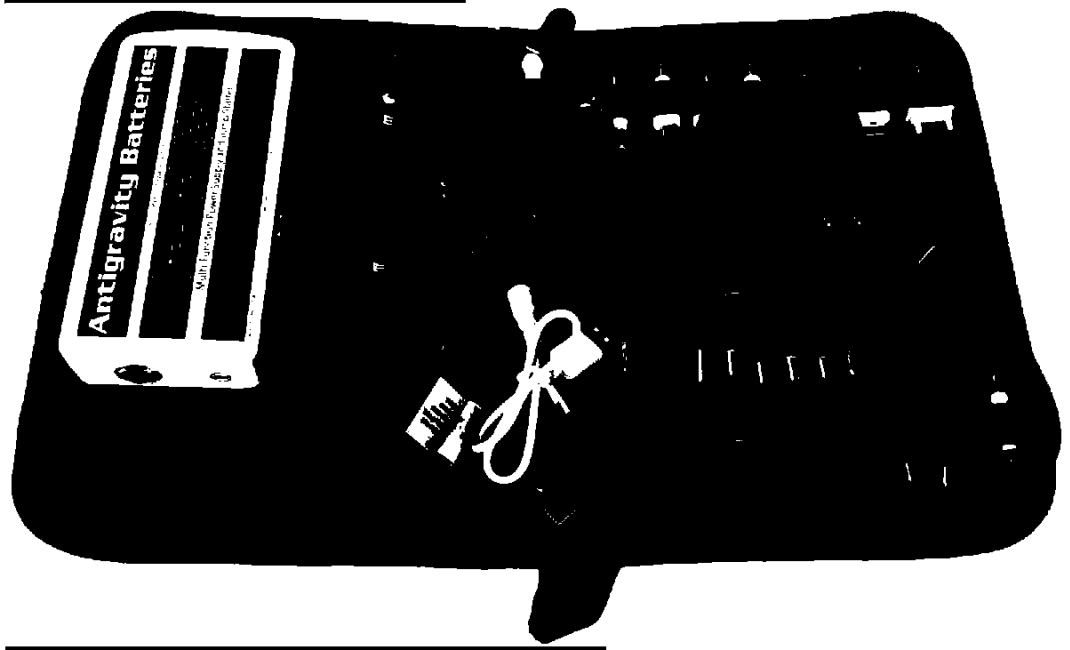
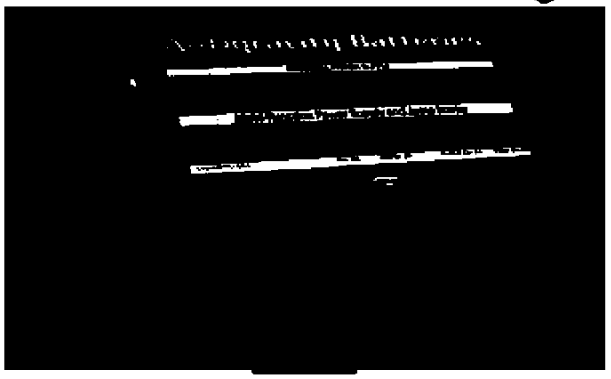
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Claim No.	Claim	Prior Art Products
15	The apparatus of claim 1, further comprising a plurality of visual indicators configured to display remaining capacity status of said internal power supply.	**Gryphon Mobile Electronics Power All** 

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Claim No.	Claim	Prior Art Products
		 DELTRAN 0000558-59; See also PowerAll Website Dated January 20, 2014: https://web.archive.org/web/20140120001814/http://www.thepowerall.com/product.html (last visited May 6, 2020)

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Claim No.	Claim	Prior Art Products
		Antigravity Batteries Micro-Start   DELTRAN 0000544; DELTRAN 0000547; DELTRAN 0000548-554; DELTRAN 0000562-63

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Claim No.	Claim	Prior Art Products
17	The apparatus of claim 1, further comprising a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity.	
19	The apparatus of claim 1, further comprising a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect presence of a vehicle battery.	

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(12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织
国 际 局

(43) 国际公布日
2014 年 7 月 10 日 (10.07.2014)

WIPO | PCT

(10) 国际公布号
WO 2014/106407 A1

(51) 国际专利分类号:
H02J 7/00 (2006.01) *H02J 9/00* (2006.01)

(21) 国际申请号: PCT/CN2013/086774

(22) 国际申请日: 2013 年 11 月 8 日 (08.11.2013)

(25) 申请语言: 中文

(26) 公布语言: 中文

(30) 优先权:
201310004817.1 2013 年 1 月 7 日 (07.01.2013) CN

(72) 发明人; 及
(71) 申请人: 雷星亮 (LEI, Xingliang) [CN/CN]; 中国广东省深圳市龙华新区大浪街道华辉路同胜科技大厦 A 座 2 楼 A, Guangdong 518000 (CN)。

(74) 代理人: 北京品源专利代理有限公司 (BEYOND ATTORNEYS AT LAW); 中国北京市海淀区莲花池东路 39 号西金大厦 6 层, Beijing 100036 (CN)。

(81) 指定国 (除另有指明，要求每一种可提供的国家保护): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW。

(84) 指定国 (除另有指明，要求每一种可提供的地区保护): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 欧洲 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG)。

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(54) **Title**: EMERGENCY POWER SOURCE

(54) **发明名称** : 应急电源

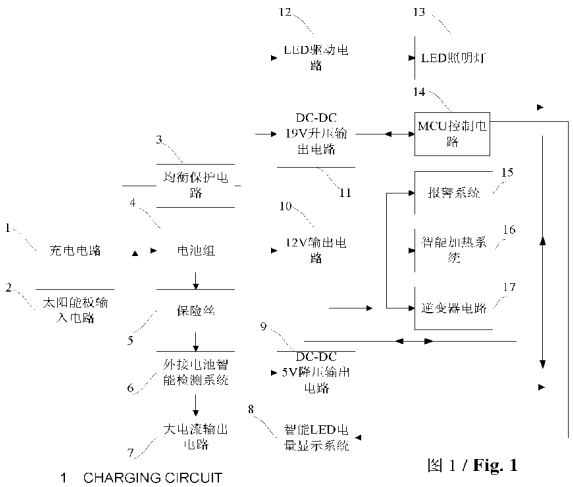


图 1 / **Fig. 1**

1 CHARGING CIRCUIT
2 SOLAR ENERGY PANEL INPUT CIRCUIT
3 EQUALIZATION PROTECTION CIRCUIT
4 BATTERY PACK
5 FUSE
6 EXTERNAL BATTERY INTELLIGENT DETECTION SYSTEM
7 HEAVY-CURRENT OUTPUT CIRCUIT
8 INTELLIGENT LED ELECTRIC-QUANTITY DISPLAY SYSTEM
9 DC-DC 5 V VOLTAGE-DROP OUTPUT CIRCUIT
10 12 V OUTPUT CIRCUIT
11 DC-DC 19 V VOLTAGE-BOOST OUTPUT CIRCUIT
12 LED DRIVE CIRCUIT
13 LED ILLUMINATION LAMP
14 MCU CONTROL CIRCUIT
15 ALARM SYSTEM
16 INTELLIGENT HEATING SYSTEM
17 INVERTER CIRCUIT

(57) **Abstract**: An emergency power source comprises a housing. A battery pack (4) is arranged in the housing for storing electric energy. The input end of the battery pack (4) is connected to a charging circuit (1) for charging the battery pack (4) and the output end of a solar energy panel input circuit (2), the output end of the battery pack (4) is connected to a heavy-current output circuit (7) for outputting a heavy current when an automobile starts, and an external battery intelligent detection system (6) is connected between the battery pack (4) and the heavy-current output circuit (7). The emergency power source is convenient for charging, can output a heavy current for starting an automobile, and can also accurately control heavy-current output.

(57) **摘要**: 一种应急电源，包括壳体，壳体的内部设置有用于储存电能的电池组（4），电池组（4）的输入端与用于给电池组（4）充电的充电电路（1）和太阳能板输入电路（2）的输出端连接，电池组（4）的输出端连接有用于汽车启动时输出大电流的大电流输出电路（7），电池组（4）与大电流输出电路（7）之间连接有外接电池智能检测系统（6）。应急电源自身充电方便，可以大电流输出用于汽车启动，还能准确控制大电流输出。

WO 2014/106407 A1

ADC EX1002
IPR2025-00885

本国际公布:

— 包括国际检索报告(条约第 21 条(3))。

应急电源

技术领域

本发明属于直流电源领域，具体涉及一种可为多种设备提供电源的应急电源。

背景技术

随着科技的日新月异，人们生活水平的日益提高，汽车、手机、电脑、数码相机等成为人们生活、出游以及旅行必备的物品，它们均采用电池供电，一旦失去电源，将完全丧失其具有的功能，给人们的生活带来诸多不便。因此，对应每种产品，厂家均提供有相应的充电器，能够将 220v 的市电转换成相应电压的直流电源对其进行充电，但是这种充电器无法满足户外充电的需求。尤其对于汽车而言，常常会遇到打不着火的问题，特别是在旅途中的汽车，因电瓶电量不足或者温度过低很难打着火，给使用者带来很多不便。

现有中国专利文献 CN 101685974 A 公开了一种移动电源，包括电池组、充电电路、MCU 微控制电路、DC-DC 调压输出电路，所述充电电路设有可与外部电源连接的输入端，所述充电电路设有的输出端与电池组电连接，电池组同时与 MCU 微控制电路和 DC-DC 调压输出电路电连接，MCU 微控制电路电连接并控制充电电路和 DC-DC 调压输出电路，采用上述技术方案的有益效果是：线路简洁、体积较小、轻巧便于携带、易操控、智能化、功率损耗低和多功能，既可以利用市电充电，又可以通过更换不同的输出转换头给多种电子产品供电或充电，管理、携带和使用方便。该申请专利解决了多种电压等级的输出且具有自充电功能，但其不具备大电流输出能力，不能作为汽车启动电源，另外，该申请文件中的电流输出后均为直流电，而在现实中，也有很多外部设备是需

要输入交流电，所以该申请专利也无法解决这类设备的临时供电问题。

发明内容

本发明的目的在于提出一种自身充电方便、可大电流输出用于汽车启动，并能准确控制大电流输出的应急电源。

为达到此目的，本发明采用以下技术方案：

一种应急电源，包括壳体，所述壳体的内部设置有用于储存电能的电池组，所述电池组的输入端与用于给所述电池组充电的充电电路、太阳能板输入电路的输出端连接，所述电池组的输出端连接有用于汽车启动时输出大电流的大电流输出电路，所述电池组与所述大电流输出电路之间连接有外接电池智能检测系统。

其中，所述电池组由以磷酸铁锂、钴酸锂、镍钴锰三元锂或锰酸锂为正极，以人造或天然石墨为负极的锂离子电芯串联或并联组成，其输出端还连接有多路 DC-DC 调压电路以及 LED 驱动电路，每路所述 DC-DC 调压电路均与 MCU 控制电路连接，所述 MCU 控制电路还连接有用于显示该应急电源的电量的智能 LED 电量显示系统，所述 LED 驱动电路的输出端连接有 LED 照明灯，所述电池组的两端并联有用于保护所述电池组的均衡保护电路。

其中，所述外接电池智能检测系统包括用于连接外接电池的红黑电瓶夹、根据检测信号控制电路导通或断开的继电器、用于识别外接铅酸电瓶或锂离子启动电池的电压的电压识别系统、及识别通过外接启动电路的电流的电流识别系统，所述继电器的线圈的两端连接所述电压识别系统，所述继电器的输入端连接电压识别系统，所述继电器的输出端连接所述大电流输出电路，所述红黑电瓶夹通过可插拔防反接插头连接或通过焊接于所述电池组正负极两端的导线连接，所述可插拔防反接插头与所述电池组的正负极连接，所述电压识别系统

与所述红黑电瓶夹连接，所述继电器为 12V 或 24V 继电器，电流规格为 20A～300A，脚位为 4～6 个，所述外接电池智能检测系统设置于所述应急电源的外部，通过可插拔防反接插头与所述应急电源连接，或者设置于所述应急电源的内部、红黑电瓶夹设置于所述应急电源的外部。

其中，所述红黑电瓶夹分别与外部电池的正负极极柱连接时，若为接对状态，所述电压识别系统显示的反馈电压为正，否则反馈电压为负，其中，所述正的反馈电压为 a～b 的范围，所述 a 为 6～24V，b 为 9～30V，取值时，a 小于 b；当反馈电压为 a～b，且为正值时，所述继电器的线圈得到电信号，触点闭合，输出端与所述大电流输出电路的输入端导通，该应急电源开始对外接的设备进行大电流供电，此时，所述电流识别系统检测经过所述大电流输出电路的电流，若该电流小于 c 时，c 为 0.1～10A，所述继电器的线圈两端的电信号消失，触点断开，输出端断开与所述大电流输出电路的连接，停止对外接的设备大电流放电，所述大电流输出电路的输出电压为 DC12V 或 DC24V，瞬间电流为 100A～600A。

其中，所述 DC-DC 调压电路包括输出电压为 19V 的 DC-DC19V 升压输出电路、输出电压为 12V 的 DC-DC12V 输出电路以及输出电压为 5V 的 DC-DC5V 降压输出电路。

其中，所述 DC-DC12V 输出电路的输出端连接有用于发出警报信号的报警系统、用于将所述电池组输出的直流电转换为交流电的逆变器电路以及用于给所述电池组加热的智能加热系统。

其中，所述逆变器电路输出的交流电的电压为 110V～220V，所述逆变器电路内置于所述壳体的内部或者外接于所述壳体。

其中，所述智能加热系统包括缠绕于所述电池组的外侧的加热丝或者加热

膜，贴附于所述电池组的外表面并与加热丝或加热膜连接的热敏电阻，及启动智能加热系统的加热启动开关；所述的加热丝或加热膜的电阻值的范围为0.1Ω～10Ω；预先设定所述电池组表面的升温上限温度为 t，t 的范围为 0～70℃，此时，打开加热启动开关，若通过所述热敏电阻反馈到所述 MCU 控制电路的所述电池组的表面温度小于 t，则加热启动开关打开，加热丝或加热膜的两端导通电流，开始对所述电池组进行加热，预先设定加热的时间为一固定值 d，d 的范围为 10～300s，当所述电池组的表面温度达到上限温度 t 时，加热启动开关自动断开，或者当加热的时间达到 d 时，智能加热系统的加热电路自动断开。

其中，所述壳体为塑胶材质、铝合金材质或混合材质的外壳，所述太阳能板输入电路设置于所述壳体的外侧，所述太阳能板输入电路的功率为 0.5W～50W，输入电压为 5V～25V。

其中，所述电池组的输出端与所述外接电池智能检测系统之间还连接有一次性或者可恢复的保险丝，所述保险丝的电流为 50A～500A。

其中，所述电流识别系统的电路包括：高精度运算放大器 U3，型号是 SGM8591，电阻 R12、R13、R14、R15、R16、R17、R18、R20、R21、RS，电容 C9、C12，开关二极管 D4，型号是 IN4148，U3 的管脚 1 悬空，U3 的管脚 2 与 R16 的一端、R15 的一端、R21 的一端连接在一起，U3 的管脚 3 与 C12 的一端、RS 的一端、BT2 的负极连接在一起，U3 的管脚 4 与 BT1 的负极、RS 的另一端一起接地，U3 的管脚 5 悬空，U3 的管脚 6 与 R20 的一端、R21 的另一端、D4 的正极连接在一起，R20 的另一端与 C12 的另一端连接，U3 的管脚 7 与 VCC 端、C9 的一端连接在一起，C9 的另一端接地，U3 的管脚 8 悬空，D4 的负极接 R17 的一端，R17 的另一端与 R18 的一端、IN2 端连接在一起，R18 的另一端接地，R15 的另一端与 R12 的一端、R13 的一端、R14 的一端连接在

一起。

其中，所述电压识别系统的电路包括：双运算放大器 U2，型号是 LM358，三端稳压电路 U1，型号是 7805，电阻 R1、R2、R4、R5、R6、R7、R8、R9、R10、R11，电容 C1、C2、C3、C4、C5、C6、C7、C8，肖特基二极管 D1、D2，型号是 SS14，三端可调分流基准源 U4，型号为 TL431，U2 的管脚 1 与 R5 的一端、C5 的一端、C4 的一端连接在一起，R5 的另一端与 R6 的一端、IN1 端连接在一起，R6 的另一端接地，U2 的管脚 2 与 U2 的管脚 5、R11 的一端、U4 的阴极、U4 的参考极、R16 的另一端连接在一起，R11 的另一端接 VCC 端，U2 的管脚 3 与 C5 的另一端、R1 的一端、R7 的一端、R8 的一端连接在一起，R1 的另一端接 C4 另一端，U2 的管脚 4 与 R7 的另一端、U4 的阳极、R9 的一端一起接地，R8 的另一端与 D2 的负极、R10 的一端连接在一起，D2 的正极接 BT2 的正极，U2 的管脚 6 与 R10 的另一端、R9 的另一端、C6 的一端、R2 的一端连接在一起，U2 的管脚 7 与 C6 的另一端、C7 的一端、R4 的一端连接在一起，R4 的另一端接 A 点，C7 的另一端接 R2 的另一端，U2 的管脚 8 与 C8 的一端、C2 的一端、C3 的一端、U1 的管脚 3、VCC 端连接在一起，C8 的另一端接地，C2 的另一端和 C3 的另一端一起接地，U1 的管脚 1 与 C1 的一端、D1 的负极连接在一起，U1 的管脚 2 与 C1 的另一端一起接地，D1 的正极接 BT1 的正极。

其中，所述继电器的电路包括：三端稳压芯片 U5，型号是 XC6219，电阻 R3、R19、R22，电容 C11、C13、C14，肖特基二极管 D5，型号是 SS14，MCU 控制芯片 J1，控制开关 Q1、Q2、Q3，型号是 SI2300，继电器，U5 的管脚 1 与 C13 的一端、U5 的管脚 3、VCC 端连接在一起，U5 的管脚 2 与 C13 的另一端、C14 的一端、J1 的管脚 2 一起接地，U5 的管脚 4 悬空，U5 的管脚 5 与 C14

的另一端、J1 的管脚 1 连接在一起，J1 的管脚 3 接 IN1 端，J1 的管脚 4 接 OUT1 端，J1 的管脚 5 接 IN2 端，J1 的管脚 6 接 OUT2 端，J1 的管脚 7 悬空，J1 的管脚 8 悬空，OUT1 端接 R3 的一端，R3 的另一端接 Q2 的栅极，Q2 的漏极与 Q3 的源极、R13 的另一端连接在一起，Q3 的漏极接 R12 的另一端，Q3 的栅极连接 A 点，Q2 的源极与 Q1 的源极、R14 的另一端连接在一起，Q1 的栅极接 R19 的一端，R19 的另一端接 OUT2 端，Q1 的漏极与 D5 的正极、继电器线圈的一端连接在一起，D5 的负极、继电器线圈的另一端、继电器的常开接点的一端、R22 的一端与 BT1 的正极连接在一起，R22 的另一端接 C11 的一端，C11 的另一端与继电器的常开接点的另一端、BT2 的正极连接在一起。

本发明的有益效果为：本发明的应急电源采用锂离子电池作为电池组，具有重量轻、体积小、耐用、瞬间放电电流大，能够反复充电的特点，可满足汽车启动的大电流需要，通过在大电流输出电路与电池组之间连接外接电池智能检测系统，可有效地控制对外接设备的大电流供电，准确可靠，有效利用电源的电能。该应急电源的电池组又连接有可输出多种电压等级的调压电路，通过将各路调压电路输出端与MCU控制电路连接，可以满足手机、电脑、数码相机、车载打气泵、车载冰箱、车载吸尘器等设备的户外供电需要；LED灯可提供户外照明；该应急电源本身可通过外部电源充电，也可以通过太阳能对其进行充电，这使得该应急电源在户外时，可以自动补充电能。另外，该应急电源自身设置有报警系统，当用户迷路或者出现状况时自行按下报警系统，报警系统会通过指示灯的显示或者报警系统发出声音提示周围，以达到求救的目的；该应急电源还连接有逆变器电路和智能加热系统，其中，逆变器电路可以将电池组输出的直流电转换为交流电，以便户外时需要交流电的设备电力不足时供电，而智能加热系统通过加热丝或加热膜以及热敏电阻，可以在外部环境温度较低

影响电源正常供电的情况下，对电源的电池组进行加热，保证电池组在低温环境下也可以正常工作，向外部提供电能。同时，该应急电源设置有红黑电瓶夹，可有效防止在于外部需要救援的电池时将正负极接反，为使用者提供便利。

附图说明

图 1 是本发明应急电源的原理示意图；

图 2 是本发明应急电源的外接电池智能检测系统的电路原理图一；

图 3 是图 2 中的外接电池智能检测系统的电路原理图二。

图中：1-充电电路；2-太阳能板输入电路；3-均衡保护电路；4-电池组；5-保险丝；6-外接电池智能检测系统；7-大电流输出电路；8-智能 LED 电量显示系统；9-DC-DC5V 降压输出电路；10-12V 输出电路；11-DC-DC19V 升压输出电路；12-LED 驱动电路；13-LED 照明灯；14-MCU 控制电路；15-报警系统；16-智能加热系统；17-逆变器电路；61-电压识别系统的电路；62-电流识别系统的电路；63-继电器的电路。

具体实施方式

下面结合附图和具体实施例对本发明作进一步说明。

如图 1 至图 3 所示，一种应急电源，包括壳体，壳体的内部设置有用于储存电能的电池组 4，电池组 4 的输入端与用于给电池组 4 充电的充电电路 1、太阳能板输入电路 2 的输出端连接，电池组 4 的输出端连接有用于汽车启动时输出大电流的大电流输出电路 7，电池组 4 与大电流输出电路 7 之间连接有外接电池智能检测系统 6。进一步地，电池组 4 由以磷酸铁锂、钴酸锂、镍钴锰三元锂或锰酸锂为正极，以人造或天然石墨为负极的锂离子电芯串联或并联组成，其输出端还连接有多路 DC-DC 调压电路以及 LED 驱动电路 12，每路 DC-DC 调压电路均与 MCU 控制电路 14 连接，MCU 控制电路 14 还连接有用于显示该

应急电源的电量的智能 LED 电量显示系统 8，LED 驱动电路 12 的输出端连接有 LED 照明灯 13，电池组 4 的两端并联有用于保护所述电池组 4 的均衡保护电路 3。其中，DC-DC 调压电路包括输出电压为 19V 的 DC-DC19V 升压输出电路 11、输出电压为 12V 的 DC-DC12V 输出电路 10 以及输出电压为 5V 的 DC-DC5V 降压输出电路 9。另外，本发明中的壳体为塑胶材质、铝合金材质或混合材质的外壳，太阳能板输入电路 2 设置于壳体的外侧，太阳能板输入电路 2 的功率为 0.5W～50W，输入电压为 5V～25V。

该应急电源采用锂离子电池组成的电池组，具有重量轻、体积小、耐用、瞬间放电电流大，能够反复充电的特点，可满足汽车启动的大电流需要。该应急电源又通过在大电流输出电路与电池组之间连接外接电池智能检测系统，可有效地控制对外接设备的大电流供电，准确可靠，有效利用电源的电能；其电池组又连接有可输出多种电压等级的调压电路，通过将各路调压电路输出端与 MCU 控制电路连接，可以满足手机、电脑、数码相机、车载打气泵、车载冰箱、车载吸尘器等设备的户外供电需要；LED 灯可提供户外照明；该应急电源本身可通过外部电源充电，在无外部电源的情况下，也可以通过太阳能对其进行充电，这使得该应急电源在户外时，可以自动补充电能。同时，通过智能 LED 电量显示系统 14，可以实时检测该应急电源的电池组 4 的电量使用状态。

DC-DC12V 输出电路 10 的输出端连接有用于发出警报信号的报警系统 15、用于将电池组 4 输出的直流电转换为交流电的逆变器电路 17 以及用于给电池组 4 加热的智能加热系统 16。该报警系统 15 可以在用户迷路或者出现状况时由用户自行按下，报警系统 15 会通过指示灯的显示或者报警系统 15 发出声音提示周围，以达到求救的目的。其中，逆变器电路 17 输出的交流电的电压为 110V～220V，可以很方便地将该应急电源与需要交流电供电的外部设备连接，电压匹

配，无需再次调压，便于这种设备在户外使用时，电力不足的情况下提供电能，保证设备的正常工作。该逆变器电路 17 可以内置于壳体的内部，也可以在该壳体上设置连接逆变器电路 17 的接口，当需要提供交流电时，直接将外部的逆变器与该接口连接，即可实现直流转换成交流的目的，操作方便。另外，智能加热系统 16 包括缠绕于电池组 4 的外侧的加热丝或者加热膜，贴附于电池组 4 的外表面并与加热丝或加热膜连接的热敏电阻，及启动智能加热系统的加热启动开关；加热丝或加热膜的电阻值的范围为 0.1Ω～10Ω；使用时，预先设定电池组 4 表面的升温上限温度为 t，t 的范围为 0～70℃，当外部环境温度较低，且已经影响电源的正常供电时，打开加热启动开关，若通过热敏电阻反馈到 MCU 控制电路 14 的电池组 4 的表面温度小于 t，则控制加热丝或者加热膜的加热启动开关打开，加热丝或加热膜的两端导通电流，该智能加热系统 16 便开始对电池组 4 进行加热；加热前，预先设定加热的时间为一固定值 d，d 的范围为 10～300s；在加热的过程中，当电池组 4 的表面温度达到上限温度 t 时，控制加热丝或者加热膜的加热启动开关自动断开，阻断通过加热丝或加热膜两端的电流的通过，或者当加热的时间达到 d，则智能加热系统 16 的加热电路自动断开，完成对电池组 4 的加热。该智能加热系统 16 通过热敏电阻自身对热的敏感特性，准确地控制智能加热系统 16 的加热电路的导通与断开，有效提高加热效率，并降低加热消耗的电能。通过增加该智能加热系统 16，该应急电源可以在外部环境温度较低影响电源正常供电的情况下，仍然能保证电池组正常工作，向外部提供电能，提高了整个系统的可靠性。

外接电池智能检测系统 6 包括用于连接外接电池的红黑电瓶夹、根据检测信号控制电路导通或断开的继电器、用于识别外接铅酸电瓶或锂离子启动电池的电压的电压识别系统、及识别通过外接启动电路的电流的电流识别系统，其

中，继电器的线圈的两端连接电压识别系统，继电器的输入端连接电压识别系统，继电器的输出端连接大电流输出电路 7，红黑电瓶夹通过可插拔防反接插头连接或通过焊接于电池组 4 正负极两端的导线连接，若红黑电瓶夹与可插拔防反接插头连接时，该可插拔防反接插头与电池组 4 的正负极连接，电压识别系统与红黑电瓶夹连接。本发明中的继电器为 12V 或 24V 继电器，电流规格为 20A～300A，脚位为 4～6 个，外接电池智能检测系统 6 设置于该应急电源的外部，通过可插拔防反接插头与该应急电源连接，或者设置于应急电源的内部、而红黑电瓶夹设置于应急电源的外部。优选的，在本发明中，外接电池智能检测系统 6 设置于应急电源的内部、而红黑电瓶夹设置于应急电源的外部。红黑电瓶夹与电池组 4 之间通过硅胶线或者其他导线连接，以供与外部设备连接，通过红黑电瓶夹与外部电池连接，也可以有效防止插反或者红黑电瓶夹碰撞造成的短路。

当红黑电瓶夹分别与外部电池的正负极极柱连接时，若为接对状态，电压识别系统显示的反馈电压为正，否则反馈电压为负，其中，正的反馈电压为 a～b 的范围，a 为 6～24V，b 为 9～30V，取值时，应使 a 小于 b；若为接反状态，继电器不工作，大电流输出电路 7 处于断开状态。若当外接电池智能检测系统 6 失效，为保证该应急电源的安全性，本发明的应急电源电路中，在电池组 4 与外接电池智能检测系统 6 之间串联连接有一次性或者可恢复的保险丝 5，该保险丝 5 的电流为 50A～500A。为确保电池组 4 的充放电安全，电池组 4 的两端连接有均衡保护电路 3，对电池组 4 进行过流过载过充过放保护。

在本发明中，当电压识别系统的反馈电压为 a～b，且为正值时，继电器的线圈接收到该电压信号，触点闭合，输出端与大电流输出电路 7 导通，该应急电源开始对外接的设备进行大电流供电，此时，电流识别系统检测经过大电流

输出电路 7 的电流，若该电流小于 c 时，c 为 0.1～10A，继电器的线圈两端的电压信号消失，触点断开，输出端断开与大电流输出电路 7 的连接，停止对外接的设备大电流放电。该大电流输出电路 7 的输出电压为 DC12V 或 DC24V，瞬间电流为 100A～600A，可以作为应急状态下汽车的启动电源使用。通过在大电流输出电路 7 与电池组 4 之间连接外接电池智能检测系统 6，可有效地控制对外接设备的大电流供电，准确可靠，有效利用电源的电能。该外接电池智能检测系统 6 可以内置于壳体的内部，也可以外接于壳体。

如图 2、图 3 所示为外接电池智能检测系统 6 的电路原理图，其中，BT1 为充电电池，即电池组 4，BT2 为被充电汽车电池。

具体地，电流识别系统的电路 62 包括：高精度运算放大器 U3，型号是 SGM8591，电阻 R12、R13、R14、R15、R16、R17、R18、R20、R21、RS，电容 C9、C12，开关二极管 D4，型号是 IN4148，U3 的管脚 1 悬空，U3 的管脚 2 与 R16 的一端、R15 的一端、R21 的一端连接在一起，U3 的管脚 3 与 C12 的一端、RS 的一端、BT2 的负极连接在一起，U3 的管脚 4 与 BT1 的负极、RS 的另一端一起接地，U3 的管脚 5 悬空，U3 的管脚 6 与 R20 的一端、R21 的另一端、D4 的正极连接在一起，R20 的另一端与 C12 的另一端连接，U3 的管脚 7 与 VCC 端、C9 的一端连接在一起，C9 的另一端接地，U3 的管脚 8 悬空，D4 的负极接 R17 的一端，R17 的另一端与 R18 的一端、IN2 端连接在一起，R18 的另一端接地，R15 的另一端与 R12 的一端、R13 的一端、R14 的一端连接在一起。

具体地，电压识别系统的电路 61 包括：双运算放大器 U2，型号是 LM358，三端稳压电路 U1，型号是 7805，电阻 R1、R2、R4、R5、R6、R7、R8、R9、R10、R11，电容 C1、C2、C3、C4、C5、C6、C7、C8，肖特基二极管 D1、D2，

型号是 SS14，三端可调分流基准源 U4，型号为 TL431，U2 的管脚 1 与 R5 的一端、C5 的一端、C4 的一端连接在一起，R5 的另一端与 R6 的一端、IN1 端连接在一起，R6 的另一端接地，U2 的管脚 2 与 U2 的管脚 5、R11 的一端、U4 的阴极、U4 的参考极、R16 的另一端连接在一起，R11 的另一端接 VCC 端，U2 的管脚 3 与 C5 的另一端、R1 的一端、R7 的一端、R8 的一端连接在一起，R1 的另一端接 C4 另一端，U2 的管脚 4 与 R7 的另一端、U4 的阳极、R9 的一端一起接地，R8 的另一端与 D2 的负极、R10 的一端连接在一起，D2 的正极接 BT2 的正极，U2 的管脚 6 与 R10 的另一端、R9 的另一端、C6 的一端、R2 的一端连接在一起，U2 的管脚 7 与 C6 的另一端、C7 的一端、R4 的一端连接在一起，R4 的另一端接 A 点，C7 的另一端接 R2 的另一端，U2 的管脚 8 与 C8 的一端、C2 的一端、C3 的一端、U1 的管脚 3、VCC 端连接在一起，C8 的另一端接地，C2 的另一端和 C3 的另一端一起接地，U1 的管脚 1 与 C1 的一端、D1 的负极连接在一起，U1 的管脚 2 与 C1 的另一端一起接地，D1 的正极接 BT1 的正极。

具体地，继电器的电路 63 包括：三端稳压芯片 U5，型号是 XC6219，电阻 R3、R19、R22，电容 C11、C13、C14，肖特基二极管 D5，型号是 SS14，MCU 控制芯片 J1，控制开关 Q1、Q2、Q3，型号是 SI2300，继电器，U5 的管脚 1 与 C13 的一端、U5 的管脚 3、VCC 端连接在一起，U5 的管脚 2 与 C13 的另一端、C14 的一端、J1 的管脚 2 一起接地，U5 的管脚 4 悬空，U5 的管脚 5 与 C14 的另一端、J1 的管脚 1 连接在一起，J1 的管脚 3 接 IN1 端，J1 的管脚 4 接 OUT1 端，J1 的管脚 5 接 IN2 端，J1 的管脚 6 接 OUT2 端，J1 的管脚 7 悬空，J1 的管脚 8 悬空，OUT1 端接 R3 的一端，R3 的另一端接 Q2 的栅极，Q2 的漏极与 Q3 的源极、R13 的另一端连接在一起，Q3 的漏极接 R12 的另一端，Q3 的栅极连

接 A 点，Q2 的源极与 Q1 的源极、R14 的另一端连接在一起，Q1 的栅极接 R19 的一端，R19 的另一端接 OUT2 端，Q1 的漏极与 D5 的正极、继电器线圈的一端连接在一起，D5 的负极、继电器线圈的另一端、继电器的常开接点的一端、R22 的一端与 BT1 的正极连接在一起，R22 的另一端接 C11 的一端，C11 的另一端与继电器的常开接点的另一端、BT2 的正极连接在一起。

当该应急电源与外部充电电池的连接断开，或电流小于设定的电流值时，电流识别系统的电路 62 中的 R15 和 R16 提供给 U3 检测信号，此时 U3 根据该检测信号发出一个输出信号给 MCU 控制芯片，以供 MCU 控制芯片判断电路的连接或断开的状态，以做出合适的指示；当输出电压低于预定值，在本发明中该电压的预定值为 8.1V 时，电压识别系统的电路 61 中的电阻 R7、R8 会提供检测信号给 U2，U2 根据该检测信号发出一个输出信号给 IN1 端，MCU 控制芯片根据 IN1 端的信号，进而控制继电器的电路 63 中的控制开关 Q2；而当输出电压高于预定值，在本发明中，该电压的预定值为 12.6V 时，电压识别系统的电路 61 中的电阻 R9、R10 会提供检测信号给 U2，U2 根据该检测信号发出一个信号控制继电器的电路 63 中的控制开关 Q3。在本发明中，通过电压识别系统的电路 61，电流识别系统的电路 62 的共同作用，给予 MCU 控制芯片信号，可通过 MCU 控制芯片的判断，最终实现控制继电器的电路 63 中的 Q1、Q2 和 Q3 的目的，进而达到充电和保护的效果。

以上所述仅为本发明的优选实施例而已，并不用于限制本发明，对于本领域的技术人员来说，本发明可以有各种更改和变化。凡在本发明的精神和原则之内，所作的任何修改、等同替换、改进等，均应包含在本发明的保护范围之内。

权 利 要 求 书

1、一种应急电源，包括壳体，所述壳体的内部设置有用于储存电能的电池组（4），其特征在于：所述电池组（4）的输入端与用于给所述电池组（4）充电的充电电路（1）、太阳能板输入电路（2）的输出端连接，所述电池组（4）的输出端连接有用于汽车启动时输出大电流的大电流输出电路（7），所述电池组（4）与所述大电流输出电路（7）之间连接有外接电池智能检测系统（6）。

2、根据权利要求 1 所述的一种应急电源，其特征在于：所述电池组（4）由以磷酸铁锂、钴酸锂、镍钴锰三元锂或锰酸锂为正极，以人造或天然石墨为负极的锂离子电芯串联或并联组成，其输出端还连接有多路 DC-DC 调压电路以及 LED 驱动电路（12），每路所述 DC-DC 调压电路均与 MCU 控制电路（14）连接，所述 MCU 控制电路（14）还连接有用于显示该应急电源的电量的智能 LED 电量显示系统（8），所述 LED 驱动电路（12）的输出端连接有 LED 照明灯（13），所述电池组（4）的两端并联有用于保护所述电池组（4）的均衡保护电路（3）。

3、根据权利要求 1 所述的一种应急电源，其特征在于：所述外接电池智能检测系统（6）包括用于连接外接电池的红黑电瓶夹、根据检测信号控制电路导通或断开的继电器、用于识别外接铅酸电瓶或锂离子启动电池的电压的电压识别系统、及识别通过外接启动电路的电流的电流识别系统，所述继电器的线圈的两端连接所述电压识别系统，所述继电器的输入端连接电压识别系统，所述继电器的输出端连接所述大电流输出电路（7），所述红黑电瓶夹通过可插拔防反接插头连接或通过焊接于所述电池组（4）正负极两端的导线连接，所述可插拔防反接插头与所述电池组（4）的正负极连接，所述电压识别系统与所述红黑电瓶夹连接，所述继电器为 12V 或 24V 继电器，电流规格为 20A～300A，脚位为 4～6 个，所述外接电池智能检测系统（6）设置于所述应急电源的外部，通

过可插拔防反接插头与所述应急电源连接，或者设置于所述应急电源的内部、而红黑电瓶夹设置于所述应急电源的外部。

4、根据权利要求 3 所述的一种应急电源，其特征在于：所述红黑电瓶夹分别与外部电池的正负极极柱连接时，若为接对状态，所述电压识别系统显示的反馈电压为正，否则反馈电压为负，其中，所述正的反馈电压为 a～b 的范围，所述 a 为 6～24V，b 为 9～30V，取值时，a 小于 b；当反馈电压为 a～b，且为正值时，所述继电器的线圈得到电信号，触点闭合，输出端与所述大电流输出电路（7）导通，该应急电源开始对外接的设备进行大电流供电，此时，所述电流识别系统检测经过所述大电流输出电路（7）的电流，若该电流小于 c 时，c 为 0.1～10A，所述继电器的线圈两端的电信号消失，触点断开，输出端断开与所述大电流输出电路（7）的连接，停止对外接的设备大电流放电，所述大电流输出电路（7）的输出电压为 DC12V 或 DC24V，瞬间电流为 100A～600A。

5、根据权利要求 2 所述的一种应急电源，其特征在于：所述 DC-DC 调压电路包括输出电压为 19V 的 DC-DC19V 升压输出电路（11）、输出电压为 12V 的 DC-DC12V 输出电路（10）以及输出电压为 5V 的 DC-DC5V 降压输出电路（9）。

6、根据权利要求 5 所述的一种应急电源，其特征在于：所述 DC-DC12V 输出电路（10）的输出端连接有用于发出警报信号的报警系统（15）、用于将所述电池组（4）输出的直流电转换为交流电的逆变器电路（17）以及用于给所述电池组（4）加热的智能加热系统（16）。

7、根据权利要求 6 所述的一种应急电源，其特征在于：所述逆变器电路（17）输出的交流电的电压为 110V～220V，所述逆变器电路（17）内置于所述壳体的内部或者外接于所述壳体。

8、根据权利要求 6 所述的一种应急电源，其特征在于：所述智能加热系统（16）包括缠绕于所述电池组（4）的外侧的加热丝或者加热膜，贴附于所述电池组（4）的外表面并与加热丝或加热膜连接的热敏电阻，及启动智能加热系统（16）的加热启动开关；所述的加热丝或加热膜的电阻值的范围为 0.1Ω～10Ω；预先设定所述电池组（4）表面的升温上限温度为 t，t 的范围为 0～70℃，此时，打开加热启动开关，若通过所述热敏电阻反馈到所述 MCU 控制电路（14）的所述电池组（4）的表面温度小于 t，则加热启动开关打开，加热丝或加热膜的两端导通电流，开始对所述电池组（4）进行加热，预先设定加热的时间为一固定值 d，d 的范围为 10～300s，当所述电池组（4）的表面温度达到上限温度 t 时，加热启动开关自动断开，或者当加热的时间达到 d 时，智能加热系统的加热电路自动断开。

9、根据权利要求 1 所述的一种应急电源，其特征在于：所述壳体为塑胶材质、铝合金材质或混合材质的外壳，所述太阳能板输入电路（2）设置于所述壳体的外侧，所述太阳能板输入电路（2）的功率为 0.5W～50W，输入电压为 5V～25V。

10、根据权利要求 1 所述的一种应急电源，其特征在于：所述电池组（4）的输出端与所述外接电池智能检测系统（6）之间还连接有一次性或者可恢复的保险丝（5），所述保险丝（5）的电流为 50A～500A。

11、根据权利要求 3 所述的一种应急电源，其特征在于，所述电流识别系统的电路（62）包括：高精度运算放大器 U3，型号是 SGM8591，电阻 R12、R13、R14、R15、R16、R17、R18、R20、R21、RS，电容 C9、C12，开关二极管 D4，型号是 IN4148，U3 的管脚 1 悬空，U3 的管脚 2 与 R16 的一端、R15 的一端、R21 的一端连接在一起，U3 的管脚 3 与 C12 的一端、RS 的一端、BT2

的负极连接在一起，U3 的管脚 4 与 BT1 的负极、RS 的另一端一起接地，U3 的管脚 5 悬空，U3 的管脚 6 与 R20 的一端、R21 的另一端、D4 的正极连接在一起，R20 的另一端与 C12 的另一端连接，U3 的管脚 7 与 VCC 端、C9 的一端连接在一起，C9 的另一端接地，U3 的管脚 8 悬空，D4 的负极接 R17 的一端，R17 的另一端与 R18 的一端、IN2 端连接在一起，R18 的另一端接地，R15 的另一端与 R12 的一端、R13 的一端、R14 的一端连接在一起。

12、根据权利要求 11 所述的一种应急电源，其特征在于：所述电压识别系统的电路（61）包括：双运算放大器 U2，型号是 LM358，三端稳压电路 U1，型号是 7805，电阻 R1、R2、R4、R5、R6、R7、R8、R9、R10、R11，电容 C1、C2、C3、C4、C5、C6、C7、C8，肖特基二极管 D1、D2，型号是 SS14，三端可调分流基准源 U4，型号为 TL431，U2 的管脚 1 与 R5 的一端、C5 的一端、C4 的一端连接在一起，R5 的另一端与 R6 的一端、IN1 端连接在一起，R6 的另一端接地，U2 的管脚 2 与 U2 的管脚 5、R11 的一端、U4 的阴极、U4 的参考极、R16 的另一端连接在一起，R11 的另一端接 VCC 端，U2 的管脚 3 与 C5 的另一端、R1 的一端、R7 的一端、R8 的一端连接在一起，R1 的另一端接 C4 另一端，U2 的管脚 4 与 R7 的另一端、U4 的阳极、R9 的一端一起接地，R8 的另一端与 D2 的负极、R10 的一端连接在一起，D2 的正极接 BT2 的正极，U2 的管脚 6 与 R10 的另一端、R9 的另一端、C6 的一端、R2 的一端连接在一起，U2 的管脚 7 与 C6 的另一端、C7 的一端、R4 的一端连接在一起，R4 的另一端接 A 点，C7 的另一端接 R2 的另一端，U2 的管脚 8 与 C8 的一端、C2 的一端、C3 的一端、U1 的管脚 3、VCC 端连接在一起，C8 的另一端接地，C2 的另一端和 C3 的另一端一起接地，U1 的管脚 1 与 C1 的一端、D1 的负极连接在一起，U1 的管脚 2 与 C1 的另一端一起接地，D1 的正极接 BT1 的正极。

13、根据权利要求 12 所述的一种应急电源，其特征在于：所述继电器的电路（63）包括：三端稳压芯片 U5，型号是 XC6219，电阻 R3、R19、R22，电容 C11、C13、C14，肖特基二极管 D5，型号是 SS14，MCU 控制芯片 J1，控制开关 Q1、Q2、Q3，型号是 SI2300，继电器，U5 的管脚 1 与 C13 的一端、U5 的管脚 3、VCC 端连接在一起，U5 的管脚 2 与 C13 的另一端、C14 的一端、J1 的管脚 2 一起接地，U5 的管脚 4 悬空，U5 的管脚 5 与 C14 的另一端、J1 的管脚 1 连接在一起，J1 的管脚 3 接 IN1 端，J1 的管脚 4 接 OUT1 端，J1 的管脚 5 接 IN2 端，J1 的管脚 6 接 OUT2 端，J1 的管脚 7 悬空，J1 的管脚 8 悬空，OUT1 端接 R3 的一端，R3 的另一端接 Q2 的栅极，Q2 的漏极与 Q3 的源极、R13 的另一端连接在一起，Q3 的漏极接 R12 的另一端，Q3 的栅极连接 A 点，Q2 的源极与 Q1 的源极、R14 的另一端连接在一起，Q1 的栅极接 R19 的一端，R19 的另一端接 OUT2 端，Q1 的漏极与 D5 的正极、继电器线圈的一端连接在一起，D5 的负极、继电器线圈的另一端、继电器的常开接点的一端、R22 的一端与 BT1 的正极连接在一起，R22 的另一端接 C11 的一端，C11 的另一端与继电器的常开接点的另一端、BT2 的正极连接在一起。

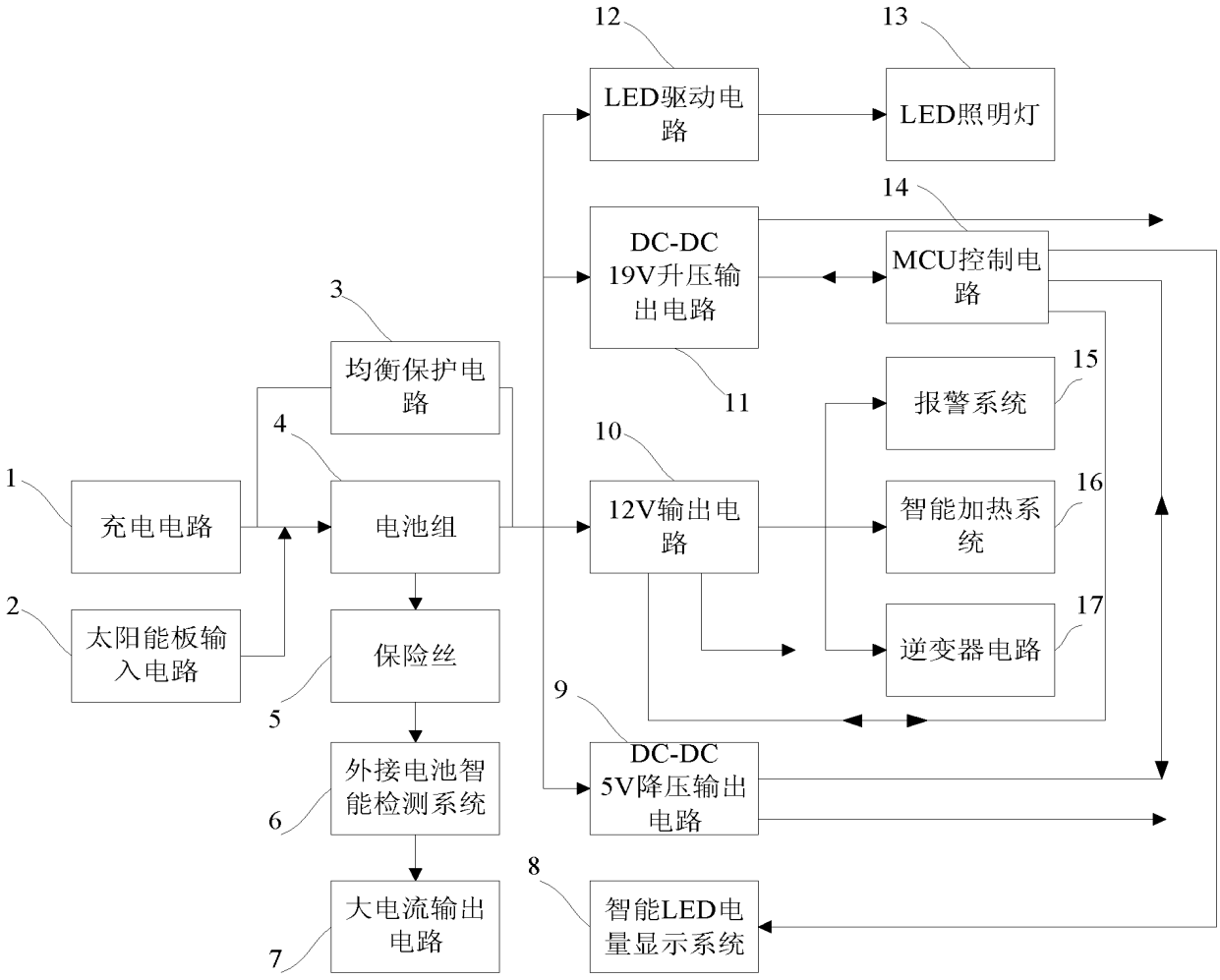

12
LED驱动电路
13
LED照明灯
14
DC-DC 19V升压输出电路
MCU控制电路
3
均衡保护电路
11
15
报警系统
4
10
1
充电电路
电池组
12V输出电路
16
智能加热系统
2
太阳能板输入电路
保险丝
17
逆变器电路
5
9
DC-DC 5V降压输出电路
外接电池智能检测系统
6
8
大电流输出电路
7
智能LED电量显示系统

图 1

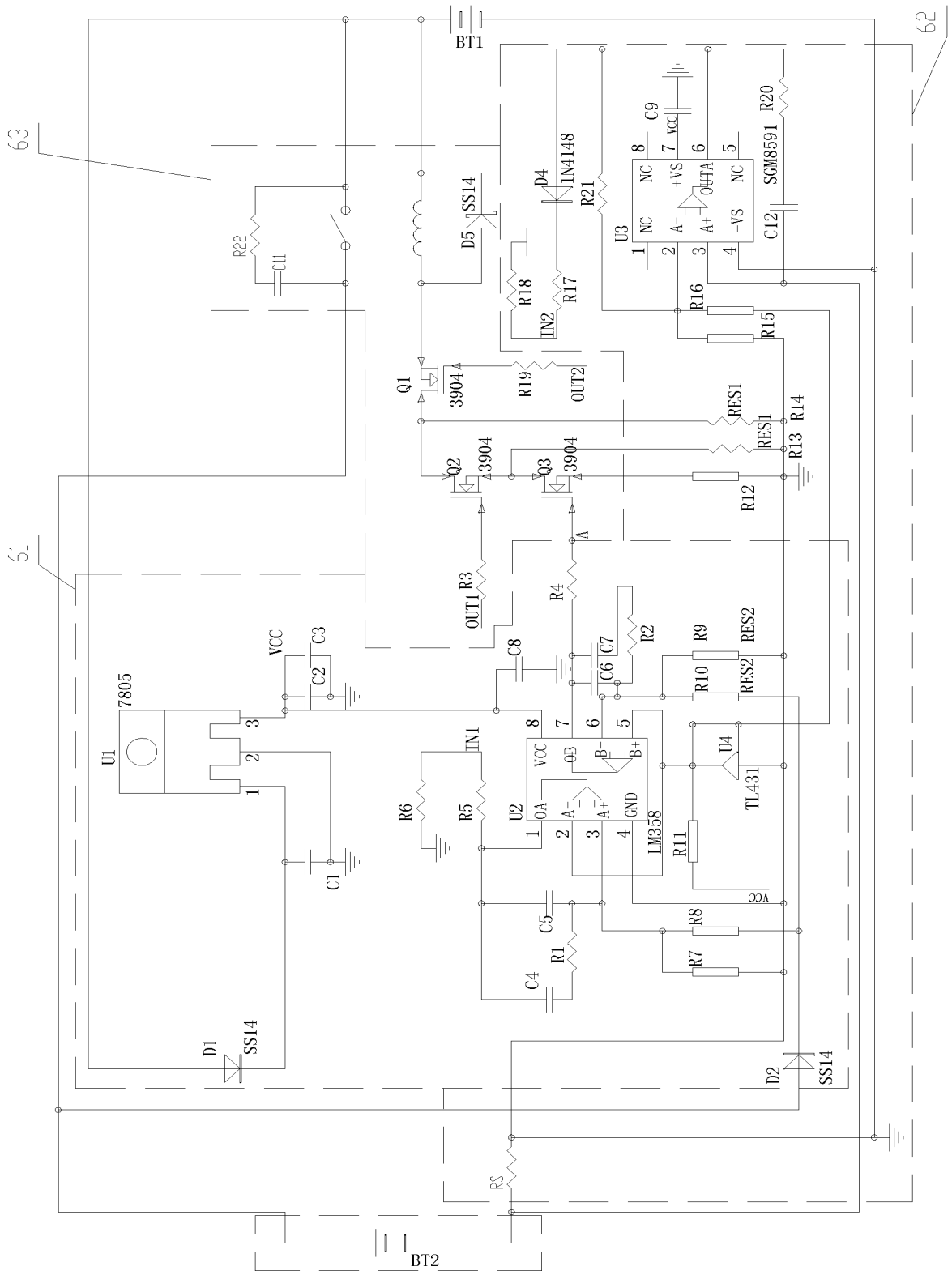

BT1
62
63
61
R22
C11
D5
SS14
D4
1N4148
R21
C9
VCC
R20
U3
NC
+VS
OUTA
SGM8591
C12
R18
R17
IN2
R16
R15
Q1
3904
R19
OUT2
RES1
R14
R13
Q2
Q3
R12
OUT1
R3
R4
A
R2
R9
RES2
R10
C8
C7
C6
C3
C2
VCC
7805
U1
IN1
R6
R5
U2
OA
OB
VCC
GND
LM358
U4
TL431
R11
C1
C5
C4
R1
R8
R7
D1
D2
R3
BT2

图 2

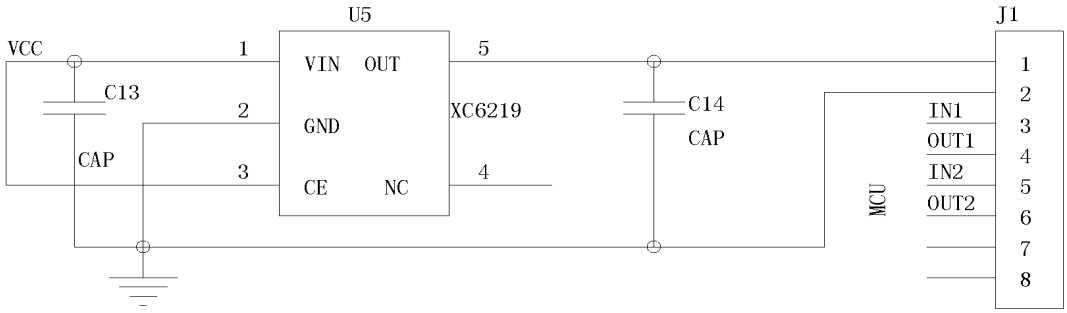

U5
VCC
1
VIN
OUT
5
C13
2
GND
XC6219
C14
CAP
CAP
3
CE
NC
4
MCU
J1
IN1
OUT1
IN2
OUT2
1
2
3
4
5
6
7
8

图 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/086774

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H02J7/00; H02J9/00; H02J; B60R16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, WPI, EPODOC: emergency, power, supply, battery, control, identify, detect, temperature, Lei Xingliang

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 102496985 A (LEI, Xingliang) 13 June 2012 (13.06.2012) description, paragraphs [0005] to [0026] and figures 1 to 6	1-13
Y	CN 201766385 U (CHEN, De) 16 March 2011 (16.03.2011) description, paragraphs [0036] to [0062] and figures 1 to 3	1-13
Y	CN 202309139 U (SHANGHAI GUANGWEI ELECTRIC CO LTD et al.) 04 July 2012 (04.07.2012) description, paragraphs [0012] to [0034] and figures 1 to 6	1-13
Y	CN 202405344 U (SHAO, Hanqi) 29 August 2012 (29.08.2012) description, paragraphs [0004], [0047], [0056] and [0057]	6-8
P, X	CN 103066662 A (LEI, Xingliang) 24 April 2013 (24.04.2013) claims 1 to 13	1-13

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 January 2014 (18.01.2014)	20 February 2014 (20.02.2014)
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer HUO, Yan Telephone No. (86-10) 62411950

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/086774

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	CN 203056633 U (LEI, Xingliang) 10 July 2013 (10.07.2013) claims 1 to 13	1-13
A	CN 2659752 Y (LONGSHENG WIRE & CABLE CO LTD) 01 December 2004 (01.12.2004)	1-13

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2013/086774

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102496985 A	13.06.2012	WO 2013082982 A1	13.06.2013
CN 201766385 U	16.03.2011	None	
CN 202309139 U	04.07.2012	None	
CN 202405344 U	29.08.2012	None	
CN 103066662 A	24.04.2013	None	
CN 203056633 U	10.07.2013	None	
CN 2659752 Y	01.12.2004	None	

ADC EX1002
IPR2025-00885

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/086774

Continuation of: A. CLASSIFICATION OF SUBJECT MATTER:

H02J 7/00 (2006.01) i

H02J 9/00 (2006.01) i

ADC EX1002
IPR2025-00885

国际检索报告

国际申请号 **PCT/CN2013/086774**

A. 主题的分类

参见附加页

按照国际专利分类(IPC)或者同时按照国家分类和 IPC 两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC: H02J7/00， H02J9/00，H02J，B60R16

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词（如使用）)

CNPAT, WPI, EPODOC: 应急电源, 车, 救急, 电瓶, 检测, 温度, 雷星亮, emergency, power, supply, battery, control, identify

C. 相关文件

类 型*	引用文件，必要时，指明相关段落	相关的权利要求
Y	CN 102496985 A (雷星亮) 13.6 月 2012 (13.06.2012) 说明书第[0005]-[0026]段，图 1-6	1-13
Y	CN 201766385 U (陈德) 16.3 月 2011 (16.03.2011) 说明书第[0036]-[0062]段，图 1-3	1-13
Y	CN 202309139 U (上海广为美线电源电器有限公司等) 04.7 月 2012 (04.07.2012) 说明书第[0012]-[0034]段，图 1-6	1-13
Y	CN 202405344 U (邵汉琦) 29.8 月 2012 (29.08.2012) 说明书第[0004]、[0047]、[0056]和[0057]段	6-8
P,X	CN 103066662 A (雷星亮) 24.4 月 2013 (24.04.2013) 权利要求 1-13	1-13
P,X	CN 203056633 U (雷星亮) 10.7 月 2013 (10.07.2013) 权利要求 1-13	1-13
A	CN 2659752 Y (龙口龙盛电线电缆有限公司) 01.12 月.2004 (01.12.2004) 全文	1-13

☐ 其余文件在 C 栏的续页中列出。 ☒ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的当天或之后公布的在先申请或专利

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件（如具体说明的）

"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相抵触，但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
18.1 月 2014 (18.01.2014)	**20.2 月 2014 (20.02.2014)**
ISA/CN 的名称和邮寄地址： 中华人民共和国国家知识产权局 中国北京市海淀区蓟门桥西土城路 6 号 100088 传真号： (86-10)62019451	受权官员 霍艳 电话号码：(86-10) **62411950**

ADC EX1002
IPR2025-00885

国际检索报告
关于同族专利的信息

国际申请号
PCT/CN2013/086774

检索报告中引用的专利文件	公布日期	同族专利	公布日期
CN 102496985 A	13.06.2012	WO 2013082982 A1	13.06.2013
CN 201766385 U	16.03.2011	无	
CN 202309139 U	04.07.2012	无	
CN 202405344 U	29.08.2012	无	
CN 103066662 A	24.04.2013	无	
CN 203056633 U	10.07.2013	无	
CN 2659752 Y	01.12.2004	无	

ADC EX1002
IPR2025-00885

国际检索报告

国际申请号
PCT/CN2013/086774

续 A. 主题的分类

H02J 7/00 (2006.01) i

H02J 9/00 (2006.01) i

ADC EX1002
IPR2025-00885

EX 1008

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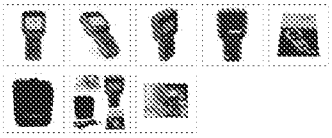
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Launch X431BST-460 Battery Tester Asian Version Russian Japanese

2 Review(s) Average rating: 4.5

Write a review | Ask a question

SKU:OBD10311-B
History: 3 Sold
Price: USD $159.00

Tweet | Share | Google+ | Pinterest

Payment Methods:

Please submit the url of the better price you found for us, we will check and get back to you with extra promotion.

159 loyalty point(s).

$159.00

Qty: 1 unit(s)

Add to Cart

Pay Check out

The safer, easier way to pay

Online Shopping Security

Learn Before You Buy
Purchase Process
Can You Ship To
Payment Methods
Warranty Policy

Product Description

Launch X431 BST-460 Battery Tester Asian Version can easily, quickly and accurately measure the actual cold cranking current capability to judge the health status of the battery itself. BST-460 battery tester can detect common faults of both starting and generator charging systems, which helps you achieve quick repair to the vehicle problems. Launch BST-460 Battery Tester Asian can support Japanese,but BST-460 can not.

Launch X431 BST-460 Battery Tester Asian Version Language: Chinese/English/Russian/Japanese

Launch X431 BST-460 Battery Tester Asian Version Scope: Suitable for 6V & 12V battery system and 12V & 24V starting and charging system detects

Launch X431 BST-460 Battery Tester Asian Version Specification:

1. 128 * 64 dot matrix , large backlit display screen (3 inches) , adjustable backlight brightness LCD display ;
2. The structure size : 181 * 90 * 30mm
3. Shell ABS anti - acid plastic , two-tone green rubber oil ;
4. Test standards , including the most commonly used battery standard in the world , such as CCA, BCI, CA, MCA, JIS, DIN, IEC , EN , SAE , GB ;
5. Operating temperature : -20-60°C (-4-140°F)

Launch X431 BST-460 Battery Tester Asian Version Advantage:
Eight lines with backlight LCD display and humane language prompted interface
Simple, secure , fast , and accurate display test results (the test takes about 3 seconds)
No emit light , no heat , no discharge , no spark , no operating dangerous
Automatic temperature compensation function
With ripple voltage test function
Removable replacement test line

Launch X431 BST-460 Battery Tester Asian Version advanced functionality :
Applicable to a variety of models, all kinds of batteries , and a variety of system mode
Directly detected in the car , no need to remove the battery
Directly test the battery of the loss of electricity , broken battery

Launch X431 BST-460 Battery Tester Asian Version Test criteria and scope :
CCA 100-2000 (SAE & BCI to develop the standard most commonly used : the cold-start battery rating)
BCI 100-2000 (international battery Committee standards)
CA 100-2000 (0 ℃ when the effective starting current rating)
MCA 100-2000 (ships standard effective starting current rating , 0 ℃)
JIS 26A17 - 245H52 (Japanese Industrial Standard)
Standard DIN 100-1400 (German Automobile Industry Committee)
The IEC 100-1400 (International Electrotechnical Commission standard)
EN 100-2000 (European Automobile Manufacturers Association standards)
SAE 100-2000 (U.S. Engineers Standard)
GB 100-1400 (Chinese National Standard)

Launch X431 BST-460 Battery Tester Asian Version package including:

1pc x Launch X431 BST-460 Battery Tester Main Unit
1pc x Removable test cable
1pc x User's Manual
1pc x Carry case





Wholesale Contact Information

Email: sales@xcar360.com
Skype: uuc050
MSN: sales@xcar360.com

How To Buy Our Products

Choose Product → Add to Shopping Cart → Payed Product → Supplier Ships Order → Get product

Product Reviews

Name	Rating	Review
jon (Posted on 2014-03-14)	☆☆☆☆☆	this product user more Languages?or greek languages used??thanks a lot Reply: It support Ru,IP,EN,CN now,not support greek. Best Regards Xcar360
		This product test battery AGM?And this tester using greek menu?Thanks a lot

ADC EX 1002
IPR2025-00885

JON
(Posted on 2014-03-07)

Reply:
Yes, but is only english now.
Best Regards
Xcar360

2
Item(s)

Show 10 per page

There are 2 Review(s) about this product, click button to Write a review

Customer Photos

No Pics yet. You can click to Post a Picture of the product and get Xcar360 points!

Product Consulting

THIS PRODUCT CAN BY CHECK BATTERY AGM.THANKS A LOT

Yes,it can do that. Best Regards Xcar360

Having problem with this product , you can Add a Consulting

Questions?

2010 - 2018 Xcar360 Automotive Technology

AO 120 (Rev. 08/10)

TO:	**Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Northern District of Ohio, Eastern Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
1:17-cv-02208	10/19/2017	for the Northern District of Ohio, Eastern Division

PLAINTIFF	DEFENDANT
The NOCO Company, Inc.	SZ Jingxinghui Electronics Technology Co., Ltd.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	9,007,015	4/14/2015	The NOCO Company
2			
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
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5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

Trials@uspto.gov
571-272-7822

Paper No. 3

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SHENZHEN CARKU TECHNOLOGY CO., LTD.,
Petitioner,

v.

THE NOCO COMPANY,
Patent Owner.

Case IPR2020-00944
Patent 9,007,015

Mailed: May 21, 2020

Before Amy Kattula, *Trial Paralegal*

NOTICE OF FILING DATE ACCORDED TO PETITION
AND
TIME FOR FILING PATENT OWNER PRELIMINARY RESPONSE

The petition for *inter partes* review filed in the above proceeding has been accorded the filing date of May 14, 2020.

Patent Owner may file a preliminary response to the petition no later than three months from the date of this notice. The preliminary response is limited to setting forth the reasons why the requested review should not be

instituted. Patent Owner may also file an election to waive the preliminary response to expedite the proceeding. For more information, please consult the Office Patent Trial Practice Guide, 77 Fed. Reg. 48756 (Aug. 14, 2012), which is available on the Board Web site at http://www.uspto.gov/PTAB.

Patent Owner is advised of the requirement to submit mandatory notice information under 37 C.F.R. § 42.8(a)(2) within 21 days of service of the petition.

The parties are encouraged to use the heading on the first page of this Notice for all future filings in the proceeding.

The parties are advised that under 37 C.F.R. § 42.10(c), recognition of counsel *pro hac vice* requires a showing of good cause. The parties are authorized to file motions for *pro hac vice* admission under 37 C.F.R. § 42.10(c). Such motions shall be filed in accordance with the "Order -- Authorizing Motion *for Pro Hac Vice* Admission" in Case IPR2013-00639, Paper 7, a copy of which is available on the Board Web site under "Representative Orders, Decisions, and Notices."

The parties are reminded that unless otherwise permitted by 37 C.F.R. § 42.6(b)(2), all filings in this proceeding must be made electronically in Patent Trial and Appeal Board End to End (PTAB E2E), accessible from the Board Web site at http://www.uspto.gov/PTAB. To file documents, users must register with PTAB E2E. Information regarding how to register with and use PTAB E2E is available at the Board Web site.

If there are any questions pertaining to this notice, please contact Amy Kattula at 571-272-5826 or the Patent Trial and Appeal Board at 571-272-7822.

Case IPR2020-00944
Patent 9,007,015

PETITIONER:

Philip Swain
pswain@foleyhoag.com

Rajesh Vallabh
rvallabh@foleyhoag.com

PATENT OWNER:

Vorys, Sater, Seymour and Pease LLP
1909 K Street, NW
9th Floor
Washington, DC 20006-1152
patlaw@vorys.com

NOTICE CONCERNING ALTERNATIVE DISPUTE RESOLUTION (ADR)

The Patent Trial and Appeal Board (PTAB) strongly encourages parties who are considering settlement to consider alternative dispute resolution as a means of settling the issues that may be raised in an AIA trial proceeding. Many AIA trials are settled prior to a Final Written Decision. Those considering settlement may wish to consider alternative dispute resolution techniques early in a proceeding to produce a quicker, mutually

agreeable resolution of a dispute or to at least narrow the scope of matters in dispute. Alternative dispute resolution has the potential to save parties time and money.

Many non-profit organizations, both inside and outside the intellectual property field, offer alternative dispute resolution services. Listed below are the names and addresses of several such organizations. The listings are provided for the convenience of parties involved in cases before the PTAB; the PTAB does not sponsor or endorse any particular organization's alternative dispute resolution services. In addition, consideration may be given to utilizing independent alternative dispute resolution firms. Such firms may be located through a standard keyword Internet search.

CPR INSTITUTE FOR DISPUTE RESOLUTION	AMERICAN INTELLECTUAL PROPERTY LAW ASSOCIATION (AIPLA)	AMERICAN ARBITRATION ASSOCIATION (AAA)	WORLD INTELLECTUAL PROPERTY ORGANIZATION (WIPO)	AMERICAN BAR ASSOCIATION (ABA)
Telephone: (212) 949-6490	Telephone: (703) 415-0780	Telephone: (212) 484-3266	Telephone: 41 22 338 9111	Telephone : (202) 662-1000
Fax: (212) 949-8859	Fax: (703) 415-0786	Fax: (212) 307-4387	Fax: 41 22 733 5428	N/A
575 Lexington Ave	241 18th Street, South, Suite 700	140 West 51st Street	34, chemin des Colombettes	1050 Connecticut Ave, NW
New York, NY 10022	Arlington, VA 22202	New York, NY 10020	CH-1211 Geneva 20, Switzerland	Washington D.C. 20036
www.cpradr.org	www.aipla.org	www.adr.org	www.wipo.int	www.americanbar.org

If parties to an AIA trial proceeding consider using alternative dispute resolution, the PTAB would like to know whether the parties ultimately decided to engage in alternative dispute resolution and the reasons why or why not. If the parties actually engage in alternative dispute resolution, the PTAB would be interested to learn what mechanism (e.g., arbitration, mediation, etc.) was used and the general result. Such a statement from the parties is not required but would be helpful to the PTAB in assessing the value of alternative dispute resolution to parties involved in AIA trial proceedings. To report an experience with ADR, please forward a summary of the particulars to the following email address: PTAB_ADR_Comments@uspto.gov

AO 120 (Rev. 08/10)

TO:	**Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Delaware on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	9/13/2018	Delaware

PLAINTIFF	DEFENDANT
The NOCO Company, Inc.	Halo2 Cloud, LLC QVC, Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	9,007,015	4/24/2015	The NOCO Company, Inc.
2			
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
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In the above—entitled case, the following decision has been rendered or judgement issued:

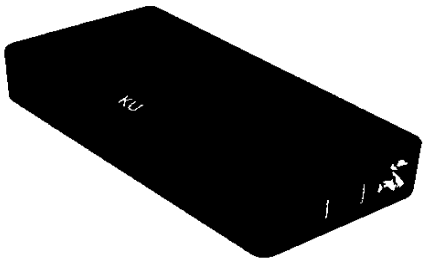
DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

CARKU™ 卡儿酷
SHENZHEN CARKU TECHNOLOGY CO.,LTD
Tel: 0086 755 23063587-877 E-mail: sales10@car-ku.com

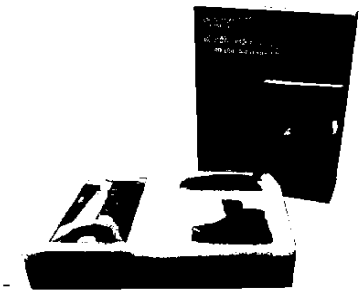
Model: E-Power-20B

Description of goods	Fast car charger	
Battery Capacity	37Wh(7500mAh)	
Dimension	155*74*31.5mm	
Weight	330g	
Output	5V/2A、5V/1A ---mobile phone, tablet PC, other digital devices 15V/10A ---car fast charge	
Input	14V/1A	
Operation Temp.	-20℃~60℃/-4℉~140℉	
Time to charge car battery	About 8minutes in fully discharge	

1pc Home charger	Input: AC/100V-240V ， Output: DC/14V1A
1pc Car charger	Input / Output: DC 15V10A
1pc User Manual	



3-in-1 Mobile Phone Cable	Micro USB, iPhone4, iPhone5	[redacted]

Individual Packing : EVA case+ Color box Size：26.5*19*6cm Whole set Weight: 1KG	
Carton	Size : 39.3*32*28cm, 0.07cbm/CTN
	Packing Rate: 10sets/CTN
	G.W.= 10 KG

AO 120 (Rev. 08/10)

TO:	**Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the Northern District of Ohio, Eastern Division on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
1:17-cv-02209	10/19/2017	for the Northern District of Ohio, Eastern Division

PLAINTIFF	DEFENDANT
The NOCO Company, Inc.	Shenzhen ChangXinYang Technology Co., Ltd.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	9,007,015	4/14/2015	The NOCO Company
2			
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

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Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 054985.000055PCT	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2014/045434	International filing date *(day/month/year)* 03 July 2014	(Earliest) Priority Date *(day/month/year)*
Applicant THE NOCO COMPANY		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the languagc of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

ADC EX1002
IPR2025-00885

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/045434

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H02J 7/00 (2014.01)
CPC - H02J7/0034 (2014.09)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B60R-016/03, B60R-016/04, F02N-11/08, H02J 7/00 (2014.01)
USPC -307/150, 320/105, 307/127, 340/636.1, 340/636.150, 361/82, 320/103

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - H02J7/0063, H02J7/0034, H02J 2001/006 (2014.09)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2005/0110467 A1 (THOMASON) 26 May 2005 (26.05.2005) entire document	1, 4-6,8-9, 12-18, 22, 25 --- 2, 3, 7, 10, 11, 19, 20, 21, 23, 24, 26
Y	WO 2013/137873 A1 (DAO) 19 September 2013 (19.09.2013) entire document	2-3, 10-11
Y	US 6362599 B1 (TURNER et al.) 26 March 2002 (26.03.2002) entire document	7, 19-20
Y	US 7148580 B2 (SODEMANN et al.) 12 December 2006 (12.12.2006) entire document	21,23,24,26
A	US 6803743 B2 (GEORGE et al.) 12 October 2004 (12.10.2004) entire document	1-26

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 October 2014	03 NOV 2014
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

P/00/016
Section 59, 104(4)

AUSTRALIA
Patents Act 1990

Statement of Grounds and Particulars

Name Brown & Watson International Pty Ltd
Address 1500 Ferntree Gully Road, Knoxfield, Victoria 3180

Address for service and correspondence in Australia is:

Phillips Ormonde Fitzpatrick
333 Collins Street
Melbourne Victoria 3000
Telephone No.: (03) 9614 1944 Facsimile No.: (03) 9614 1867

Reference: 2019201559

We provide the following information in support of the notice of opposition in relation to Patent Application No. 2019201559

The grounds and particulars of our opposition are as follows:

Lack of Novelty

1. The alleged invention so far as claimed in each of the said claims is not an invention within the meaning of section 18(1)(b)(i) of the *Patents Act 1990* (Cth) in that, so far as claimed in each claim, it was not novel when compared with the prior art base as it existed before the priority date of each claim.

Particulars

(a) United States Patent Publication US20040130298 in the name of Krieger et al (published 8 July 2004).

(b) International Patent Application WO2004036714 in the name of Vector Products, Inc (published 29 April 2004).

(c) United States Patent Publication US20070285049 in the name of Krieger et al (published 13 December 2007).

(d) United States Patent Publication US20130154543 in the name of Richardson et al (published 20 June 2013).

ADC EX1002
IPR2025-00885
This data, for application number 2019201559, is current as of 2020-05-25 21:00 AEST

(e) Australian Patent Application 2015258229 in the name of The NOCO Company (published 28 January 2016). This document forms part of the prior art base for at least claims 1 to 3 as those claims are not entitled to a priority date earlier than the filing date of the opposed application.

(f) The offering for sale and sale by ATD Tools, Inc of a product identified as the ATD 5900 Jump Starter prior to July 2014.

Lack of Inventive Step

2. The alleged invention is not an invention within the meaning of section 18(1)(b)(ii) of the *Patents Act 1990* (Cth) in that, so far as claimed in each claim, the Opposed Application did not involve an inventive step when compared with the prior art base as it existed before the priority date of each claim.

Particulars

(a) The Opponent will rely upon the common general knowledge as it existed in the patent area before the priority date of each claim. The common general knowledge included the following:

(i) A portable booster device or jump starter for jump-starting a vehicle having a depleted or discharged battery, including an internal power supply which can be connected in circuit with the vehicle's engine starter through a pair of cables.

(ii) It is undesirable for a jump starter to allow electrical connection between the internal power supply and the jumper cables if the cables are not connected to a vehicle battery.

(iii) It is undesirable for a jump starter to allow electrical connection between the internal power supply and the jumper cables if the polarity of the connection between cables and the vehicle battery is incorrect.

(iv) A jump starter can include a switch such as a relay or MOSFET switch which can switch the electrical connection between the internal power supply and the jumper cables on or off.

(v) A jump starter can include a microprocessor to receive input signals and to output information and control signals to provide information and control the status and operation of the jump starter.

(vi) A jump starter can include a means for determining whether the connector cables are connected to a vehicle battery and to send a signal to a microprocessor indicating the determined condition so that the microprocessor can prevent electrical connection between the internal power supply and the connector cables if the cables are not connected to a battery.

(vii) A jump starter can include a means for determining the polarity of a connection between the connector cables and the vehicle battery and to send a signal to a microprocessor indicating the determined polarity so that the microprocessor can prevent electrical connection between the internal power supply and the connector cables if the polarity of the connection between the cables and the vehicle battery is incorrect.

(viii) The jumper cables can be permanently connected to the jump starter or can be a separate component which is detachably connected to the jump starter via an electrical outlet.

(ix) The internal power supply of a jump starter may be in the form of a lithium ion battery.

(x) A jump starter can include a means for determining the operating temperature of one or more components of the device and sending a signal to the microprocessor indicating the determined temperature.

(xi) A jump starter can include one or more USB ports for charging the internal power supply and or providing power from the internal power supply to the USB port.

(xii) A jump starter can include a light powered by the internal power supply to provide illumination for a user of the device.

(xiii) A jump starter can include one or more visual indicators such as LED lights or an LCD display to convey information outputs from the microprocessor to a user of the device.

(xiv) The disclosure in each of the documents described in paragraphs 1(a) to 1(e) above, taken separately.

(xv) The information disclosed by the sale described in paragraph 1(f) above.

(b) As an alternative to paragraphs 2(a)(xiv) and 2(a)(xv), the Opponent will rely upon the common general knowledge as it existed in the patent area before the priority date of each claim, together with:

(i) Any single disclosure described in paragraphs 2(a)(xiv) and 2(a)(xv); or

(ii) the disclosure of a combination of the documents described in paragraphs 2(a)(xiv);

being information made publicly available before the priority date of the claim, and in the case of information mentioned in paragraphs 2(b)(ii), information that the skilled person would be reasonably expected to have combined.

Not a Manner of Manufacture

3. The alleged invention, so far as is claimed in each claim, is not a patentable invention within the meaning of section 18(1)(a) of the *Patents Act 1990* (Cth) in that it is not a manner of manufacture within the meaning of section 6 of the Statute of Monopolies.

Particulars

(a) The alleged invention consists of merely the use of known integers, (being, for example an internal battery, an output port, status sensors and a microcontroller), the known properties of which made them suitable for use and/or for combination.

Lack of Utility

4. The alleged invention, so far as is claimed in each claim, is not an invention within the meaning of section 18(1)(a) of the Patents Act 1990 (Cth) because it is not useful.

Particulars

(a) An objective of the alleged invention is to provide further improvements to vehicle jump start devices which address the problems identified in paragraph [0003] without the purported shortcomings of the prior art associated with complexity, cost or potential for malfunction. The specification provides no indication as to how the invention provides an apparatus which improves on the prior art with respect to complexity,

cost or potential for malfunction. There is no aspect of the invention as claimed which inherently provides an apparatus which improves on the prior art with respect to complexity, cost or potential for malfunction. Accordingly, the invention as claimed fails to meet the promise of the invention.

(b) It is an object of the invention to provide an apparatus which improves on the prior art with respect to potential for malfunction. The specification states that:

i. The apparatus can include a voltage measurement circuit to determine of the internal battery voltage is too low or too high and take action to prevent damage to electronic components;

ii. The apparatus can include temperature sensors to determine if the internal battery is too hot to allow jumpstarting, adding safety to the design;

iii. The apparatus can include back charge protection diodes so that if the car electrical system is charging from its alternator, it cannot back-charge (and thereby damage) the internal battery.

Claims 1 to 3 which do not include any of the above features fail to meet the promise of the invention with respect to making improvements to prevent malfunction of the apparatus.

Disclosure not Clear or Complete Enough, including Best Method

5. The complete specification of the Opposed Application does not comply with the requirements of sections 40(2)(a) and 40(2)(aa) of the *Patents Act 1990* (Cth) in that the complete specification does not disclose the invention in a manner which is clear enough and complete enough for the invention to be performed by a person skilled in the relevant art, and the complete specification does not disclose the best method known to the Applicant of performing the invention.

Particulars

(a) The apparatus of claims 1 to 3 define a reverse polarity sensor which provides an output signal indicating that the positive and negative polarity terminals of the vehicle battery are properly connected. The specification provides an example of a reverse polarity sensor which provides a signal indicating that the positive and negative polarity

terminals of the vehicle battery are improperly connected. However, the specification fails to provide a clear and complete disclosure of a reverse polarity sensor which provides an output signal which unambiguously indicates that the positive and negative polarity terminals of the vehicle battery are properly connected.

(b) The apparatus of claims 1 to 3 define a positive and negative polarity vehicle battery terminal connector. The specification fails to provide a clear and complete disclosure of a means for connecting the apparatus to a vehicle battery other than via an output port to which is connected the specific jumper cable device described in paragraph [0040] by reference to figure 4.

(c) The apparatus of claims 1 and 3 define a microcontroller which receives input signals from the sensors simultaneously. The specification fails to provide a clear and complete disclosure of the timing of receipt of input signals by the microcontroller whether simultaneous or otherwise.

(d) Claim 4 defines an apparatus according to claims 1 to 3 in which the isolation sensor is a separate isolation sensor. Claims 1 to 3 therefore encompass an apparatus in which the isolation sensor is not a separate isolation sensor. The specification fails to provide a clear and complete disclosure of an apparatus which does not have a separate isolation sensor.

(e) The specification does not include details of the best method of performing the invention known to the applicant at the filing date. The specification contains no information regarding the best method of performing the invention beyond those which where disclosed in WO2016003471 filed on 3 July 2014. The applicant has made statements indicating that the jump starter apparatus manufactured and sold by it have undergone numerous improvements after 3 July 2014, details of which are not included in the specification.

Lack of Clarity and Succinctness

6. The complete specification of the Opposed Application does not comply with the requirements of section 40(3) of the *Patents Act 1990* (Cth) in that the claims of the complete specification are not clear and succinct.

Particulars

(a) Claim 1 defines that the microcontroller is configured to provide a deactivating output signal in response to input signals from the sensors indicating the absence of a vehicle battery and/or an improper polarity connection. It is unclear how the microcontroller could receive input signals from the sensors indicating both the absence of a vehicle battery and an improper polarity connection.

(b) Claim 8 defines an apparatus which includes a single removable plug being connected to the positive and negative polarity cables. It is unclear from claims 8 or claims 1 to 3 what the positive and negative polarity cables are.

Lack of Support

7. The complete specification of the Opposed Application does not comply with the requirements of section 40(3) of the *Patents Act 1990* (Cth) in that the claims are not supported by the matter disclosed in the complete specification.

Particulars

(a) Claims 1 to 3 are not supported by the matter disclosed in the specification. The apparatus of claims 1 to 3 define a reverse polarity sensor which provides an output signal indicating that the positive and negative polarity terminals of the vehicle battery are properly connected. The specification provides an example of a reverse polarity sensor which provides a signal indicating that the positive and negative polarity terminals of the vehicle battery are improperly connected. However, the specification provides no support for a reverse polarity sensor which provides an output signal which unambiguously indicates that the positive and negative polarity terminals of the vehicle battery are properly connected.

(b) The apparatus of claims 1 to 3 define a positive and negative polarity vehicle battery terminal connector. The specification provides no support for a means for connecting the apparatus to a vehicle battery other than via an output port to which is connected the specific jumper cable device described in paragraph [0040] by reference to figure 4.

(c) The apparatus of claims 1 and 3 define a microcontroller which receives input signals from the sensors simultaneously. The specification

provides no support for a microcontroller having defined timing of receipt of input signals whether simultaneous or otherwise.

(d) Claim 4 defines an apparatus according to claims 1 to 3 in which the isolation sensor is a separate isolation sensor. Claims 1 to 3 therefore encompass an apparatus in which the isolation sensor is not a separate isolation sensor. The specification provides no support for an apparatus which does not have a separate isolation sensor.

Document ID e.g. D1, D2 etc	**Document Citation**	**Document accompanies the Statement**	**S 101 M only** The document has been provided in evidence	**Document is OPI***
	US20040130298	Y		
	WO2004036714	N		X
	US20070285049	Y		
	US20130154543	Y		
	AU2015258229	N		X

*a) If the document is an AU or WO patent that is OPI, place a cross in this column
b) If the document is already on the file of an OPI AU application, list the number of that application

Dated: 21 May 2020

PHILLIPS ORMONDE FITZPATRICK

Attorneys for:
Brown & Watson International Pty Ltd

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF OHIO
EASTERN DIVISION

THE NOCO CO., INC.,	)	**CASE NO.: 1:18-cv-02780-PAG**
	)	
Plaintiff	)	**JUDGE PATRICIA A. GAUGHAN**
	)	
-vs-	)	**Magistrate Judge Jonathan D. Greenberg**
	)	
	)	
SMARTECH PRODUCTS, INC., et al.,	)	
	)	
Defendants	)	
	)	

SMARTECH, INC.'S INVALIDITY AND UNENFORCEABILITY CONTENTIONS

In accordance with Local Patent Rule 3.5, the Court's Case Management Order and an agreed extension by the parties, Defendant SmarTech, Inc. ("SmarTech") submits its invalidity and unenforceability contentions. Generally, SmarTech identifies the following prior art patents and commercially available devices that renders the cited claims invalid:

Prior Art Patents

1. *Automotive Jump Starter with Polarity Detection and Current Routing Circuitry,* Lincoln Thomason, published May 2, 2005, Pub. No. US 2005/0110467 (SMARTECH 00025-00034) ("Thomason")
2. *Portable Power Supply,* Yuan Dao, published September 19, 2013, U.S. Pub. No. 2013/0241488 (SMARTECH 00035-00043) ("Dao")
3. *Method and Apparatus for Sensing Status of a Vehicle,* Steven Richard Turner, Kaushik Rajashekara, and Gary Andrew Cameron, March 26, 2002, Patent No. 6,362,599 (SMARTECH 00044-00061) ("Turner")

Prior Art Commercially Available Products

1. Bestek 2400A Peak Current Portable Car Jump Starter Power Bank with 1000mAh Capacity (SMARTECH 00062-00069)("Bestek")
2. HALO 7800 mAh Portable Charger for Cell Phones & Tablets (SMARTECH 00070-00071) ("HALO")
3. Schumacher Lithium Iron Jump Starter – SL1 Red Fuel (SMARTECH 00072-00073) ("Schumacher")
4. Other commercial devices that have been available or are available to the general public that will be identified through discovery and depositions.

How each piece of prior art relates to the alleged patent claims is addressed in the following chart:

Claim 1: An internal power supply; An output port having positive and negative polarity outputs; A vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs; A reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port; A power switch connected between said internal power supply and said output port; A microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 1 obvious pursuant to 35 U.S.C. § 103.
Claim 2: The apparatus of claim 1, wherein said internal power supply comprises a lithium ion battery.	Thomason and Dao when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 2 obvious pursuant to 35 U.S.C. § 103.
Claim 3: The apparatus of claim 2, wherein said lithium ion battery comprises a battery pack of multiple lithium ion	Thomason and Dao when combined with Bestek, Halo, Schumacher, and other devices commercially available on the

batteries.	market render claim 3 obvious pursuant to 35 U.S.C. § 103.
Claim 4: The apparatus of claim 1, wherein said power switch comprises a plurality of FET's in parallel.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 4 obvious pursuant to 35 U.S.C. § 103.
Claim 5: The apparatus of claim 1, wherein said vehicle isolation sensor and reverse polarity sensor comprise optically coupled isolator photo transistors.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 5 obvious pursuant to 35 U.S.C. § 103.
Claim 6: The apparatus of claim 1, further comprising a plurality of power diodes coupled between said output port and said internal power supply to prevent back-charging of said internal power supply from an electrical system connected to said output port.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 6 obvious pursuant to 35 U.S.C. § 103.
Claim 7: The apparatus of claim 1, further comprising a temperature sensor configured to detect temperature of said internal power supply and to provide a temperature signal to said microcontroller.	Thomason and Turner when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 7 obvious pursuant to 35 U.S.C. § 103.
Claim 8: The apparatus of claim 1, further comprising a voltage measurement circuit configured to measure output voltage of said internal power supply and to provide a voltage measurement signal to said microcontroller	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 8 obvious pursuant to 35 U.S.C. § 103.
Claim 9: The apparatus of claim 1, further comprising a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 9 obvious pursuant to 35 U.S.C. § 103.
Claim 10: The apparatus of claim 1, further comprising a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 10 obvious pursuant to 35 U.S.C. § 103.
Claim 12: The apparatus of claim 1, further comprising a	Thomason when combined with Bestek, Halo, Schumacher, and

flashlight circuit configured to provide a source of light to a user.	other devices commercially available on the market render claim 12 obvious pursuant to 35 U.S.C. § 103.
Claim 13: The apparatus of claim 12, wherein said source of light is at least one LED.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 13 obvious pursuant to 35 U.S.C. § 103.
Claim 14: The apparatus of claim 13, wherein said microcontroller is configured to control said at least one LED to provide a visual alarm indicating an emergency situation.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 14 obvious pursuant to 35 U.S.C. § 103.
Claim 15: The apparatus of claim 1, further comprising a plurality of visual indicators configured to display remaining capacity status of said internal power supply.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 15 obvious pursuant to 35 U.S.C. § 103.
Claim 17: The apparatus of claim 1, further comprising a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 17 obvious pursuant to 35 U.S.C. § 103.
Claim 18: The apparatus of claim 1, further comprising separate visual indicators configured to display the power on status of the apparatus and the jump start boost power status of power supplied to said output port.	Thomason when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 18 obvious pursuant to 35 U.S.C. § 103.
Claim 19: The apparatus of claim 1, further comprising a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect the presence of a vehicle battery.	Thomason and Turner when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 19 obvious pursuant to 35 U.S.C. § 103.
Claim 20: The apparatus of claim 19, wherein said microcontroller is configured to detect actuation of said manual override switch for at least a predetermined period of time before activation of said manual override mode.	Thomason and Turner when combined with Bestek, Halo, Schumacher, and other devices commercially available on the market render claim 20 obvious pursuant to 35 U.S.C. § 103.

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As discovery is ongoing and this case is just beginning, SmarTech reserves the right to amend or supplement its invalidity and unenforceability contentions. Further, in accordance with Rule 3.6, SmarTech produces copies of the prior art contemporaneously with these contentions.

Respectfully submitted,

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CERTIFICATE OF SERVICE

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(12) STANDARD PATENT APPLICATION (11) Application No. **AU 2016269555 A1**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Portable vehicle battery jump start apparatus with safety protection

(51) International Patent Classification(s)
H02J 7/14 (2006.01) ***H02J 1/00*** (2006.01)
B60R 16/00 (2006.01) ***H02J 7/00*** (2006.01)
B60R 16/03 (2006.01)

(21) Application No: **2016269555** (22) Date of Filing: **2016.12.09**

(43) Publication Date: **2017.01.05**
(43) Publication Journal Date: **2017.01.05**

(62) Divisional of:
2015258229

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ABSTRACT

A handheld device for jump starting a vehicle engine includes a rechargeable lithium ion battery pack (32) and a microcontroller (1). The lithium ion battery is coupled to a power output port of the device through a power switch circuit (15) actuated by the microcontroller. A vehicle battery isolation sensor (12) connected in circuit with positive and negative polarity outputs detects the presence of a vehicle battery (72) connected between the positive and negative polarity outputs. A reverse polarity sensor (10) connected in circuit with the positive and negative polarity outputs detects the polarity of a vehicle battery connected between the positive and negative polarity outputs, such that the microcontroller will enable power to be delivered from the lithium ion power pack to the output port only when a good battery is connected to the output port and only when the battery is connected with proper polarity of positive and negative terminals.

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PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

FIELD OF THE INVENTION

[0001] The present invention relates generally to apparatus for jump-starting a vehicle having a depleted or discharged battery.

BACKGROUND TO THE INVENTION

[0002] Prior art devices are known for jump-starting a vehicle, which provide either a pair of electrical connector cables that connect a fully-charged battery of another vehicle to the engine start circuit of the dead battery vehicle, or portable booster devices which include a fully-charged battery which can be connected in circuit with the vehicle's engine starter through a pair of cables.

[0003] Problems with the prior art arose when either the jumper terminals or clamps of the cables were inadvertently brought into contact with each other while the other ends were connected to a charged battery, or when the positive and negative terminals were connected to the opposite polarity terminals in the vehicle to be jumped, thereby causing a short circuit resulting in sparking and potential damage to batteries and/or bodily injury.

[0004] Various attempts to eliminate these problems have been made in the prior art. U.S. Patent No. 6,212,054 issued April 3, 2001, discloses a battery booster pack that is polarity sensitive and can detect proper and improper connections before providing a path for electric current flow. The device uses a set of LEDs connected to optical couplers oriented by a control circuit. The control circuit controls a solenoid assembly controlling the path of power current. The control circuit causes power current to flow through the solenoid assembly only if the points of contact of booster cable clamp connections have been properly made.

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[0005] U.S. Patent No. 6,632,103 issued October 14, 2003, discloses an adaptive booster cable connected with two pairs of clips, wherein the two pairs of clips are respectively attached to two batteries to transmit power from one battery to the other battery. The adaptive booster cable includes a polarity detecting unit connected to each clip, a switching unit and a current detecting unit both provided between the two pairs of clips. After the polarity of each clip is sensed by the polarity detecting unit, the switching unit generates a proper connection between the two batteries. Therefore, the positive and negative terminals of the two batteries are correctly connected based on the detected result of the polarity detecting unit.

[0006] U.S. Patent No. 8,493,021 issued July 23, 2013, discloses apparatus that monitors the voltage of the battery of a vehicle to be jump started and the current delivered by the jump starter batteries to determine if a proper connection has been established and to provide fault monitoring. Only if the proper polarity is detected can the system operate. The voltage is monitored to determine open circuit, disconnected conductive clamps, shunt cable fault, and solenoid fault conditions. The current through the shunt cable is monitored to determine if there is a battery explosion risk, and for excessive current conditions presenting an overheating condition, which may result in fire. The system includes an internal battery to provide the power to the battery of the vehicle to be jump started. Once the vehicle is started, the unit automatically electrically disconnects from the vehicle's battery.

[0007] U.S. Patent No. 5,189,359 issued February 23, 1993, discloses a jumper cable device having two bridge rectifiers for developing a reference voltage, a four-input decoder for determining which terminals are to be connected based on a comparison of the voltage at each of the four terminals to the reference voltage, and a pair of relays for effecting the correct connection depending on the determination of the decoder. No connection will be made unless only one terminal of each battery has a higher voltage than the reference voltage, indicating "positive" terminals, and one has a lower voltage than the reference voltage, indicating "negative" terminals, and that, therefore, the two

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high voltage terminals may be connected and the two lower voltage terminals may be connected. Current flows once the appropriate relay device is closed. The relay device is preferably a MOSFET combined with a series array of photodiodes that develop MOSFET gate-closing potential when the decoder output causes an LED to light.

[0008] U.S. Patent No. 5,795,182 issued August 18, 1998, discloses a polarity independent set of battery jumper cables for jumping a first battery to a second battery. The apparatus includes a relative polarity detector for detecting whether two batteries are configured cross or parallel. A three-position high current capacity crossbar pivot switch is responsive to the relative polarity detector for automatically connecting the plus terminals of the two batteries together and the minus terminals of the two batteries together regardless of whether the configuration detected is cross or parallel, and an undercurrent detector and a delay circuit for returning the device to its ready and unconnected state after the device has been disconnected from one of the batteries. The crossbar pivot switch includes two pairs of contacts, and a pivot arm that pivots about two separate points to ensure full electrical contact between the pairs of contacts. The invention can also be used to produce a battery charger that may be connected to a battery without regard to the polarity of the battery.

[0009] U.S. Patent No. 6,262,492 issued July 17, 2001, discloses a car battery jumper cable for accurately coupling an effective power source to a failed or not charged battery, which includes a relay switching circuit connected to the power source and the battery by two current conductor pairs. First and second voltage polarity recognition circuits are respectively connected to the power source and the battery by a respective voltage conductor pair to recognize the polarity of the power source and the battery. A logic recognition circuit produces a control signal subject to the polarity of the power source and the battery, and a driving circuit controlled by the control signal from the logic recognition circuit drives the relay switching circuit, enabling the two poles of the power source to be accurately coupled to the two poles of the battery.

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[0010] U.S. Patent No. 5,635,817 issued June 3, 1997, discloses a vehicle battery charging device that includes a control housing having cables including a current limiting device to prevent exceeding of a predetermined maximum charging current of about 40 to 60 amps. The control housing includes a polarity detecting device to verify the correct polarity of the connection of the terminals of the two batteries and to electrically disconnect the two batteries if there is an incorrect polarity.

[0011] U.S. Patent No. 8,199,024 issued June 12, 2012, discloses a safety circuit in a low-voltage connecting system that leaves the two low-voltage systems disconnected until it determines that it is safe to make a connection. When the safety circuit determines that no unsafe conditions exist and that it is safe to connect the two low-voltage systems, the safety circuit may connect the two systems by way of a "soft start" that provides a connection between the two systems over a period of time that reduces or prevents inductive voltage spikes on one or more of the low-voltage systems. When one of the low-voltage systems has a completely-discharged battery incorporated into it, a method is used for detection of proper polarity of the connections between the low-voltage systems. The polarity of the discharged battery is determined by passing one or more test currents through it and determining whether a corresponding voltage rise is observed.

[0012] U.S. Patent No. 5,793,185 issued August 11, 1998, discloses a hand-held jump starter having control components and circuits to prevent overcharging and incorrect connection to batteries.

[0013] While the prior art attempted solutions to the abovementioned problems as discussed above, each of the prior art solutions suffers from other shortcomings, either in complexity, cost or potential for malfunction. Accordingly, there exists a need in the art for further improvements to vehicle jump start devices.

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SUMMARY OF THE INVENTION

[0014] In accordance with an aspect of the invention, an apparatus is provided for jump starting a vehicle engine, comprising: an internal power supply; an output port having positive and negative polarity outputs; a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs; a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port; a power switch connected between said internal power supply and said output port; and a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

[0015] In accordance with an embodiment of the invention, the internal power supply is a rechargeable lithium ion battery pack.

[0016] A jumper cable device may also be provided, having a plug configured to plug into said output port; a pair of cables integrated with the plug at one respective end thereof; said pair of cables being configured to be separately connected to terminals of a battery at another respective end thereof.

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[0017] Comprises/comprising and grammatical variations thereof when used in this specification are to be taken to specify the presence of stated features, integers, steps or components or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Fig. 1 is a functional block diagram of a handheld vehicle battery boost apparatus in accordance with one aspect of the present invention;

[0019] Figs. 2A – 2C are schematic circuit diagrams of an example embodiment of a handheld vehicle battery boost apparatus in accordance with an aspect of the invention;

[0020] Fig. 3 is a perspective view of a handheld jump starter booster device in accordance with one example embodiment of the invention; and

[0021] Fig. 4 is a plan view of a jumper cable usable with the handheld jump starter booster device in accordance with another aspect of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] FIG. 1 is a functional block diagram of a handheld battery booster according to one aspect of the invention. At the heart of the handheld battery booster is a lithium polymer battery pack 32, which stores sufficient energy to jump start a vehicle engine served by a conventional 12 volt lead-acid or valve regulated lead-acid battery. In one example embodiment, a high-surge lithium polymer battery pack includes three 3.7V, 2666 mAh lithium polymer batteries in a 3S1P configuration. The resulting battery pack provides 11.1V, 2666Ah (8000Ah at 3.7V, 29.6Wh). Continuous discharge current is 25C (or 200 amps), and burst discharge current is 50C (or 400 amps). The maximum charging current of the battery pack is 8000mA (8 amps).

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[0023] A programmable microcontroller unit (MCU) 1 receives various inputs and produces informational as well as control outputs. The programmable MCU 1 further provides flexibility to the system by allowing updates in functionality and system parameters, without requiring any change in hardware. According to one example embodiment, an 8 bit microcontroller with 2K x 15 bits of flash memory is used to control the system. One such microcontroller is the HT67F30, which is commercially available from Holtek Semiconductor Inc.

[0024] A car battery reverse sensor 10 monitors the polarity of the vehicle battery 72 when the handheld battery booster device is connected to the vehicle's electric system. As explained below, the booster device prevents the lithium battery pack from being connected to the vehicle battery 72 when the terminals of the battery 72 are connected to the wrong terminals of the booster device. A car battery isolation sensor 12 detects whether or not a vehicle battery 72 is connected to the booster device, and prevents the lithium battery pack from being connected to the output terminals of the booster device unless there is a good (e.g. chargeable) battery connected to the output terminals.

[0025] A smart switch FET circuit 15 electrically switches the handheld battery booster lithium battery to the vehicle's electric system only when the vehicle battery is determined by the MCU 1 to be present (in response to a detection signal provided by isolation sensor 12) and connected with the correct polarity (in response to a detection signal provided by reverse sensor 10). A lithium battery temperature sensor 20 monitors the temperature of the lithium battery pack 32 to detect overheating due to high ambient temperature conditions and overextended current draw during jump starting. A lithium battery voltage measurement circuit 24 monitors the voltage of the lithium battery pack 32 to prevent the voltage potential from rising too high during a charging operation and from dropping too low during a discharge operation.

[0026] Lithium battery back-charge protection diodes 28 prevent any charge current being delivered to the vehicle battery 72 from flowing back to the lithium battery pack 32 from the vehicle's electrical system. Flashlight LED circuit 36 is

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provided to furnish a flashlight function for enhancing light under a vehicle's hood in dark conditions, as well as providing SOS and strobe lighting functions for safety purposes when a vehicle may be disabled in a potentially dangerous location. Voltage regulator 42 provides regulation of internal operating voltage for the microcontroller and sensors. On/Off manual mode and flashlight switches 46 allow the user to control power-on for the handheld battery booster device, to control manual override operation if the vehicle has no battery, and to control the flashlight function. The manual button functions only when the booster device is powered on. This button allows the user to jump-start vehicles that have either a missing battery, or the battery voltage is so low that automatic detection by the MCU is not possible. When the user presses and holds the manual override button for a predetermined period time (such as three seconds) to prevent inadvertent actuation of the manual mode, the internal lithium ion battery power is switched to the vehicle battery connect port. The only exception to the manual override is if the car battery is connected in reverse. If the car battery is connected in reverse, the internal lithium battery power shall never be switched to the vehicle battery connect port.

[0027] USB charge circuit 52 converts power from any USB charger power source, to charge voltage and current for charging the lithium battery pack 32. USB output 56 provides a USB portable charger for charging smartphones, tablets, and other rechargeable electronic devices. Operation indicator LEDs 60 provide visual indication of lithium battery capacity status as well as an indication of smart switch activation status (indicating that power is being provided to the vehicle's electrical system).

[0028] Detailed operation of the handheld booster device will now be described with reference to the schematic diagrams of Figs. 2A-2C. As shown in Fig. 2A, the microcontroller unit 1 is the center of all inputs and outputs. The reverse battery sensor 10 comprises an optically coupled isolator phototransistor (4N27) connected to the terminals of vehicle battery 72 at input pins 1 and 2 with a diode D8 in the lead conductor of pin 1 (associated with the negative terminal CB-), such that if the battery 72 is connected to the terminals of the booster

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device with the correct polarity, the optocoupler LED 11 will not conduct current, and is therefore turned off, providing a "1" or high output signal to the MCU 1. The car battery isolation sensor 12 comprises an optically coupled isolator phototransistor (4N27) connected to the terminals of vehicle battery 72 at input pins 1 and 2 with a diode D7 in the lead conductor of pin 1 (associated with the positive terminal CB+), such that if the battery 72 is connected to the terminals of the booster device with the correct polarity, the optocoupler LED 11A will conduct current, and is therefore turned on, providing a "0" or low output signal to the MCU, indicating the presence of a battery across the jumper output terminals of the handheld booster device.

[0029] If the car battery 72 is connected to the handheld booster device with reverse polarity, the optocoupler LED 11 of the reverse sensor 10 will conduct current, providing a "0" or low signal to microcontroller unit 1. Further, if no battery is connected to the handheld booster device, the optocoupler LED 11A of the isolation sensor 12 will not conduct current, and is therefore turned off, providing a "1" or high output signal to the MCU, indicating the absence of any battery connected to the handheld booster device. Using these specific inputs, the microcontroller software of MCU 1 can determine when it is safe to turn on the smart switch FET 15, thereby connecting the lithium battery pack to the jumper terminals of the booster device. Consequently, if the car battery 72 either is not connected to the booster device at all, or is connected with reverse polarity, the MCU 1 can keep the smart switch FET 15 from being turned on, thus prevent sparking/short circuiting of the lithium battery pack.

[0030] As shown in Fig. 2B, the FET smart switch 15 is driven by an output of the microcontroller 1. The FET smart switch 15 includes three FETs (Q15, Q18, and Q19) in parallel, which spreads the distribution of power from the lithium battery pack over the FETs. When that microcontroller output is driven to a logic low, FETs 16 are all in a high resistance state, therefore not allowing current to flow from the internal lithium battery negative contact 17 to the car battery 72 negative contact. When the microcontroller output is driven to a logic high, the FETs 16 (Q15, Q18, and Q19) are in a low resistant state, allowing current to flow

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freely from the internal lithium battery pack negative contact 17 (LB-) to the car battery 72 negative contact (CB-). In this way, the microcontroller software controls the connection of the internal lithium battery pack 32 to the vehicle battery 72 for jumpstarting the car engine.

[0031] Referring back to Fig. 2A, the internal lithium battery pack voltage can be accurately measured using circuit 24 and one of the analog-to-digital inputs of the microcontroller 1. Circuit 24 is designed to sense when the main 3.3V regulator 42 voltage is on, and to turn on transistor 23 when the voltage of regulator 42 is on. When transistor 23 is conducting, it turns on FET 22, thereby providing positive contact (LB+) of the internal lithium battery a conductive path to voltage divider 21 allowing a lower voltage range to be brought to the microcontroller to be read. Using this input, the microcontroller software can determine if the lithium battery voltage is too low during discharge operation or too high during charge operation, and take appropriate action to prevent damage to electronic components.

[0032] Still referring to Fig. 2A, the temperature of the internal lithium battery pack 32 can be accurately measured by two negative temperature coefficient (NTC) devices 20. These are devices that reduce their resistance when their temperature rises. The circuit is a voltage divider that brings the result to two analog-to-digital (A/D) inputs on the microcontroller 1. The microcontroller software can then determine when the internal lithium battery is too hot to allow jumpstarting, adding safety to the design.

[0033] The main voltage regulator circuit 42 is designed to convert internal lithium battery voltage to a regulated 3.3 volts that is utilized by the microcontroller 1 as well as by other components of the booster device for internal operating power. Three lithium battery back charge protection diodes 28 (see Fig. 2B) are in place to allow current to flow only from the internal lithium battery pack 32 to the car battery 72, and not from the car battery to the internal lithium battery. In this way, if the car electrical system is charging from its alternator, it

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cannot back-charge (and thereby damage) the internal lithium battery, providing another level of safety.

[0034] The main power on switch 46 (Fig. 2A) is a combination that allows for double pole, double throw operation so that with one push, the product can be turned on if it is in the off state, or turned off if it is in the on state. This circuit also uses a microcontroller output 47 to "keep alive" the power when it is activated by the on switch. When the switch is pressed the microcontroller turns this output to a high logic level to keep power on when the switch is released. In this way, the microcontroller maintains control of when the power is turned off when the on/off switch is activated again or when the lithium battery voltage is getting too low. The microcontroller software also includes a timer that turns the power off after a predefined period of time, (such as, e.g. 8 hours) if not used.

[0035] The flashlight LED circuit 45 shown in Fig. 2B controls the operation of flashlight LEDs. Two outputs from the microcontroller 1 are dedicated to two separate LEDs. Thus, the LEDs can be independently software-controlled for strobe and SOS patterns, providing yet another safety feature to the booster device. LED indicators provide the feedback the operator needs to understand what is happening with the product. Four separate LEDs 61 (Fig. 2A) are controlled by corresponding individual outputs of microcontroller 1 to provide indication of the remaining capacity of the internal lithium battery. These LEDs are controlled in a "fuel gauge" type format with 25%, 50%, 75% and 100% (red, red, yellow, green) capacity indications. An LED indicator 63 (Fig. 2B) provides a visual warning to the user when the vehicle battery 72 has been connected in reverse polarity. "Boost" and on/off LEDs 62 provide visual indications when the booster device is provide jump-start power, and when the booster device is turned on, respectively.

[0036] A USB output 56 circuit (Fig. 2C) is included to provide a USB output for charging portable electronic devices such as smartphones from the internal lithium battery pack 32. Control circuit 57 from the microcontroller 1 allows the USB Out 56 to be turned on and off by software control to prevent the internal

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lithium battery getting too low in capacity. The USB output is brought to the outside of the device on a standard USB connector 58, which includes the standard voltage divider required for enabling charge to certain smartphones that require it.

[0037] The USB charge circuit 52 allows the internal lithium battery pack 32 to be charged using a standard USB charger. This charge input uses a standard micro-USB connector 48 allowing standard cables to be used. The 5V potential provided from standard USB chargers is up-converted to the 12.4VDC voltage required for charging the internal lithium battery pack using a DC-DC converter 49. The DC-DC converter 49 can be turned on and off via circuit 53 by an output from the microcontroller 1.

[0038] In this way, the microcontroller software can turn the charge off if the battery voltage is measured to be too high by the A/D input 22. Additional safety is provided for helping to eliminate overcharge to the internal lithium battery using a lithium battery charge controller 50 that provides charge balance to the internal lithium battery cells 51. This controller also provides safety redundancy for eliminating over discharge of the internal lithium battery.

[0039] Fig. 3 is a perspective view of a handheld device 300 in accordance with an exemplary embodiment of the invention. 301 is a power on switch. 302 shows the LED "fuel gauge" indicators 61. 303 shows a 12 volt output port connectable to a cable device 400, described further below. 304 shows a flashlight control switch for activating flashlight LEDs 45. 305 is a USB input port for charging the internal lithium battery, and 306 is a USB output port for providing charge from the lithium battery to other portable devices such as smartphones, tablets, music players, etc. 307 is a "boost on" indicator showing that power is being provided to the 12V output port. 308 is a "reverse" indicator showing that the vehicle battery is improperly connected with respect to polarity. 309 is a "power on" indicator showing that the device is powered up for operation.

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[0040] Fig. 4 shows a jumper cable device 400 specifically designed for use with the handheld device 300. Device 400 has a plug 401 configured to plug into 12 volt output port 303 of the handheld device 300. A pair of cables 402a and 402b are integrated with the plug 401, and are respectively connected to battery terminal clamps 403a and 403b via ring terminals 404a and 404b. The port 303 and plug 401 may be dimensioned so that the plug 401 will only fit into the port 303 in a specific orientation, thus ensuring that clamp 403a will correspond to positive polarity, and clamp 403b will correspond to negative polarity, as indicated thereon. Additionally, the ring terminals 404a and 404b may be disconnected from the clamps and connected directly to the terminals of a vehicle battery. This feature may be useful, for example, to permanently attach the cables 302a-302b to the battery of a vehicle. In the event that the battery voltage becomes depleted, the handheld booster device 300 could be properly connected to the battery very simply by plugging in the plug 401 to the port 303.

[0041] The invention having been thus described, it will be apparent to those skilled in the art that the same may be varied in many ways without departing from the spirit or scope of the invention. Any and all such variations are intended to be encompassed within the scope of the following claims.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Apparatus for jump starting a vehicle engine, comprising:

an internal power supply;

an output port having positive and negative polarity outputs;

a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs;

a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port;

a power switch connected between said internal power supply and said output port; and

a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

2. The apparatus of claim 1, wherein said internal power supply comprises a lithium ion battery.

3. The apparatus of claim 2, wherein said lithium ion battery comprises a battery pack of multiple lithium ion batteries.

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4. The apparatus of claim 1, wherein said power switch comprises a plurality of FETs in parallel.

5. The apparatus of claim 1, wherein said vehicle isolation sensor and reverse polarity sensor comprise optically coupled isolator phototransistors.

6. The apparatus of claim 1, further comprising a plurality of power diodes coupled between said output port and said internal power supply to prevent back-charging of said internal power supply from an electrical system connected to said output port.

7. The apparatus of claim 1, further comprising a temperature sensor configured to detect temperature of said internal power supply and to provide a temperature signal to said microcontroller.

8. The apparatus of claim 1, further comprising a voltage measurement circuit configured to measure output voltage of said internal power supply and to provide a voltage measurement signal to said microcontroller.

9. The apparatus of claim 1, further comprising a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus.

10. The apparatus of claim 1, further comprising a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device.

11. The apparatus of claim 1, further comprising a USB charging port configured to provide charging power from an external power source to said internal power supply.

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12. The apparatus of claim 1, further comprising a flashlight circuit configured to provide a source of light to a user.

13. The apparatus of claim 12, wherein said source of light is at least one LED.

14. The apparatus of claim 13, wherein said microcontroller is configured to control said at least one LED to provide a visual alarm indicating an emergency situation.

15. The apparatus of claim 1, further comprising a plurality of visual indicators configured to display remaining capacity status of said internal power supply.

16. The apparatus of claim 15, wherein said plurality of visual indicators comprises a plurality of LEDs providing output light of different colors.

17. The apparatus of claim 1, further comprising a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity.

18. The apparatus of claim 1, further comprising separate visual indicators configured to display the power on status of the apparatus, and the jump start boost power status of power supplied to said output port.

19. The apparatus of claim 1, further comprising a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect presence of a vehicle battery.

20. The apparatus of claim 19, wherein said microcontroller is configured to detect actuation of said manual override switch for at least a predetermined period of time before activation of said manual override mode.

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21. The apparatus of claim 1, further comprising a jumper cable device including a plug configured to plug into said output port, a pair of cables integrated with the plug at one respective end thereof and being configured to be connected to terminals of a battery at another respective end thereof.

22. The apparatus of claim 21, wherein said jumper cable device further comprises a pair of ring terminals configured to respectively connect said pair of cables at said another end thereof with one of a battery terminal and a battery terminal clamp.

23. The apparatus of claim 21, wherein said output port and said plug are dimensioned so that the plug will fit into the output port only in one specific orientation.

THE NOCO COMPANY

WATERMARK PATENT AND TRADE MARKS ATTORNEYS

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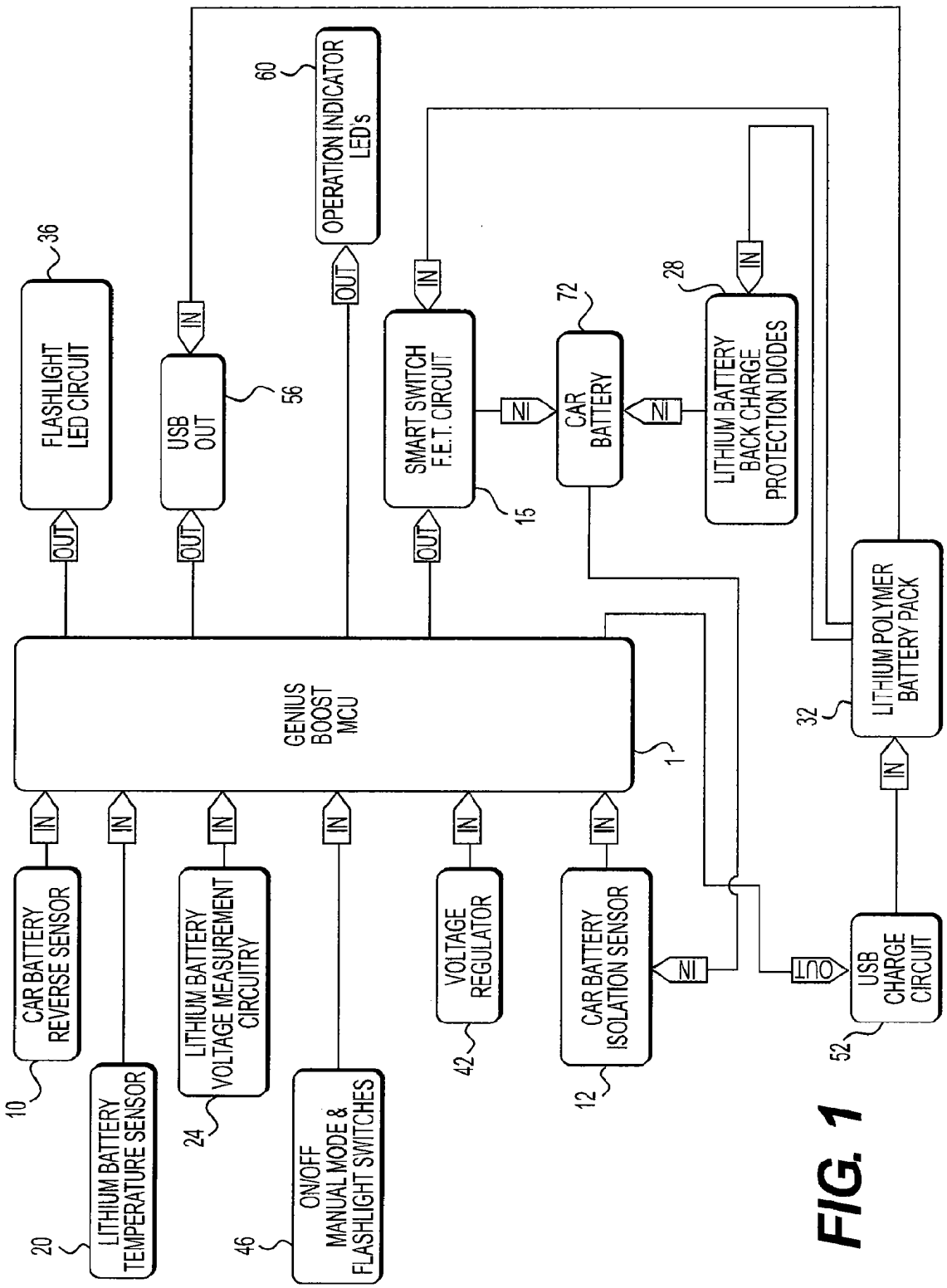


FIG. 1

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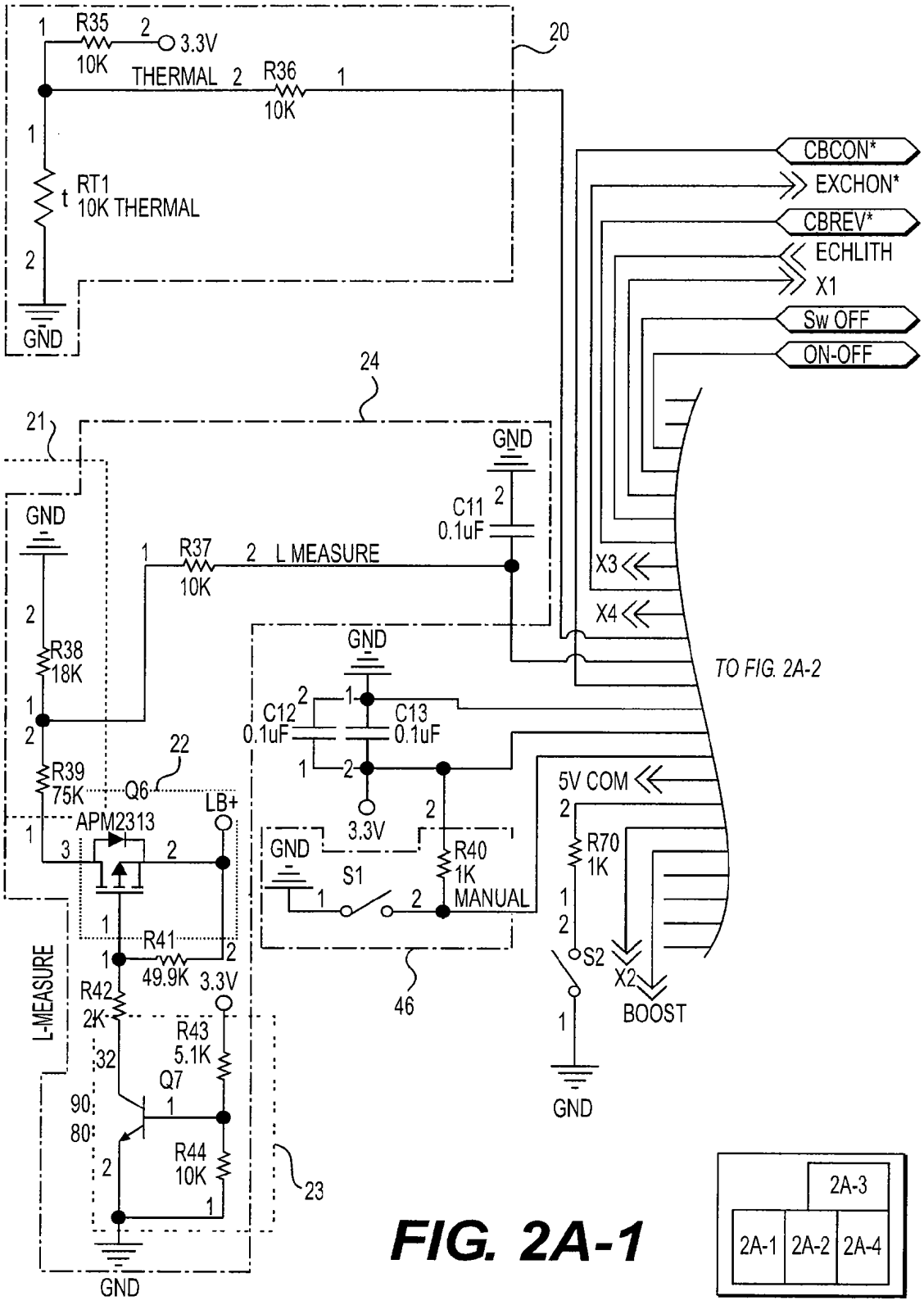
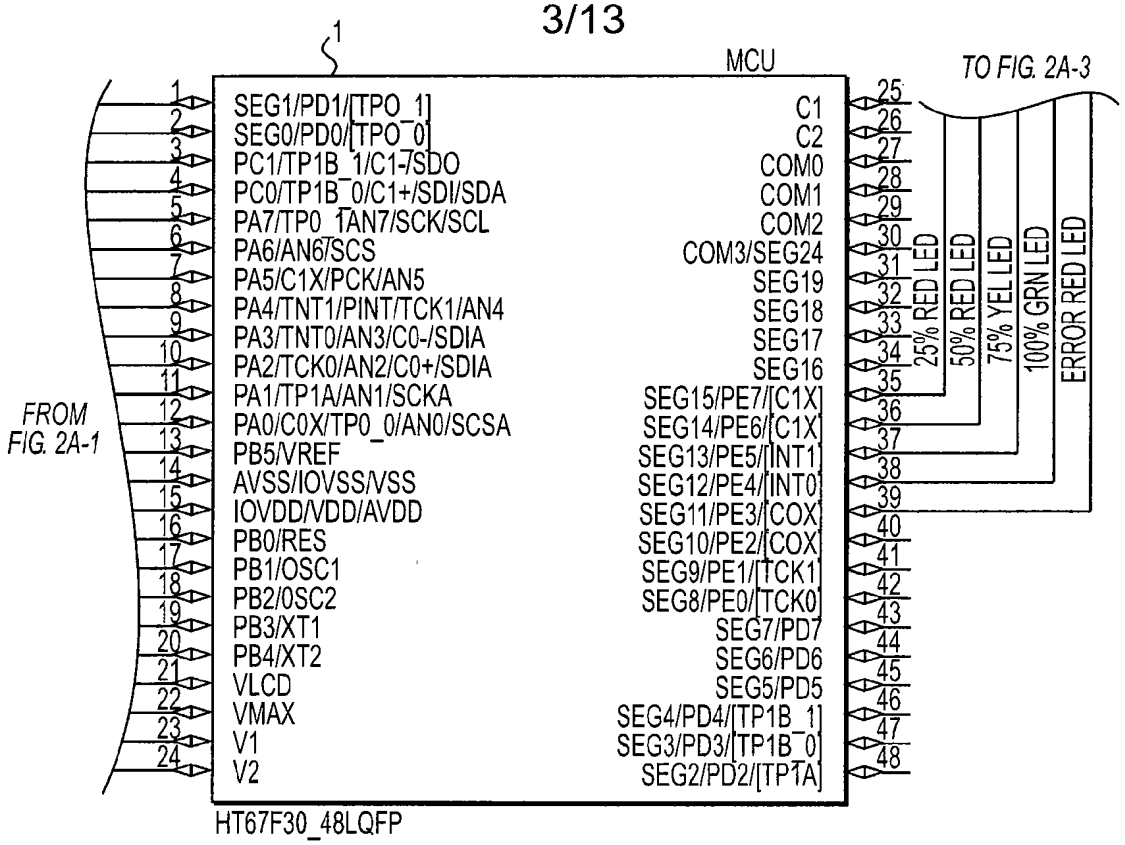
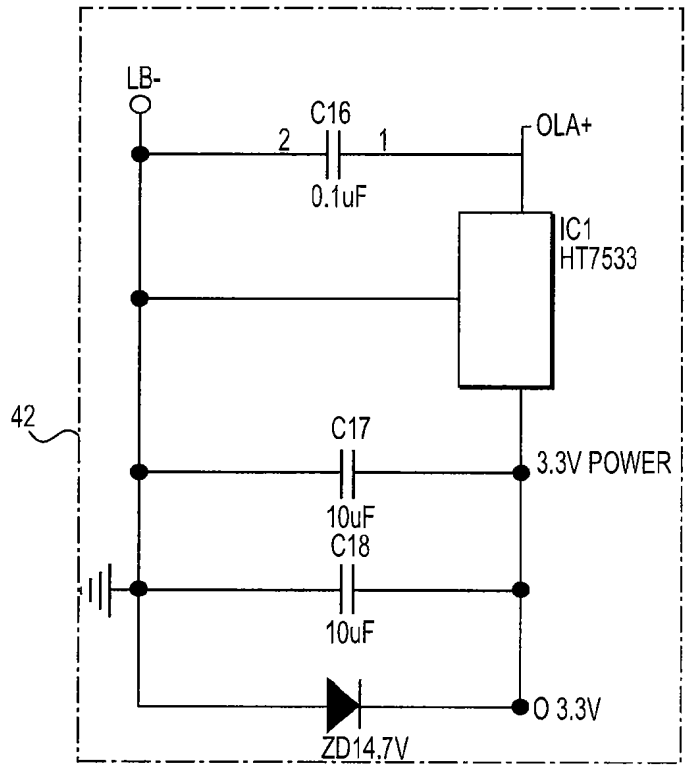


FIG. 2A-1

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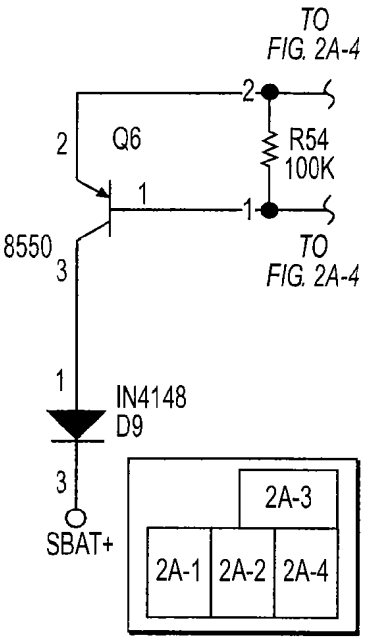


FIG. 2A-2

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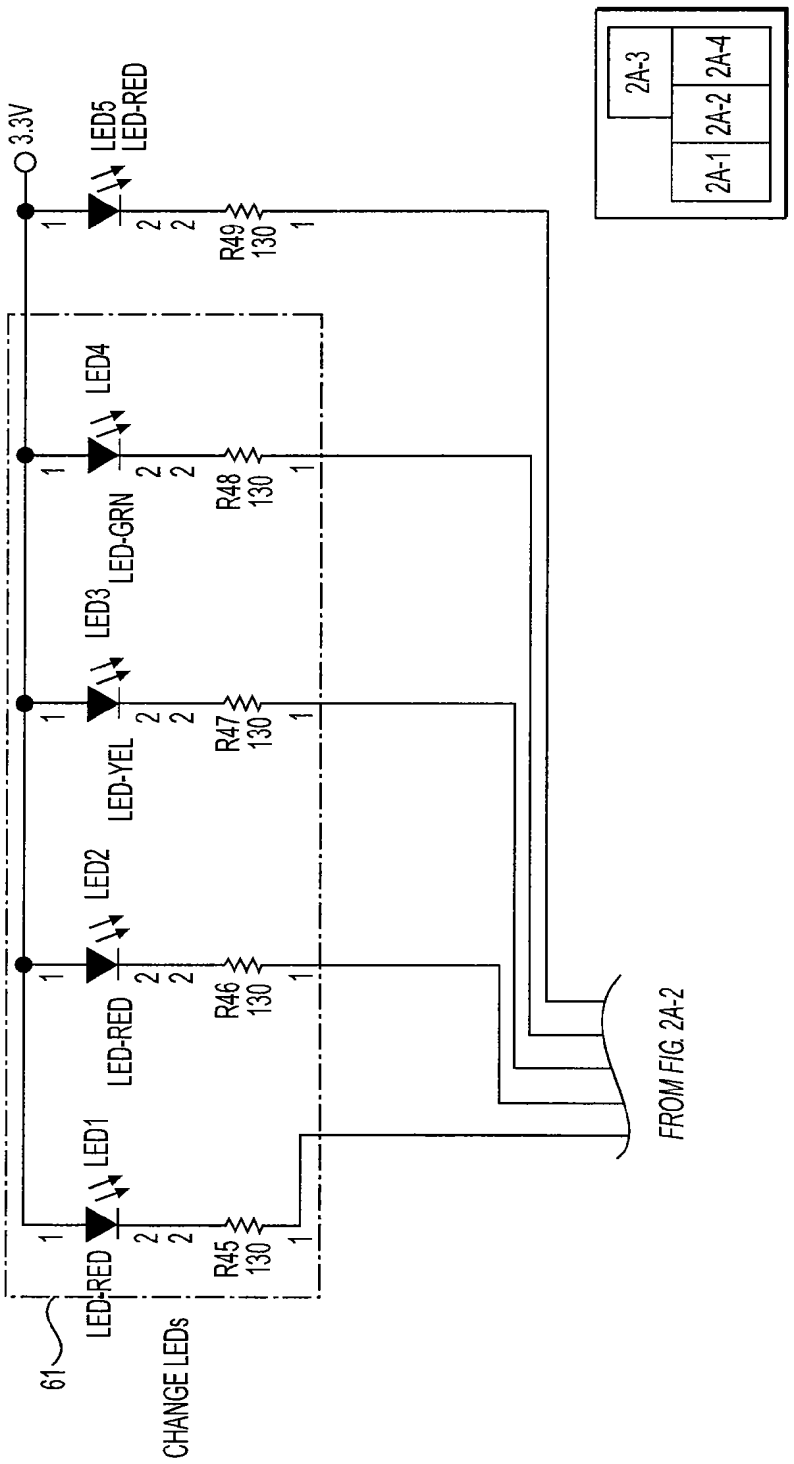


FIG. 2A-3

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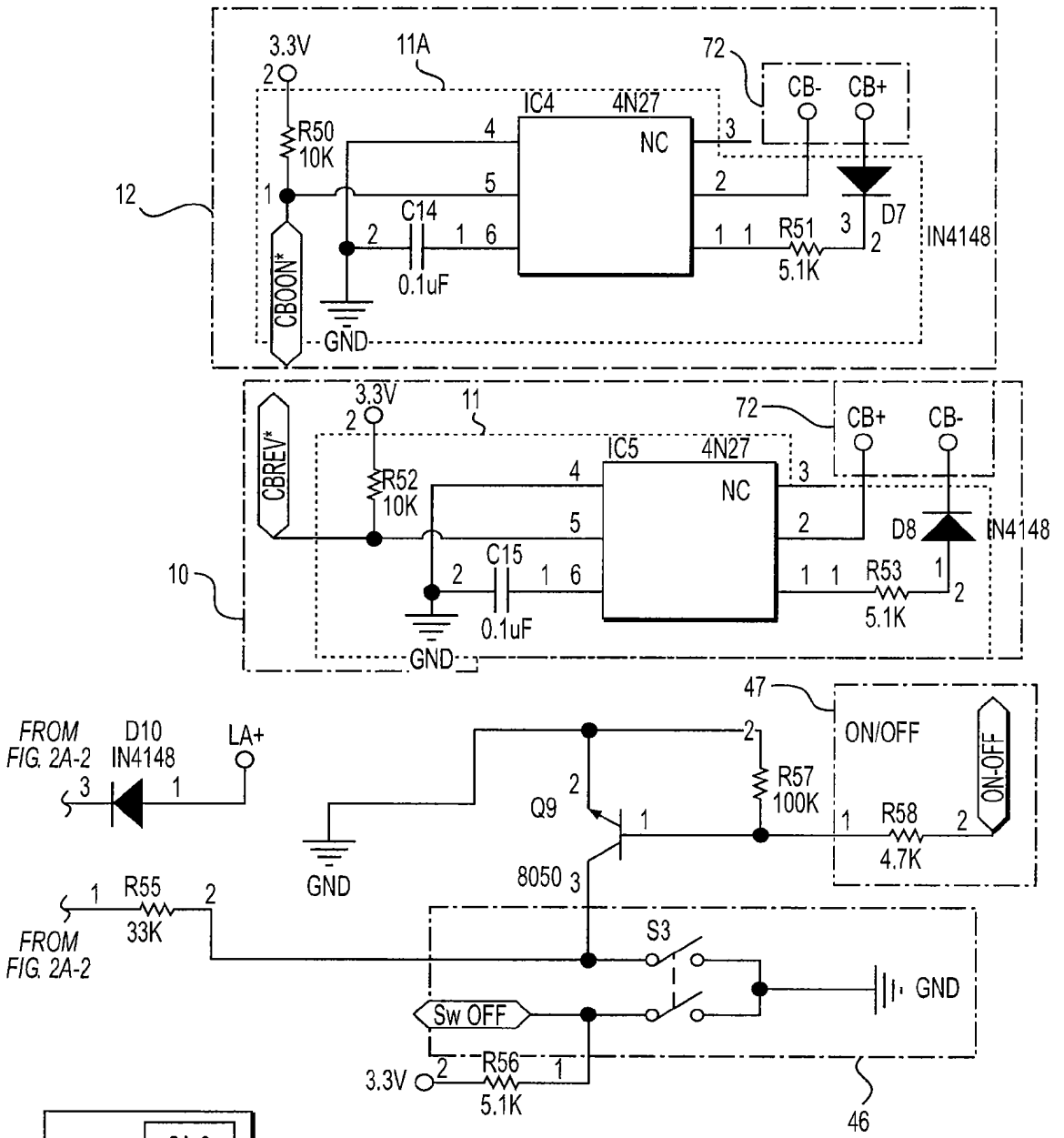


FIG. 2A-4

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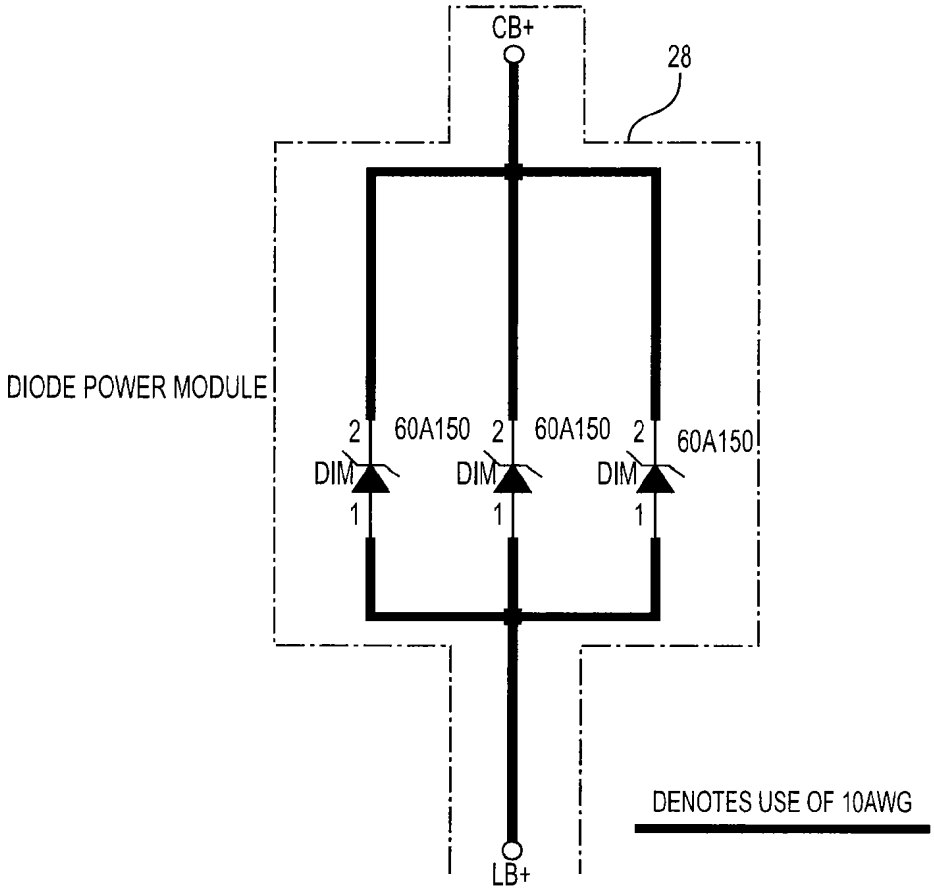
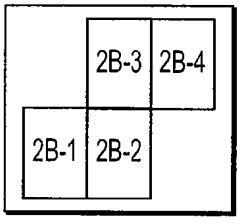


FIG. 2B-1



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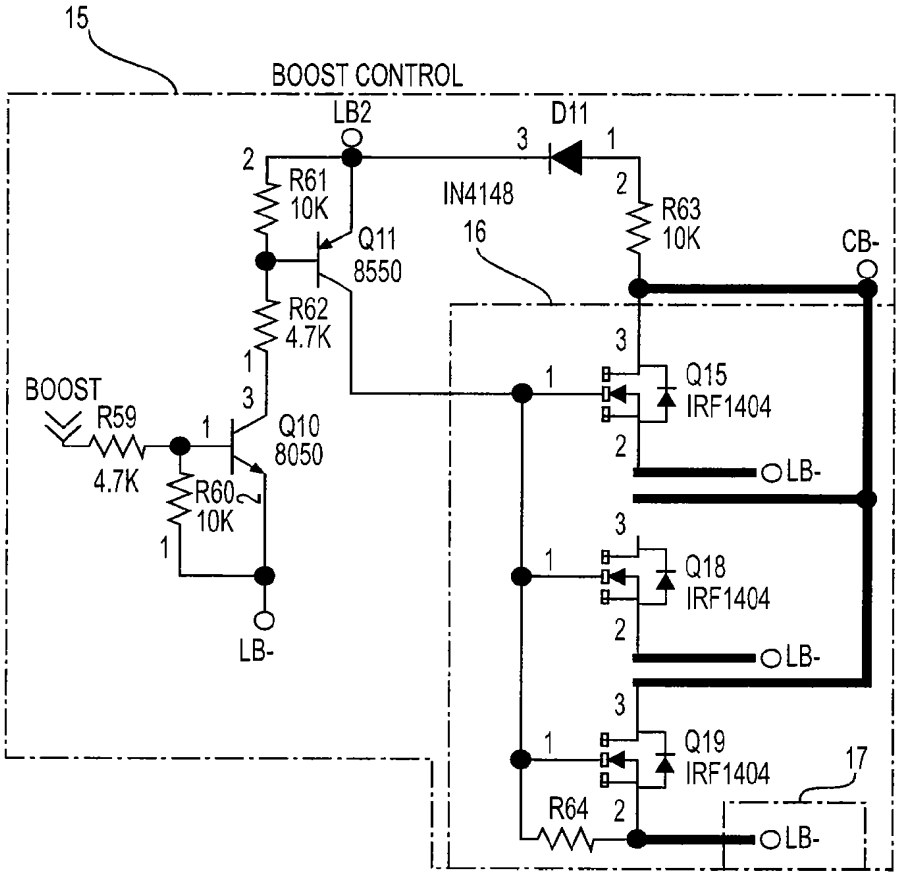
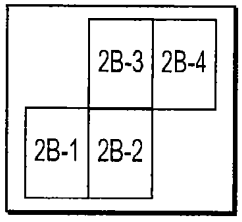


FIG. 2B-2



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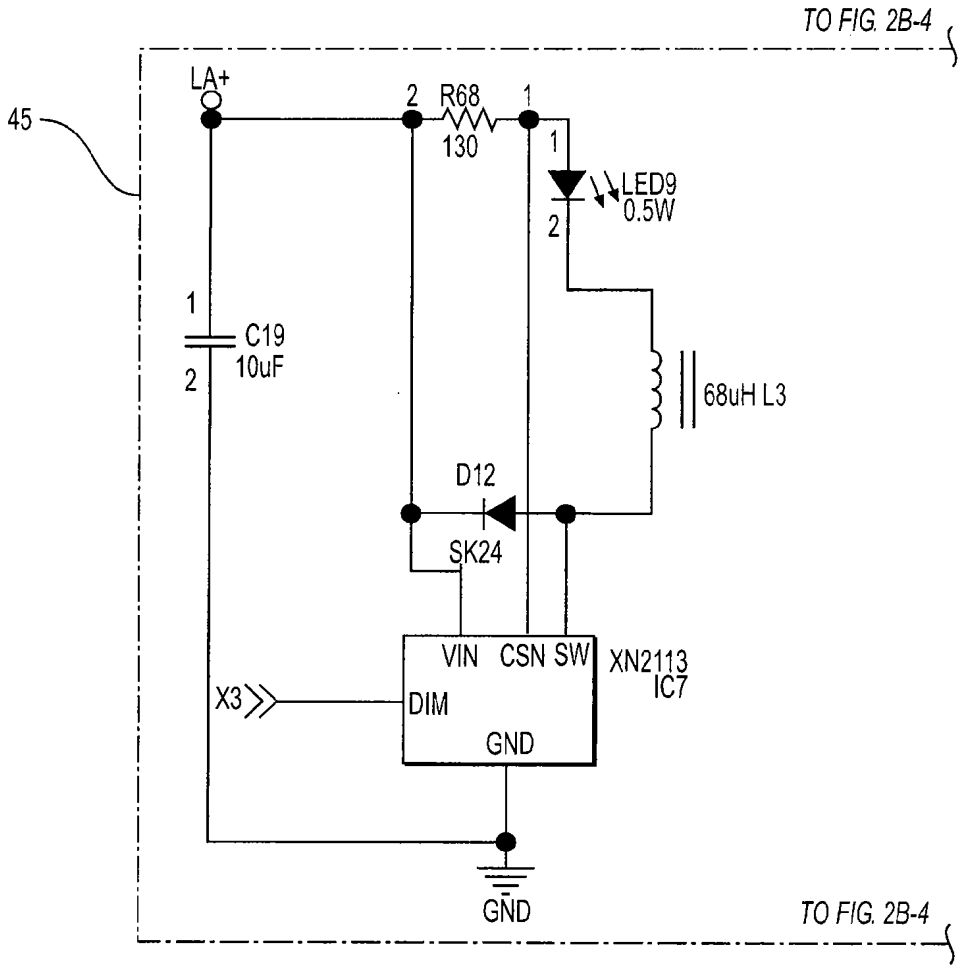
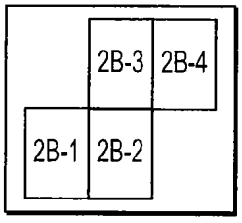


FIG. 2B-3



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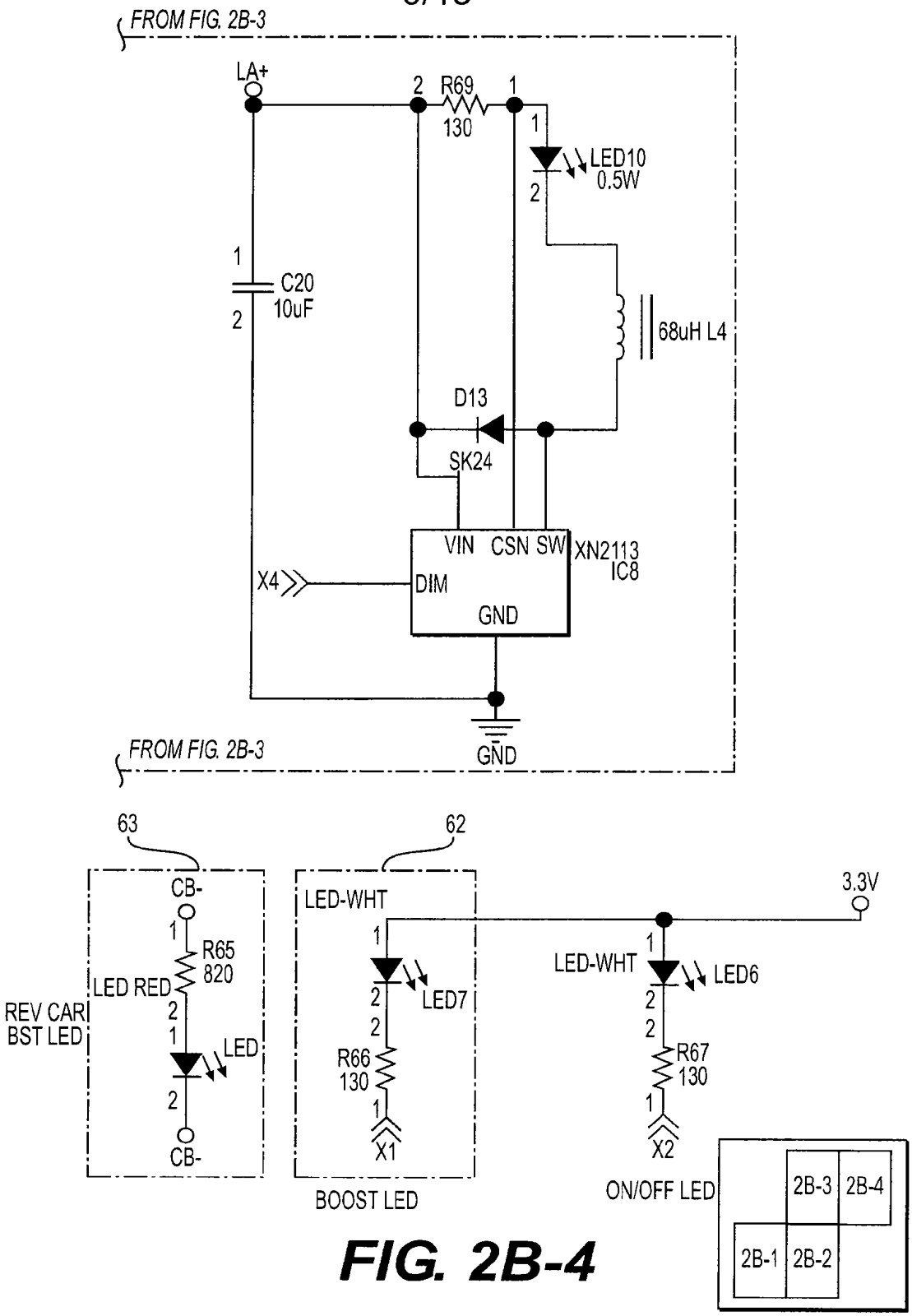


FIG. 2B-4

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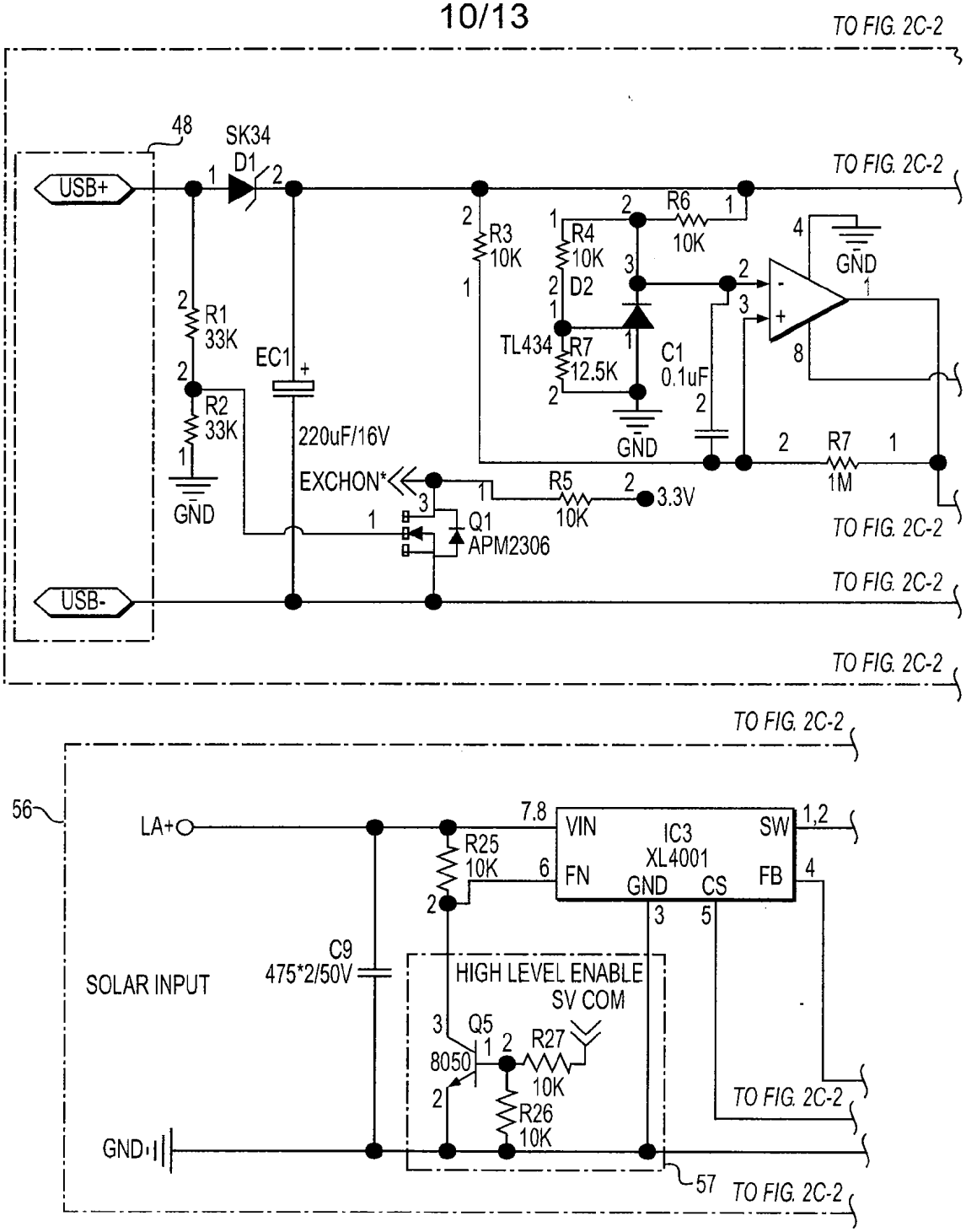
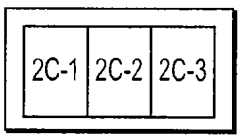


FIG. 2C-1



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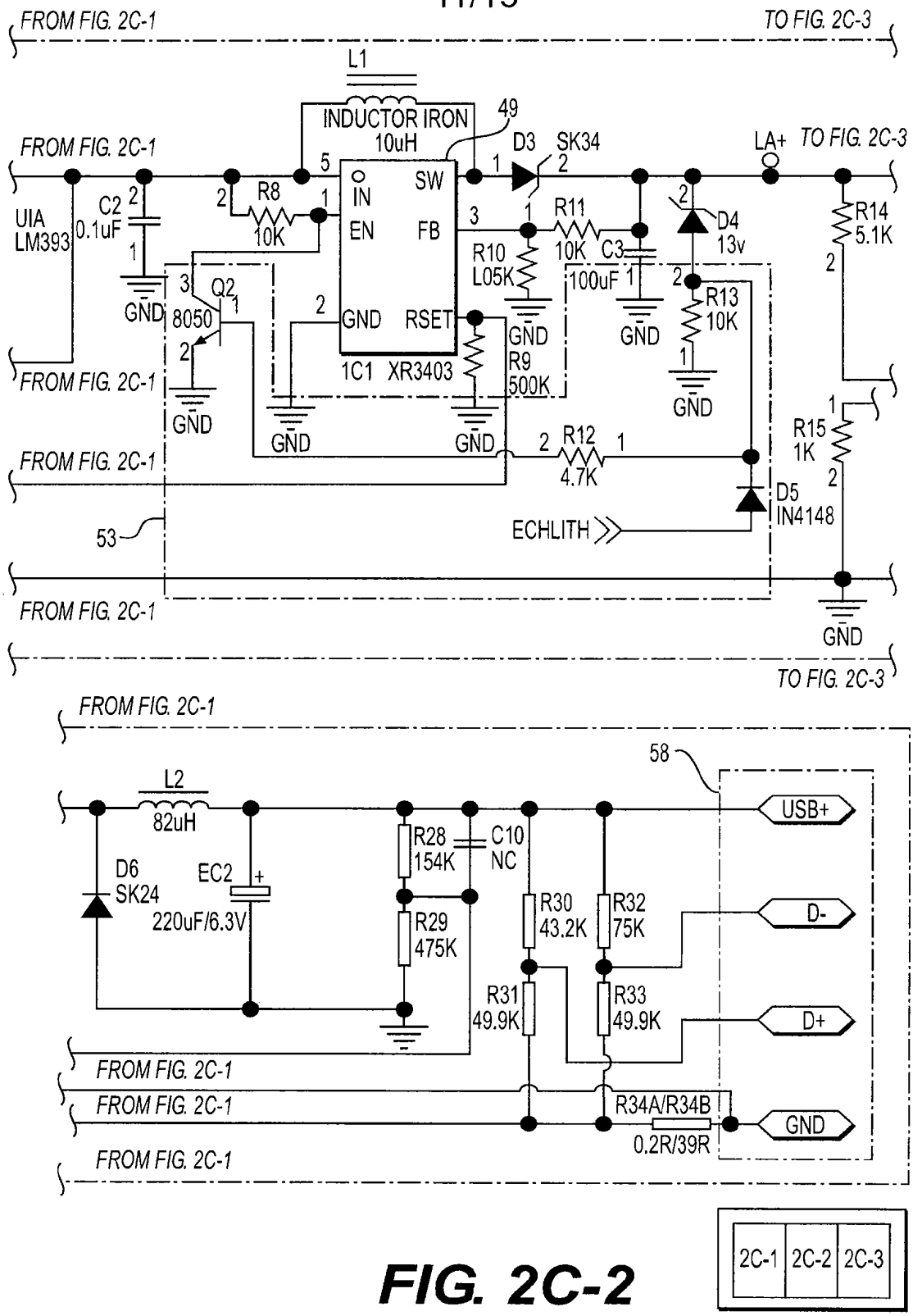
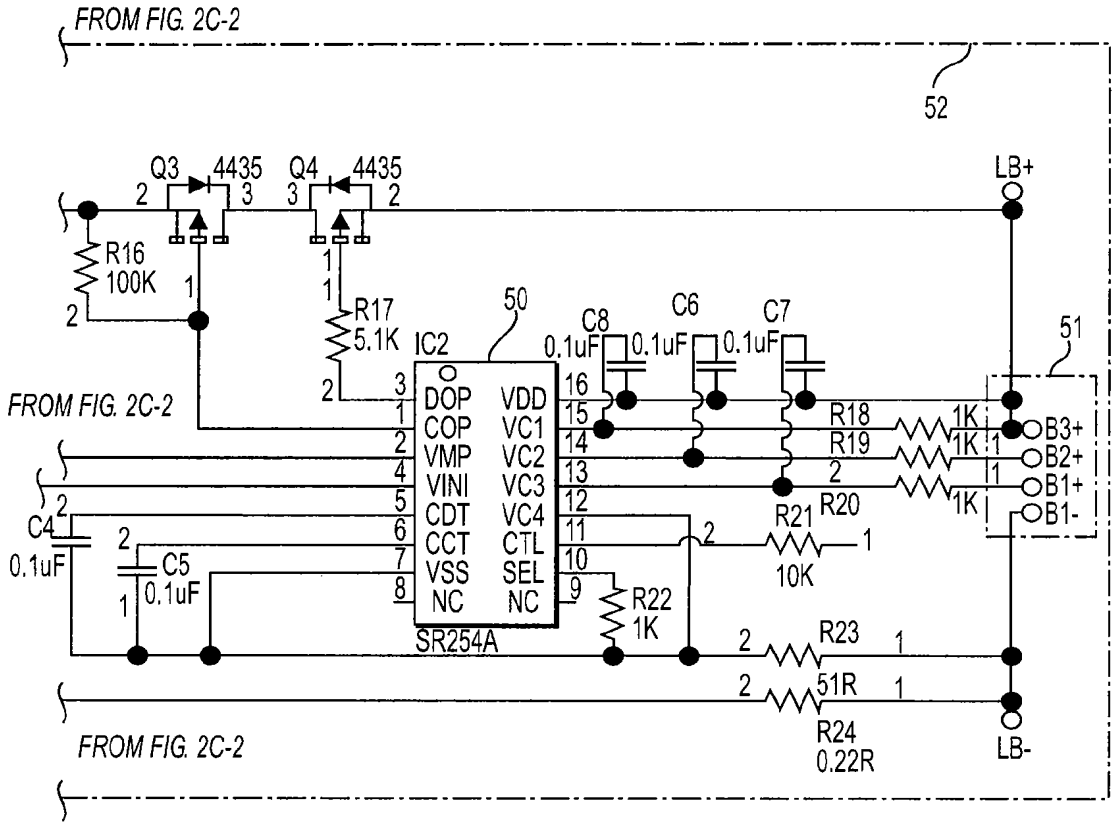


FIG. 2C-2

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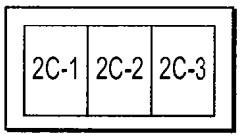


FIG. 2C-3

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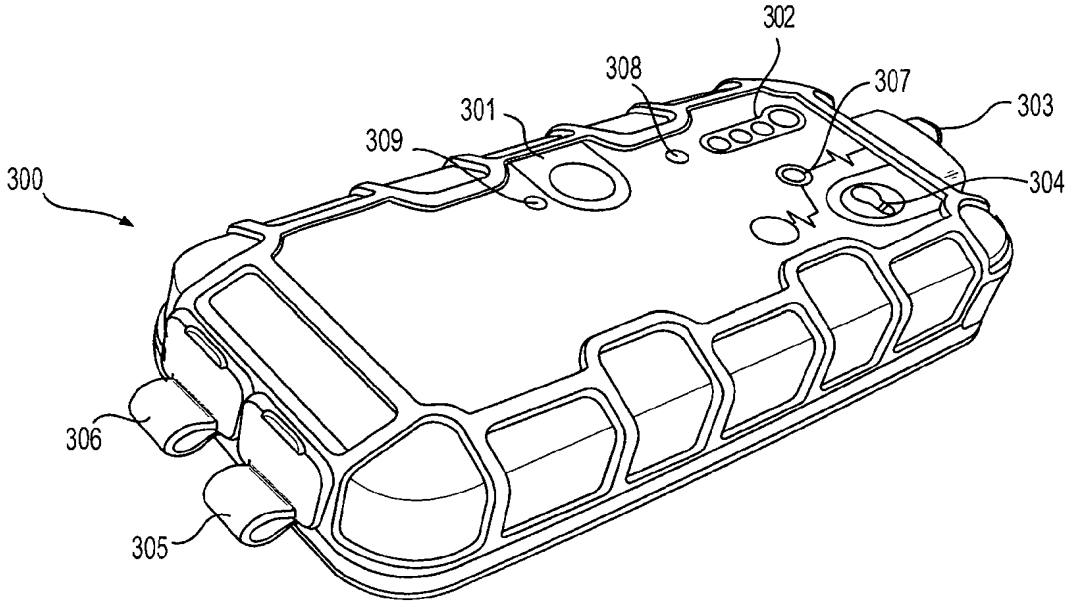


FIG. 3

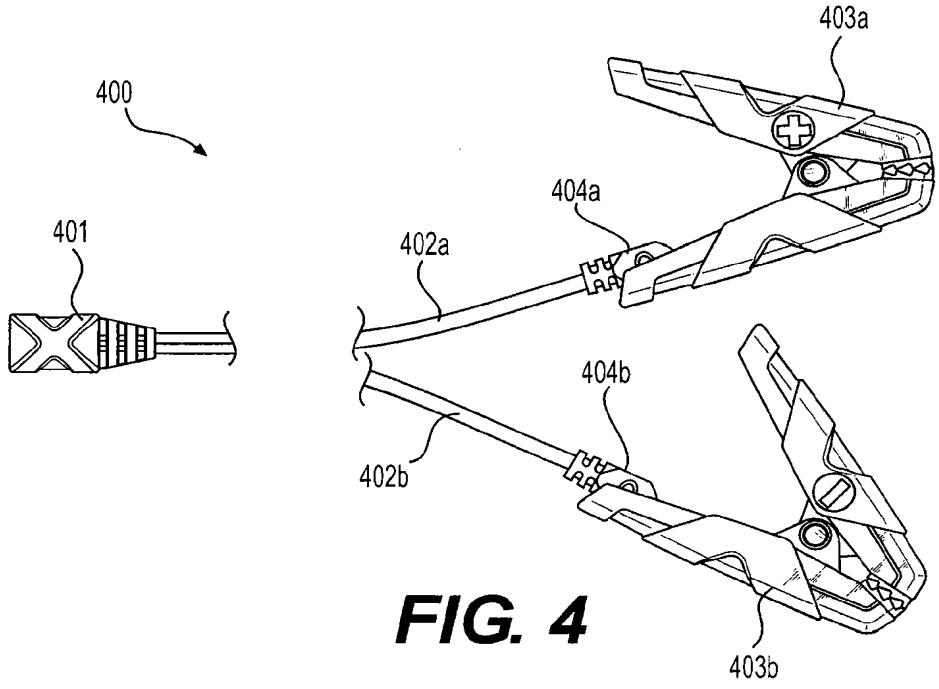


FIG. 4

Espacenet

CN103066662A Emergency power supply

Applicants: LEI XINGLIANG

Inventors: LEI XINGLIANG

Classifications:

IPC ***H02J7/00; H02J9/00;***

CPC **B60L8/003 (EP,US); H02J1/00 (US); H02J1/122 (EP); H02J9/04 (US); H02J9/061 (EP,US);** H02J1/122 (US); Y02T10/7083 (EP,US); Y10T307/625 (EP,US);

Priorities: CN201310004817A 2013-01-07

Application: CN103066662A·2013-01-07

Publication: CN103066662A·2013-04-24

Published as: CN103066662A;**CN103066662B; EP2942852A1; EP2942852A4; EP2942852B1; ES2727664T3; US2015340907A1; US9954391B2; WO2014106407A1**

Emergency power supply

Abstract

The invention relates to an emergency power supply which comprises a shell body. A battery pack used for storing electric energy is arranged in the shell body, and an input end of the battery pack is connected with output ends of a charging circuit used for charging the battery pack and a solar panel input circuit. An output of the battery pack is connected with a large current output circuit used for outputting large currents when an automobile is started, and an externally connected battery intelligent detecting system is connected between the battery pack and the large current output circuit. The emergency power supply is convenient to charge, capable of outputting large currents for starting an automobile, and capable of accurately controlling current output.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)授权公告号 CN 103066662 A
(43)申请公布日 2013.04.24

(21)申请号 201310004817.1

(22)申请日 2013.01.07

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(51)Int.Cl.
H02J 7/00(2006.01)
H02J 9/00(2006.01)

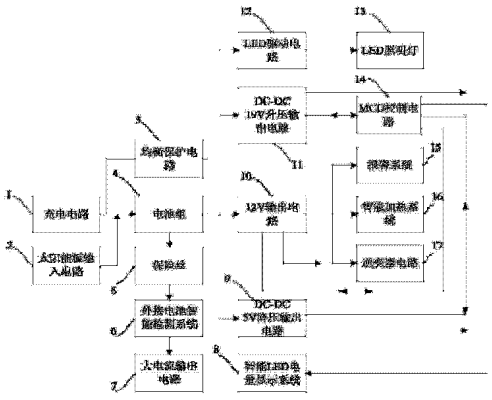
权利要求书3页 说明书7页 附图3页

(54)发明名称

应急电源

(57)摘要

本发明涉及一种应急电源，包括壳体，所述壳体的内部设置有用于储存电能的电池组，所述电池组的输入端与用于给所述电池组充电的充电电路、太阳能板输入电路的输出端连接，所述电池组的输出端连接有用于汽车启动时输出大电流的大电流输出电路，所述电池组与所述大电流输出电路之间连接有外接电池智能检测系统。该应急电源自身充电方便、可大电流输出用于汽车启动，并能准确控制大电流输出。



CN 103066662 A

1. 一种应急电源，包括壳体，所述壳体的内部设置有用于储存电能的电池组（4），其特征在于：所述电池组（4）的输入端与用于给所述电池组（4）充电的充电电路（1）、太阳能板输入电路（2）的输出端连接，所述电池组（4）的输出端连接有用于汽车启动时输出大电流的大电流输出电路（7），所述电池组（4）与所述大电流输出电路（7）之间连接有外接电池智能检测系统（6）。

2. 根据权利要求 1 所述的一种应急电源，其特征在于：所述电池组（4）由以磷酸铁锂、钴酸锂、镍钴锰三元锂或锰酸锂为正极，以人造或天然石墨为负极的锂离子电芯串联或并联组成，其输出端还连接有多路 DC-DC 调压电路以及 LED 驱动电路（12），每路所述 DC-DC 调压电路均与 MCU 控制电路（14）连接，所述 MCU 控制电路（14）还连接有用于显示该应急电源的电量的智能 LED 电量显示系统（8），所述 LED 驱动电路（12）的输出端连接有 LED 照明灯（13），所述电池组（4）的两端并联有用于保护所述电池组（4）的均衡保护电路（3）。

3. 根据权利要求 1 所述的一种应急电源，其特征在于：所述外接电池智能检测系统（6）包括用于连接外接电池的红黑电瓶夹、根据检测信号控制电路导通或断开的继电器、用于识别外接铅酸电瓶或锂离子启动电池的电压的电压识别系统、及识别通过外接启动电路的电流的电流识别系统，所述继电器的线圈的两端连接所述电压识别系统，所述继电器的输入端连接电压识别系统，所述继电器的输出端连接所述大电流输出电路（7），所述红黑电瓶夹通过可插拔防反接插头连接或通过焊接于所述电池组（4）正负极两端的导线连接，所述可插拔防反接插头与所述电池组（4）的正负极连接，所述电压识别系统与所述红黑电瓶夹连接，所述继电器为 12V 或 24V 继电器，电流规格为 20A ～ 300A，脚位为 4 ～ 6 个，所述外接电池智能检测系统（6）设置于所述应急电源的外部，通过可插拔防反接插头与所述应急电源连接，或者设置于所述应急电源的内部、而红黑电瓶夹设置于所述应急电源的外部。

4. 根据权利要求 3 所述的一种应急电源，其特征在于：所述红黑电瓶夹分别与外部电池的正负极极柱连接时，若为接对状态，所述电压识别系统显示的反馈电压为正，否则反馈电压为负，其中，所述正的反馈电压为 a ～ b 的范围，所述 a 为 6 ～ 24V，b 为 9 ～ 30V，取值时，a 小于 b；当反馈电压为 a ～ b，且为正值时，所述继电器的线圈得到电信号，触点闭合，输出端与所述大电流输出电路（7）导通，该应急电源开始对外接的设备进行大电流供电，此时，所述电流识别系统检测经过所述大电流输出电路（7）的电流，若该电流小于 c 时，c 为 0.1 ～ 10A，所述继电器的线圈两端的电信号消失，触点断开，输出端断开与所述大电流输出电路（7）的连接，停止对外接的设备大电流放电，所述大电流输出电路（7）的输出电压为 DC12V 或 DC24V，瞬间电流为 100A ～ 600A。

5. 根据权利要求 2 所述的一种应急电源，其特征在于：所述 DC-DC 调压电路包括输出电压为 19V 的 DC-DC19V 升压输出电路（11）、输出电压为 12V 的 DC-DC12V 输出电路（10）以及输出电压为 5V 的 DC-DC5V 降压输出电路（9）。

6. 根据权利要求 5 所述的一种应急电源，其特征在于：所述 DC-DC12V 输出电路（10）的输出端连接有用于发出警报信号的报警系统（15）、用于将所述电池组（4）输出的直流电转换为交流电的逆变器电路（17）以及用于给所述电池组（4）加热的智能加热系统（16）。

7. 根据权利要求 6 所述的一种应急电源，其特征在于：所述逆变器电路（17）输出的交流电的电压为 110V ～ 220V，所述逆变器电路（17）内置于所述壳体的内部或者外接于所述壳体。

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8. 根据权利要求 6 所述的一种应急电源，其特征在于：所述智能加热系统（16）包括缠绕于所述电池组（4）的外侧的加热丝或者加热膜，贴附于所述电池组（4）的外表面并与加热丝或加热膜连接的热敏电阻，及启动智能加热系统（16）的加热启动开关；所述的加热丝或加热膜的电阻值的范围为 0.1Ω ～ 10Ω；预先设定所述电池组（4）表面的升温上限温度为 t，t 的范围为 0 ～ 70℃，此时，打开加热启动开关，若通过所述热敏电阻反馈到所述 MCU 控制电路（14）的所述电池组（4）的表面温度小于 t，则加热启动开关打开，加热丝或加热膜的两端导通电流，开始对所述电池组（4）进行加热，预先设定加热的时间为一固定值 d，d 的范围为 10 ～ 300s，当所述电池组（4）的表面温度达到上限温度 t 时，加热启动开关自动断开，或者当加热的时间达到 d 时，智能加热系统的加热电路自动断开。

9. 根据权利要求 1 所述的一种应急电源，其特征在于：所述壳体为塑胶材质、铝合金材质或混合材质的外壳，所述太阳能板输入电路（2）设置于所述壳体的外侧，所述太阳能板输入电路（2）的功率为 0.5W ～ 50W，输入电压为 5V ～ 25V。

10. 根据权利要求 1 所述的一种应急电源，其特征在于：所述电池组（4）的输出端与所述外接电池智能检测系统（6）之间还连接有一次性或者可恢复的保险丝（5），所述保险丝（5）的电流为 50A ～ 500A。

11. 根据权利要求 3 所述的一种应急电源，其特征在于，所述电流识别系统的电路（62）包括：高精度运算放大器 U3，型号是 SGM8591，电阻 R12、R13、R14、R15、R16、R17、R18、R20、R21、RS，电容 C9、C12，开关二极管 D4，型号是 IN4148，U3 的管脚 1 悬空，U3 的管脚 2 与 R16 的一端、R15 的一端、R21 的一端连接在一起，U3 的管脚 3 与 C12 的一端、RS 的一端、BT2 的负极连接在一起，U3 的管脚 4 与 BT1 的负极、RS 的另一端一起接地，U3 的管脚 5 悬空，U3 的管脚 6 与 R20 的一端、R21 的另一端、D4 的正极连接在一起，R20 的另一端与 C12 的另一端连接，U3 的管脚 7 与 VCC 端、C9 的一端连接在一起，C9 的另一端接地，U3 的管脚 8 悬空，D4 的负极接 R17 的一端，R17 的另一端与 R18 的一端、IN2 端连接在一起，R18 的另一端接地，R15 的另一端与 R12 的一端、R13 的一端、R14 的一端连接在一起。

12. 根据权利要求 11 所述的一种应急电源，其特征在于：所述电压识别系统的电路（61）包括：双运算放大器 U2，型号是 LM358，三端稳压电路 U1，型号是 7805，电阻 R1、R2、R4、R5、R6、R7、R8、R9、R10、R11，电容 C1、C2、C3、C4、C5、C6、C7、C8，肖特基二极管 D1、D2，型号是 SS14，三端可调分流基准源 U4，型号为 TL431，U2 的管脚 1 与 R5 的一端、C5 的一端、C4 的一端连接在一起，R5 的另一端与 R6 的一端、IN1 端连接在一起，R6 的另一端接地，U2 的管脚 2 与 U2 的管脚 5、R11 的一端、U4 的阴极、U4 的参考极、R16 的另一端连接在一起，R11 的另一端接 VCC 端，U2 的管脚 3 与 C5 的另一端、R1 的一端、R7 的一端、R8 的一端连接在一起，R1 的另一端接 C4 另一端，U2 的管脚 4 与 R7 的另一端、U4 的阳极、R9 的一端一起接地，R8 的另一端与 D2 的负极、R10 的一端连接在一起，D2 的正极接 BT2 的正极，U2 的管脚 6 与 R10 的另一端、R9 的另一端、C6 的一端、R2 的一端连接在一起，U2 的管脚 7 与 C6 的另一端、C7 的一端、R4 的一端连接在一起，R4 的另一端接 A 点，C7 的另一端接 R2 的另一端，U2 的管脚 8 与 C8 的一端、C2 的一端、C3 的一端、U1 的管脚 3、VCC 端连接在一起，C8 的另一端接地，C2 的另一端和 C3 的另一端一起接地，U1 的管脚 1 与 C1 的一端、D1 的负极连接在一起，U1 的管脚 2 与 C1 的另一端一起接地，D1 的正极接 BT1 的正极。

13. 根据权利要求 12 所述的一种应急电源，其特征在于：所述继电器的电路（63）包括：

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三端稳压芯片 U5，型号是 XC6219，电阻 R3、R19、R22，电容 C11、C13、C14，肖特基二极管 D5，型号是 SS14，MCU 控制芯片 J1，控制开关 Q1、Q2、Q3，型号是 SI2300，继电器，U5 的管脚 1 与 C13 的一端、U5 的管脚 3、VCC 端连接在一起，U5 的管脚 2 与 C13 的另一端、C14 的一端、J1 的管脚 2 一起接地，U5 的管脚 4 悬空，U5 的管脚 5 与 C14 的另一端、J1 的管脚 1 连接在一起，J1 的管脚 3 接 IN1 端，J1 的管脚 4 接 OUT1 端，J1 的管脚 5 接 IN2 端，J1 的管脚 6 接 OUT2 端，J1 的管脚 7 悬空，J1 的管脚 8 悬空，OUT1 端接 R3 的一端，R3 的另一端接 Q2 的栅极，Q2 的漏极与 Q3 的源极、R13 的另一端连接在一起，Q3 的漏极接 R12 的另一端，Q3 的栅极连接 A 点，Q2 的源极与 Q1 的源极、R14 的另一端连接在一起，Q1 的栅极接 R19 的一端，R19 的另一端接 OUT2 端，Q1 的漏极与 D5 的正极、继电器线圈的一端连接在一起，D5 的负极、继电器线圈的另一端、继电器的常开接点的一端、R22 的一端与 BT1 的正极连接在一起，R22 的另一端接 C11 的一端，C11 的另一端与继电器的常开接点的另一端、BT2 的正极连接在一起。

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应急电源

技术领域

[0001] 本发明属于直流电源领域，具体涉及一种可为多种设备提供电源的应急电源。

背景技术

[0002] 随着科技的日新月异，人们生活水平的日益提高，汽车、手机、电脑、数码相机等成为人们生活、出游以及旅行必备的物品，它们均采用电池供电，一旦失去电源，将完全丧失其具有的功能，给人们的生活带来诸多不便。因此，对应每种产品，厂家均提供有相应的充电器，能够将 220v 的市电转换成相应电压的直流电源对其进行充电，但是这种充电器无法满足户外充电的需求。尤其对于汽车而言，常常会遇到打不着火的问题，特别是在旅途中的汽车，因电瓶电量不足或者温度过低很难打着火，给使用者带来很多不便。

[0003] 现有中国专利文献 CN101685974A 公开了一种移动电源，包括电池组、充电电路、MCU 微控制电路、DC-DC 调压输出电路，所述充电电路设有可与外部电源连接的输入端，所述充电电路设有的输出端与电池组电连接，电池组同时与 MCU 微控制电路和 DC-DC 调压输出电路电连接，MCU 微控制电路电连接并控制充电电路和 DC-DC 调压输出电路，采用上述技术方案的有益效果是：线路简洁、体积较小、轻巧便于携带、易操控、智能化、功率损耗低和多功能，既可以利用市电充电，又可以通过更换不同的输出转换头给多种电子产品供电或充电，管理、携带和使用方便。该申请专利解决了多种电压等级的输出且具有自充电功能，但其不具备大电流输出能力，不能作为汽车启动电源，另外，该申请文件中的电流输出后均为直流电，而在现实中，也有很多外部设备是需要输入交流电，所以该申请专利也无法解决这类设备的临时供电问题。

发明内容

[0004] 本发明的目的在于提出一种自身充电方便、可大电流输出用于汽车启动，并能准确控制大电流输出的应急电源。

[0005] 为达到此目的，本发明采用以下技术方案：

[0006] 一种应急电源，包括壳体，所述壳体的内部设置有用于储存电能的电池组，所述电池组的输入端与用于给所述电池组充电的充电电路、太阳能板输入电路的输出端连接，所述电池组的输出端连接有用于汽车启动时输出大电流的大电流输出电路，所述电池组与所述大电流输出电路之间连接有外接电池智能检测系统。

[0007] 其中，所述电池组由以磷酸铁锂、钴酸锂、镍钴锰三元锂或锰酸锂为正极，以人造或天然石墨为负极的锂离子电芯串联或并联组成，其输出端还连接有多路 DC-DC 调压电路以及 LED 驱动电路，每路所述 DC-DC 调压电路均与 MCU 控制电路连接，所述 MCU 控制电路还连接有用于显示该应急电源的电量的智能 LED 电量显示系统，所述 LED 驱动电路的输出端连接有 LED 照明灯，所述电池组的两端并联有用于保护所述电池组的均衡保护电路。

[0008] 其中，所述外接电池智能检测系统包括用于连接外接电池的红黑电瓶夹、根据检测信号控制电路导通或断开的继电器、用于识别外接铅酸电瓶或锂离子启动电池的电压的

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电压识别系统、及识别通过外接启动电路的电流的电流识别系统，所述继电器的线圈的两端连接所述电压识别系统，所述继电器的输入端连接电压识别系统，所述继电器的输出端连接所述大电流输出电路，所述红黑电瓶夹通过可插拔防反接插头连接或通过焊接于所述电池组正负极两端的导线连接，所述可插拔防反接插头与所述电池组的正负极连接，所述电压识别系统与所述红黑电瓶夹连接，所述继电器为 12V 或 24V 继电器，电流规格为 20A ～ 300A，脚位为 4 ～ 6 个，所述外接电池智能检测系统设置于所述应急电源的外部，通过可插拔防反接插头与所述应急电源连接，或者设置于所述应急电源的内部、红黑电瓶夹设置于所述应急电源的外部。

[0009] 其中，所述红黑电瓶夹分别与外部电池的正负极极柱连接时，若为接对状态，所述电压识别系统显示的反馈电压为正，否则反馈电压为负，其中，所述正的反馈电压为 a ～ b 的范围，所述 a 为 6 ～ 24V，b 为 9 ～ 30V，取值时，a 小于 b；当反馈电压为 a ～ b，且为正值时，所述继电器的线圈得到电信号，触点闭合，输出端与所述大电流输出电路的输入端导通，该应急电源开始对外接的设备进行大电流供电，此时，所述电流识别系统检测经过所述大电流输出电路的电流，若该电流小于 c 时，c 为 0.1 ～ 10A，所述继电器的线圈两端的电信号消失，触点断开，输出端断开与所述大电流输出电路的连接，停止对外接的设备大电流放电，所述大电流输出电路的输出电压为 DC12V 或 DC24V，瞬间电流为 100A ～ 600A。

[0010] 其中，所述 DC-DC 调压电路包括输出电压为 19V 的 DC-DC19V 升压输出电路、输出电压为 12V 的 DC-DC12V 输出电路以及输出电压为 5V 的 DC-DC5V 降压输出电路。

[0011] 其中，所述 DC-DC12V 输出电路的输出端连接有用于发出警报信号的报警系统、用于将所述电池组输出的直流电转换为交流电的逆变器电路以及用于给所述电池组加热的智能加热系统。

[0012] 其中，所述逆变器电路输出的交流电的电压为 110V ～ 220V，所述逆变器电路内置于所述壳体的内部或者外接于所述壳体。

[0013] 其中，所述智能加热系统包括缠绕于所述电池组的外侧的加热丝或者加热膜，贴附于所述电池组的外表面并与加热丝或加热膜连接的热敏电阻，及启动智能加热系统的加热启动开关；所述的加热丝或加热膜的电阻值的范围为 0.1Ω ～ 10Ω；预先设定所述电池组表面的升温上限温度为 t，t 的范围为 0 ～ 70℃，此时，打开加热启动开关，若通过所述热敏电阻反馈到所述 MCU 控制电路的所述电池组的表面温度小于 t，则加热启动开关打开，加热丝或加热膜的两端导通电流，开始对所述电池组进行加热，预先设定加热的时间为一固定值 d，d 的范围为 10 ～ 300s，当所述电池组的表面温度达到上限温度 t 时，加热启动开关自动断开，或者当加热的时间达到 d 时，智能加热系统的加热电路自动断开。

[0014] 其中，所述壳体为塑胶材质、铝合金材质或混合材质的外壳，所述太阳能板输入电路设置于所述壳体的外侧，所述太阳能板输入电路的功率为 0.5W ～ 50W，输入电压为 5V ～ 25V。

[0015] 其中，所述电池组的输出端与所述外接电池智能检测系统之间还连接有一次性或者可恢复的保险丝，所述保险丝的电流为 50A ～ 500A。

[0016] 其中，所述电流识别系统的电路包括：高精度运算放大器 U3，型号是 SGM8591，电阻 R12、R13、R14、R15、R16、R17、R18、R20、R21、RS，电容 C9、C12，开关二极管 D4，型号是 IN4148，U3 的管脚 1 悬空，U3 的管脚 2 与 R16 的一端、R15 的一端、R21 的一端连接在一起，

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U3 的管脚 3 与 C12 的一端、RS 的一端、BT2 的负极连接在一起，U3 的管脚 4 与 BT1 的负极、RS 的另一端一起接地，U3 的管脚 5 悬空，U3 的管脚 6 与 R20 的一端、R21 的另一端、D4 的正极连接在一起，R20 的另一端与 C12 的另一端连接，U3 的管脚 7 与 VCC 端、C9 的一端连接在一起，C9 的另一端接地，U3 的管脚 8 悬空，D4 的负极接 R17 的一端，R17 的另一端与 R18 的一端、IN2 端连接在一起，R18 的另一端接地，R15 的另一端与 R12 的一端、R13 的一端、R14 的一端连接在一起。

[0017] 其中，所述电压识别系统的电路包括：双运算放大器 U2，型号是 LM358，三端稳压电路 U1，型号是 7805，电阻 R1、R2、R4、R5、R6、R7、R8、R9、R10、R11，电容 C1、C2、C3、C4、C5、C6、C7、C8，肖特基二极管 D1、D2，型号是 SS14，三端可调分流基准源 U4，型号为 TL431，U2 的管脚 1 与 R5 的一端、C5 的一端、C4 的一端连接在一起，R5 的另一端与 R6 的一端、IN1 端连接在一起，R6 的另一端接地，U2 的管脚 2 与 U2 的管脚 5、R11 的一端、U4 的阴极、U4 的参考极、R16 的另一端连接在一起，R11 的另一端接 VCC 端，U2 的管脚 3 与 C5 的另一端、R1 的一端、R7 的一端、R8 的一端连接在一起，R1 的另一端接 C4 另一端，U2 的管脚 4 与 R7 的另一端、U4 的阳极、R9 的一端一起接地，R8 的另一端与 D2 的负极、R10 的一端连接在一起，D2 的正极接 BT2 的正极，U2 的管脚 6 与 R10 的另一端、R9 的另一端、C6 的一端、R2 的一端连接在一起，U2 的管脚 7 与 C6 的另一端、C7 的一端、R4 的一端连接在一起，R4 的另一端接 A 点，C7 的另一端接 R2 的另一端，U2 的管脚 8 与 C8 的一端、C2 的一端、C3 的一端、U1 的管脚 3、VCC 端连接在一起，C8 的另一端接地，C2 的另一端和 C3 的另一端一起接地，U1 的管脚 1 与 C1 的一端、D1 的负极连接在一起，U1 的管脚 2 与 C1 的另一端一起接地，D1 的正极接 BT1 的正极。

[0018] 其中，所述继电器的电路包括：三端稳压芯片 U5，型号是 XC6219，电阻 R3、R19、R22，电容 C11、C13、C14，肖特基二极管 D5，型号是 SS14，MCU 控制芯片 J1，控制开关 Q1、Q2、Q3，型号是 SI2300，继电器，U5 的管脚 1 与 C13 的一端、U5 的管脚 3、VCC 端连接在一起，U5 的管脚 2 与 C13 的另一端、C14 的一端、J1 的管脚 2 一起接地，U5 的管脚 4 悬空，U5 的管脚 5 与 C14 的另一端、J1 的管脚 1 连接在一起，J1 的管脚 3 接 IN1 端，J1 的管脚 4 接 OUT1 端，J1 的管脚 5 接 IN2 端，J1 的管脚 6 接 OUT2 端，J1 的管脚 7 悬空，J1 的管脚 8 悬空，OUT1 端接 R3 的一端，R3 的另一端接 Q2 的栅极，Q2 的漏极与 Q3 的源极、R13 的另一端连接在一起，Q3 的漏极接 R12 的另一端，Q3 的栅极连接 A 点，Q2 的源极与 Q1 的源极、R14 的另一端连接在一起，Q1 的栅极接 R19 的一端，R19 的另一端接 OUT2 端，Q1 的漏极与 D5 的正极、继电器线圈的一端连接在一起，D5 的负极、继电器线圈的另一端、继电器的常开接点的一端、R22 的一端与 BT1 的正极连接在一起，R22 的另一端接 C11 的一端，C11 的另一端与继电器的常开接点的另一端、BT2 的正极连接在一起。

[0019] 本发明的有益效果为：本发明的应急电源采用锂离子电池作为电池组，具有重量轻、体积小、耐用、瞬间放电电流大，能够反复充电的特点，可满足汽车启动的大电流需要，通过在大电流输出电路与电池组之间连接外接电池智能检测系统，可有效地控制对外接设备的大电流供电，准确可靠，有效利用电源的电能。该应急电源的电池组又连接有可输出多种电压等级的调压电路，通过将各路调压电路输出端与 MCU 控制电路连接，可以满足手机、电脑、数码相机、车载打气泵、车载冰箱、车载吸尘器等设备的户外供电需要；LED 灯可提供户外照明；该应急电源本身可通过外部电源充电，也可以通过太阳能对其进行充电，这使得

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该应急电源在户外时，可以自动补充电能。另外，该应急电源自身设置有报警系统，当用户迷路或者出现状况时自行按下报警系统，报警系统会通过指示灯的显示或者报警系统发出声音提示周围，以达到求救的目的；该应急电源还连接有逆变器电路和智能加热系统，其中，逆变器电路可以将电池组输出的直流电转换为交流电，以便户外时需要交流电的设备电力不足时供电，而智能加热系统通过加热丝或加热膜以及热敏电阻，可以在外部环境温度较低影响电源正常供电的情况下，对电源的电池组进行加热，保证电池组在低温环境下也可以正常工作，向外部提供电能。同时，该应急电源设置有红黑电瓶夹，可有效防止在于外部需要救援的电池时将正负极接反，为使用者提供便利。

附图说明

[0020] 图 1 是本发明应急电源的原理示意图；

[0021] 图 2 是本发明应急电源的外接电池智能检测系统的电路原理图一；

[0022] 图 3 是图 2 中的外接电池智能检测系统的电路原理图二。

[0023] 图中：1- 充电电路；2- 太阳能板输入电路；3- 均衡保护电路；4- 电池组；5- 保险丝；6- 外接电池智能检测系统；7- 大电流输出电路；8- 智能 LED 电量显示系统；9-DC-DC5V 降压输出电路；10-12V 输出电路；11-DC-DC19V 升压输出电路；12-LED 驱动电路；13-LED 照明灯；14-MCU 控制电路；15- 报警系统；16- 智能加热系统；17- 逆变器电路；61- 电压识别系统的电路；62- 电流识别系统的电路；63- 继电器的电路。

具体实施方式

[0024] 下面结合附图和具体实施例对本发明作进一步说明。

[0025] 如图 1 至图 3 所示，一种应急电源，包括壳体，壳体的内部设置有用于储存电能的电池组 4，电池组 4 的输入端与用于给电池组 4 充电的充电电路 1、太阳能板输入电路 2 的输出端连接，电池组 4 的输出端连接有用于汽车启动时输出大电流的大电流输出电路 7，电池组 4 与大电流输出电路 7 之间连接有外接电池智能检测系统 6。进一步地，电池组 4 由以磷酸铁锂、钴酸锂、镍钴锰三元锂或锰酸锂为正极，以人造或天然石墨为负极的锂离子电芯串联或并联组成，其输出端还连接有多路 DC-DC 调压电路以及 LED 驱动电路 12，每路 DC-DC 调压电路均与 MCU 控制电路 14 连接，MCU 控制电路 14 还连接有用于显示该应急电源的电量的智能 LED 电量显示系统 8，LED 驱动电路 12 的输出端连接有 LED 照明灯 13，电池组 4 的两端并联有用于保护所述电池组 4 的均衡保护电路 3。其中，DC-DC 调压电路包括输出电压为 19V 的 DC-DC19V 升压输出电路 11、输出电压为 12V 的 DC-DC12V 输出电路 10 以及输出电压为 5V 的 DC-DC5V 降压输出电路 9。另外，本发明中的壳体为塑胶材质、铝合金材质或混合材质的外壳，太阳能板输入电路 2 设置于壳体的外侧，太阳能板输入电路 2 的功率为 0.5W ～ 50W，输入电压为 5V ～ 25V。

[0026] 该应急电源采用锂离子电池组成的电池组，具有重量轻、体积小、耐用、瞬间放电电流大，能够反复充电的特点，可满足汽车启动的大电流需要。该应急电源又通过在大电流输出电路与电池组之间连接外接电池智能检测系统，可有效地控制对外接设备的大电流供电，准确可靠，有效利用电源的电能；其电池组又连接有可输出多种电压等级的调压电路，通过将各路调压电路输出端与 MCU 控制电路连接，可以满足手机、电脑、数码相机、车载打

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气泵、车载冰箱、车载吸尘器等设备的户外供电需要；LED 灯可提供户外照明；该应急电源本身可通过外部电源充电，在无外部电源的情况下，也可以通过太阳能对其进行充电，这使得该应急电源在户外时，可以自动补充电能。同时，通过智能 LED 电量显示系统 14，可以实时检测该应急电源的电池组 4 的电量使用状态。

[0027] DC-DC12V 输出电路 10 的输出端连接有用于发出警报信号的报警系统 15、用于将电池组 4 输出的直流电转换为交流电的逆变器电路 17 以及用于给电池组 4 加热的智能加热系统 16。该报警系统 15 可以在用户迷路或者出现状况时由用户自行按下，报警系统 15 会通过指示灯的显示或者报警系统 15 发出声音提示周围，以达到求救的目的。其中，逆变器电路 17 输出的交流电的电压为 110V ～ 220V，可以很方便地将该应急电源与需要交流电供电的外部设备连接，电压匹配，无需再次调压，便于这种设备在户外使用时，电力不足的情况下提供电能，保证设备的正常工作。该逆变器电路 17 可以内置于壳体的内部，也可以在该壳体上设置连接逆变器电路 17 的接口，当需要提供交流电时，直接将外部的逆变器与该接口连接，即可实现直流转换成交流的目的，操作方便。另外，智能加热系统 16 包括缠绕于电池组 4 的外侧的加热丝或者加热膜，贴附于电池组 4 的外表面并与加热丝或加热膜连接的热敏电阻，及启动智能加热系统的加热启动开关；加热丝或加热膜的电阻值的范围为 0.1Ω ～ 10Ω；使用时，预先设定电池组 4 表面的升温上限温度为 t，t 的范围为 0 ～ 70℃，当外部环境温度较低，且已经影响电源的正常供电时，打开加热启动开关，若通过热敏电阻反馈到 MCU 控制电路 14 的电池组 4 的表面温度小于 t，则控制加热丝或者加热膜的加热启动开关打开，加热丝或加热膜的两端导通电流，该智能加热系统 16 便开始对电池组 4 进行加热；加热前，预先设定加热的时间为一固定值 d，d 的范围为 10 ～ 300s；在加热的过程中，当电池组 4 的表面温度达到上限温度 t 时，控制加热丝或者加热膜的加热启动开关自动断开，阻断通过加热丝或加热膜两端的电流的通过，或者当加热的时间达到 d，则智能加热系统 16 的加热电路自动断开，完成对电池组 4 的加热。该智能加热系统 16 通过热敏电阻自身对热的敏感特性，准确地控制智能加热系统 16 的加热电路的导通与断开，有效提高加热效率，并降低加热消耗的电能。通过增加该智能加热系统 16，该应急电源可以在外部环境温度较低影响电源正常供电的情况下，仍然能保证电池组正常工作，向外部提供电能，提高了整个系统的可靠性。

[0028] 外接电池智能检测系统 6 包括用于连接外接电池的红黑电瓶夹、根据检测信号控制电路导通或断开的继电器、用于识别外接铅酸电瓶或锂离子启动电池的电压的电压识别系统、及识别通过外接启动电路的电流的电流识别系统，其中，继电器的线圈的两端连接电压识别系统，继电器的输入端连接电压识别系统，继电器的输出端连接大电流输出电路 7，红黑电瓶夹通过可插拔防反接插头连接或通过焊接于电池组 4 正负极两端的导线连接，若红黑电瓶夹与可插拔防反接插头连接时，该可插拔防反接插头与电池组 4 的正负极连接，电压识别系统与红黑电瓶夹连接。本发明中的继电器为 12V 或 24V 继电器，电流规格为 20A ～ 300A，脚位为 4 ～ 6 个，外接电池智能检测系统 6 设置于该应急电源的外部，通过可插拔防反接插头与该应急电源连接，或者设置于应急电源的内部、而红黑电瓶夹设置于应急电源的外部。优选的，在本发明中，外接电池智能检测系统 6 设置于应急电源的内部、而红黑电瓶夹设置于应急电源的外部。红黑电瓶夹与电池组 4 之间通过硅胶线或者其他导线连接，以供与外部设备连接，通过红黑电瓶夹与外部电池连接，也可以有效防止插反或者红

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黑电瓶夹碰撞造成的短路。

[0029] 当红黑电瓶夹分别与外部电池的正负极极柱连接时，若为接对状态，电压识别系统显示的反馈电压为正，否则反馈电压为负，其中，正的反馈电压为 a ～ b 的范围，a 为 6 ～ 24V，b 为 9 ～ 30V，取值时，应使 a 小于 b ；若为接反状态，继电器不工作，大电流输出电路 7 处于断开状态。若当外接电池智能检测系统 6 失效，为保证该应急电源的安全性，本发明的应急电源电路中，在电池组 4 与外接电池智能检测系统 6 之间串联连接有一次性或者可恢复的保险丝 5，该保险丝 5 的电流为 50A ～ 500A。为确保电池组 4 的充放电安全，电池组 4 的两端连接有均衡保护电路 3，对电池组 4 进行过流过载过充过放保护。

[0030] 在本发明中，当电压识别系统的反馈电压为 a ～ b，且为正值时，继电器的线圈接收到该电压信号，触点闭合，输出端与大电流输出电路 7 导通，该应急电源开始对外接的设备进行大电流供电，此时，电流识别系统检测经过大电流输出电路 7 的电流，若该电流小于 c 时，c 为 0. 1 ～ 10A，继电器的线圈两端的电压信号消失，触点断开，输出端断开与大电流输出电路 7 的连接，停止对外接的设备大电流放电。该大电流输出电路 7 的输出电压为 DC12V 或 DC24V，瞬间电流为 100A ～ 600A，可以作为应急状态下汽车的启动电源使用。通过在大电流输出电路 7 与电池组 4 之间连接外接电池智能检测系统 6，可有效地控制对外接设备的大电流供电，准确可靠，有效利用电源的电能。该外接电池智能检测系统 6 可以内置于壳体的内部，也可以外接于壳体。

[0031] 如图 2、图 3 所示为外接电池智能检测系统 6 的电路原理图，其中，BT1 为充电电池，即电池组 4，BT2 为被充电汽车电池。

[0032] 具体地，电流识别系统的电路 62 包括 ：高精度运算放大器 U3，型号是 SGM8591，电阻 R12、R13、R14、R15、R16、R17、R18、R20、R21、RS，电容 C9、C12，开关二极管 D4，型号是 IN4148，U3 的管脚 1 悬空，U3 的管脚 2 与 R16 的一端、R15 的一端、R21 的一端连接在一起，U3 的管脚 3 与 C12 的一端、RS 的一端、BT2 的负极连接在一起，U3 的管脚 4 与 BT1 的负极、RS 的另一端一起接地，U3 的管脚 5 悬空，U3 的管脚 6 与 R20 的一端、R21 的另一端、D4 的正极连接在一起，R20 的另一端与 C12 的另一端连接，U3 的管脚 7 与 VCC 端、C9 的一端连接在一起，C9 的另一端接地，U3 的管脚 8 悬空，D4 的负极接 R17 的一端，R17 的另一端与 R18 的一端、IN2 端连接在一起，R18 的另一端接地，R15 的另一端与 R12 的一端、R13 的一端、R14 的一端连接在一起。

[0033] 具体地，电压识别系统的电路 61 包括 ：双运算放大器 U2，型号是 LM358，三端稳压电路 U1，型号是 7805，电阻 R1、R2、R4、R5、R6、R7、R8、R9、R10、R11，电容 C1、C2、C3、C4、C5、C6、C7、C8，肖特基二极管 D1、D2，型号是 SS14，三端可调分流基准源 U4，型号为 TL431，U2 的管脚 1 与 R5 的一端、C5 的一端、C4 的一端连接在一起，R5 的另一端与 R6 的一端、IN1 端连接在一起，R6 的另一端接地，U2 的管脚 2 与 U2 的管脚 5、R11 的一端、U4 的阴极、U4 的参考极、R16 的另一端连接在一起，R11 的另一端接 VCC 端，U2 的管脚 3 与 C5 的另一端、R1 的一端、R7 的一端、R8 的一端连接在一起，R1 的另一端接 C4 另一端，U2 的管脚 4 与 R7 的另一端、U4 的阳极、R9 的一端一起接地，R8 的另一端与 D2 的负极、R10 的一端连接在一起，D2 的正极接 BT2 的正极，U2 的管脚 6 与 R10 的另一端、R9 的另一端、C6 的一端、R2 的一端连接在一起，U2 的管脚 7 与 C6 的另一端、C7 的一端、R4 的一端连接在一起，R4 的另一端接 A 点，C7 的另一端接 R2 的另一端，U2 的管脚 8 与 C8 的一端、C2 的一端、C3 的一端、U1 的管

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脚 3、VCC 端连接在一起，C8 的另一端接地，C2 的另一端和 C3 的另一端一起接地，U1 的管脚 1 与 C1 的一端、D1 的负极连接在一起，U1 的管脚 2 与 C1 的另一端一起接地，D1 的正极接 BT1 的正极。

[0034] 具体地，继电器的电路 63 包括：三端稳压芯片 U5，型号是 XC6219，电阻 R3、R19、R22，电容 C11、C13、C14，肖特基二极管 D5，型号是 SS14，MCU 控制芯片 J1，控制开关 Q1、Q2、Q3，型号是 SI2300，继电器，U5 的管脚 1 与 C13 的一端、U5 的管脚 3、VCC 端连接在一起，U5 的管脚 2 与 C13 的另一端、C14 的一端、J1 的管脚 2 一起接地，U5 的管脚 4 悬空，U5 的管脚 5 与 C14 的另一端、J1 的管脚 1 连接在一起，J1 的管脚 3 接 IN1 端，J1 的管脚 4 接 OUT1 端，J1 的管脚 5 接 IN2 端，J1 的管脚 6 接 OUT2 端，J1 的管脚 7 悬空，J1 的管脚 8 悬空，OUT1 端接 R3 的一端，R3 的另一端接 Q2 的栅极，Q2 的漏极与 Q3 的源极、R13 的另一端连接在一起，Q3 的漏极接 R12 的另一端，Q3 的栅极连接 A 点，Q2 的源极与 Q1 的源极、R14 的另一端连接在一起，Q1 的栅极接 R19 的一端，R19 的另一端接 OUT2 端，Q1 的漏极与 D5 的正极、继电器线圈的一端连接在一起，D5 的负极、继电器线圈的另一端、继电器的常开接点的一端、R22 的一端与 BT1 的正极连接在一起，R22 的另一端接 C11 的一端，C11 的另一端与继电器的常开接点的另一端、BT2 的正极连接在一起。

[0035] 当该应急电源与外部充电电池的连接断开，或电流小于设定的电流值时，电流识别系统的电路 62 中的 R15 和 R16 提供给 U3 检测信号，此时 U3 根据该检测信号发出一个输出信号给 MCU 控制芯片，以供 MCU 控制芯片判断电路的连接或断开的状态，以做出合适的指示；当输出电压低于预定值，在本发明中该电压的预定值为 8.1V 时，电压识别系统的电路 61 中的电阻 R7、R8 会提供检测信号给 U2，U2 根据该检测信号发出一个输出信号给 IN1 端，MCU 控制芯片根据 IN1 端的信号，进而控制继电器的电路 63 中的控制开关 Q2；而当输出电压高于预定值，在本发明中，该电压的预定值为 12.6V 时，电压识别系统的电路 61 中的电阻 R9、R10 会提供检测信号给 U2，U2 根据该检测信号发出一个信号控制继电器的电路 63 中的控制开关 Q3。在本发明中，通过电压识别系统的电路 61，电流识别系统的电路 62 的共同作用，给予 MCU 控制芯片信号，可通过 MCU 控制芯片的判断，最终实现控制继电器的电路 63 中的 Q1、Q2 和 Q3 的目的，进而达到充电和保护的效果。

[0036] 以上所述仅为本发明的优选实施例而已，并不用于限制本发明，对于本领域的技术人员来说，本发明可以有各种更改和变化。凡在本发明的精神和原则之内，所作的任何修改、等同替换、改进等，均应包含在本发明的保护范围之内。

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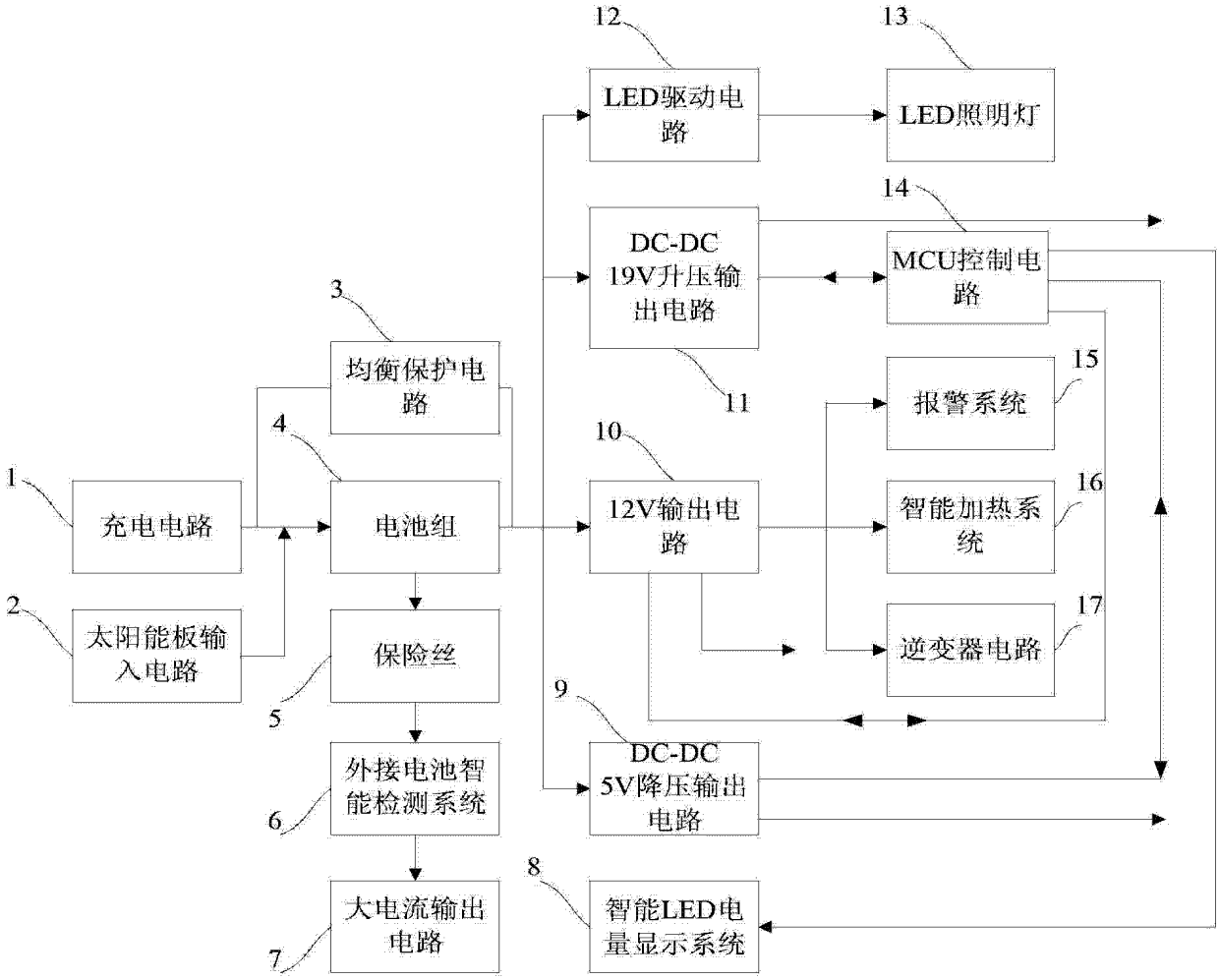


图 1

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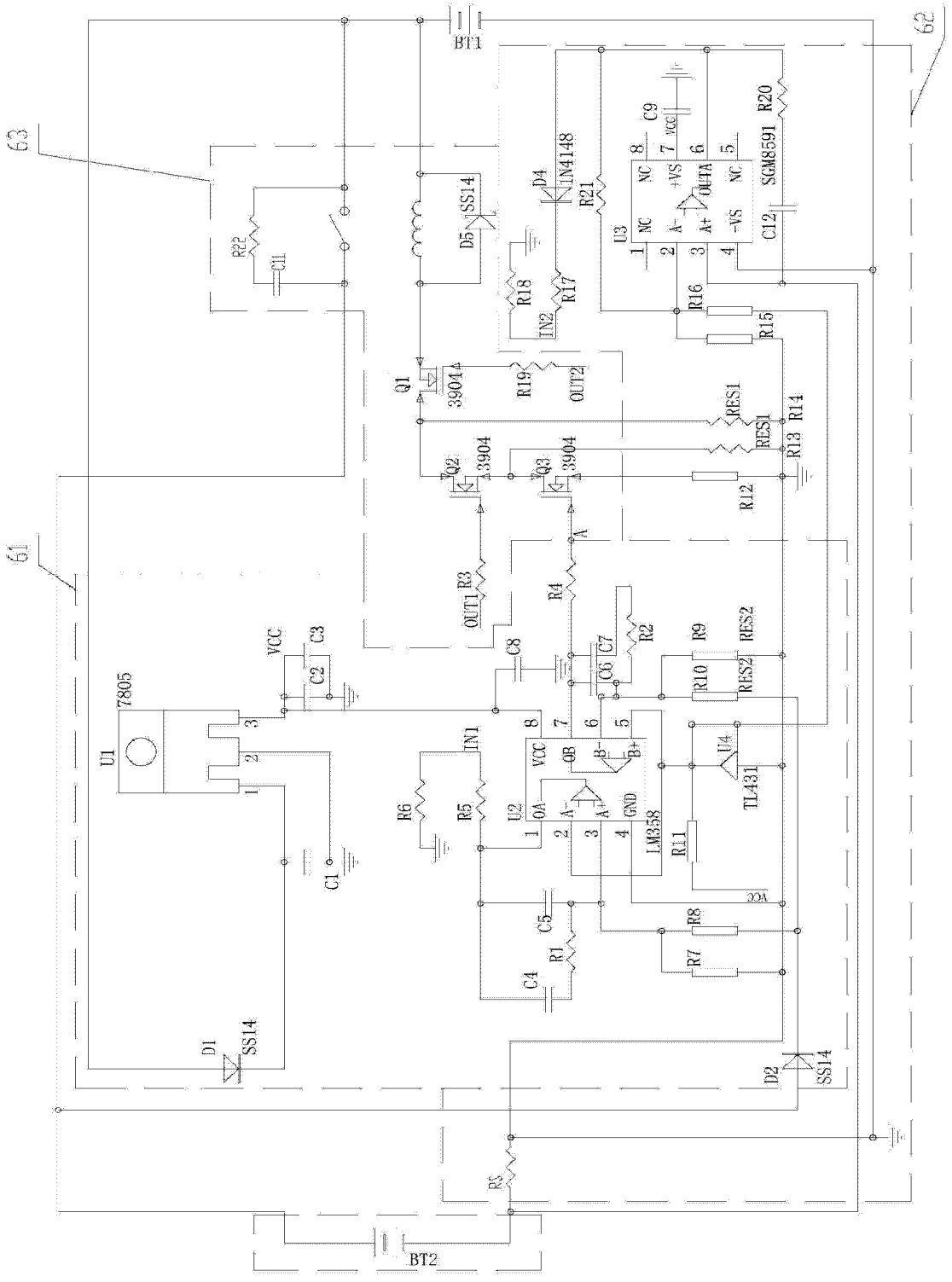


图 2

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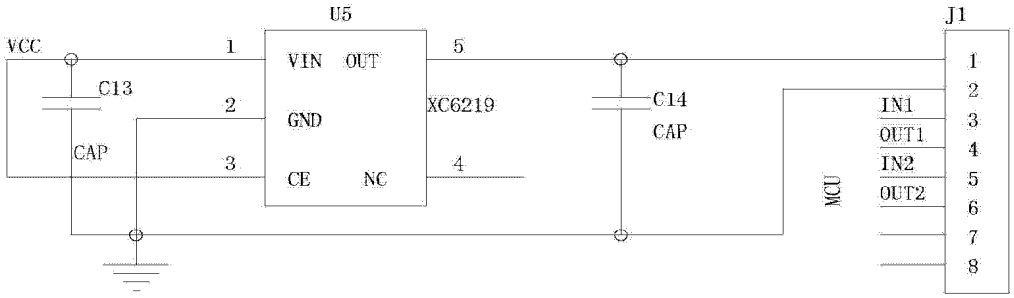


图 3

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AUSTRALIA

Patents Act

IN THE MATTER of Australian Patent Application No. 2016269555 in the name of The NOCO Company

- and -

Opposition thereto by Brown & Watson International Pty Ltd

DECLARATION

I, Max Dirnberger of 15 Grand Valley Terrace, Lysterfield, Victoria make the following declaration:

1. I am the owner of my own technology design consulting business. From 1971 to 1974 I studied communications electronics at Richard Fehrenbach Gewerbeschule in Freiburg, Germany. I have worked in the field of electronic design for over 40 years. From 1981 to 1991 I was employed as a senior technical officer for NEC Australia. I have owned my own consulting business since 1990 and continue to practice in the field of electronic design as part of that business.

2. In the course of conducting my business, I have provided design services to companies operating in a wide range of industries including the automotive and telecommunications industries. Examples of electronic design projects I have undertaken include:

    a. In the late 1980's while working at NEC I designed a line I/F card for telephony applications and a 16bit data collection unit based on the Motorola 68000 which at the time was a workstation class device;
    b. In about 1990 I designed an alarm panel for Ambulance Victoria's head office;

c. In about 1991 I designed a programmable injector driver for General Motors' research at Fishermen's Bend, Melbourne;
d. In 1993 I designed a communications translator for General Motors' end of line (EOL) testing of vehicles at their plant in Elizabeth, South Australia;
e. In 1994 I designed an airbag system tester for General Motors EOL testing of vehicles at their plant in Elizabeth, South Australia;
f. In 1995 I designed an automated tester for Delco Electronics in Singapore for production EOL testing
g. In 1995 I designed a "Smart Solenoid" for General Motors for their VS model LPG vehicles. In about 1998 I designed a revised version of the Smart Solenoid for the VT series of vehicles.
h. In the early 2000's I worked with Optiscan Imaging in Melbourne developing a confocal microscope for in vivo imaging.

3. The work I have undertaken has involved the design of circuitry, PCB layouts and embedded microcontrollers for automotive electronics and testing equipment, automotive LPG systems and modification of existing OEM automotive electronic components to meet Australian standards. As discussed in greater detail below, I have also been involved in the design of an automotive jump starter product.

My Instructions

4. Initially, I was asked by Phillips Ormonde Fitzpatrick to describe my awareness and understanding of the operation of jump starter devices in particular by reference to such a device designed by me in 2010. After providing those comments, I was then provided with the following documents:

(a) United States Patent Application 20040130298;

(b) International Patent Application 2004036714;

(c) United States Patent Application 20070285049; and

(d) United States Patent Application 20130154543.

and asked to describe my understanding of the jump starter devices disclosed in those documents.

5. After providing my understanding of the matters described in the above documents, I was provided with a copy of the specification for Australian Patent Application 2016269555 ("**AU'555**") and asked to comment on the disclosure of this document and to compare what is claimed in AU'555 with the disclosure in the documents referred to above. In performing the above tasks, I have been asked to confine my comments to information known to me prior to July 2014.

Jump Starters

6. I am familiar with the electrical device known as a jump starter. Essentially a jump starter consists of a portable battery which can be connected to the battery of an automotive vehicle in order to supplement the vehicle battery for the purpose of starting. For example if the vehicle battery has a sufficiently low voltage (current delivering capacity) it may be unable to power the vehicles starter motor to start the vehicle engine. By supplementing the vehicles battery with the battery of the jump starter, the vehicle engine can be started.

7. In about early 2010 I was engaged by Brown & Watson International Pty Ltd ("**BW**") to design a new portable jump starter for sale in Australia ("**the BW Jumpstarter**"). The jump starter I was engaged in designing was to have the following features:

   a. an internal battery able to be charged from a mains power source;

   b. capability to switch between 12 and 24 volts as selected by the user;

   c. a visual display to convey certain information to a user of the device including the status of the internal battery the mode selected by the user and any fault conditions;

   d. safety protections to prevent against short circuits, reverse polarity connections, incorrect voltage selection and overheating;

   e. an auxiliary DC power outlet for connecting to external electrical devices such as lamps and DC appliances etc;

   f. a data logging facility to log information including discharge and use cycles in non-volatile memory.

8. The functions of the jump starter as described in greater detail below were to be controlled by a microprocessor. The microprocessor would receive relevant inputs for example from the voltage selection switch or sensors relating to the safety protections and would produce outputs to control the operation of the jump starter and display relevant information to a user.

9. Attached hereto and marked **Annexure MD-1)** are copies of some early specification sheets prepared by me to describe the intended functionality of the jump starter I was engaged to design. At the top of page 1 of the specifications is a sketch of the user interface panel for the front of the jump starter. The panel includes an override button, a 12 volt DC auxiliary outlet, charging and charged LED indicator lights, a push button to check the status of the internal battery and commence a jump starting operation and an LCD screen for displaying information.

10. Below the sketch of the interface panel is a table which sets out how the jump starter would be programmed to function in response to various events which might occur during its operation. The table identifies the relevant event, what will be shown on the LCD display, the condition of the display backlight and any audible alert emitted. For certain events, some additional information is provided to the right of the table.

11. The third page of the specifications is a flowchart which illustrates the intended operation of the jump starter. As noted above, the jump starter includes a switch to enable the user to select either 12 or 24 volts. The switch used for this jumpstarter included a third, off position. Operation of the jump starter commences with a user turning the switch from the off position to either the 12 or 24 volt position and connecting the clamps of the jumper cables to the depleted battery.

12. With the voltage selected, the jump starter would then check if the internal battery voltage was above a certain threshold (11.0 volts in the case illustrated). If a low battery voltage event was detected, the microprocessor would cause the LCD display to convey this information to the user indicating a requirement to charge the jumpstarter internal battery.

13. If the jump starter's internal battery has sufficient voltage the system checks whether the positive and negative clamps are connected to a depleted battery. As set out in the table referred to above, the LCD display indicates to a user when the positive or negative clamp is connected individually and when the jump started is connected (both

clamps). The system also measures the voltage between the clamps when connected and depending on the measured voltage may determine an incorrect battery voltage event or a reverse polarity event. In either case, the microprocessor would cause the LCD display to convey this information to the user indicating that the fault needs to be corrected.

14. If the clamps are connected to a battery matching the selected voltage and with the correct polarity, the microprocessor activates the solenoid to connect the internal battery to the jumper cables, facilitating jump starting in conjunction with the vehicle battery. The device continues to monitor the jump starting process and for example if the clamps are disconnected or the jump starter is overloaded, the solenoid will be switched off to disconnect the internal battery from the jumper cables.

15. As noted above, the jump starter also included an override button. Sometimes, the voltage of a depleted battery is so low that when the jump starter seeks to measure the voltage, it is below a minimum threshold even though the jumper cables are correctly connected. Because the measured voltage is below the threshold level in the ordinary operation of the device the microprocessor would not activate the solenoid. The override button provides a means to nevertheless jump start a depleted battery in such circumstances. By pushing the override button, the microprocessor is signaled to activate the solenoid despite the measured voltage, provided the other safety parameters are met. Such an override event would be recorded in the device memory.

16. Attached hereto and marked **Annexure MD-2)** is a copy of a product manual for the BW Jumpstarter I designed. The manual describes the operation of the device and includes at pages 8 and 9 details which are essentially the same as those set out in the specifications prepared by me and referred to above.

17. The BW Jumpstarter discussed above was designed to meet certain requirements and to use certain types of components, some of which were already being used in existing BW products. It is apparent to me that the device could be modified in a number of ways to suit different market applications.

18. For example, the device described above was able to be switched between 12 and 24 volts. The 24 volt capability is required to jump start trucks and is not necessary for ordinary passenger vehicle applications. Accordingly, if a device was intended to be

sold to a general consumer market, the voltage switching capability could be removed to simplify the device.

19. Another change which might be made in a product intended to be sold to a general consumer market would be the type of internal battery used. The jump starter described above used heavy duty lead acid batteries capable of delivering a high charge current. While such batteries have a number of advantages for the application for which the BW Jumpstarter was designed, they have some disadvantages, particularly in the context of a product intended to be sold to a general consumer market. Firstly, such batteries are relatively bulky and therefore heavy. For a product intended to be sold to a general consumer market it is often desirable to make the product small and light weight. Further, such batteries will tend to self-discharge over time. For a product intended to be sold to a general consumer market where the jump starter might be placed in the boot of a vehicle and only used very infrequently, this may be problematic.

20. An option for addressing both of these issues would be to use a lithium ion battery. In 2010 when I was involved in the design of the jump starter described above, I would have been unlikely to consider using a lithium ion battery due to the cost. However the cost of such batteries has reduced since that time. As at July 2014, Lithium ion batteries could be used in a jump starter device to reduce both the size and weight of the device and also provide a battery with low self-discharge.

21. Another change which I might consider if I was designing a product intended to be sold to a general consumer market would be the nature of the switch which connects the internal battery to the jumper cables. In the BW Jumpstarter I designed, an electromechanical switch in the form of a solenoid was used. However in a general consumer device I would consider using a solid state transistor such as a FET in place of the solenoid.

22. The jump starter could also be modified to include additional functionality for example to include a radio or to otherwise act as a speaker or to have USB ports for downloading logged data from the jump starter or charging electronic devices such as a mobile phone.

US20040130298

23. I have been provided with a copy of United States Patent Application 20040130298 ("US'298") and been asked to provide my comments in relation to the matters disclosed in that document. Annexed hereto and marked **Annexure MD-3)** is a copy of US' 298.

24. US'298 is titled "Microprocessor controlled booster apparatus with polarity protection". As described in paragraphs [0002] to [0009] the invention of US'298 relates to a device for jumpstarting an automotive vehicle with a depleted battery.

25. At paragraphs [0010] to [0021] of US'298, under the heading summary of the invention, there is reverence to a number of embodiments beginning with a discussion of a polarity protection circuit for use in a jumpstarter device. The polarity protection circuit is electrically connected to the battery to be charged referred to as a depleted battery and to a boosting battery. The polarity protection circuit prevents current flow between the batteries unless proper polarity is achieved. In one embodiment, the device includes a microprocessor which forms part of the polarity protection circuit and which may perform other detection and control functions within the device. In paragraph [0020], it is said that in one embodiment a computer (microprocessor) controlling the jumpstarter device may be programmed to measure the voltage at the clamps of the device when attached to a depleted battery. If no voltage is detected at the clamps, a "bad battery" fault is indicated. If a voltage is detected, the device proceeds with a jumpstarting operation.

26. Beginning at paragraph [0028] of US'298, there is a detailed description of a number of embodiments of the invention. By reference to Figure 1, there is described a jumpstarter device which includes a polarity protection circuit. The device includes a boosting battery with positive and negative terminals which are coupled to a pair of alligator clamps which in turn may be connected to a depleted battery. The boosting battery is connected to the clamps via a wire or a battery cable.

27. At paragraph [0030] of US'298 it is said the device also includes a switch which is activated to electrically connect the boosting battery to the depleted battery only when there is a correct polarity connection between them. In the example described by reference to Figure 1, the switch is a number of solid state devices in the form of field effect transistors (FETs) connected in parallel. The FET switches are maintained in an

off or non-conducting state when there is no voltage at the clamps, to prevent current flow from the boosting battery to the depleted battery.

28. Beginning at paragraph [0030] of US'298 there is a description of how the switch is activated by a polarity sensing circuit. The polarity sensing circuit is in the form of an opto-isolator which includes a phototransistor and an LED connected to the positive terminal of the boosting battery. Opto-isolators are routinely used as part of sensor circuits in electronic devices, particularly as part of polarity sensors. The operation of the polarity sensing circuit is described in paragraphs [0033] and [0034]. When the clamps of the jumpstarter device are connected to a depleted battery in the correct polarity, the LED is properly biased and emits light. The light emitted by the LED causes the phototransistor to switch on allowing current to flow to the control electrodes of the FETs which make up the switch. With the FETs placed in a conductive state, the circuit between the boosting battery and the depleted battery is complete.

29. If the clamps of the jumpstarter device are connected to a depleted battery in the incorrect polarity, the LED is reverse biased and does not emit light. The absence of light from the LED causes the phototransistor to remain in a non-conductive state which in turn means that the control electrodes of the FETs remain off. With the FETs in a non-conductive state, there is no current flow from the boosting battery to the depleted battery.

30. At paragraph [0035] of US'298 it is said when a correct polarity connection is made, and the depleted battery charged or the automotive vehicle jumpstarted, the clamps are disconnected. With the clamps disconnected, the LED of the opto-isolator is no longer forward biased and the phototransistor switches off which in turn switches off the FETs. The boosting circuit is reset and a short circuit by contact between the clamps is prevented.

31. In the embodiment described by reference to Figure 1, the opto-isolator is directly responsible for the switching of the FETs. In another embodiment of the invention of US'298 described by reference to Figure 5, the jumpstarter device includes a microprocessor. As described in paragraph [0043], the microprocessor can be programmed to perform the control functions needed for the operation of the jumpstarter. In addition, the device can include a display and an input device to enable a user to receive and input information from/to the device. The microprocessor can

monitor the voltage or current being supplied to the depleted battery, the voltage or current of the depleted battery and can detect short circuits or other faults.

32. At paragraph [0045] of US'298 it is said that in an embodiment in which the device has a microprocessor, it is the microprocessor which is used to control the FETs of the switch. In this embodiment, an opto-isolator as previously described provides one of two signals to the microprocessor to indicate whether there is a correct or reverse polarity connection between the clamps and the depleted battery. The microprocessor provides an output signal to activate the switch into a conducting state if the signal received from the opto-conductor indicates a correct polarity connection.

33. As described in paragraph [0047], if the clamps are connected to a depleted battery with an incorrect polarity the switch will remain off. The microprocessor may cause an error message to be displayed to a user and activate an audible alarm.

34. At paragraph [0048] of US'298 there is a description of the microprocessor being programmed to detect if the clamps are connected to a battery. With the switch deactivated and in a non-conducting state, the microprocessor detects whether the clamps are connected to a battery. If not, then the switch will remain in a non-conductive state. This check is performed once every second and can therefore also detect whether the clamps have been disconnected from a battery.

35. The device of US'298 can also be used to determine the voltage of a depleted battery. As described in paragraph [0054], with the switch in a non-conductive state, the clamps may be connected to a depleted battery. The voltage regulator then produces a voltage signal proportional to the voltage of the depleted battery which is used by the microprocessor to determine and display that voltage.

36. At paragraph [0055] of US'298 it is said that the microprocessor can also be programmed to detect a battery which is either faulty or which has a voltage too low to allow jump starting. It is said that when the clamps are connected to a battery with a very low voltage, the microprocessor does not detect any voltage at the clamps and a fault is displayed if an attempt to jump start the vehicle is made. As described at paragraph [0056], this fault may also be detected if there is no battery connected to the clamps and an attempt to jump start is made.

37. From the above description, it is apparent to me that US'298 describes by reference to Figure 5, a jump starter device controlled by a microprocessor which can:

a. detect if the clamps of the device are connected to a battery with an incorrect polarity and if so, to display an error message to a user;

b. detect if the clamps of the device are connected to a battery with a very low voltage or no battery at all and if, to display an error message to a user; and

c. if the device is connected with the correct polarity to a battery with a sufficiently high voltage, activate a switch to allow a jumpstarting operation to occur.

38. At paragraph [0064] of US'298 it is said that the display incorporated in the jump starter can display information available to the microprocessor which may include results of the self-test, the status or condition of the internal battery and the depleted battery and a reverse polarity connection warning.

WO2004036714

39. I have been provided with a copy of International Patent Application WO2004036714 ("WO'714") and been asked to provide my comments in relation to the matters disclosed in that document. Annexed hereto and marked **Annexure MD-4)** is a copy of WO'714.

40. WO'714 is titled "High frequency battery charger and method of operating the same". This document describes a device which can be used for both charging a depleted battery and also jump starting a battery.

41. Beginning at page 12 of WO'714 is a description of various embodiments of the invention. As described at page 12 line 9, the power source for the device may be either a battery or an AC input such as a typical wall socket.

42. Beginning at page 19 of WO'714 there is a description of an embodiment of the invention by reference to Figure 4. It is said that in this embodiment of the invention, a microprocessor controls many of the functions of the battery charger. The microprocessor is connected to switches in the form of FETs. A display is coupled to the microprocessor to convey outputs to a user and user controls are also connected to the microprocessor.

43. At page 21 of WO'714, it is said that the device described by reference to Figure 4 may also include additional polarity and short circuit protection as described by reference to Figure 5.

44. As described at page 22, only when the polarity detection circuit detects that the depleted battery has been connected to the battery charger with correct polarity is power supplied to the depleted battery. The polarity detection circuit detects the polarity of the connection of the clamps and provides a signal to the microprocessor in response to which, the microprocessor controls the operation of the battery charger to supply power to the battery or indicate an incorrect polarity.

45. The polarity detection circuit as described includes an opto-isolator which includes an LED and a phototransistor. When the battery is connected with correct polarity, the LED is forward biased and turns on the phototransistor. This provides a logic high signal to the microprocessor indicating that a correct polarity connection has been made. If the clamps are connected with incorrect polarity, the LED is reverse biased and no signal is provided to the microprocessor.

46. At page 23 of WO'714 there is reference to a means for detecting the presence of the battery at the clamps and one such means is described. At page 24 it is said that the means for detecting the presence of a battery at the clamps may also detect the presence of a current flowing through the clamps to determine whether the clamps are connected to a battery. The microprocessor is adapted to detect the current flowing through the clamps which indicates that they are connected to a battery. No current flowing through the clamps indicates they are not connected to a battery.

47. It is also said that the means for detecting the presence of a battery at the clamps may also be used to detect a bad battery or a battery whose voltage is too low to be charged. As discussed above, a depleted battery will typically have some charge but may be so depleted that it does not have any voltage. It is said that when the clamps of the battery charger are connected to this type of battery, it is as if the battery charger is not connected to anything because the voltage is so low that the microprocessor does not detect any voltage across the clamps. In this situation a fault is displayed if an attempt is made to charge the battery. It is said that this type of fault will also occur if no connection or a poor connection is made to the battery. The microprocessor can be programmed to display a suggestion to a user that the battery be reconditioned before charging is attempted or to check if the clamps are connected to a battery.

US20070285049

48. I have been provided with a copy of United States Patent Application 20070285049 ("US'049") and been asked to provide my comments in relation to the matters disclosed in that document. Annexed hereto and marked **Annexure MD-5)** is a copy of US'049.

49. US'049 is titled "Jump Starter with built-in battery charger". This document describes a jumpstarter device which also has the capability of charging portable batteries or otherwise providing power to recharge electronic devices.

50. At paragraphs [0013] to [0015] there is a description of the general features of the jump starter. It includes an internal power source which may be a battery of certain types and a variety of AC and DC power outlets via which various devices may be plugged in for charging. The power outlets may include a USB port and a charging port for mobile telephones.

51. As noted in paragraph [0014], the battery may provide power for a microprocessor which controls the operation of the various components of the jump starter.

52. At paragraph [0016] of US'049 it is said that the battery may be used to provide jump starting power to vehicles and reference is made to US application No. 10/315,061 which I understand to be US'298 discussed above. I understand that the device described in US'049 may therefore include the circuitry described by reference to Figure 5 of US'298, including a microprocessor, and further including additional circuitry to provide the further functionality described in US'049. It is also noted in paragraph [0016] that for the purpose of connecting the device to a depleted vehicle battery a pair of jumper cables may be provided.

53. Paragraph [0017] of US'049 describes how the jumper cables may be detachable from the housing of the device and may include a plug that may be received in the housing to connect the cables to the device's battery. The cables also have a pair of clamps for connection to the depleted battery.

54. Paragraph [0024] of US'049 describes a set of indicator lights to display the status of the internal battery of the device. It is also said that the microprocessor may monitor the various components of the jump starter and display those results.

US20130154543

55. I have been provided with a copy of United States Patent Application 20130154543 ("US'543") and been asked to provide my comments in relation to the matters disclosed in that document. Annexed hereto and marked **Annexure MD-6)** is a copy of US' 543.

56. US'543 is titled "Method and apparatus for providing supplemental power to an engine". This document describes a device which can be used to jump start a vehicle with a depleted battery. As described in paragraph [0007] the invention monitors the voltage of the vehicle battery to determine if a proper connection has been made and to provide fault monitoring. The system will only operate if a correct polarity connection is made. A range of other safety measures are provided.

57. At paragraph [0014] of US'543, it is said that the jump starter of the invention includes a programmable microprocessor which receives inputs and produces informational and control outputs. These inputs and outputs are shown in a functional sense in Figure 1 and include inputs from a reverse voltage sensor, vehicle voltage sensor, battery temperature sensor, automatic/manual mode push button. The outputs include control and data to be shown on an LCD display, reverse voltage LED, auto/manual mode LED, fault LED and an Annunciator (audible alarm).

58. As described in paragraph [0016], the device includes a reverse voltage sensor which monitors the polarity of the jumper cables and a vehicle voltage sensor which monitors the voltage of the vehicle battery. As described in paragraph [0017] a battery temperature sensor monitors the temperature of the jump starter's batteries to detect overheating and includes automatic and manual pushbutton inputs to accept user input to select either mode of operation.

59. As described in paragraph [0020], the microprocessor outputs include the provision of data to an LCD display to indicate user instructions, error messages and real time sensor data. If the microprocessor determines a reverse polarity connection between the jumper cables and the vehicle battery, a reverse voltage LED is illuminated. There are auto/manual mode LEDs which are illuminated respectively depending on the mode selected.

60. At paragraph [0021] of US'543, there is reference to the control of a contact relay by a relay control output from the microprocessor. When the jump starter operation is

successfully initiated, the relay is closed allowing the device battery to be connected to the depleted vehicle battery. If the jump starting process is successfully completed or a fault condition is detected, the relay is opened to disconnect the respective batteries.

61. The operation of the jump starter is described by reference to the schematic illustrated in Figure 2 and the processing flow charts in Figures 3 to 8. When the jump starter is powered on, the microprocessor undertakes a series of system checks and displays an error message if any fault is detected. After the system checks have been completed, the main processing loop begins as well as an interrupt service routine which monitors the input sensor values and user input buttons.

62. As described a paragraph [0027] of US'543, if the system does not detect a battery charging voltage when the jumper cables have been connected to the battery of the vehicle, the voltage is measured by the reverse polarity sensor. If a reverse polarity connection is determined, and error flag is set, an error message is displayed on the LCD and the reverse voltage LED is illuminated. Any further jump starter action is ignored until the reverse polarity condition is corrected.

63. As described at paragraphs [0028] to [0032] of US'543, the microprocessor also performs a range of other checks to determine for example the state of charge of the jump starter battery and the temperature of the battery.

64. As described at paragraph [0033] of US'543, the jump starter includes automatic and manual push buttons. If one of these two buttons has been selected, the system will compare the user selected voltage with the voltage of the vehicle to determine if the selection is correct. If the selection is incorrect, this will be displayed to the user and further operation of the jumpstarter is prevented until the voltage selection is corrected.

65. As described at paragraph [0035] of US'543, if the selected voltage is determined to be correct and the automatic push button was selected, a countdown time is started and displayed to the user. During the 90 second countdown period, attempts to jump start the vehicle can be made. A "Jumps Starter On" message is displayed and the Auto Mode LED is on. The system continues to monitor the jump starter and if a fault is detected, the contact relay will open disconnecting the jumpstarter battery from the clamps. If the battery temperature exceeds a maximum threshold, the contact relay is opened and error message is displayed along with a fault LED.

AU2016269555

66. I have been provided with a copy of Australian Patent Application AU2016269555 and been asked to provide my comments in relation to the matters disclosed in that document. I have also been asked to compare the claims of AU'555 with the documents discussed above. Annexed hereto and marked **Annexure MD-7)** is a copy of AU'555.

67. Beginning at page 1 of AU'555 there is a discussion of the background to the invention including reference to a number of existing jumpstarter devices. In paragraph [0003] there is reference to two problems with known devices;

    a. The jumper terminals or cable clamps could be inadvertently brought into contact with each other causing a short circuit; and

    b. The terminals could be connected with the incorrect polarity.

68. For the reasons discussed above, I consider that both of these issues had been completely resolved well before July 2014 including in the jumpstarted I designed for BW. Paragraphs [0004] to [0012] go on to discuss various patent documents which are said to described jumpstarter devices or jumper cables which address one or both of these problems.

69. At paragraph [0013] of AU'555 it is said that these attempts to solve the identified problems suffer from shortcomings either in complexity, cost or potential for malfunction and this is said to leave a need for further improvements in jump start devices. I understand that the invention of AU'555 is therefore intended to make such improvements.

70. At paragraph [0014] of AU'555 there is set out what is said to be an aspect of the invention, namely an apparatus for jump starting a vehicle engine having the following features:

    a. an internal power supply;

    b. an output port having positive and negative polarity outputs;

c. a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs;

d. a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port;

e. a power switch connected between said internal power supply and said output port; and

f. a microcontroller configured

i. to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and

ii. to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

71. It is not apparent to me that a jumpstarter having the features described above will provide an improvement over known devices with respect to any of complexity, cost or potential for malfunction. The apparatus described appears to me to be a typical jumpstarter controlled by a microprocessor and having well known safety features including the ability to detect the presence of a battery and the polarity of the device's connection to that battery. This information is then used by the microprocessor to determine whether it is safe to commence a jump starting operation.

72. The device as described in paragraph [0014] does not include jumper cables or clamps. Rather it is said that the vehicle battery is connected between the positive and negative polarity outputs of an output port.

73. At paragraph [0015] of AU'555 it is said that in one embodiment the internal power supply is a lithium ion battery pack. As discussed above, the use of such batteries was a well-known design option which could be incorporated in a jump starter depending on the intended application.

74. At paragraph [0016] of AU'555 it is said that a jumper cable device may also be provided, having a plug which can be plugged into the output port. In the absence of such a cable, it is not readily apparent to me how the output port of the jump starter device is to be connected to a vehicle battery.

75. Beginning at paragraph [0022] of AU'555 is a detailed description of the invention by reference to drawings including a functional block diagram and circuit diagrams. The device as described includes a lithium ion battery pack and a programmable microprocessor. The device includes a reverse polarity sensor and a battery isolation sensor and a FET switch circuit controlled by the microprocessor.

76. In paragraph [0026] there is reference to further features of the jump starter including the provision of a flashlight function and a manual override button to enable jumpstarting of a completely depleted battery. For the reasons discussed above, these are all standard features of existing jumpstarters.

77. In paragraph [0027] there is reference to the inclusion of USB ports both for charging the internal battery and for using that battery to charge other electronic devices. Again, for the reasons discussed above, I consider the use of USB ports to be routine design options for such a device. I note however that using a USB port to charge the internal battery will likely result in a very lengthy charge cycle.

78. A description of the operation of the jumpstarter commences at paragraph [0028] of AU'555 by reference to the circuit diagrams. As described, both the reverse polarity sensor and the vehicle battery isolation sensor are implemented as opto-couplers. For the reasons discussed above, the use of opto-couplers for such purposes is well known.

79. In paragraphs [0031] and [0032] there is reference to measuring the battery pack voltage and temperature to assist with the safe operation of the jump starter device. For the reasons discussed above, such measures are well known in the context of jump starters.

80. At paragraph [0039] of AU'555 there is reference to Figure 3 which illustrates a device according to the invention. The device includes a power on switch, various LED indicators, USB ports and an output port.

81. At paragraph [0040] of AU'555 there is reference to a jumper cable device which can be connected to the output port of the device shown in Figure 3 via a plug. The jumper cable device includes a pair of clamps at the opposite end to the plug. Other than the jumper cable device described in paragraph [0040] by reference to Figure 4, the specification of AU'555 provides no indication of how the output port of the jump starter is connected to a vehicle battery.

82. Beginning at page 14 of AU'555 there are 23 claims which are said to define the invention. Claim 1 is in the same terms as the summary of the invention referred to in paragraph 70 above. The device includes an output port. The output port has positive and negative polarity outputs and a vehicle battery can be connected between those outputs. Having regard to the use of the term port and the description of the invention in the specification of AU'555, I understand the term "output port" to require the device to have some means for connecting a plug or other terminal of a jumper cable for the purpose of connecting the jumpstarter apparatus to a vehicle battery. This is in contrast to a jumpstarter device in which the jumper cable leads are in permanent connection to the device as in the BW Jumpstarter I designed.

83. As defined in claim 1, the microcontroller receives input signals from the vehicle battery isolation sensor and the reverse polarity sensor. In response to signals indicating the presence of a vehicle battery and a proper polarity connection, the microcontroller provides an output signal to the power switch to turn it on. I understand that if the microcontroller receives signals indicating the presence of a vehicle battery and a proper polarity connection, then the microcontroller will turn the power switch on without any further input from the user of the device.

84. Claim 1 also requires that microcontroller be configured so that the power switch is not turned on when signals from the sensors indicate either the absence of a vehicle

battery or an incorrect polarity connection. In a device having a manual override button, the microprocessor is configured such that the switch may be turned on even if there is a signal indicating that there is no vehicle battery present provided the override button is pressed and there is a correct polarity connection. I understand that the device defined in claim 1 does not include a manual override function because the microcontroller is configured so that the power switch is not turned on when a signal from the vehicle battery isolation sensor indicates the absence of a vehicle battery.

85. The BW Jumpstarter has many of the features defined in claim 1 of AU'555. It includes an internal power supply, a vehicle battery isolation sensor and a reverse polarity sensor which send respective signals to a microprocessor and a power switch in the form of a solenoid. If the vehicle battery isolation sensor and the reverse polarity sensor send respective signals to the microprocessor indicating the presence of a vehicle battery with a correct polarity connection, the microprocessor will send an output signal to the solenoid to connect the jump starter battery to the clamps. If a reverse polarity connection is detected, the microprocessor will not activate the solenoid and there will be no connection between the internal battery and the jumper cables. If the absence of a connection to a depleted battery is detected, the microprocessor will not activate the solenoid and there will be no connection between the internal battery and the jumper cables unless the override procedure is activated by a user.

86. The jumpstarter described in US'298 has each of the features of claim 1 except an output port. As described in paragraph [0028] of US'298, the boosting battery of the jumpstarter is connected to clamps via a wire or a battery cable. It is possible that this indicates a non-permanent connection between a jumper cable and the jumpstarter as defined in claim 1 although this is unclear. The use of a detachable jumper cable is simply a design choice having regard to the intended application of the jumpstarter.

87. The jumpstarter described in US'298 has both a vehicle battery isolation sensor and a reverse polarity sensor. The reverse polarity sensor is described in paragraph [0045] of US'298, in the context of a device having a microprocessor. The vehicle battery isolation sensor is described in paragraphs [0055] and [0056]. If the microprocessor does not receive a signal regarding the voltage at the clamps indicating the presence of a vehicle battery, a fault condition is displayed suggesting that the user either recondition the battery or check that the clamps are properly connected.

88. The jumpstarter described in WO'714 has each of the features of claim 1 except an output port. It has both a vehicle battery isolation sensor and a reverse polarity sensor as described at pages 22 to 24. Again, the use of a detachable jumper cable is simply a design choice having regard to the intended application of the jumpstarter.

89. The jumpstarter described in US'049 has each of the features of claim 1. As discussed above, US'049 indicates that the device described may include the circuitry described in US'298. Further, it is said that for the purpose of connecting the device to a depleted vehicle battery a pair of jumper cables may be provided which may be detachable from the housing of the device and may include a plug that may be received in the housing to connect the cables to the device's battery.

90. The jumpstarter described in US'543 has each of the features of claim 1 except an output port. It has both a vehicle battery isolation sensor and a reverse polarity sensor as described at paragraph [0016]. Again, the use of a detachable jumper cable is simply a design choice having regard to the intended application of the jumpstarter.

91. Claim 2 of AU'555 defines the apparatus of claim 1, wherein the internal power supply comprises a lithium ion battery. For the reasons discussed above, the use of a lithium ion battery is simply a design choice having regard to the intended application of the jumpstarter.

92. Claim 3 of AU'555 defines the apparatus of claim 2, wherein the lithium ion battery comprises a battery pack of multiple lithium ion batteries. Having regard to the nature of lithium ion cells available it is self-evident that a battery pack of multiple lithium ion batteries would be required to provide sufficient power for jumpstarting a vehicle.

93. Claim 4 of AU'555 defines the apparatus of claim 1, wherein the power switch comprises a plurality of FETs in parallel. US'298 and therefore US'049 describe the use of multiple FET switches connected in parallel. For the reasons discussed above, I consider that FET switches are a routine alternative to electromechanical switches such as solenoids which may be chosen for use in a jumpstarter depending on the intended application.

94. Claim 5 of AU'555 defines the apparatus of claim 1, wherein the vehicle isolation sensor and reverse polarity sensor comprise optically coupled isolator phototransistors. US'298 and therefore US'049 as well as WO'714 describe the use of optically coupled isolator phototransistors as part of a reverse polarity sensor. Optically

coupled isolator phototransistors are routinely used as part of sensor circuits in electronic devices and the use of an opto-isolator as part of the vehicle isolation sensor is a routine design choice.

95. Claim 6 of AU'555 defines the apparatus of claim 1, further comprising a plurality of power diodes coupled between said output port and said internal power supply to prevent backcharging of said internal power supply from an electrical system connected to said output port.

96. Claim 7 of AU'555 defines the apparatus of claim 1, further comprising a temperature sensor configured to detect temperature of said internal power supply and to provide a temperature signal to said microcontroller. US'543 describes a battery temperature sensor. Temperature sensors were included in the BW Jumpstarter I designed and are a routine feature to include in such a device.

97. Claim 8 of AU'555 defines the apparatus of claim 1, further comprising a voltage measurement circuit configured to measure output voltage of said internal power supply and to provide a voltage measurement signal to said microcontroller. Each of the BW Jumpstarter, US'298 and therefore US'049 as well as WO'714 and US'543 describe circuitry to measure the output voltage of the internal jumpstarter battery and to provide a voltage measurement to the a microprocessor.

98. Claim 9 of AU'555 defines the apparatus of claim 1, further comprising a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus. Each of US'298 and therefore US'049 as well as WO'714 and US'543 describe a voltage regulator to convert the battery voltage a voltage suitable to provide operating power to internal components of the jumpstarter including the microprocessor.

99. Claim 10 of AU'555 defines the apparatus of claim 1, further comprising a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device. US'049 describes a USB port for providing charging power to an external device. For the reasons discussed above, I consider that the inclusion of a USB port in a jumpstarter to provide for charging of external electronic devices is a routine design choice.

100. Claim 11 of AU'555 defines the apparatus of claim 1, further comprising a USB charging port configured to provide charging power from an external power source to said internal power supply. I consider that the inclusion of a USB port in a jumpstarter to provide for charging of the internal battery of the jumpstarter is a routine design choice.

101. Claim 12 of AU'555 defines the apparatus of claim 1, further comprising a flashlight circuit configured to provide a source of light to a user. The BW Jumpstarter included an LED worklight with the necessary circuitry to allow a user to operate that light. I consider that the inclusion of a flashlight circuit in a jump starter configured to provide a source of light to a user is a routine design choice.

102. Claim 13 of AU'555 defines the apparatus of claim 12, wherein said source of light is at least one LED. As noted above, the BW Jumpstarter included an LED worklight. I consider the use of an LED in a jump starter configured to provide a source of light to a user is a routine design choice.

103. Claim 14 of AU'555 defines the apparatus of claim 13, wherein said microcontroller is configured to control said at least one LED to provide a visual alarm indicating an emergency situation. I consider configuring a microprocessor to control an LED in a jump starter to provide a visual alarm indicating an emergency situation is a routine design choice.

104. Claim 15 of AU'555 defines the apparatus of claim 1, further comprising a plurality of visual indicators configured to display the remaining capacity status of said internal power supply. US'298 and therefore US'049 describes a display which can present information from the microprocessor including the status or condition (percent of charge) of the jumpstarter battery. Additionally, US'049 describes a set of indicator lights to show the status of the jumpstarter's internal battery. I consider that the use of a visual display in a jumpstarter to indicate the capacity of the internal battery to a user of the jumpstarter is a routine design choice.

105. Claim 16 of AU'555 defines the apparatus of claim 15, wherein said plurality of visual indicators comprises a plurality of LEDs providing output light of different colors. I consider the using a plurality of LEDs to provide light of different colours is a routine design choice.

106. Claim 17 of AU'555 defines the apparatus of claim 1, further comprising a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity. Each of the BW Jumpstarter, US'298 and therefore US'049 as well as WO'714 and US'543 describe a visual indicator of a detected reverse polarity connection.

107. Claim 18 of AU'555 defines the apparatus of claim 1, further comprising separate visual indicators configured to display the power on status of the apparatus, and the jump start boost power status of power supplied to said output port. US'543 describes the display of both an Auto Mode LED indicating that the device is on and a "Jump Starter On" message indicating a starting cycle is in progress.

108. Claim 19 of AU'555 defines the apparatus of claim 1, further comprising a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect presence of a vehicle battery. For the reasons discussed above, I consider that the inclusion of a manual override switch is inconsistent with the requirement of claim 1 that the microcontroller be configured so that the power switch is not turned on when signals from the sensors indicate either the absence of a vehicle battery or an incorrect polarity connection. As discussed above, the BW Jumpstarter I designed included a manual override function. I consider that the inclusion of a manual override function in a jumpstarter to allow the jumpstarting of a battery which is highly depleted is a routine design choice.

109. Claim 20 of AU'555 defines the apparatus of claim 19, wherein said microcontroller is configured to detect actuation of said manual override switch for at least a predetermined period of time before activation of said manual override mode.

110. Claim 21 of AU'555 defines the apparatus of claim 1, further comprising a jumper cable device including a plug configured to plug into said output port, a pair of cables integrated with the plug at one respective end thereof and being configured to be connected to terminals of a battery at another respective end thereof. US'049 describes a jumper cable device including a plug to be connected to an output port of a jumpstarter and a pair of battery terminal clamps at the opposite end of the jumper cable.

111. Claim 22 of AU'555 defines the apparatus of claim 21, wherein said jumper cable device further comprises a pair of ring terminals configured to respectively connect

said pair of cables at said another end thereof with one of a battery terminal and a battery terminal clamp. The use of ring terminals to connect a jumper cable to a terminal clamp is a routine design choice.

112. Claim 23 of AU'555 defines the apparatus of claim 21, wherein said output port and said plug are dimensioned so that the plug will fit into the output port only in one specific orientation. US'049 describes a jumper cable device including a plug which appears to be dimensioned so that it can only be plugged in one specific orientation. I consider that providing a plug which can only be plugged in one specific orientation is a matter of routine design choice.

113. I make this declaration conscientiously believing that the statements in this declaration are true in every particular.

DECLARANT: .....

DECLARED AT: Lysterfield

DATED: 6-Sept. 2019

ADC EX1002
IPR2025-00885

AUSTRALIA

Patents Act

IN THE MATTER of Australian Patent Application No. 2016269555 in the name of The NOCO Company

- and -

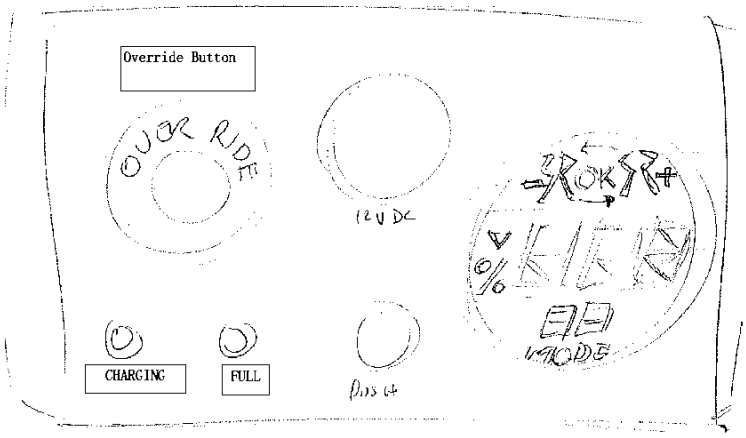
Opposition thereto by Brown & Watson International Pty Ltd

ANNEXURE MD-1

The attached is **Annexure MD-1** referred to in the Declaration of Max Dirnberger declared on 6th day of September 2019 in the above matter.

Human Machine Interface panel (HMI)

Front Panel



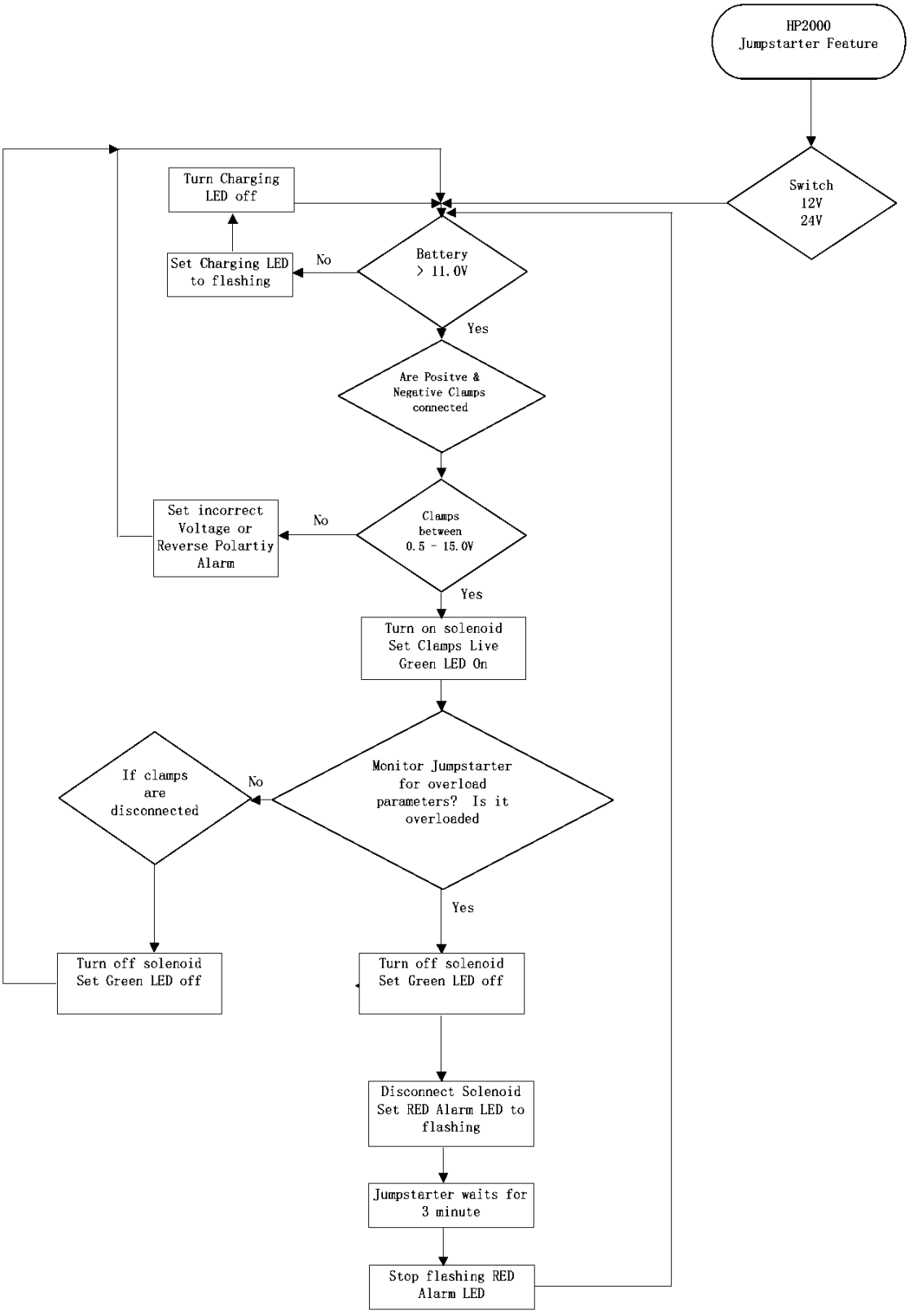
Event	Display	Backlight	Siren	Additional information
Incorrect Voltage	ERR -> Show clamp voltage	Flashing	Beeping Intermittantly on	
Reverse Connection	 REV -> CON	Flashing & LCD Flashing	Constantly on	
Low Battery From either LVD <11.0V or Jumpstarter < 12.0V	LO -> Bat	OFF	Beeping Intermittantly	If Jumpsterter < 12.0V. Show LO BAT only when clamps are connected to the battery.
Jumpstart Over Temp	Ot	Flashing	OFF	
Accessories Overload	ACC -> OL	Flashing	Beeping Intermittantly on	
Accessories LVD	ACC. -> LVD	OFF	OFF	
Battery Charging Bulk Timed Out	BAt -> ERR	Flashing	OFF	
Jumpstarter Connected		ON	OFF	
Negative Clamp Connected		ON	OFF	
Postive Clamp Connected		ON	OFF	
Internal Battery Status Button		ON	OFF	
Mode at the bottom shows switch position 12V		OFF	OFF	
Mode at the bottom shows switch position 24V		OFF	OFF	

Note: We want to ship the HP2200 with the alarms disabled

This could be done by pressing the Volt display button and switching the 12/24V to off.

Reason

We do not want the LO BAT alarm beeping during transport and shipping. Disable when batt sw changed to off with batt status button press


HP2000
Jumpstarter Feature
Switch
12V
24V
Turn Charging
LED off
Set Charging LED
to flashing
No
Battery
> 11.0V
Yes
Are Positve &
Negative Clamps
connected
Set incorrect
Voltage or
Reverse Polartiy
Alarm
No
Clamps
between
0.5 - 15.0V
Yes
Turn on solenoid
Set Clamps Live
Green LED On
If clamps
are
disconnected
No
Monitor Jumpstarter
for overload
parameters? Is it
overloaded
Yes
Turn off solenoid
Set Green LED off
Turn off solenoid
Set Green LED off
Disconnect Solenoid
Set RED Alarm LED to
flashing
Jumpstarter waits for
3 minute
Stop flashing RED
Alarm LED

AUSTRALIA

Patents Act

IN THE MATTER of Australian Patent Application No. 2016269555 in the name of The NOCO Company

- and -

Opposition thereto by Brown & Watson International Pty Ltd

ANNEXURE MD-2

The attached is **Annexure MD-2** referred to in the Declaration of Declaration of Max Dirnberger declared on 6th day of September 2019 in the above matter.

PROJE

2 x 22 AMP HOUR

JUMPSTA



P/No.s HP2012, HP2200

IMPORTANT SAFETY INFORMATION

Please read this manual thoroughly before use and store in a safe place for future reference.

WARNINGS

- Risk of explosive gas. Working in the vicinity of a lead-acid battery can be dangerous. Batteries release explosive gases during normal operation, charging and while jumpstarting a battery. Before using this jumpstarter, read and follow the instructions carefully. Follow all manufacturer's instructions and warnings of the vehicle's battery and other equipment being used.
- Jumpstart lead-acid batteries only. Do not use to jumpstart dry-cell batteries commonly found in household appliances. These batteries may burst and cause injury and/or property damage.
- Do not smoke, use matches, use a cigarette lighter, or allow a spark or flame near the battery.
- Do not allow metal to come in contact with the battery posts. It may spark or short-circuit the battery and cause an explosion.
- Always wear eye protection when operating the jumpstarter
- Remove rings, bracelets, necklaces and watches when working with a lead-acid battery.
- Contains a sealed non-spillable lead acid battery and must be disposed of properly.
- Ensure correct polarity when connecting to vehicle.
- Do not submerge jumpstarter in water.

IMPORTANT CHARGING INFORMATION

- Charge jumpstarter prior to first use, this may take up to 24 hours.
- Fully recharge the jumpstarter after every use and follow charging instructions.
- When jumpstarter is not in use ensure jumpstarter is always on charge.
- Do not allow jumpstarter to become very flat. If the jumpstarter's battery is below 12.6V in 12V mode or below 25.2V in 24V mode, ensure the jumpstarter is charged immediately.

FEATURES

ENGINE STARTING CAPABILITIES

HP2012

The HP2012 is suitable for starting 12V vehicles.
12V: Petrol vehicles up to 6 litres and diesel vehicles up to 4.5 litres

HP2200

The HP2200 is suitable for starting both 12V and 24V vehicles.
12V: Petrol vehicles up to 6 litres and diesel vehicles up to 4.5 litres
24V: Petrol & Diesel vehicles up to 7 litres in capacity.

TOTAL SAFEGUARD PROTECTION

POLARITY & SURGE PROTECTION

Prevents sparking from accidental reverse connection, as well as protecting your vehicle from spikes in voltage levels.

CRANKING PROTECTION

Prevents your jumpstarter batteries from being over discharged often caused by over cranking.

DISCHARGE PROTECTION

Discharge protection disconnects power to all 12V accessories when the battery voltage reaches low levels.

UNDER & OVER VOLTAGE PROTECTION

The jumpstarter will deactivate and sound an alarm if connected to a battery of a different voltage to the setting of the jumpstarter, preventing reverse charge and damage to the jumpstarter battery. This feature will also disconnect the jumpstarter if the vehicles alternator is malfunctioning with high voltage.

LCD DIGITAL DISPLAY

The jumpstarter is fitted with an LCD digital display that displays the batteries state of charge, battery voltage mode, correct connection and other warning messages during operation.

HEAVY-DUTY FULLY INSULATED LEADS

Long 1.6m leads allow easy connection to the vehicles battery while the jumpstarter is on the ground. Quality cable ensures optimal performance.

HIGH PERFORMANCE BATTERY
High quality AGM battery delivers instant starting power to vehicles. Maintenance free and fully sealed battery ensures convenience and safety.

240V AND 12V RECHARGING
4A adaptor allows recharging from a 240 Volt AC outlet.
The DC lead allows charging from either the 12V or 24V accessory socket.

5 STAGE AUTOMATIC CHARGE CONTROL
Both the HP2012 and HP2200 feature in-built 5 stage charge control that delivers a complete and thorough charge to the jumpstarter batteries in both 240VAC and 12/24VDC charge modes. 5 stage charging gives your jumpstarter batteries longer life, better performance and can be left connected permanently without risk of overcharging.

REVERSE POLARITY PROTECTION & ALARM
Prevents sparking from accidental reverse connection. The alarm sounds when the jumpstarter clamps are connected incorrectly.

SURGE PROTECTED
The HP2012/HP2200 features built in surge protection so you can safely jump start vehicles with EFI and computer management systems.

PORTABLE POWER
The accessory socket & heavy duty accessory sockets can be used to power 12 Volt DC appliances such as camping lights, radios, MP3 players and computers.

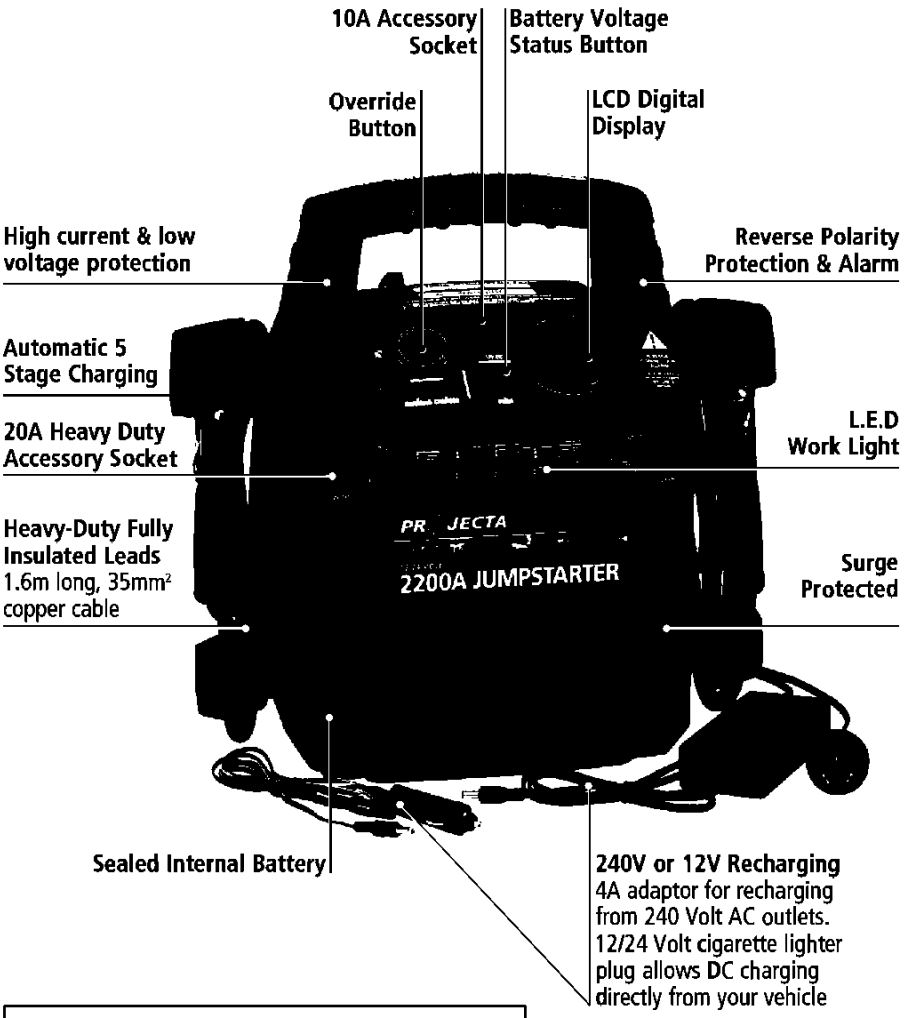
INBUILT L.E.D WORK LIGHT
An inbuilt L.E.D work light provides illumination for safer, more convenient operation at night.

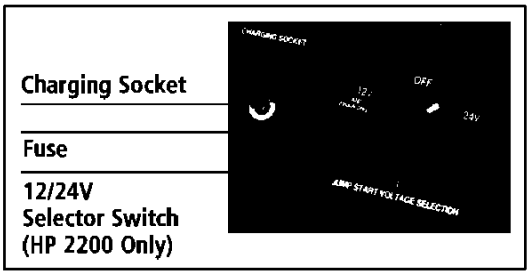
SPECIFICATIONS

Part No.	HP2012	HP2200
Battery		
Battery Capacity	2 x 12V 22Ah AGM	2 x 12V 22Ah AGM
Battery Short Circuit Current	2000A	2200A at 12V,1100A at 24V
Clamp Output	600A	640A at 12V, 500A at 24V
12V DC Power outlets		
Accessory Socket	10A	10A
Heavy Duty Accessory Socket	20A	20A
Protection	20A overload, 11.0V LVD (25A ATS Fuse)	20A overload, 11.0V LVD (25A ATS Fuse)
Jumpstarter Leads		
Length	1.6 meters	1.6 meters
Cable	35mm2	35mm2
Polarity Protection	MCU controlled solenoid	MCU controlled solenoid
Overload Protection	MCU controlled solenoid	MCU controlled solenoid
Recharging		
240V	4A	4A
DC Charging	12V–24V 4A	12V–24V 4A
Control	Automatic 5 Stage	Automatic 5 Stage
Jumpstart connection voltages		
12V Mode	1.2V–15.0V	1.2V–15.0V
24V Mode	N/A	15.1V–30V
Override	0V–1.2V	0V–1.2V
LCD Display		
Jumpstart Mode	12V	12V & 24V
Jumpstarter Battery Voltage	Battery test button	Battery test button
L.E.D Charge Indication		
Blue	Charging	Charging
Green	Fully Charged	Fully Charged
Dimensions & Weight		
Height	370mm	370mm
Width	390mm	390mm
Depth	200mm	200mm
Weight	16.3Kg	17.5Kg

PRODUCT OVERVIEW

Image of HP2200 (HP2012 not shown)





VEHICLE JUMPSTARTING INSTRUCTIONS

NOTE: Instructions for negatively earthed vehicles only

1. Insert supplied fuse into fuse holder below charging socket.
2. Your jumpstarter should be charged for 24 hours prior to first use and as soon as possible after each use.
3. Before making any connections, check the jumpstarter battery status by pressing the red INTERNAL BATTERY STATUS button. The jumpstarter's battery voltage should be above 12.6V in 12V mode and above 25.2V in 24V mode.
4. Turn your vehicle's ignition OFF before connecting the jumpstarter's clamps to your vehicle.

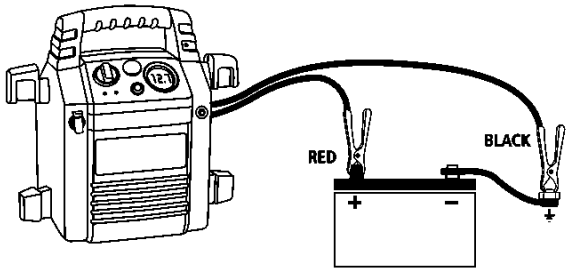
5a. To operate the HP2012 rotate the switch at the back of the unit to ON AND CHARGING. The HP2012 will jumpstart 12V vehicles only.

5b. If operating the HP2200 select the required voltage to suit the vehicle by rotating the switch on the back of the jumpstarter to 12V AND CHARGING or 24V.

6. Connect the Red Positive (+) clamp to the positive (+) terminal of the battery in the vehicle and the Black Negative (-) clamp to any non-moving metal part of the engine block. DO NOT CONNECT TO FUEL LINE. Always double check that you have the proper connections.

   If the jumpstarter fails to start your vehicle refer to the LCD screen for any error it may indicate & check that the clamps are correctly connected with good contact. If the vehicle's battery is below 1.2V ensure all connections are correct and then press the OVER RIDE button to manually engage the jumpstarter.

7. Turn the vehicle's ignition to ON and start the vehicle. After the engine has started, rotate the power switch to the OFF position.
8. Disconnect the Black clamp and then the Red clamp
9. Recharge the jumpstarter.



UNDERSTANDING YOUR JUMPSTARTER

STATUS	SCREEN DISPLAY	SCREEN ILLUMINATION
Incorrect Battery Voltage	ERR / v240* (Scrolling Display) *Example only: Display shows actual battery voltage.	Screen flashing
Reverse Connection	- OK + (+/- Alternating) REV / CON (Scrolling Display)	Screen flashing
Low Battery Voltage **12V Mode:** less than 12.0V **24V Mode:** less than 24.0V	LO / BAT (Scrolling Display)	ON
Low Battery Voltage **Switched Off:** less than 11.5V	LO / BAT (Scrolling Display)	OFF
Input Charge Voltage Above 30.0V	OVL	Screen flashing
Jumpstarter Over Temperature	OL	Screen flashing
Accessories Current Overload	ACC / OL (Scrolling Display)	Screen flashing
Accessories Low Voltage Disconnect (LVD)	ACC / LVO (Scrolling Display)	OFF
Battery Charging Bulk Timed Out	BAT / ERR (Scrolling Display)	Screen flashing
Positive (Red) Clamp Connected	- OK +	ON
Negative (Black) Clamp Connected	- OK +	ON
Jumpstarter Connected	- OK +	ON
Internal Battery Voltage (Battery Status Button)	v 12.8 MODE 12v	ON
Jumpstarter Mode (When switched to 12V)	MODE 12v	OFF
Jumpstarter Mode (When switched to 24V, HP2200 only)	MODE 24v	OFF

ALARM	REMEDY
Beeping Intermittently	Check voltage of battery being jumpstarted. Ensure the jumpstarter voltage is switched to the same voltage as the vehicle being jumpstarted
Constantly On	Check the jumpstarter clamps are connected correctly to the battery
Beeping Intermittently	Recharge jumpstarter
Beeping Intermittently	Recharge jumpstarter **OR** to override/cancel warning hold the BATTERY STATUS button while the jumpstarter is switched to the off position
OFF	Check input charge voltage is below 30V
OFF	Allow jumpstarter temperature to cool down
Beeping Intermittently	Check current draw of appliance being used
OFF	Recharge jumpstarter or press Override button
OFF	Disconnect any appliance connected to the jumpstarter. If no load is connected to the jumpstarter the batteries may be faulty and require replacing
OFF	No action required
OFF	No action required
OFF	No action required
OFF	No action required
OFF	No action required
OFF	No action required

CHARGING WITH AC ADAPTOR

IMPORTANT: DO NOT POWER ANY APPLIANCE FROM THE JUMPSTARTER WHILE IT IS BEING CHARGED USING THE AC CHARGER.

1. To charge, rotate the switch on the back of the unit to ON AND CHARGING (HP2012) or 12V AND CHARGING (HP2200).
2. Plug the output end of the AC charger into the charging socket (back of jumpstarter) and connect the charger to a 240VAC outlet and turn ON.
3. The CHARGING LED will illuminate blue when charging & the FULL LED will illuminate solid green when the jumpstarter is fully charged. The jumpstarter will automatically stop charging and the jumpstarter will initiate maintenance charge mode keeping the battery fully charged and ready for use without the risk of overcharging.

   Charging time: 15 hours if the battery is completely flat.

WHEN TO CHARGE

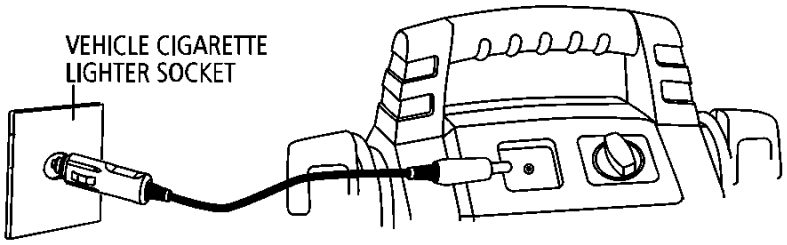
Your jumpstarter is shipped fully charged, however, an extended period of time may elapse in shipment or storage before the jumpstarter is purchased. Therefore you should charge the jumpstarter before using it for the first time. It is recommended to charge fully after each use. If the jumpstarter is not being used, it is recommended to leave the jumpstarter permanently on charge ensuring the battery is always maintained fully charged and ready for use.

CHARGING WITH 12V DC

Your Jumpstarter can be recharged from a 12V DC socket. A single-ended accessory plug and lead is included for recharging while driving.

1. To charge, rotate the switch on the back of the unit to ON AND CHARGING (HP2012) and 12V AND CHARGING (HP2200).
2. Connect the 12V charging lead to your vehicles cigarette lighter socket and to the jumpstarter's charging socket.
3. Start the car. The vehicle's alternator will charge both the jumpstarter and the vehicle battery at the same time. The CHARGING LED will illuminate blue while charging and the FULL LED will illuminate solid green when fully charged. The jumpstarter's charge control will automatically stop charging and initiate maintenance mode keeping the battery fully charged and ready for use without risk of overcharging. Once the vehicle is turned off the jumpstarter will stop charging.

Note: Appliances can be run from the jumpstarter during DC charging, for example a fridge or light.



L.E.D CHARGE INDICATORS

Your jumpstarter unit features two coloured L.E.D's that illuminate various signals to indicate different stages of charging.

L.E.D	L.E.D SIGNAL & STAGES OF CHARGING				
	Bulk	**Absorption**	**Analysis**	**Recondition**	**Float**
Charging (Blue)	Solid On ———	Solid On ———	Off	Flashing - - - - -	Off
Charged (Green)	Off	Flashing - - - - -	Flashing - - - - -	Flashing - - - - -	Solid On ———

5 5TAGE5 OF CHARGING:

BULK (CONSTANT CURRENT)

The bulk stage reduces charging time by charging the battery at the maximum rate (constant current) to a set voltage, at which point the battery is approximately 80% charged.

ABSORPTION (CONSTANT VOLTAGE)

The absorption stage charges the battery to 100% by adjusting the charge rate allowing the battery to absorb more power.

ANALYSIS

The analysis mode tests the battery to ensure that it has taken the charge; if the battery passes the test the charger will proceed to the float stage, but if the battery fails the test, the charger will apply a recondition charge to try to return the battery to full charge.

RECONDITION

If after charging, the battery is unable to hold the charge the battery reconditioning function is initiated automatically. This is most likely to take place on batteries that have been deeply discharged, prior to charging.

FLOAT

The float stage maintains the battery at 100% charge without overcharging or damaging the battery. This means the charger can be left connected to the battery indefinitely.

ADC EX1002
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USING THE PROJECTA HP2012/HP2200 JUMPSTARTER AS A POWER SUPPLY

These jumpstarter's utilise 2 x 22Ah AGM batteries and can be used as a power supply by connecting a cigarette lighter or accessory plug into the 12V DC socket at the front of the jumpstarter.
It is recommended to check the battery capacity before running accessories.

Below is a list of approximate run times for various appliances.

Appliance	Estimated power consumption (Watts)	Estimated time* (Hours)
Car phones, fluorescent lights	4	77
Radios, depth finders	9	54
Fridges (portable compressor style)	14	39
Camcorders, portable TVs	15	31
Electrical tools, bilge pumps	24	18
Cooler/warmers, spotlights	48	8
Air compressors, car vacuum cleaners	80	4

*Estimated time is based on a fully charged jumpstarter

IMPORTANT: OVER CURRENT & LOW VOLTAGE PROTECTION

Over Current Protection: If the power demand on the jumpstarter exceeds 20 Amps an alarm will sound & the power to the appliance will be automatically disconnected. Check the current draw of the appliance connected to the jumpstarter is not greater than 20A.

Low Voltage Protection: If the jumpstarter's battery voltage falls below 11V while running an appliance, the appliance will be automatically disconnected. It is recommended to recharge the jumpstarter immediately. Once the battery voltage reaches 13V the appliance will automatically reconnect.
Note: As a result of the appliance being disconnected the jumpstarter batteries may increase in voltage slightly above 11V. In circumstances where it is essential to keep the appliance running the OVER RIDE button can be pressed allowing you to continue powering the appliance for a short period of time before the 11V disconnect point is reached again.

CHECKING BATTERY CAPACITY

The jumpstarter is equipped with a LCD DIGITAL DISPLAY. When the BATTERY VOLTAGE STATUS button is pressed the display will indicate the battery voltage level.

To check the battery capacity :

Step 1 Disconnect any appliance and accessories that might be running from the jumpstarter, as this will effect the reading. Ensure the jumpstarter is not being charged.

Step 2 Press the battery voltage button and read the LED voltage display (displayed as volts).

Step 3 Refer to the table below for the conversion of volts to battery capacity as a percentage.

Battery Capacity	Battery voltage reading (12V)	Battery voltage reading (24V)
100%	12.6 Volt or greater	25.2 Volt
75%	12.4 Volt	24.8 Volt
50%	12.2 Volt	24.4 Volt
25%	12.0 Volt	24.0 Volt
0%	11.0 Volt	22.0 Volt

FREQUENTLY ASKED QUESTIONS

Q. How do I work out how long my appliance will run from the Jumpstarter

A. When the jumpstarter is fully charged the battery will be able to provide 44 Amp hours of 12V power. If you have an appliance that uses 2.5 Amps and you use it for one hour, you have just used 2.5 Amp hours.

For example:-
The jumpstarter is powered by 2 x 22Ah (44Ah) batteries and you are powering a small TV drawing approximately 2.5 Amps

Equation: 44 Amp hours ÷ 2.5 Amps = 17.6 Hours (18 hours)

Q. How can I improve the charging time when charging from my vehicle?

A. Disconnect any appliances connected to the jumpstarter. Car cigarette lighter sockets are usually connected to the battery with small (light) cable. If your jumpstarter is taking longer than 11–13 hours to recharge, the cable between the vehicle's battery and cigarette lighter socket may require upgrading.

Q. When I use the 12 Volt DC sockets the appliance does not work?

A. Check to make sure the appliance does not exceed the rated current of the socket used.

Accessory Socket:	Max 10A
Heavy Duty Accessory Socket:	Max 20A
Maximum Combined Load:	20A

If the load on your jumpstart exceeds 20A the jumpstarter will disengage the power accessories. To restart the jumpstarter and continue powering your appliance press the OVER RIDE button on the front of the jumpstarter.

Q. When I connect the jumpstarter up to the battery the alarm is going off?

A. The jumpstarter is designed to give off an alarm in the following circumstances.

1. If the positive and negative clamps are touching each other.
2. Reverse connection i.e. positive clamp connected to negative terminal or negative clamp connected to positive terminal.
3. If the jumpstarter voltage is different to the vehicle's voltage.
4. Over temperature protection, jumpstarter has reached high operating temperature's. Cease operation of the jumpstarter for 10 minutes to allow the unit to cool down before resuming operation.
5. The battery is very flat & jumpstarter may need recharging.

Q. Why didn't my jumpstarter start my vehicle?

A. There could be a number of reasons why the jumpstarter did not start your vehicle.

Check the following:

1. Ensure the jumpstarter battery is fully charged. Press the INTERNAL BATTERY STATUS button to check the condition of the battery (state of charge). Refer to page 13 ("Checking Battery Capacity") for further information.
2. Ensure you have followed the correct operating procedure. Refer to page 7 ("Vehicle Jumpstarting Instructions").
3. Ensure the correct voltage is selected on the jumpstarter for the type of vehicle being jumpstarted, 12V mode for 12V vehicles & 24V mode for 24V vehicles (HP2200 Only).
4. The vehicle's battery may be below 1.2V, the minimum start voltage for the jumpstarter. Ensure all connections are correct, then press the OVER RIDE button, to manually activate the jumpstarter. Refer to page 7 ("Vehicle Jumpstarting Instructions, Step 5") for further information.
5. Ensure the vehicle being jumpstarted does not require more than:

   HP2012: 600 Amps Clamp Output

   HP2200: 640 Amps Clamp Output at 12V OR
   500 Amps Clamp Output at 24V.

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NOTES

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WARRANTY STATEMENT

Brown & Watson International Pty Ltd ("BWI") of 1500 Ferntree Gully Road, Knoxfield, Vic., telephone (03) 9730 6000, fax (03) 9730 6050, warrants that all products described in its current catalogue will under normal use and service be free of failures in material and workmanship for a period of one (1) year from the date of the original purchase by the customer as marked on the invoice. This warranty does not cover ordinary wear and tear, abuse, alteration of products or damage caused by the purchaser.

To make a warranty claim the consumer must deliver the product at their cost to the original place of purchase or to any other place which may be nominated by either BWI or the retailer from where the product was bought in order that the warranty assessment may be performed. The consumer must also deliver the original invoice evidencing the date and place of purchase together with an explanation in writing as to the nature of the claim.

In the event that the claim is determined to be for a minor failure of the product then BWI reserves the right to repair or replace it at its discretion. In the event that a major failure is determined the consumer will be entitled to a replacement or a refund as well as compensation for any other reasonably foreseeable loss or damage.

This warranty is in addition to any other rights or remedies that the consumer may have under State or Federal legislation.

IMPORTANT NOTE

Our goods come with guarantees that cannot be excluded under the Australian Consumer Law. You are entitled to a replacement or refund for a major failure and compensation for any other reasonably foreseeable loss or damage. You are also entitled to have the goods repaired or replaced if the goods fail to be of acceptable quality and the failure does not amount to a major failure.

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IS157
Issue 3 9.8.13

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Patents Act

IN THE MATTER of Australian Patent Application No. 2016269555 in the name of The NOCO Company

- and -

Opposition thereto by Brown & Watson International Pty Ltd

ANNEXURE MD-3

The attached is **Annexure MD-3** referred to in the Declaration of Declaration of Max Dirnberger declared on 6th day of September 2019 in the above matter.

US 20040130298A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2004/0130298 A1

Krieger et al. (43) Pub. Date: Jul. 8, 2004

(54) MICROPROCESSOR CONTROLLED BOOSTER APPARATUS WITH POLARITY PROTECTION

(76) Inventors: **Michael Krieger**, Miami Beach, FL (US); **Bruce Randolph**, Ft. Lauderdale, FL (US)

Correspondence Address:
VENABLE, BAETJER, HOWARD AND CIVILETTI, LLP
P.O. BOX 34385
WASHINGTON, DC 20043-9998 (US)

(21) Appl. No.: **10/315,061**

(22) Filed: **Dec. 10, 2002**

Related U.S. Application Data

(60) Provisional application No. 60/357,146, filed on Feb. 19, 2002. Provisional application No. 60/369,839, filed on Apr. 5, 2002.

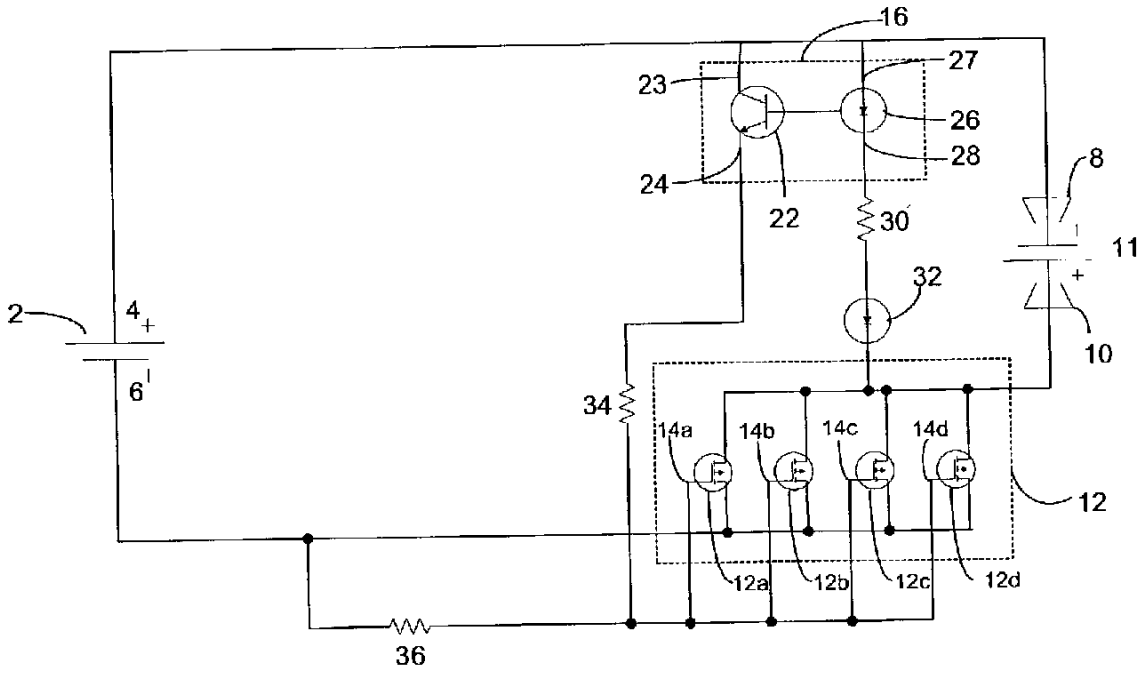
Publication Classification

(51) **Int. Cl.**[7] **H02J 7/04**

(52) **U.S. Cl.** **320/165**

(57) **ABSTRACT**

A polarity protection circuit for a battery booster device is provided. According to an exemplary embodiment, the polarity protection circuit is comprised of solid-state devices. Preferably no mechanical or electro-mechanical devices, such as solenoids are included in the polarity protection circuit. The polarity protection circuit is electrically connected to the battery to be charged and to the boosting battery. The polarity protection circuit prevents current flow between the batteries unless proper polarity is achieved.



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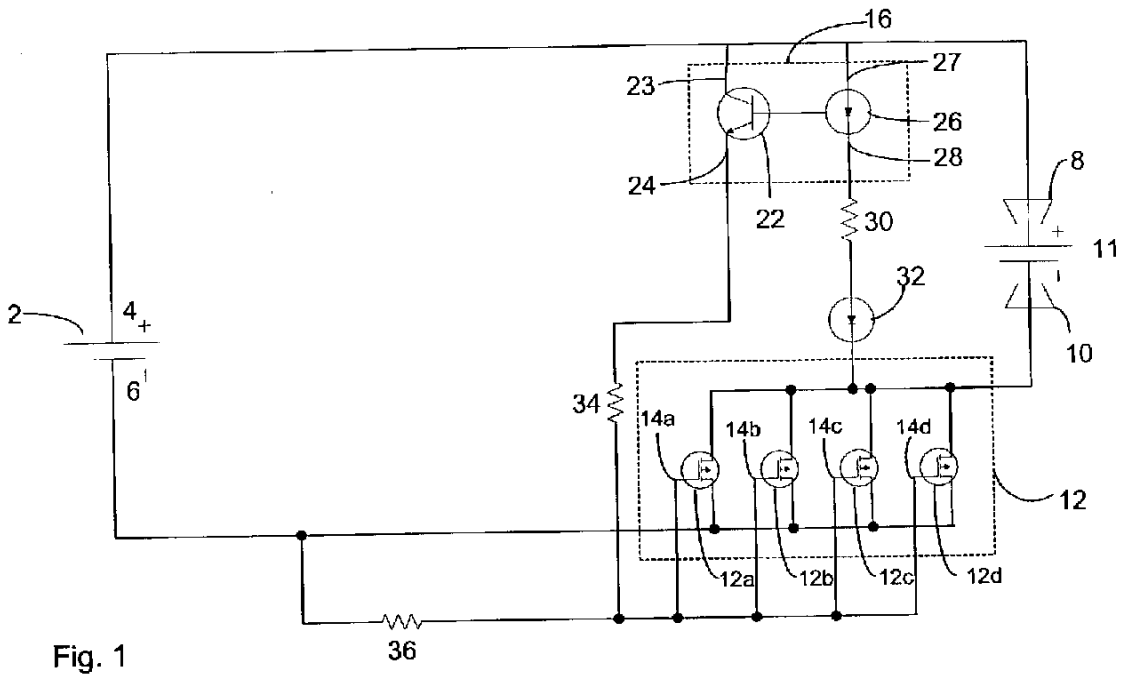

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Fig. 1

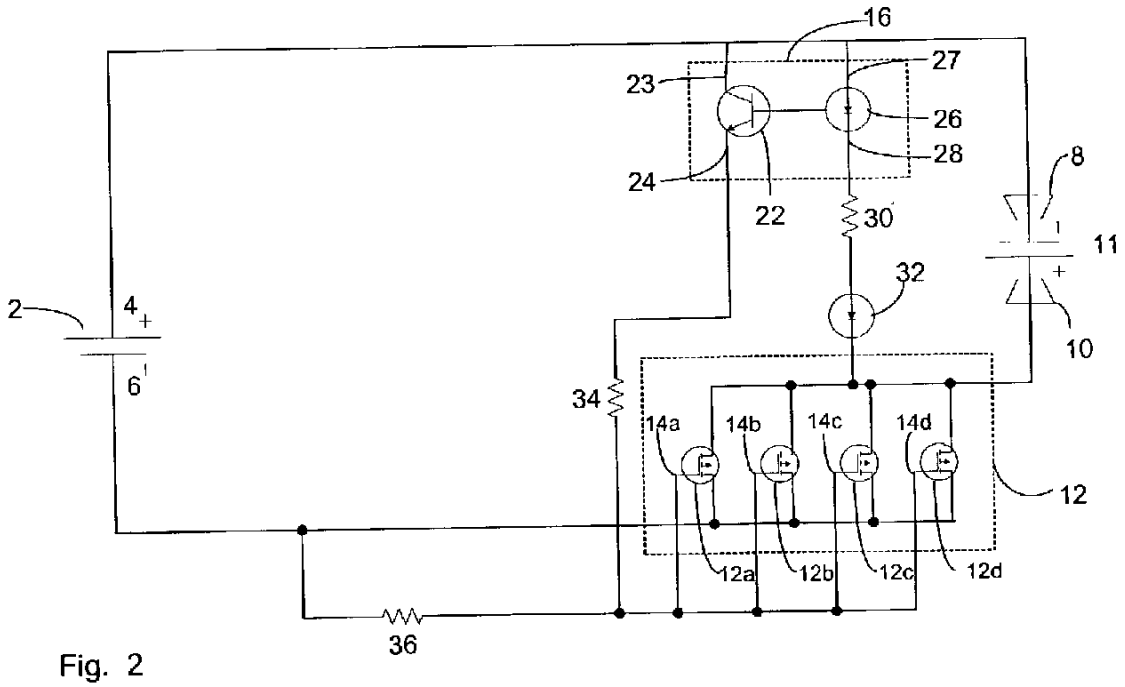

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Fig. 2

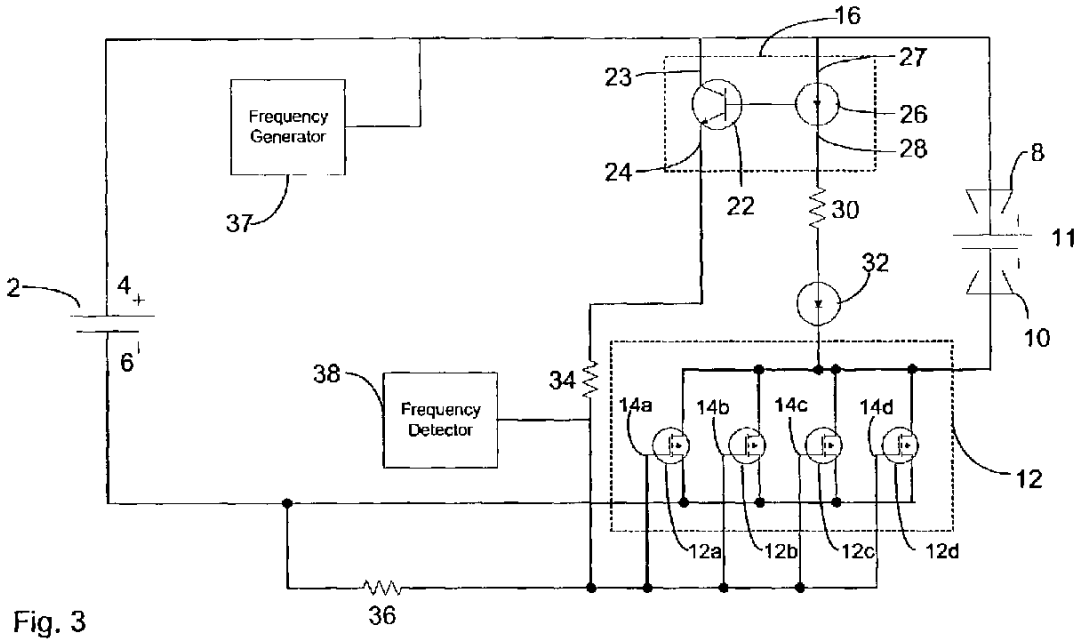

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Frequency Detector
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Fig. 3

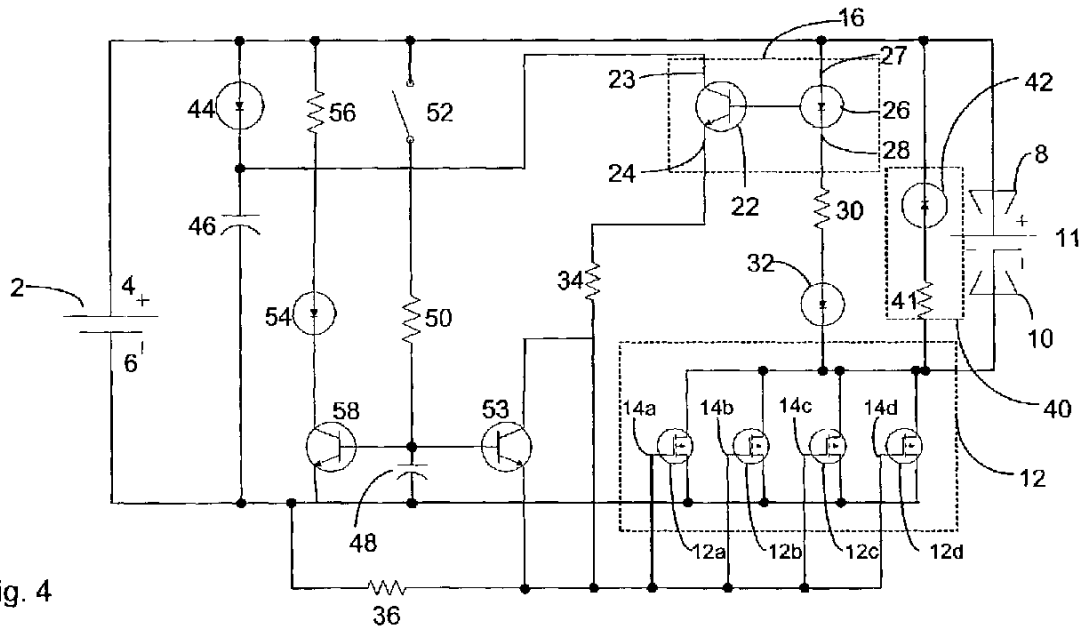

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Fig. 4

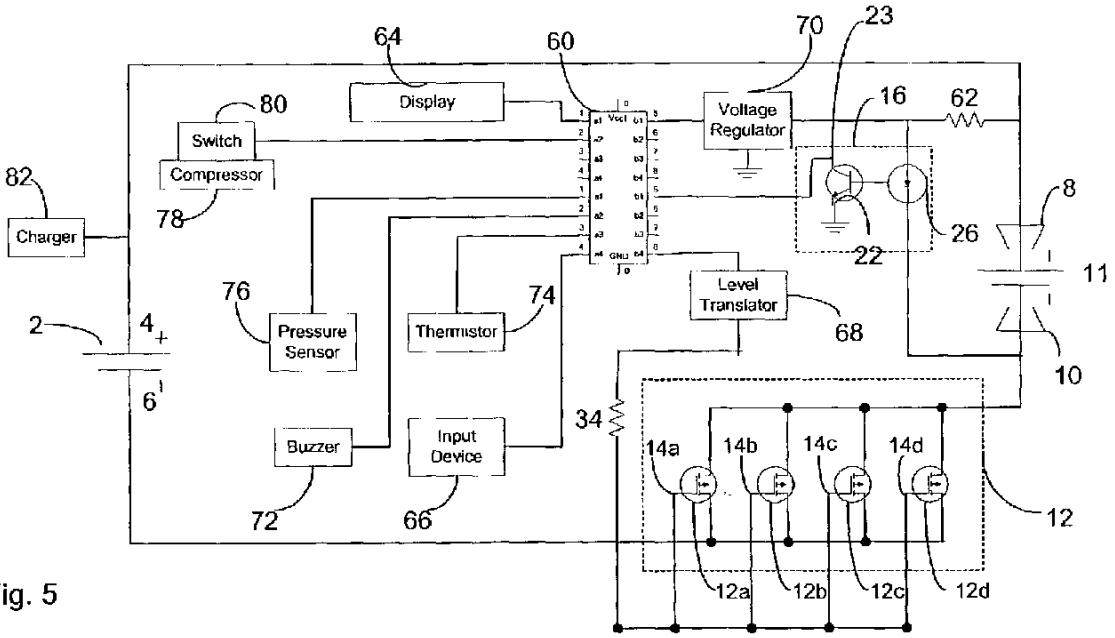

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Display
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Switch
Compressor
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Charger
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Buzzer
Input Device
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14b
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66
12
12a
12b
12c
12d

Fig. 5

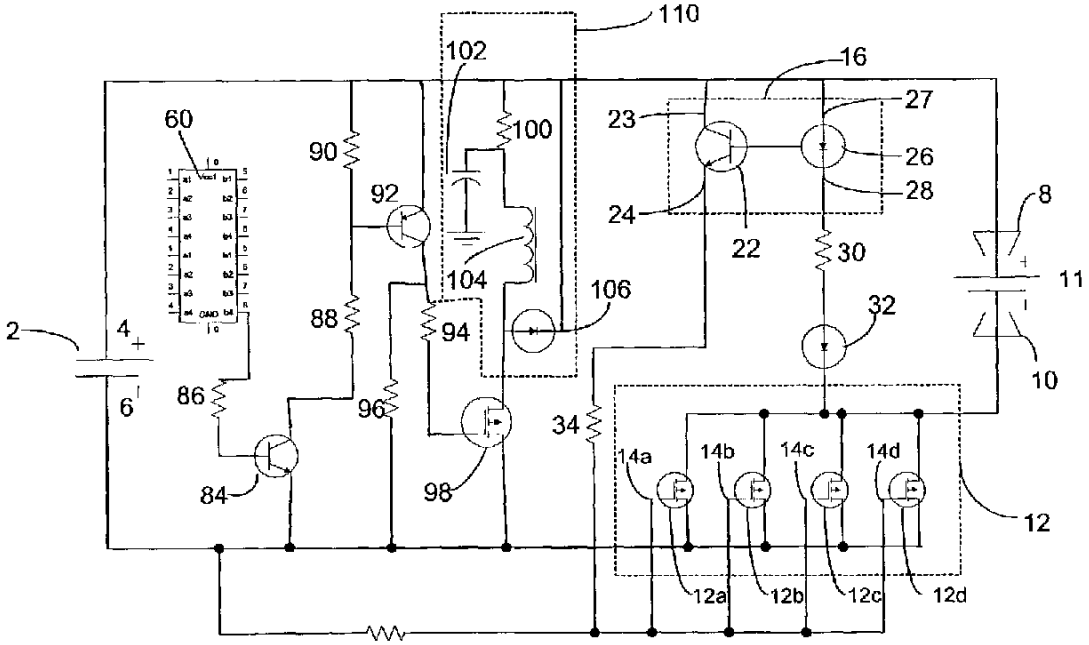

110
102
16
60
100
27
23
26
90
92
24
28
8
22
30
11
104
106
32
2
4
88
94
10
86
96
34
14a
14b
14c
14d
84
98
12
12a
12b
12c
12d
36

Fig. 6

MICROPROCESSOR CONTROLLED BOOSTER APPARATUS WITH POLARITY PROTECTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Application Ser. Nos. 60/357,146 filed Feb. 19, 2002 and 60/369,839 filed Apr. 5, 2002, the contents of both of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a booster device used for boosting a depleted battery and in particular to microprocessor control of the booster apparatus and a polarity protection circuit.

BACKGROUND OF THE INVENTION

[0003] It is well known that when an engine of an automobile is not able to be started due to insufficient electric power, a battery of the automobile can be jump started by power from a battery of another automobile or from a battery in a booster device to thereby start the engine.

[0004] To boost the battery of the automobile which is of insufficieut electric power by power from another battery, the two batteries must be connected through a pair of electric wires. For example, the positive terminal of the depleted battery should be connected to the positive terminal of the boosting battery. The negative terminals of the two batteries should be connected in a corresponding manner.

[0005] Making this connection, however, can be very dangerous if the batteries are connected incorrectly. A battery has a small internal resistance, and there is a voltage difference between a battery with sufficient electric power and a battery with insufficient electric power. Current will thus flow between the two batteries as soon as a connection is made. When the two batteries are connected correctly, which means that terminals of corresponding polarities are connected respectively as described above, a large current passes through the electric wires. When the two batteries are connected erroneously, a current which passes through the electric wires is 10 to 20 times larger than the current existing on the electric wires when the batteries are correctly connected. Additionally, incorrect connection may result in one or both of the batteries being short-circuited. Under such conditions, one or both of the batteries may be damaged, and in some cases, an explosion, fire and damage to the vehicle or to a person may result.

[0006] Thus, there is a need for a device, which can be used to ensure that the connection of the two batteries is made correctly and in a safe manner. The device should minimize any risk resulting from incorrect connection between the two batteries and from a short-circuit of one or both of the batteries.

[0007] The failure of an engine of an automobile to start due to insufficient electric power, in addition to being due to a battery with insufficient power, may also be due to a bad alternator that has failed to replenish the charge ou an otherwise good battery. With a bad alternator, even if the battery is replaced, the new battery does not accumulate electric charge, and its charge is soon drained out again. A bad alternate r needs to be replaced in order to prevent recurring low battery problems. Detecting a bad alternator, however, is not an easy task to an inexperienced person.

[0008] Also, other simple tasks such as checking the air pressure of a tire, checking for freon gas leakage, and inflating a tire to a proper pressure can often be difficult to those without the necessary experience and know-how. It would also be convenient to know the state of the charge of the jump starter battery itself, as well as the state of charge the depleted battery before and after a jump start.

[0009] There is therefore a need for a self-contained jump starter system that can be used as a jump starter, tester, and diagnostic system for a vehicle to assist in performing vehicle diagnostics and minor vehicle repairs. There is also a need for a portable, self-contained jump starter system of the above type that is rugged, has a minimum number of components, is user friendly to people who are not experienced with automobiles, provides self-testing and vehicle diagnostics, and is relatively inexpensive so as to be affordable by a large number of consumers.

SUMMARY OF THE INVENTION

[0010] A polarity protection circuit is provided. According to an exemplary embodiment, the polarity protection circuit is comprised of solid-state devices. Preferably no mechanical or electro-mechanical devices, such as solenoids are included in the polarity protection circuit. The polarity protection circuit is electrically counected to the battery to be charged (depleted battery) and to a boosting battery or other power source. The polarity protection circuit prevents current flow between the batteries unless proper polarity is achieved. The polarity protection circuit is described below in the context of a battery booster device, but it can be used in conjunction with any charging or boosting device.

[0011] Typically, a battery booster device comprises a pair of cables connected at one end to a built-in battery or other power source arranged in a portable box. The other ends of the cables are connected to a pair of alligator clamps. The built-in battery provides a DC power source for boosting a depleted battery. When the clamps are connected to the depleted battery, current flows from the built-in battery of the battery booster device to the depleted battery. As mention above, a polarity protection circuit is provided in the booster device and prevents current flow between the batteries unless a proper polarity connection between the two batteries is achieved.

[0012] In a further embodiment, the battery booster device may also comprise a microprocessor. The microprocessor can be used as part of a polarity protection circuit. It may also perform additional detection and control functions, such as detecting a bad alternator, detecting a freon leak, and detecting low tire pressure and controlling an air compressor to address the low tire pressure. In connection with this, the booster device may further include a display and/or other notification devices, such as a visual or audio indicator.

[0013] In another embodiment of the invention, a polarity detection circuit is provided. The circuit comprises: cables for conuecting a boosting battery to a depleted battery; a polarity sensing circuit coupled to the boosting battery for providing an enable signal when a correct polarity connection is made between the boosting battery and the depleted battery; and a solid state switch coupled to the polarity

sensing circuit, the solid state switch permitting current flow between the boosting battery and the depleted battery when it receives the enabling signal.

[0014] In another exemplary embodiment, a booster apparatus is provided. The apparatus comprises: a boosting battery having a positive terminal and a negative terminal; a first cable coupled to the positive terminal of the boosting battery and having a clamp for connection to a terminal of a depleted battery; a second cable coupled to the negative terminal of the boosting battery and having a clamp for connection to another terminal of the depleted battery; a solid state switch arranged in series with one of the cables; a polarity sensing circuit coupled between the first cable and the second cable, the polarity sensing circuit providing an enable signal to place the solid state switch in a conducting state when a correct polarity connection is made between the boosting battery and the depleted battery.

[0015] In a further embodiment, a booster apparatus comprises: means for providing power; means for connecting the means for providing power to a depleted battery; means for detecting polarity of the connection between the means for providing power and the depleted battery and for generating an enable signal when correct polarity is detected; and at least one field-effect transistor (FET) having a control electrode and being coupled to the means for detecting polarity, the control electrode receiving the enable signal and turning the FET on to allow current flow between the means for providing power and the depleted battery.

[0016] In another embodiment, a jump starter system comprises: a boosting battery having positive and negative terminals; a pair a battery cables having first ends connected to the positive and negative terminals, respectively, of the boosting battery and second ends adapted for connection to positive and negative terminals of a depleted battery; a semiconductor switch connected electrically with one of the terminals of the boosting battery and the battery cable respectively connected thereto; a polarity sensing circuit coupled to the battery cables and producing a first signal only when the battery cables connect the positive terminal of the boosting battery to the positive terminal of the depleted battery and the negative terminal of the boosting battery to the negative terminal of the depleted battery; and a microprocessor coupled to the semiconductor switch and the polarity sensing circuit and being responsive to the first signal from the polarity sensing circuit for activating the semiconductor switch to enable a current flow between the boosting battery and the depleted battery.

[0017] In another embodiment, a computer-readable information storage medium for use with a computer controlling a jump starter system, comprising a first battery having positive and negative terminals, a pair a battery cables having first ends connected to the positive and negative terminals, respectively, of the first battery and second ends adapted for connection to positive and negative terminals of a depleted battery in a vehicle, the computer-readable information storage medium sto res computer-readable program code for causing the computer to perform the steps of: checking for a rapid rise in voltage after the vehicle has been started; indicating the alternator is working properly if the rapid rise in voltage is present; and indicating the alternator is not working properly if the rapid rise in voltage is not present.

[0018] In another embodiment, a computer-readable information storage medium for use with a computer controlling a jump starter system, comprising a first battery having positive and negative terminals, a pair a battery cables having first ends connected to the positive and negative terminals, respectively, of the first battery and second ends adapted for connection to positive and negative terminals of a depleted battery, the computer-readable information storage medium stores computer readable program code for causing the computer to perform the steps of: measuring a charge rate of the battery; determining an amount of time the battery has been receiving a current; measuring a voltage of the battery; and detecting an overtime fault if the charge rate is greater than a predetermined current, the battery has been receiving a current longer than a predetermined amount of time, and the voltage of the battery is greater than or equal to a predetermined voltage.

[0019] In another embodiment, a computer-readable information storage medium for use with a computer controlling a jump starter system, comprising a first battery having positive and negative terminals, a pair a battery cables having first ends connected to the positive and negative terminals, respectively, of the first battery and second ends adapted for connection to positive and negative terminals of a depleted battery, the computer-readable information storage medium stores computer-readable program code for causing the computer to perform the steps of: measuring a charge rate of the battery; determining an amount of time the battery has been receiving a current; measuring a voltage of the battery; and detecting a shorted cell battery fault if the charge rate is greater than a predetermined current, the battery has been receiving a current more a predetermined amount of time, and the voltage of the battery is less than or equal to a predetermined voltage.

[0020] In another embodiment, a computer-readable information storage medium for use with a computer controlling a jump starter system, comprising a first battery having positive and negative terminals, a pair a battery cables having first ends connected to the positive and negative terminals, respectively, of the first battery and second ends including clamps adapted for connection to positive and negative terminals of a depleted battery, the computer-readable information storage medium stores computer-readable program code for causing the computer to perform the steps of: measuring a voltage at the clamps; indicating a bad battery fault if no voltage is detected at the clamps; and proceeding with a jump starting operation if a voltage is detected at the clamps.

[0021] In another embodiment, a computer-readable information storage medium for use with a computer controlling jump starter system, comprising a first battery having positive and negative terminals, a pair a battery cables having first ends connected to the positive and negative terminals, respectively, of the first battery and second ends adapted for connection to positive and negative terminals of a depleted battery, the computer readable information storage medium stores computer-readable program code for causing the computer to perform the steps of: measuring a charge current of the battery; determining an amount of time the battery has been receiving current; measuring a voltage of the battery; and detecting an open cell battery fault if the charge current is less than a predetermined current, the battery has been

receiving current more a predetermined amount of time, and the voltage of the battery is greater than or equal to a predetermined voltage.

BRIEF DESCRIPTION OF THE FIGURES

[0022] **FIG. 1** is a circuit schematic that illustrates a polarity protection circuit according to a preferred embodiment of the invention;

[0023] **FIG. 2** is a circuit schematic that illustrates a polarity protection circuit according to another preferred embodiment of the invention;

[0024] **FIG. 3** is a circuit schematic that illustrates a polarity protection circuit according to another preferred embodiment of the invention;

[0025] **FIG. 4** is a circuit schematic that illustrates a polarity protection circuit according to another preferred embodiment of the invention;

[0026] **FIG. 5** is a circuit schematic that illustrates a microprocessor controlled booster system according to another embodiment of the invention; and

[0027] **FIG. 6** is a circuit schematic that illustrates a microprocessor controlled booster system according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] **FIG. 1** illustrates a battery booster device including a polarity protection circuit according to an exemplary embodiment of the invention. A boosting battery **2** with a positive terminal **4** and a negative terminal **6** is provided in the booster device. The positive terminal **4** of the boosting battery **2** is coupled to one of a pair of alligator clamps **8, 10** to be connected to a battery to be charged **11** (depleted battery) via a wire or battery cable. The negative terminal **6** of the boosting battery **2** is connected to the other of the alligator clamps **8, 10** to be connected to the battery to be charged **11** via a wire or battery cable.

[0029] A switch **12** is coupled to one of the wires or battery cables to be connected to the depleted battery **11**. The switch **12** is activated to complete a boosting circuit between the boosting battery **2** and the depleted battery **11** only when a correct polarity connection between the batteries is attained. In the embodiment shown, the switch **12** is arranged between the negative terminal **6** of the boosting battery **2** and the alligator clamp **10** intended to be connected to the negative terminal of the depleted battery **11**. The switch **12** is thus a current handling device a nd part of the boosting circuit. Of course, other locations of the switch in the boosting circuit are possible.

[0030] The switch **12** is preferable a solid state device, such as a transistor, diode, field effect transistor (FET), etc. **FIG.** 1 represents the switch **12** as a number FETs **12***a*-**12***d* connected in parallel with each other. The FETs **12***a*-**12***d* are preferably high power, very low on-resistance types. The number of FETs provided depends upon the current flow in the circuit and the type of FET used. Control electrodes **14***a*-**14***d* of the FETs **12***a*-**12***d* are electrically connected to the negative terminal **6** of the boosting battery through a resistor **36**. This arrangement maintains the FETs **12***a*-**12***d* in an off or non-conducting state when there is no voltage at the clamps, preventing current flow from the boosting battery **2** to clamps **8, 10** and to the depleted battery **11**.

[0031] The switch **12** is activated by a polarity sensing circuit **16** to allow current flow from the boosting battery **2** to the depleted battery **11**. The polarity sensing circuit **16** is coupled to the boosting battery **2** and to the depleted battery **11** when the clamps **8, 10** are connected to the depleted battery **11**. The polarity sensing circuit **16** senses the polarity of the connection between the boosting battery **2** and the depleted battery **11** and provides a signal indicating the state of the connection. The signal from the polarity sensing circuit **16** is provided to the switch **12**. When a proper polarity connection is signaled, the switch **12** completes the boosting circuit and permits current flow to the depleted battery **11**.

[0032] In the embodiment shown in **FIG. 1**, the polarity sensing circuit comprises an opto-isolator **16**. The opto-isolator **16** comprises a phototransistor **22** and a light emitting diode (LED) **26**. A collector **23** of the phototransistor **22** and an anode **27** of the LED **26** are electrically connected to the positive terminal **4** of the boosting battery **2**. The emitter **24** of the phototransistor **22** is electrically connected to control electrodes **14***a*-**14***d* of the FETs **12***a*-**12***d* comprising the switch **12** via resistor **34**. The cathode **28** of the LED **26** is electrically connected to one of the electrodes of the FETs **12***a*-**12***d* through resistor **30** and diode **32**. The other of the electrodes of the FETs **12***a*-**12***d* is electrically connected to the negative terminal **6** of the boosting battery **2**.

[0033] During operation of the battery booster device depicted in **FIG. 1**, the FETs **12***a*-**12***d* are initially held in a non-conducting state via resistor **36**. The opto-isolator **16** only turns on when it is properly biased as a result of a correct polarity connection being made between the boosting battery **2** and the depleted battery **11**. When the LED **26** is properly biased, phototransistor **22** in the opto-isolator **16** turns on. Current flow through phototransistor **22** biases the control electrodes of the FETs **12***a*-**12***d* into a conducting state, enabling current flow through the FETs **12***a*-**12***d* to the depleted battery **11**. More specifically, when the depleted battery **11** is properly connected to the boosting battery **2** as shown in **FIG. 1**, the LED **26** and diode **32** are forward biased. Current thus flows through these diodes and resistor **30**. Resistor **30** is provided to regulate the amount of current that flows through the opto-isolator **16**. The current flow through LED **26**, resistor **30** and diode **32** activates the phototransistor **22**, turning it on. When the phototransistor **22** is turned on, current flows through the phototransistor **22**, resistor **34** and to the control electrodes of the FETs **12***a*-**12***d*. The control electrodes of the FETs **12***a*-**12***d* are activated in response to this current, and the FETs **12***a*-**12***d* are turned on into a conducting state. The boosting circuit is now closed, and current can flow from the boosting battery **2** through the FETs **12***a*-**12***d* to the depleted battery **11**. The re is no need for any mechanical or electro-mechanical devices, as the FETs are the current handling devices.

[0034] When an improper polarity connection is made between the boosting battery **2** and the depleted battery **11**, as shown in **FIG. 2**, the LED **26** in the opto-isolator **16** and diode **32** are reversed biased. Diode **32** prevents current flow from the depleted battery **11** in a reverse direction. Thus, there is essentially no current flow through the LED **26**,

diode **32** and resistor **30**. Consequently, the phototransistor **22** in the opto-isolator **16** is in a non-conducting state. In turn, the FETs **12***a*-**12***d* of the switch are in a non-conducting state, and there is essentially no current flow from the boosting battery **2** to the depleted battery **11**, preventing a potentially dangerous situation.

[**0035**] Once a proper polarity connection is made between the batteries, the depleted battery **11** is charged or the vehicle is jump started. The alligator clamps **8**, **10** are then disconnected from the battery to be charged **11**. When the clamps are disconnected, diode **26** is no longer forward biased and no current flows therethrough, turning the phototransistor **22** in the opto-isolator off, which in turn, turns the FETs **12***a*-**12***d* off. The boosting circuit is then, in effect, reset, preventing short-circuits or a reverse polarity connection being made after a proper polarity connection is made. In a further embodiment, described below in conjunction with **FIG. 3**, the battery booster device can be provided with a disable switch that interrupts the boosting circuit to ensure the safe disconnection of the clamps from the depleted battery **11** or a microprocessor or other circuitry can be programmed to detect when the depleted battery is disconnected.

[**0036**] Turning now to **FIG. 3**, another embodiment of the present invention is described. The embodiment shown in **FIG. 3** operates in a similar manner to the embodiment described above in regard to **FIG. 1**. **FIG. 3** differs from **FIG. 1** in that **FIG. 3** includes a frequency generator and a frequency detector. The frequency generator and frequency detector are used to detect disconnection of the clamps **8**, **10** from the depleted battery **11** or other interruption of the boosting circuit. The frequency generator **37** is adapted to inject a signal of a particular frequency into the boosting circuit. A frequency detector **38** is adapted to detect the frequency injected into the boosting circuit by the frequency generator **37**. The frequency generator **37** and frequency detector **38** are preferably arranged on opposite sides of depleted battery **11**. When the depleted battery **11** is connected with proper polarity, a path exists for the frequency injected by the frequency generator **37** to travel through the circuit. The frequency detector **38** detects the injected frequency, and the battery boosting process proceeds normally. When the clamps **8**, **10** are removed from the depleted battery **11** or the circuit is otherwise interrupted, current flow is stopped, and the frequency detector **38** no longer detects the frequency injected by the frequency generator **37**. The frequency detector is adapted to then turn FETs **12***a*-**12***d* to a non-conducting state, resetting the boosting circuit. This prevents short circuits or a reverse polarity connection being made after a proper polarity connection has been established.

[**0037**] **FIG. 4** illustrates another embodiment of the present invention. The embodiment shown in **FIG. 4** includes many of the same elements described above in connection with FIGS. **1-3**. These same elements are labeled with the same reference numbers in all the figures. The circuit shown in **FIG. 4** operates in a manner similar to that described above in regard to FIGS. **1-3**, and only the differences are described in detail below.

[**0038**] The embodiment of the invention shown in **FIG. 4** includes an indicator **40** for indicating when a proper polarity connection between booster battery **2** and depleted battery **11** is established. The indicator **40** may provide a visual or audio indication to a user that a proper polarity connection has or has not been established. The indicator **40** illustrated in **FIG. 4** includes a resistor **41** and an LED **42**. When the alligator clamps **8**, **10** are connected to the depleted battery **11**, the resistor **41** and LED **42** are connected across the terminals of the depleted battery **11**. If the alligator clamps **8**, **10** are connected to depleted battery **11** with an incorrect polarity, LED **42** is forward biased and is illuminated indicating an incorrect connection. However, essentially nothing else occurs in the boosting circuit. The opto-isolator **16** prevents any other current flow. For example, the LED **26** in the opto-isolator **16** and diode **32** are reversed biased, preventing current flow in a reverse direction. Thus, there is no current flow through these diodes and resistor **30**. Consequently, the phototransistor **22** in the opto-isolator **16** remains off. In turn the FETs **12***a*-**12***d* remain in a non-conducting state and there is no current flow from the boosting battery **2** to the depleted battery **11**.

[**0039**] If the alligator clamps **8**, **10** are connected to the depleted battery **11** with a proper polarity the LED **42** is reverse biased and is not illuminated. The opto-isolator **16** is turned on, and the boosting circuit is completed as described above in connection with **FIG. 1**.

[**0040**] In some instances during the jump-starting process, the voltage of the boosting battery **2** may drop to low levels, for example, 2 volts or lower. In such instances, the voltage of the boosting battery **2** may become insufficient to maintain the FETs **12***a*-**12***d* in a conducting state. Thus, a means for maintaining the FETs **12***a*-**12***d* in a conducting state is provided. In the embodiment shown in **FIG. 4**, this means comprises a diode **44** and a capacitor **46** arranged in series with each other and connected across the terminals **4**, **6** of the boosting battery **2**. An anode of diode **44** is coupled to the positive terminal **4** of the boosting battery **2**. The collector of the phototransistor **22** in the opto-isolator **16** is coupled between the diode **44** and the capacitor **46**. The combination of the diode **44** and the capacitor **46** provides a high level of gate voltage that is required to keep the FETs **12***a*-**12***d* in a conducting state even if the boosting battery's voltage decays to a low level.

[**0041**] The embodiment of **FIG. 4** also includes a means for interrupting the current flow to the depleted battery **11** after a proper polarity connection has been established. This means for interrupting allows for safe removal of the alligator clamps **8**, from the depleted battery **11**. The means for interrupting in the illustrated embodiment includes a combination of capacitor **48**, resistor **50**, switch **52** and transistor **53**. These elements are used to turn the FETs **12***a*-**12***d* into a non-conducting state to allow for safe removal of the alligator clamps **8**, **10**. For example, switch **52** is coupled to one of the cables attached to one of clamps **8**, **10**. Resistor **50** and capacitor **48** are coupled to the other of the cables and connected in series with switch **52**. Switch **52** may be a momentary switch that when depressed, charges capacitor **48** through resistor **50**. The charging of capacitor **48** turns transistor **53** into a conducting state. The current flow from phototransistor **22** in the opto-isolator **16** is thus short-circuited across the control electrodes of the FETs **12***a*-**12***d*, turning the FETs **12***a*-**12***d* into a non-conducting state. Thus, the connection between the two batteries **2**, **11** is open circuited and the alligator clamps **8**, **10** can be safely removed from depleted battery **11**.

[0042] Further, an indicator for indicating it is safe to remove the alligator clamps from the depleted battery **11** may also be provided. In **FIG. 4**, the indicator includes LED **54**, resistor **56** and transistor **58** coupled in series between the cables. A control electrode of the transistor **58** is coupled to switch **52**. When switch **52** is depressed, transistor **58** is turned on by the current flow through the switch **52**. Current thus flows through the transistor **58** and resistor **56**, illuminating LED **54**. Illuminated LED **54** indicates it is safe to remove the alligator clamps **8**, **10** from the depleted battery **11**.

[0043] Referring now to **FIG. 5**, an example of a microprocessor controlled jump starter system according to an embodiment of the invention is described. The microprocessor **60** can be programmed to perform essentially all of the control functions needed for operation of the jump starter. A display **64** and an input device **66** may be coupled to the microprocessor **60** to enable an operator to receive information from and input information into the microprocessor **60**, respectively.

[0044] By way of a feedback circuit or other means, the microprocessor **60** can monitor the voltage and/or current being supplied to the depleted battery **11** from the booster battery **2**, the voltage and/or current of the battery **11** and can detect short circuits or other faults, as described in more de tail below. A resistive divider may be used to provide the voltage and current measurements to the microprocessor's A/D input. A visual or audio indication of the faults is given, for example on display **64**. A scrolling message describing the fault, a representative code, or other message may be displayed.

[0045] In this embodiment, microprocessor **60** is used to control the switch **12**. Opto-isolator **16** is coupled to clamps **8**, **10** via resistor **62** such that LED **26** is forward biased when a correct polarity connection between the boosting battery **2** and the depleted battery **11** is made. When forward biased, LED **26** turns on phototransistor **22**. The collector **23** of the phototransistor **22** is coupled to a supply voltage via internal circuitry in the microprocessor **60**. When the phototransistor **22** is on, a first signal of a first voltage is present at the collector **23** and is sensed by the microprocessor **60**. When the phototransistor **22** is off, a second signal of a second voltage is present at the collector **23** and is sensed by the microprocessor **60**. The microprocessor **60** provides output signals to activate the switch **12** into a conducting state when it receives the first signal and provides an output signal to deactivate the switch **12** into a non-conducting state when it receives the second signal. Additionally, the microprocessor can deactivate switch **12** to terminate the jnmp starting process when a fault is detected.

[0046] The ontput signals from the microprocessor **60** to control switch **12** are provided to control electrodes **14***a*-**14***d* of transistors **12***a*-**12***d*, as shown in **FIG. 5**. The control electrodes **14***a*-**14***d* of the transistors are electrically connected to the microprocessor **60** via a level translator **68**. Microprocessors normally run on low voltages, e.g., 5 volts. A low voltage power supply is provided to the microprocessor **60** from battery **2** via a voltage regulator **70**. The low voltage outpnt signals from the microprocessor **60** should be translated to higher voltages before being snpplied to the transistors **12***a*-**12***d*. The level translator **68** translates the output voltage of the microprocessor **60** to the higher levels that are needed to operate transistors **12***a*-**12***d*. Accordingly, the output signals from the microprocessor **60** are used by the level translator **68** to generate control signals for the control electrodes of the FETs.

[0047] If the polarity connections of clamps **8**, **10** to the depleted battery **11** are not correct, the switch **12** remains off. The display **64** may be controlled by the microprocessor **60** to display a message indicating reverse polarity. The microprocessor **60** may additionally activate an alarm such as buzzer **72** in response to the incorrect polarity connection.

[0048] Microprocessor **60** can be programmed to detect if clamps **8**, **10** are connected to a battery or have been disconnected. To perform the detection, the microprocessor **60** deactivates the switch **12** into a non-conducting state. Via the feedback circuit or other means, the microprocessor detects whether clamps **8**,**10** are connected to a battery. If no battery is present, the switch **12** is placed in a non-conducting state, that is, all the FETs **12***a*-**12***d* are placed in a non-conducting state. If a battery is present, the jump starting process continues. The check is preferably performed about once a second and takes less than a few thousandths of a second to complete. As such, the check is transparent to the operation of the jump starter. A comparator or operational amplifer can also be used to perform this check.

[0049] The microprocessor **60** may also be used to conduct a test of an alternator of a vehicle. When the alternator of a vehicle is working properly, the voltage level of the depleted battery **11** rises rapidly immediately after the battery is jump-started. The rapid rise in voltage can be detected by the microprocessor **60** based on the signals the microprocessor receives from opto-isolator circuit **16**. If a rapid rise in voltage is detected, a message that the alternator is working properly may be shown on display **64**. If no rapid rise in voltage is detected, then a message that the alternator may be malfunctioning can be shown on display **64**. The rapid rise in voltage may vary depending on how depleted the battery **11** is. The microprocessor is preferably programmed to account for this variance.

[0050] According to a further embodiment of the invention, the booster system may include a freon gas leakage sensor. The sensor **74** may comprise a thermistor for sensing temperature changes due to the extreme cold produced at the point of a freon leak. The sensor **74** may alternatively comprise a transducer, snch as a pressnre transducer, to sense the point of a freon leak, since freon is under a high pressure in the system and the point of a leak presents a high pressure zone. The sensor is coupled to the microprocessor **60**. The sensor generates an electrical signal upon detection of some physical change, e.g., a temperature or pressure change accompanying freon gas leakage. Upon receiving such a signal from the sensor **74**, the microprocessor **60** may cause a message indicating a leak to appear on the display **64**.

[0051] According to another embodiment of the invention, the booster system includes means for checking the inflation of the tires of the vehicle. An air pressure sensor **76** may be provided to measure the air pressure of the tires. The air pressure sensor **76** is coupled to an input of the microprocessor **60**. The microprocessor **60** receives an air pressure measurement from the air pressure sensor **76** and displays the air pressure to the operator via display **64**. Additionally,

a built-in compressor **78** can be connected to the microprocessor **60** through a switch **80**. According to this embodiment of the invention, a desired pressure is selected via the input device **66**. The compressor **78** is then controlled by microprocessor **60** to inflate the tire to the selected a ir pressure. The compressor **78** is automatically deactivated by the microprocessor **60** when the desired pressure is attained.

[0052] According to yet another embodiment of the invention, the microprocessor **60** can be programmed to detect the charge levels of the boosting battery **2** and the depleted battery **11**. The detected charge levels can then be communicated to an operator via display **64**. Voltage regulator **70** is coupled to the boosting battery **2** and the depleted battery **11** for detecting their charge levels.

[0053] In order to measure the charge level of the boosting battery **2**, clamps **8, 10** should be disconnected from the depleted battery **11**. The voltage regulator then produces a voltage proportional to the voltage of the boosting battery **2**, and which is within the operating range of the microprocessor **60**. The microprocessor **60** is programmed to detect when the voltage of tbe boosting battery **2** falls below a predetermined level, for example, about 80% of its rated value. The buzzer **72** or other device can then be activated to indicate to the operator that the charge of the boosting battery **2** is low and that it should be recharged. The booster system may be plugged into a standard 110/220-volt electrical outlet via a standard wall charger **82** to recharge the boosting battery **2**.

[0054] In order to measure the voltage of the depleted battery **11**, switch **12** between the boosting battery **2** and the depleted battery **11** should be in a non-conducting state. Microprocessor **60** can be controlled via operator input from input device **66** to place switch **12** in a non-conducting state. Clamps **8, 10** are then connected to the depleted battery **11**. The voltage regulator produces a voltage proportional to the voltage of the depleted battery **11**. The microprocessor **60** receives this signal from the voltage regulator **70** and determines and displays the voltage of the depleted battery **11** on display **64**.

[0055] The microprocessor **60** can also be programmed to detect a bad battery or a battery whose voltage is too low to be jump started. Normally, even a dead battery bas some voltage, usually about 3-5 volts. Occasionally, however, a battery does not have any voltage as it is so deeply depleted that the battery is totally dead. This type of battery cannot be immediately jump started, and sometimes it can not even be charged at all. When the clamps **8, 10** are connected to this type of battery, it is as if the jump starter is not connected to anything. As the voltage of such a battery is extremely low, the microprocessor **60** does not detect any voltage at the clamps **8, 10**. A fault is displayed if an attempt is made to jump start a vehicle with this type of battery.

[0056] This type of fault may also be detected if there is no battery connected to clamps **8,10** or a poor connection is made to the depleted battery **11** and the jump starter is activated. When the fault occurs, the microprocessor **60** can be programmed to terminate the jump starting process and to display a suggestion to a user that the battery be reconditioned before jump starting is attempted or to check if the clam ps **8, 10** are properly connected to the battery **11**.

[0057] In another embodiment of the invention, the microprocessor **60** is programmed to determine the cold-cranking amps (CCA) available from the depleted battery **11**. CCA is the amount of power exerted by a battery when starting a vehicle on a cold day. The definition by Battery Council International (BCI) is the discharge load in amperes which a new fully charged battery at 0 degrees Farenheit can deliver for 30 seconds and maintain a voltage of 1.2 volts per cell or higher.

[0058] CCA is determined in the described embodiment by connecting a resistance in parallel with the battery **11**. The resistance should be connected for a short period of time so not to drain the battery. The voltage of the battery is determined when under the load of the resistance. The lower the voltage of the battery under the load is, the lower the CCA of the battery is. The microprocessor is programmed to correlate the measured voltage to a CCA value. The CCA value may then be displayed to the user.

[0059] If a battery has a shorted cell, it is unlikely that the battery voltage will increase as it is attempted to provide a charge to the battery and jump start the vebicle. However, a charge must be provided to the battery for some period of time before it can be determined if the battery has a shorted cell. The microprocessor **60** can be programmed to monitor the voltage, current, and time of charging to detect a shorted cell. If a charge rate of the battery is greater than a predetermined current, the battery has been charging more a predetermined amount of time, and the voltage of the battery is less than or equal to a predetermined voltage, a shorted cell is detected. For example, if the charge rate of the battery is greater than 2 amps, the battery has been charging for more than 1 hour, and the voltage of the battery is less than or equal to about 11 volts, the jump starting process is terminated, and a shorted cell fault is indicated to the user.

[0060] The process for detecting an open cell battery is similar to the process for detecting a sborted cell battery. An open cell battery has some voltage due to leakage between the open cell and its connectors. However, the open cell battery does not have the ability to either accept or deliver current. When the jump starter is connected to an open cell battery, the microprocessor detects a voltage at the clamps **8, 10**, but when the jump starting process begins, no appreciable current is detected. If no current is detected after a predetermined period of time, for example five minutes, an open cell battery is detected, the jump starting process is ended, and the appropriate fault displayed.

[0061] Many vehicles have interface ports for providing basic engine diagnostic data. The jump starter system may further have an interface for downloading basic engine diagnostic data from an interface port of such vehicles. The jump starter system may additionally have a printer port for printing information for record keeping or analysis. Memory inside the microprocessor **60** can be used for storing data that is used for later review and analysis.

[0062] Further, the microprocessor **60** may run a self-test on the booster to determine whether all components of the booster system are running properly. Each component is turned on and off quickly to determine if any malfunctions exist. Results of the self-test may be displayed on the display **64**. Buzzer **72** or another alarm may be activated to indicate any malfunctions.

[0063] Also, the microprocessor **60** can be programmed to sound the buzzer **72** or other alarm when there is information

shown on the display **64** and when there is an error/fault condition, such as detection of a low charge level of the changing battery **2** or detection of a bad alternator.

[**0064**] In another embodiment, the microprocessor **60** controls a de-sulfating process. The electrode plates of lead-acid vehicle batteries collect sulfur deposits over time which eventually render the battery useless. However, hy removing the sulfur deposits from the plates, such a hattery can be rejuvenated, that is, re-conditioned. It is known that battery reconditioning can be achieved by applying periodic short current bursts (on the order of microseconds) from the boosting battery **2** to the depleted battery **11**. According to this embodiment of the invention, the microprocessor **60** is programmed to initiate the de-sulfating process through its control of the switch **12** and to display a "de-sulfating in progress" message on the display **64**. An exemplary embodiment of circuitry that may be used to perform the de-sulfating process is shown in **FIG. 6**.

[**0065**] **FIG. 6** includes many of the same components discussed above in regard to the preceding figures. In addition to those components, a transistor **84** is coupled to microprocessor **60** via resistor **86**. Microprocessor **60** outputs a signal to a control electrode of transistor **84**, turning transistor **84** on and off. When transistor **84** is turned on, current flows through resistors **88** and **90**, turning on transistor **92**. In turn, current flows through transistor **92**, and resistors **94** and **96**, turning on transistor **98**. Transistor **98** acts as a switch for activating a pulse generating circuit **110** that generates a pulsing current used to condition the battery **11**. Wheu transistor **98** is in a conducting state, current flows through resistor **100**, capacitor **102**, inductor **104**, and diode **106**, which comprise the pulse generating circuit **110**, to generate a current pulse.

[**0066**] The display **64**, which may be, for example, a scrolling or flashing display, displays information available to the microprocessor **60** which may include, but which is not limited to, results of the self test, the status or condition (e.g., percent of charge) of the jump starter battery **2** as well as of the depleted **11**, a "Warning: Reverse Polarity" message if a polarity of counectious of the jump starter system is not correct, a "Ready to Start" message when everything is properly connected, a "De-Sulfating in Progress" message when a de sulfating process is in progress, and various other diagnostics including, for example, detection of a bad alternator, desired and actual pressure readings from those jump starter systems that have air compressors and/or pressure sensors, and freon gas leakage readings for those jump starter systems that have freon gas leakage sensors.

[**0067**] In summary, the microprocessor can be programmed to control the polarity protection operation, performing of diagnostics of the vehicle battery and other systems, scanning of the display, various functions of the microprocessor initiated by operator input through the input device, conducting a de-sulfating process, activating the buzzer or other alarm, detection of freon leaks, basic engine diagnostics which may interface with the vehicle's interface port, re-charging the jump starter battery, and inflation of tires based on a stored value or on user input. The above listing of functions is intended to be exemplary and is not exhanstive of the types of functions that the microprocessor can control in the context of the jump starter system disclosed herein. The embodiments illustrated and discussed in this specification are intended only to teach those skilled in the art the best way known to the inventors to make and use the invention. Nothing in this specification should be considered as limiting the scope of the present invention. The above-described embodiments of the invention may be modified or varied, and elements added or omitted, without departing from the invention, as appreciated by those skilled in the art in light of the above teachings. It is therefore to be understood that, within the scope of the claims and their equivalents, the invention may be practiced otherwise than as specifically described.

We claim:

1. A polarity detection circuit, comprising:

cables for connecting a first battery to a depleted battery;

a polarity sensing circuit coupled to the first battery for providing an enable signal wheu a correct polarity connection is made between the first battery and the depleted battery; and

a solid state switch coupled to the polarity sensing circuit, the solid state switch permitting current flow between the first battery and the depleted battery when it receives the enable signal.

2. The polarity detection circuit of claim 1, further comprising:

a safety switch that when activated prevents the solid state switch from permitting current flow between the first battery and the depleted battery.

3. The polarity detection circuit of claim 1, whereiu the polarity sensing circuit comprises an opto-isolator.

4. The polarity detection circuit of claim 1, whereiu the polarity sensing circuit comprises an LED coupled to one of the cables, the diode being forward biased when a correct polarity connection is made between the first battery and the depleted battery; aud

a phototransistor coupled to the diode, current flow through the forward biased LED turning on the phototransistor to provide the enable signal.

5. The polarity detection circuit of claim 1, wherein the solid state switch comprises at least one transistor.

6. The polarity detection circuit of claim 5, whereiu the current from the first battery flows through the at least one transistor to the depleted battery.

7. The polarity detection circuit of claim 1, whereiu the solid state switch comprises at least one FET having a control electrode, the control electrode receiving the enable signal to place the FET into a conducting state.

8. The polarity detection circuit of claim 7, wherein the FET is a part of a current path between the first battery and the depleted battery.

9. The polarity detection circuit of claim 1, further comprising a frequency generator coupled to one of the cables and injecting a signal of a predetermined freqnency into that cable.

10. The polarity detection circuit of claim 9, further comprising a frequency detector coupled to the other one of the cables, the frequency detector preventing the solid state switch from permitting current flow between the first battery and the depleted battery when the frequency detector ceases to detect the signal of predetermined frequency injected by the frequency generator.

11. A booster apparatus, comprising:

a first battery having a positive terminal and a negative terminal;

a first cable coupled to the positive terminal of the first battery and being provided with means for connecting to a terminal of a depleted battery;

a second cable coupled to the negative terminal of the first battery and being provided with means for connecting to another terminal of the depleted battery;

a solid state switch coupled in series with one of the cables and the first battery;

a polarity sensing circuit coupled between the first cable and the second cable, the polarity sensing circuit providing an enable signal to place the solid state switch in a conducting state when a correct polarity connection is made between the first battery and the depleted battery.

12. The booster apparatus of claim 11, wherein only a single cable is connected to each terminal of the depleted battery.

13. The booster apparatus of claim 11, wherein the solid state switch comprises a plurality of transistors connected in parallel with each other between one of the means for connecting and one of the terminals of the first battery.

14. The booster apparatus of claim 13, wherein the transistors are a part of a current path between the first battery and the depleted battery.

15. The booster apparatus of claim 11, further comprising:

a frequency generator coupled to one of the first and second cables and injecting a frequency into that cable; and

a frequency detector coupled to the other one of the first and second cables, the frequency detector opening the solid state switch when the frequency detector ceases to detect the frequency from the frequency generator.

16. The booster apparatus of claim 11, further comprising a microprocessor coupled to the solid state switch and the polarity sensing circuit and being responsive to the enable signal from the polarity sensing circuit to control the solid state switch to enable a current flow between the first battery and the depleted battery.

17. The booster apparatus of claim 16, wherein the depleted battery is intended for use in a vehicle.

18. The booster apparatus of claim 16, further comprising a display coupled to the microprocessor for displaying selected outputs of the microprocessor and an input device for accepting operator inputs to the microprocessor for controlling the jump starter system.

19. The booster apparatus of claim 16, further comprising at least one sensor connected to an input of the microprocessor for producing a signal representing a measured value.

20. The booster apparatus of claim 16, further comprising an audible alarm connected to an output of the microprocessor, wherein the microprocessor is connected to the first battery for automatically measuring the voltage of the first battery and producing a signal to activate the alarm when the voltage of the first battery is below a predetermined level.

21. The booster apparatus of claim 18, further comprising an air compressor controlled by an output of the microprocessor.

22. The booster apparatus of claim 21, wherein the microprocessor is programmed to accept a desired tire inflation pressure value input by an operator via the input device and to display the desired pressure on the display, the microprocessor automatically controlling the air compressor to inflate a tire to the desired pressure by comparing a measured pressure of the tire to the desired pressure until the desired pressure is attained.

23. The booster apparatus of claim 16, wherein the polarity sensing circuit comprises an opto-isolator.

24. The booster apparatus of claim 23, wherein the opto-isolator includes a uni-directional current conducting, light emitting component that only conducts current when the battery cables connect the positive terminal of the first battery to the positive terminal of the depleted battery and the negative terminal of the first battery to the negative terminal of the depleted battery.

25. The booster apparatus of claim 16, further comprising:

a safety switch opening the solid state switch to thus disable current flow between the first battery and the depleted battery.

26. The booster apparatus of claim 16, further comprising:

a high voltage providing circuit for keeping the solid state switch in a conducting state even if the voltage of the first battery decays to a low level.

27. The booster apparatus of claim 25, further comprising:

an indicator for indicating that the cables can be safely removed from the depleted battery.

28. The booster apparatus of claim 16, further comprising:

an indicator for indicating that a correct polarity connection is made between the first battery and the depleted battery.

29. The booster apparatus of claim 16, further comprising:

a measurement device for measuring the voltage of at least one of the first battery and the depleted battery.

30. The booster apparatus of claim 29, wherein the voltage is measured at least one of before the depleted battery is charged and after the depleted battery is charged.

31. The booster apparatus of claim 16, further comprising:

a de-sulfating circuit controlled by the microprocessor for de-sulfating a battery.

32. The booster apparatus of claim 16, further comprising means for detecting a voltage surge after the depleted battery is jump started.

33. The booster apparatus of claim 16, wherein the microprocessor is programmed to detect a voltage surge after the depleted battery is jump started.

34. A portable booster apparatus, comprising:

means for providing power;

means for connecting the means for providing power to a depleted battery;

means for detecting polarity of the connection between the means for providing power and the depleted battery and for generating an enable signal when a correct polarity is detected; and

at least one FET having a control electrode and being coupled to the means for detecting polarity, the control electrode receiving the enable signal and placing the FET into a conducting state to allow current flow between the means for providing power and the depleted battery.

35. The booster apparatus of claim 34, further comprising means for indicating a correct polarity connection to a user.

36. The booster apparatus of claim 35, wherein the means for indicating comprises a LED.

37. The booster apparatus of claim 34, further comprising means for interrupting current flow after a correct polarity connection has been established.

38. The booster apparatus of claim 37, further comprising at least one sensor connected to an input of the microprocessor for producing a measured signal representing the presence of the depleted battery at the means for connecting and wherein the means for interrupting comprises a microprocessor programmed to place the FET in a non-conducting state if no depleted battery is present.

39. The booster apparatus of claim 38, wherein the microprocessor is programmed to place the at least one FET in a non-conducting state, then check the measured signal about once every second, and place the at least one FET in a conducting state if a depleted battery is present.

40. The booster apparatus of claim 37, wherein the means for interrupting comprises a momentary switch adapted to short circuit the control electrode of the FET when depressed.

41. The booster apparatus of claim 37, further comprising an indicator for indicating when current flow has been interrupted.

42. The booster apparatus of claim 34, further comprising:

means for injecting a signal of a predetermined frequency into the means for connecting; and

means for detecting frequency coupled to the means for connecting on an opposite side of the depleted battery than the means for injecting, the means for detecting placing the FETs into a non-conducting state when the means for detecting ceases to detect the frequency from the means for injecting.

43. The booster apparatus of claim 34, wherein the means for detecting polarity comprises an opto-isolator.

44. A jump starter system, comprising:

a first battery having positive and negative terminals;

a pair a battery cables having first ends connected to the positive and negative terminals, respectively, of the first battery and second ends adapted for connection to positive and negative terminals of a depleted battery;

means for measuring a charge rate of the depleted battery;

means for determining an amount of time the depleted battery has been charging;

means for measuring a voltage of the depleted battery; and

means for detecting at least one of an overtime fault, a shorted cell battery fault, a bad battery fault, and an open cell battery fault based on at least one of the charge rate, amount of time and voltage of the depleted battery.

45. The charger claim 44, further comprising a display on which fault is visually indicated.

46. The charger of claim 44, wherein the means for detecting detects the overtime fault if the charge rate is greater than a predetermined current, the depleted battery has been charging longer than a predetermined amount of time, and the voltage of the depleted battery is greater than or equal to a predetermined voltage.

47. The charger claim 46, wherein the predetermined current is 2 amps, the predetermined time is 18 hours, and the predetermined voltage is 12 volts.

48. The charger of claim 44, wherein the means for detecting detects the shorted cell battery fault if the charge current is greater than a predetermined current, the depleted battery has been charging more a predetermined amount of time, and the voltage of the depleted battery is less than or equal to a predetermined voltage.

49. The charger claim 48, wherein the predetermined time is 1 hour, and the predetermined voltage is 11 volts.

50. The charger of claim 44, wherein the means for detecting detects the bad battery fault if no voltage is detected at the means for measuring.

51. The charger of claim 44, wherein the means for detecting detects the open cell battery fault if the charge current is less than a predetermined current, the depleted battery has been charging more a predetermined amount of time, and the voltage of the depleted battery is greater than or equal to a predetermined voltage.

52. A computer-readable information storage medium for use with a computer controlling a jump starter system, comprising a first battery having positive and negative terminals, a pair a battery cables having first ends connected to the positive and negative terminals, respectively, of the first battery and second ends adapted for connection to positive and negative terminals of a depleted battery, the computer-readable information storage medium storing computer-readable program code for causing the computer to perform the steps of:

measuring a charge rate of the depleted battery;

determining an amount of time the depleted battery has been charging;

measuring a voltage of the depleted battery; and

detecting at least one of an overtime fault, a shorted cell battery fault, a bad battery fault, an open cell battery fault, and an alternator fault based on at least one of the charge rate, amount of time and voltage of the battery.

53. The computer-readable information storage medium of claim 52 further comprising code for causing the computer to perform the step of visually indicating the fault on a display.

54. The computer-readable information storage medium of claim 52 further comprising code for causing the computer to perform the step of detecting the overtime fault if the charge rate is greater than a predetermined current, the depleted battery has been charging longer than a predetermined amount of time, and the voltage of the depleted battery is greater than or equal to a predetermined voltage.

55. The computer-readable information storage medium of claim 54, wherein the predetermined current is 2 amps, the predetermined time is 18 hours, and the predetermined voltage is 12 volts.

56. The computer-readable information storage medium of claim 52 further comprising code for causing the computer to perform the step of detecting the shorted cell battery fault if the charge current is greater than a predetermined current, the depleted battery has been charging more a

predetermined amount of time, and the voltage of the depleted battery is less than or equal to a predetermined voltage.

57. The computer-readable information storage medium of claim 56, wherein the predetermined time is 1 hour, and the predetermined voltage is 11 volts.

58. The computer-readable information storage medium of claim 52 further comprising code for causing the computer to perform the steps of:

indicating the bad battery fault if no voltage is detected at the second ends of the cables; and

proceeding with a charging operation if a voltage is detected at the second ends of the cables.

59. The computer-readable information storage medium of claim 52 further comprising code for causing the computer to perform the step of detecting the open cell battery fault if the charge current is less than a predetermined current, the depleted battery has been charging more a predetermined amount of time, and the voltage of the depleted battery is greater than or equal to a predetermined voltage.

60. The computer-readable information storage medium of claim further comprising code for causing the computer to perform steps of:

checking for a rapid rise in voltage after the vehicle has been started;

indicating the alternator is working properly if the rapid rise in voltage is present; and

indicating the alternator is not working properly if the rapid rise in voltage is not present.

* * * * *

AUSTRALIA

Patents Act

IN THE MATTER of Australian Patent Application No. 2016269555 in the name of The NOCO Company

- and -

Opposition thereto by Brown & Watson International Pty Ltd

ANNEXURE MD-4

The attached is **Annexure MD-4** referred to in the Declaration of Declaration of Max Dirnberger declared on 6th day of September 2019 in the above matter.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 April 2004 (29.04.2004)

PCT

(10) International Publication Number
WO 2004/036714 A2

(51) International Patent Classification[7]: H02J

(21) International Application Number: PCT/US2003/018746

(22) International Filing Date: 16 June 2003 (16.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/270,391 15 October 2002 (15.10.2002) US
PCT/US03/02147 24 January 2003 (24.01.2003) US

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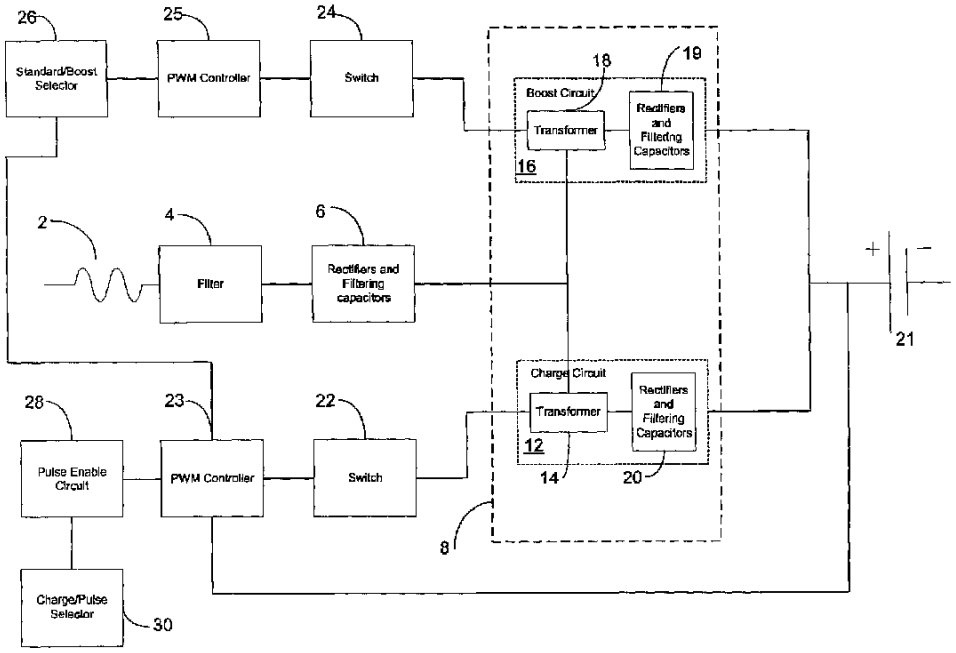
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

[Continued on next page]

(54) Title: HIGH FREQUENCY BATTERY CHARGER AND METHOD OF OPERATING SAME



(57) Abstract: A high frequency charger includes a charge circuit for charging a depleted battery and a boost circuit for jump-starting a vehicle. Two separate high frequency transformers are provided for the charge and boost circuits. A selector switch selectively activates at least one of the charging circuit and the boost circuit.

WO 2004/036714 A2

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

HIGH FREQUENCY BATTERY CHARGER AND METHOD OF OPERATING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

Priority is claimed with respect to PCT/US03/02147, filed January 24, 2003 which claims priority of U.S. Application Serial No. 10/270,391 filed October 15, 2002 and U.S. Provisional Application Nos. 60/363,202 filed March 11, 2002 and 60/350,897 filed January 25, 2002.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a battery charger or booster and in particular to a high frequency charger.

Technical Background

Dual-mode battery chargers currently exist. When operated in a first mode, the battery charger delivers a high current output for a short duration of time. This short duration, high current can be used to jump-start a vehicle with a dead battery. In a second mode, the battery charger provides a low current output that is used to charge the battery back to its full charge. Known dual-mode battery chargers typically use a single large transformer to achieve the dual-mode capability. The single transformer is usually a linear type transformer. A tap of a primary winding of the transformer is changed in order to achieve the dual capability with the linear-type transformer. As the tap of the transformer is changed, the output voltage, and hence, according to Ohm's Law, the output current of the transformer is changed, resulting in the dual-mode capability. Use of a single transformer for both modes of operation has the advantage of being very cost-efficient and very effective.

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However, this approach also has several disadvantages. One of the disadvantages is that known single transformer battery chargers are very large and cumbersome. Standard linear transformers require iron for their cores, adding to the weight of the battery charger. They also require orders of magnitude more wire to form their windings than do high frequency chargers, again adding to the weight of the battery charger.

Additionally, although the linear transformer can provide a high current output, the high current output can only be provided for a very short period of time. As the transformer operates in high current mode, it generates an excessive amount of heat. In fact, so much heat may be generated that the transformer actually melts down. If a meltdown occurs, the transformer will not operate in either the high current mode or the low current mode. Linear transformers are also very lossy in terms of magnetic losses and eddy current losses, resulting in inefficiency.

Further, to charge an automobile battery that is of insufficient electric power by providing power from another power source, like a battery charger, the power source and the battery must be connected through a pair of electric wires, typically having clamps at their ends for connection to the battery. Making this connection can be very dangerous if there is a problem with the connection. For example, it is well known that sparking or arcing often occurs when a connection is being attempted between a battery charger and a battery. Additionally, sparking or arcing may occur when the clamps are connected to the battery with a reverse polarity. Sparking or arcing can also occur even after an apparently good connection is made. The sparking or arcing may occur due to corroded or poor terminal connections.

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In the past, the use of a delay circuit or "soft start" was used to prevent sparking. A delay circuit prevents power flow to the battery from occurring until a connection is made between the battery and the battery charger. This method helps to prevent sparking upon the initial connection of the battery and battery charger. However, it does not prevent any sparking that occurs as a result of poor or corroded connections, the existence of which can only be determined after current flow begins. Sparking or arcing may result in damage to the battery, and under certain circumstances, an explosion, fire and damage to the vehicle or to a person may result.

Additionally, a characteristic of liquid electrolyte type batteries, particularly lead acid batteries used in vehicles, is that chemical compound deposits slowly build up on the plates to partially or entirely cover and displace the normal plate surfaces. Low current recharging is inadequate in that it can not, as such, sufficiently remove such deposits that with the passage of time crystallize and choke the battery plates by interfering with electrolyte movement. When this occurs a battery may still appear to have taken a charge and even the electrolyte may check as being correct, but the battery does not hold the charge because the plates are effectively shorted. Batteries using other electrolytes also face reclaiming, maintenance and charging problems that need to be successfully addressed.

Thus, there is a need for a method to release the deposits that are built up on the plate surfaces, where the deposits may either go back into the solution or be broken up. There is also a need for a simple and lightweight dual-mode battery charger. The battery charger should be able to provide a high current output that is sufficient to start an automobile or other vehicle with a dead battery, yet be easy to construct and safe to operate.

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According to a variation on the preceding embodiment of the invention, there is provided a high frequency charger that includes a charge circuit and a boost circuit. In this embodiment, the charge circuit and the boost circuit are constructed using a single high frequency transformer having two windings on its primary side, a charge winding and a boost winding. The charge winding and the boost winding effectively form (along with the single secondary winding) the first and second high frequency transformers of the preceding embodiment of the invention (and may thus be thought of as the two separate transformers in other embodiments of the invention). The boost winding is adapted to provide a high current that can be used to jump-start a vehicle with a depleted battery.

DEFINITIONS:

In describing the invention, the following definitions are applicable throughout this application.

A "computer" refers to any apparatus that is capable of accepting a structured input, processing the structured input according to prescribed rules, and producing results of the processing as output. Examples of a computer include a computer; a general-purpose computer; a supercomputer; a mainframe; a super mini-computer; a mini-computer; a workstation; a microcomputer; a processor; a server; an interactive television; a hybrid combination of a computer and an interactive television; and application-specific hardware to emulate a computer and/or software. A computer can have a single processor or multiple processors, which can operate in parallel and/or not in parallel. A computer also refers to two or more computers connected together via a network for transmitting or receiving information between the computers. An example of such a computer includes a distributed computer system for processing information via computers linked by a network.

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A "computer-readable medium" refers to any storage device used for storing data accessible by a computer. Examples of a computer-readable medium include a magnetic hard disk; a floppy disk; an optical disk, like a CD-ROM or a DVD; a magnetic tape; a memory chip (e.g., ROM or RAM); and a carrier wave used to carry computer-readable electronic data, such as those used in transmitting and receiving e-mail or in accessing a network.

"Software" refers to prescribed rules to operate a computer. Examples of software include software; code segments; instructions; computer programs; and programmed logic.

A "computer system" refers to a system having a computer, where the computer comprises a computer-readable medium embodying software to operate the computer.

SUMMARY OF THE INVENTION

According to an embodiment of the invention, a high frequency charger for charging a battery is provided. The charger comprises a charge circuit including a first high frequency transformer. A first switch switches the first high frequency transformer at a first frequency. The charger also includes means for measuring a charge rate of the battery; means for determining an amount of time the battery has been charging; means for measuring a voltage of the battery; and means for detecting an overtime fault if the charge rate is greater than a predetermined current, the battery has been charging longer than a predetermined amount of time, and the voltage of the battery is greater than or equal to a predetermined voltage.

In another embodiment, the high frequency charger comprises: a charge circuit including a first high frequency transformer; a first switch switching the first high frequency transformer at a first frequency; means for measuring a charge rate of the battery; means for

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determining an amount of time the battery has been charging; means for measuring a voltage of the battery; and means for detecting a shorted cell battery fault if the charge rate is greater than a predetermined current, the battery has been charging more a predetermined amount of time, and the voltage of the battery is less than or equal to a predetermined voltage.

In another embodiment, the high frequency charger for charging a battery comprises a charge circuit including a first high frequency transformer; a first switch switching the first high frequency transformer at a first frequency; clamps for connecting the charger to the battery; means for measuring a voltage at the clamps; means for indicated a bad battery fault if no voltage is detected at the clamps.

In another embodiment, the high frequency charger comprises a charge circuit including a first high frequency transformer; a first switch switching the first high frequency transformer at a first frequency; means for measuring a charge current of the battery; means for determining an amount of time the battery has been charging; means for measuring a voltage of the battery; and means for detecting an open cell battery fault if the charge current is less than a predetermined current, the battery has been charging more a predetermined amount of time, and the voltage of the battery is greater than or equal to a predetermined voltage.

According to an embodiment of the invention, there is provided a high frequency charger that includes a charge circuit and a boost circuit. In a preferred embodiment, the charge circuit includes a first high frequency transformer. A switch switches this first high frequency transformer at a predetermined frequency. The boost circuit includes a second high frequency transformer that is separate from the first high frequency transformer in the charge circuit. The

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first and second high frequency transformers are operated in a similar manner. However, the boost circuit is adapted provide a high current that can be used to jump-start a vehicle with a depleted battery.

According to a variation on the preceding embodiment of the invention, there is provided a high frequency charger that includes a charge circuit and a boost circuit. In this embodiment, the charge circuit and the boost circuit are constructed using a single high frequency transformer having two windings on its primary side, a charge winding and a boost winding. The charge winding and the boost winding effectively_form (along with the single secondary winding) the first and second high frequency transformers of the preceding embodiment of the invention (and may thus be thought of as the two separate transformers in other embodiments of the invention). The boost winding is adapted to provide a high current that can be used to jump-start a vehicle with a depleted battery.

In a preferred embodiment, a PWM controller provides a driving signal to the switch such that the transformer of the charge circuit is switched to output a pulse. The pulse output of the charge circuit can be used to condition the battery.

As noted, the transformer in the charge circuit and the transformer in the boost circuit are preferably separate from each other, that is, there are two transformers and associated circuits. Thus, the battery charger is not dependent on the same transformer for both standard charging and boosting. For example, if the transformer in a conventional charger burns out while performing a boost function, all the functionality of the charger may be lost, as one transformer is used for both functions. However, in the present embodiment, either of the transformers still

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operates even if the other transformer is disabled for some reason.

A control circuit for a high frequency charger is also provided. In an exemplary embodiment, the control circuit includes a pulse width modulation (PWM) controller having a reference voltage input, a control input, and an output for a control signal. A switch receives the control signal and is switched on and off in response to the control signal. A voltage divider network divides the voltage applied to the reference voltage input and the control input. A duty cycle of the control signal output from the PWM controller varies based on the percentage of the reference voltage that is applied to the control.

In a further embodiment, the voltage divider network comprises a first resistor having a first terminal connected to the reference voltage input and a second terminal connected to the control input. A plurality of second resistors each has a first terminal connected to the second terminal of the first resistor and a second terminal. A plurality of transistors are also provided, each having a first electrode connected to the second terminal of one of the second resistors, a second electrode that is grounded, and a third electrode receiving an enable signal. The enable signal turns the transistors on and off, selectively connecting one of the second resistors to ground.

In another embodiment, a method for reducing arcing in a battery charger comprises: providing a test current that is lower than a charging current from the battery charger to a battery; detecting if the test current is present at the battery; if the test current is not detected at the battery, indicating a fault; and if the test current is detected at the battery, increasing the test current a predetermined amount and returning to the detecting step.

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According to another aspect of the invention there is provided a computer-readable storage medium for use with a computer for controlling a high frequency charger including a charge circuit having a first high frequency transformer; a first switch switching the first high frequency transformer at a predetermined frequency for producing a charge signal in a first mode of operation; the charge circuit operating in at least one of a pulse mode and a charge mode; and a selector for selecting one of the charge mode and the pulse mode, the computer-readable information storage medium storing computer-readable program code for causing the computer to perform the steps of: detecting a selected mode of operation for the charger; and when a pulse mode is selected, a) generating a driving signal for the first switch for a first period of time; b) disabling the first switch for a second period of time; and c) returning to step a).

According to yet a further aspect of the invention, there is provided a computer-readable information storage medium for use with a computer controlling a high frequency charger comprising a charge circuit including a high frequency transformer; and a switch switching the high frequency transformer at a predetermined frequency, the computer-readable information storage medium storing computer-readable program code for causing the computer to perform the steps of: checking a flag indicating the battery is in a bulk charge state or an absorption charge state; if the battery is in the bulk charge state, increasing a duty cycle of a driving signal for the first switch if a current provided by the battery charger is less than a desired current; decreasing the duty cycle of the driving signal for the first switch if a current provided by the battery charger is greater than the desired current; setting the flag indicating the battery is in the absorption charge

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stage when a voltage of the battery is greater than or equal a predetermined voltage and has been charging for a predetermined period of time, otherwise ending the charging process; if the battery is in the absorption charge stage, decreasing the duty cycle of the driving signal for the first switch if the voltage of the battery is greater than or equal to a predetermined voltage; increasing the duty cycle of the driving signal for the first switch if the voltage of the battery is less than the predetermined voltage; and stopping the charging process when the battery has been charging for more than a predetermined time.

According to yet another embodiment of the invention, computer-readable information storage medium for use with a computer controlling a high frequency charger comprising a charge circuit including a first high frequency transformer; a first switch switching the first high frequency transformer at a first frequency; a boost circuit including a second high frequency transformer; a second switch switching the second high frequency transformer at a second frequency, and a selector for selecting one of a charge mode for charging a depleted battery and a boost mode for supplying a boosting current to start a vehicle with the depleted battery, the computer-readable information storage medium storing computer-readable program code for causing the computer to perform the steps of: detecting a selected mode of operation; if the boost mode is selected, controlling the boost circuit to supplying a boosting current to the depleted battery; checking for a rapid rise in voltage after the vehicle has been started; if the rapid rise in voltage is present, indicating the alternator is working properly; and if the rapid rise in voltage is not present, indicating the alternator is not working properly.

According to yet another embodiment of the invention, a high frequency charger for charging a battery, comprises a

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charge circuit including a first high frequency transformer; a first switch switching the first high frequency transformer at a first frequency; a filter coupled to the first and second high frequency transformers for passing a DC voltage signal; means for coupling a resistance in parallel with the battery; means for measuring a voltage of the battery while the battery is coupled to the resistance; and means for correlating the measured voltage to a CCA value.

The above and other features of the invention, along with attendant benefits and advantages will become apparent from the following detailed description when considered with the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a block diagram showing a dual high frequency charger according to an embodiment of the present invention.

Figure 2 is a diagram of waveforms generated by control circuits according to an embodiment of the present invention.

Figure 3 is a circuit schematic in partial block diagram form showing an embodiment of the pulse enable circuit and the pulse width modulation controller shown in Figure 1.

Figure 4 is a block diagram of a battery charger according to a further embodiment of the invention.

Figure 5 is a block diagram of a battery charger according to a further embodiment of the invention.

Figures 6 and 7 are flow diagrams of a method according to an embodiment of the invention.

Figure 8 is a flow diagram of a method according to another embodiment of the invention.

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Figure 9 is a partial block diagram showing an alternative implementation of the dual high frequency charger embodiments of Figures 1 and 4.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Figure 1, there is shown a high frequency charger, according one embodiment of the invention, which includes a high frequency transformer portion 8. The high frequency transformer portion 8 typically receives a DC signal as its input. The DC signal can be provided from a battery or from an AC input. In the embodiment illustrated, an AC input 2, which may be provided by a typical wall-socket, is coupled to a filter 4, for example, a pi filter or an LC filter. The filter 4 is used to smooth and clean the AC input. An AC signal output from the filter 4 is provided to conventional rectifiers and filtering capacitors 6 for rectifying the AC signal. The rectifier is preferably a full-wave rectifier of a type known to one skilled in the art and provides a DC output of, for example, approximately 150 volts DC.

The full-wave rectified and filtered DC output from rectifier 6 is provided to the high frequency transformer portion 8 of the battery charger. The high frequency transformer portion 8 includes a charge circuit 12 and a boost circuit 16. The boost circuit 16 is used to provide a high current boost that can be used to jump-start a vehicle with a dead battery. The charge circuit 12 is used for normal charging of the battery. The operation of the boost circuit 16 and the charge circuit 12 may take place sequentially, in any order, or simultaneously. The charge circuit 12 and the boost circuit 16 each include a high frequency transformer 14, 18, respectively. A DC output from the rectifiers and filtering capacitors 6 is provided to each of the high frequency transformers 14, 18.

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Transformers typically receive an AC input and provide an AC output. For example, a transformer plugged into an ordinary wall-socket is provided with a 120-Volt AC input and outputs an AC signal that is dependent on the secondary winding of the transformer. Thus, high frequency transformers 14, 18 need to be manipulated to behave so that the DC signal from rectifiers 6 looks like an AC input. This manipulation is accomplished by switching the DC output from rectifier 6 through the high frequency transformers. The transformers are turned on and off at a high frequency, for example, about 20kHz and above. This switching causes the transformers to behave as though their input is AC.

This switching can be accomplished using essentially any type of switch, for example, a field effect transistor (FET) or other electronic switch. The high frequency transformers 14, 18 of the illustrated embodiment are switched by switches 22, 24, respectively, coupled thereto. The switches 22, 24 are, in turn, controlled by PWM controllers 23, 25. The PWM controller may be, for example, a TL 494 Motorola type controller or a discrete controller. The PWM controller generates a PWM driving signal for turning the switches on and off.

The charge circuit 12 is capable of operation in two modes, a charge mode and a pulse mode. In the charge mode, the charge circuit 12 operates to charge a battery. In the pulse mode, the charge circuit 12 operates to condition or desulfate a battery. A user may select between one of these two modes via selector 30. The selector 30 provides the user's selection to a pulse enable circuit 28. The pulse enable circuit 28 controls the PWM controller 23 in accordance with whether the charge mode or the pulse mode of operation is selected for the charge circuit 12.

When the pulse mode is selected, the pulse enable circuit 28 controls the PWM controller 23 to alternately be

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active and output a driving signal to the switch 22 and be inactive and not drive the switch 22. A cycle of enabling/disabling the switching of the switch 22 is repeated under the control of the PWM controller 23. Figure 2 illustrates exemplary output waveforms for the pulse enable circuit 28 and the PWM controller 23. In the pulse mode, the pulse enable circuit 28 is activated such that its output signal W_1 varies between low and high states as shown in Figure 2. The PWM controller 23 is activated depending upon the output signal W_1 of the pulse enable circuit 28. During a first time period t1, the output W_1 of the pulse enable circuit 28 is high and the PWM controller 23 is activated to generate a PWM driving signal W_2, as shown in Figure 2. The driving signal W_2 of the PWM controller 23 is provided to the switch 22, e.g., to the gate of a FET comprising switch 22, to turn it on and off. For example, the driving signal from the PWM controller 23 may have a duty cycle of less than 15% so that the FET is turned on for a very short period of time, outputs current to the battery, and is then disabled. The driving signal modulates the FET. During a second time period t2, the output W_1 of the pulse enable circuit 28 is low and the PWM controller is deactivated. No driving signal is provided to the FET, and the FET remains off. Pulsing of the high frequency transformer in this manner chops its output to condition the battery.

During the pulse mode, a series of output current pulses are generated by the battery charger and are provided to the discharged battery 21. The current pulses may have a frequency of about one pulse per second and a rise time of about 100 volts/microsecond or less.

When the charge mode is selected via selector 30, the PWM controller 23 is preferably always activated. Operation of the PWM controller 23 may be controlled in part via

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feedback from the battery 21 being charged. The duty cycle of the driving signal generated by PWM controller 23 is varied based on the charging state of the battery. A feedback signal from the battery being charged 21 to the PWN controller 23 provides the information on the charging state of the battery. The more power the battery needs, the higher the duty cycle; and the less power the battery needs, the lower the duty cycle. Switch 22 switches transformer 14 in accordance with the driving signal to charge the battery.

Referring again to Figure 1, boost circuit 16 is now described. Boost circuit 16 provides a high current pulse that can be used to jump-start a dead battery. The boost circuit 16 is enabled via a standard/boost selector 26, which a user can actuate. When actuated, selector 26 enables PWM controller 25 to generate a signal that drives switch 24, which, in an exemplary embodiment, comprises a FET. The frequency of the driving signal for FET 24 in the high power boost circuit can be the same as or different from the frequency of the driving signal for switch 22 in the charge circuit, for example, about 20kHz, or even higher. When the same frequency is used, the clock frequency for the PWM controller 23 associated with the charge circuit 12 to be shared by the PWM controller 25 for the high power boost circuit 16.

The high power boost circuit 16 receives a DC input from the rectifier 6. The DC input is provided to high frequency transformer 18 in the high power boost circuit 16. Preferably, the high frequency transformer 18 in the high power boost circuit 16 is separate from the high frequency transformer 14 in the charge circuit 12. The high frequency transformer 18 in the high power boost circuit 16 outputs a relatively high current with respect to the output of the charge circuit 12. For example, the current output from the boost circuit 16 may range from about 30 amps to about 500

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amps, compared to about 2-25 amps for the charge circuit 12. Additionally, the output from the boost circuit 16 is typically only generated for a short period of time, for example, about 3-40 seconds. Accordingly, the high frequency transformer 18 in the high power boost circuit 16 is preferably slightly larger than the high frequency transformer 14 in the charge circuit 12.

The high frequency transformer 18 has a duty cycle such that it may be on half the time and off the half the time, even though there may always be an output from the transformer that is rectified, filtered and used to recharge the battery. The PWM controller 25 is typically turned off for about 60-90% of the time and is turned on for about 10-40%, and then it is turned back off again to achieve the duty cycle for the high frequency charger. During the 10-40% of the time the PWM controller 25 is on, switch 24 switches the high frequency transformer. This provides a high current pulse out of the high frequency transformer through rectifier 19 to the battery to be charged.

Both the transformer 14 in the charge circuit 12 and the transformer 18 in the boost circuit 16 output an AC signal that needs to be converted to DC in order to be used by the battery. Therefore, the output of the high frequency charger in the charge circuit passes through standard rectifiers and filtering capacitors 19, 20 to provide a DC output. The high frequency transformer 14 in the charge circuit 12 is preferably a relatively small transformer capable of delivering a relatively low current, preferably between about between 2 and about 30 amperes, and a voltage corresponding to whatever the battery needs, for example, about 14.2 volts. The switching operation for the high frequency transformer 18 in the high power boost circuit 16 by switch 24 is preferably performed in a manner similar to that described above with regard to the charge circuit 12

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but, due to its different construction, results in a current output from the boost circuit from about 30 amps to about 500 amps.

Turning now to Figure 3, an example of circuitry that may comprise the pulse enable circuit 28 is described. In the illustrated embodiment, the pulse enable circuit 28 incorporates manual control of the PWM controller 23. A user can thus control the charging of the battery. The PWM controller 23 has an input 31 to which a reference voltage is applied, and a dead time control input 32. The dead time control input 32 controls the duty cycle of the driving signal from output 34 of the PWM controller 23 based on a percentage of the reference voltage that is applied to the dead time control input 32. For example, when the full reference voltage is applied to the dead time control input 32, the duty cycle of the output signal of PWM controller 23 is set to zero, the switch 22 (Fig. 1) is off, and no voltage is applied to the battery being charged. When no voltage is applied to the dead time control input 32, the duty cycle of the output signal of the PWM controller 23 is set to its maximum, and a maximum current is applied to the battery. The duty cycle of the driving signal from output 34 of the PWM controller 23 varies between these two extremes in dependence on the percentages of the reference voltage applied to dead time control input 32.

In the embodiment shown in Figure 3, a combination of a counter circuit 36 and a number of transistors 38-41 is used to control the percentage of the reference voltage that is applied to the dead time control input 32. The counter 36 is preferably either a low active device with diodes or a high output active decade counter, for example a 4017B CMOS IC. Of course other arrangements are possible within the scope of the invention. Outputs of the counter 36 are each connected to transistors. Four transistors 38-41 for four

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outputs of counter 36 are shown in Figure 3. The number of outputs and corresponding transistors may vary depending upon the type of counter used. Each transistor may be of a BJT or of a FET type. A control electrode of each transistor 38-41 is connected through a corresponding resistor 42-45 to a separate output of the counter 36. A first electrode in the main current path of each transistor 38-41 is coupled to ground. A second electrode in the main current path of each transistor 38-41 is coupled to a resistor 46-49, respectively. Each of the resistors 46-49 is coupled to the dead time control input 32 of the PWM controller 23. Each of the resistors 46-49 is also coupled to resistor 51, which is, in turn coupled to the reference voltage input 30 of the PWM controller 23.

The resistors 46-49, the associated transistors 38-41, and the resistor 51 form a voltage divider. The voltage difference between the reference voltage input 30 and the dead time control input 32 is controlled by the values of the resistors 46-49. For example, each of the resistors 46-49 can be selected to have a different resistance. The voltage drops across the resistors 46-49 will vary accordingly. Thus, the percentage of the reference voltage applied to the dead time control input 32 varies depending on which transistor 38-41 is turned on and the value of its associated resistor 46-49.

For example, as the counter 36 is clocked, one of the outputs of the counter 36 becomes active and turns on the respective transistor 38-41 connected to that output. Only one of the transistors 38-41 may be turned on at any one time. The turned on transistor 38-41 provides a current path from the dead time control input 32, through its respective resistor 46-49, to ground, thereby altering the voltage at the dead time control input 32 with respect to

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the voltage at the reference voltage input 30. Alternately, more than one of the transistors 38-41 is turned on.

A switch 53, such as a push button switch, may be coupled to a clock input 37 and used to clock the counter 36. For example, actuating the switch once clocks the counter 36 from the zero output to the first output, actuating the switch a second time clocks the counter 36 to the second output, and so on. As each output of the counter 36 becomes active, the transistor associated with that output turns on, altering the voltage at the dead time control input 32. Thus, the duty cycle of the driving signal from PWM controller 23 can be manually stepped through various levels.

Figure 4 is a block diagram of a battery charger according to another embodiment of the present invention. The embodiment shown in Figure 4 includes a microprocessor that controls many of the functions of the battery charger. The general operating principles of the battery charger are the same as for the previous embodiment and are not discussed in detail here.

In this embodiment, a microprocessor 50 is coupled to switches 22, 24, which may, for example, comprise FETs, and to the high frequency transformer portion 8. A display 52 is also coupled to the microprocessor 50. The display 52 is used to display various diagnostic and output information regarding the battery charger. User controls for turning the battery charger on and off, as well as the selectors 26, 30 (see Fig. 1) and the push-button switch 53 (Fig. 3) for controlling the operation of the battery charger in the step mode may also be coupled to the microprocessor 50.

The microprocessor 50 can be programmed to perform essentially all of the control functions needed for operation of the battery charger. For example, the microprocessor 50 can be programmed to control the charging

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process. When the charge/pulse selector 30 is actuated to select the charge mode, the microprocessor 50 receives this selection and controls the charging operation of the battery. This can be accomplished using the well-known negative delta V or other charge technique known to those of skill in the art. When the charge/pulse switch 30 is actuated to select the pulse mode, the microprocessor 50 receives this selection and controls the battery charger to perform the desulfation process. The microprocessor 50 may also include a timer such that the battery charger automatically shuts down after a predetermined period of time.

The microprocessor 50 can also monitor the charging operation. By way of a feedback circuit described below or other means, the microprocessor 50 can monitor the voltage and/or current being supplied to the battery from the battery charger and the voltage and/or current of the battery and can detect short circuits or other faults, as described in more detail below. A resistive divider may be used to provide the voltage and current measurements to the microprocessor's A/D input. A visual or audio indication of the faults is given, for example on display 52. A scrolling message describing the fault, a representative code, or other message may be displayed. The microprocessor 50 can also be programmed to control the actual pulse width modulation function. In this case, PWM controllers 23 and 25 (Fig. 1) can be eliminated and their functionality incorporated into the microprocessor 50.

In a further embodiment, the circuit shown in Figure 4 may include a logic setting that allows the high frequency charger to provide a power supply 56. The power supply 56 may be accessed via a typical cigarette plug adapter provided on the battery charger.

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The embodiments shown in Figures 1 and 4 may be alternatively implemented by incorporating the apparatus of Figure 9 to implement high frequency transformer portion 8. Figure 9 shows the use of a single high frequency transformer 18' to implement the two high frequency transformers 14 and 18. Switching circuits 22 and 24 are tied to different taps (18c' and 18b', respectively) of the primary side of transformer 18'. Lead 18a' of transformer 18' is coupled to the DC current source formed by components 2, 4, and 6 of Figures 1 and 4. As shown, switching circuit 24 controls a tap 18c' corresponding to a winding that implements the transformer 14 of the charge circuit 12, while switching circuit 22 controls a tap 18b' corresponding to a winding that implements the transformer 18 of the boost circuit 16. The latter winding necessarily produces the high current output needed to provide the boost function. The rectifiers and filtering capacitors 19' replace components 19 and 20 of Figure 1 and 4. Other components of the apparatus are as shown in Figures 1 and 4.

Figure 4 also illustrates a feedback circuit that may be provided to prevent the battery from being overcharged. The feedback circuit ensures that the proper amount of current is supplied to the battery. An opto-isolator 58 is coupled between the microprocessor 50 and the battery 21 being charged and provides information regarding the battery charging process to the microprocessor.

Additional polarity and short-circuit protection circuitry can also be provided, as shown in the embodiment of Figure 5. Figure 5 is a partial schematic diagram of a battery charger showing only the short circuit and polarity protection elements to simplify the understanding of this embodiment. The other elements of the battery charger can be included as shown in Figures 1, 3, and 4.

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In this embodiment, the battery charger is provided with a polarity detection circuit. Only when the polarity detection circuit detects that the battery has been connected to the battery charger with correct polarity is power supplied to the battery. Typically, the battery charger includes a pair of clamps 60, 61 for connection to the positive terminal and the negative terminal, respectively, of the battery to be charged 21. A polarity detection circuit detects the polarity of the connection of clamps 60, 61 and provides a signal to the microprocessor 50. In response to the signal from polarity detection circuit, the microprocessor controls the operation of the battery charger to supply power to the battery 21 or indicate an incorrect polarity accordingly.

In the embodiment illustrated in Figure 5, the polarity detection circuit includes an opto-isolator 62 connected to clamps 60, 61 and to microprocessor 50. The opto-isolator includes a light-emitting diode (LED) 63 and a phototransistor 65. When the battery 21 is connected with correct polarity, clamp 60 is connected to the positive terminal and clamp 61 is connected to the negative terminal of the battery 21. LED 63 is then forward biased and turns on phototransistor 65. When the phototransistor 65 is turned on, it provides a logic high signal to a pin a4 of the microprocessor 50. The logic high signal indicates to the microprocessor 50 that a correct polarity connection has been made. Connecting clamp 60 to the negative terminal of battery 21 reverse biases the LED 63, and no signal is provided to the microprocessor 50.

In response to the logic high signal, the microprocessor 50 outputs a control signal to a control circuit for completing the connection between the battery charger and the battery 21. Here, the control circuit includes a transistor 72 coupled between one of the clamps

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60, 61 and the charger circuit. Transistor 72 acts as a switch to connect battery 21 to the charger circuit. Only when switch 72 is closed will transistor 69 complete the connection between the battery charger and the battery 21. The opening and closing of transistor 72 is controlled via transistors 69 and 70. A control electrode of transistor 69 receives the control signal from the microprocessor. When the control signal is received, transistor 69 turns on, which, in turn, turns on transistor 70. Current flow through transistor 70 activates a control electrode for transistor 72 and turns transistor 72 on, completing the circuit between the charger circuit and battery 21. Only when the control signal is provided to transistor 69 is it possible for transistor 72 to be turned on.

Once a correct polarity connection has been established, the transistor 72 may remain on even after clamps 60, 61 are disconnected from the battery 21. The disconnected clamps are thus still powered-up. Therefore, a means for detecting the presence of a battery at the clamps may be provided. The microprocessor 50 can be programmed to detect when the clamps 60, 61 have been disconnected and, in response, turn transistor 72 off. A voltage divider comprised of resistors 74 and 76 is provided for this purpose. The voltage divider divides the voltage across the clamps 60, 61 and provides a portion of this voltage to the microprocessor 50. When the clamps are disconnected from the battery 21, the voltage across the clamps 60, 61 will greatly increase. The voltage provided by the voltage divider will also increase in a corresponding manner. When the voltage provided to the microprocessor 50 exceeds a selected amount, for example, 18 volts, the microprocessor 50 detects that the clamps 60, 61 have been disconnected and immediately turns off transistors 69 and 70, which turns off

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transistor 72. Various resistors, such as resistor 78, may also be included in the circuit.

According to another embodiment of the invention, the means for detecting the presence of a battery at the clamps may detect the presence of a current flowing through the clamps 60, 61, instead of, or in addition to the voltage across the clamps. The presence of a current flowing through the clamps 60, 61 may indicate whether the clamps 60, 61 are connected to a battery. A current flows through the clamps when they are connected to a battery and no current should flow through the clamps when they are not connected to a battery. The microprocessor 50 is adapted to detect the current flowing through the clamps 60, 61. When no current is detected, the microprocessor 50 detects that the clamps 60, 61 have been disconnected and immediately turns off transistors 69 and 70, which turns off transistor 72.

The means for detecting the presence of a battery at the clamps may also be used to detect a bad battery or a battery whose voltage is too low to be charged. Normally, even a dead battery has some voltage, usually about 3-5 volts. Occasionally, however, a battery does not have any voltage as it is so deeply discharged that the battery is totally dead. This type of battery cannot be immediately charged, if it can be charged at all. When the clamps of the battery charger are connected to this type of battery, it is as if the battery charger is not connected to anything. As the voltage of such a battery is extremely low, the microprocessor 50 does not detect any voltage across the clamps. A fault is displayed if an attempt is made to charge the battery. This type of fault will also occur if no connection or a poor connection is made to the battery 21 and the charger is activated. When the fault occurs, the microprocessor 50 can be programmed to display a suggestion

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to a user that the battery be reconditioned before charging is attempted or to check if the clamps are connected to a battery.

In another embodiment of the invention, the microprocessor 50 is programmed to determine the cold-cranking amps (CCA) available from the battery 21. CCA is the amount of power exerted by a battery when starting a vehicle on a cold day. The definition by Battery Council International (BCI) is the discharge load in amperes which a new fully charged battery at 0 degrees Farenheit can deliver for 30 seconds and maintain a voltage of 1.2 volts per cell or higher.

CCA is determined in the described embodiment by connecting a resistance in parallel with the battery 21. The resistance should be connected for a short period of time so not to drain the battery. The voltage of the battery is determined when under the load of the resistance. The lower the voltage of the battery under the load, the lower the CCA of the battery. The microprocessor is programmed to correlate the measured voltage to a CCA value. The CCA value may then be displayed to the user.

Turning now to Figures 6 and 7, here are illustrated flow diagrams of a software program that can be used to control the operation of the microprocessor according to an exemplary embodiment of the present invention. At the start of the program, the battery charger is initialized, steps 100-108. The microprocessor checks the state of the various user controls that may be provided on the battery charger. These controls may include, for example, the charge/pulse selector 30, the boost selector 26, and any other user controls. The state of the input controls is checked after a predetermined period of time has passed, for example, 200 microseconds, in order to allow the control signals to reach the microprocessor. During this initialization process and

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throughout the charging process, the microprocessor can detect various faults with the battery charger. For example, the battery charger may be provided with a temperature sensor that can detect the temperature of the battery. If the temperature of the battery is above a prescribed temperature, the microprocessor determines that the battery is overheated and shuts down the battery charger. A fault message may also be shown on display 52 indicating the overheated condition. If the sensed temperature is below the prescribed limit, the charging process proceeds.

Next, the microprocessor determines which of the operating modes (charging, pulsing, boosting, etc.) has been selected, steps 110-112. In the embodiment shown in figures 6 and 7, the processes for the charging mode and the battery-conditioning mode are illustrated. If none of the available operating modes has been selected, the process returns to the initialization step and checks the state of the input controls again.

Once an operating mode is selected, that selection may be shown to the user via display 52. For example, if the battery-conditioning mode has been selected, this selection is shown to the user via display 52, step 114. The battery conditioning mode is then begun. A timer is checked to determine if the battery charger has previously been operating in the battery-conditioning mode for a predetermined period of time. In this embodiment, it is checked if the battery charger has been operating in the battery-conditioning mode for 24 hours. If the charger has been operating in the battery-conditioning mode for greater than 24 hours, the battery conditioning process is complete and the process returns to the initialization step 102. If the battery conditioning process has been ongoing for less than 24 hours, the battery conditioning process continues.

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The battery charger pulses the battery to perform the conditioning. The switching of the FET switch 22 is controlled to generate the conditioning pulses, steps 118-124. For example, the microprocessor may enable the PWM controller 23 to switch the FET on and off for a period of time, about 50 microseconds. The PWM controller 23 is then turned off, disabling the FET switch 22. The FET is not switched when the PWN controller 23 is off. The PWM controller 23 may remain off for about 1 second. The process then returns to the step 114 and repeats until the battery conditioning operation has been performed for 24 hours, at which time the battery conditioning process is completed.

When the microprocessor detects that the charge mode has been selected, the process proceeds to step 126. Here, the charging current being supplied to the battery 21 is shown to the user via display 52. The microprocessor detects if the charging process is complete. This may be done by checking if a flag indicating that the charging process is complete is set. If the charge complete flag is set, the charger is turned off and a charge complete indicator, for example, an LED, is activated to indicate to a user that charging is complete. The process then returns to the initialization stage and awaits further instructions via the user input, steps 128-132.

If the charge complete flag is not set, the process proceeds to step 134 (in Figure 7) and detects if a battery is connected to the charger. This check can prevent current from being supplied from the battery charger unless a battery is connected to the battery charger, preventing a potentially hazardous situation. The means for detecting the presence of a battery at the clamps discussed above in connection with figure 5 can be perform this check. Additionally, the process for detecting a bad battery or a

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battery that has a voltage too low to be charged as described above may also be performed at this time. If a bad battery, a low voltage battery or no battery is detected, a fault is displayed; the charger may then be disabled in step 136, and the process returns to the initialization stage.

When a connection to a battery is detected, the microprocessor enables PWM controller 23 to generate a driving signal for FET switch 22, steps 138-142. If the charging process has already been initiated, these steps may be skipped. Next, it is determined if the battery charger is operating in a bulk charging mode or an absorption charging mode. This determination is made by examining an absorption stage flag. If the absorption stage flag is set, the battery is in the absorption charging mode, and the process proceeds according to step 168. If the absorption stage flag is not set, the battery is still in the bulk charging mode. The process then proceeds with step 146 to continue the bulk charging mode and to determine when the bulk charging mode has been completed.

Additional fault checks may be performed at this time to ensure the charging operation is proceeding correctly, steps 146-154. The fault checks may also be performed at other times during the process. The microprocessor can detect various faults, including a shorted cell battery, an open cell battery, and an overtime allowed for the charging process, among others. Various measurement means are provided to measure the required parameters and to supply this information to the microprocessor.

If a battery has a shorted cell, it is unlikely that the battery voltage will increase as it is attempted to charge the battery. However, charging must be attempted for some period of time before it can be determined if the battery has a shorted cell. The microprocessor can be

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programmed to monitor the voltage, current, and time of charging to detect a shorted cell. If a charge rate is greater than a predetermined current, the battery has been charging more a predetermined amount of time, and the voltage of the battery is less than or equal to a predetermined voltage, a shorted cell is detected. For example, if the charge rate of the battery is greater than 2 amps, the battery has been charging for more than 1 hour, and the voltage of the battery is less than or equal to about 11 volts, the charger is turned off, and a shorted cell fault is indicated to the user.

The process for detecting an open cell battery is similar to the process for detecting a shorted cell battery. An open cell battery has some voltage due to leakage between the open cell and its connectors. However, the open cell battery does not have the ability to either accept or deliver current. When the battery charger is connected to an open cell battery, the microprocessor detects a voltage at the clamps of the battery charger, but when the charging process begins, no appreciable current is detected. If no current is detected after a predetermined period of time, for example five minutes, an open cell battery is detected and the appropriate fault displayed. If an open cell or shorted cell fault is not detected, the process may proceed to step 156.

Step 156 determines if the battery has been charging for an extended period of time, yet the charging process is not complete, an overtime fault. There may be situations when the voltage of a battery increases during charging, in contrast to a shorted cell battery, but the battery is not fully charged within a predetermined period of time. This can happen, for example, on a very large battery which is being charged at a very low current rate. A 100 amp hour battery cannot be charged with a change rate of 2 amps in a

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reasonable amount of time. Therefore, the charge rate is too low to finish charging in a reasonable period of time and a fault is indicated. Additionally, another type of failure mode in a battery can cause this same circumstance, that is, a battery with a severe internal leakage.

An overtime fault occurs if a predetermined voltage is not reached within a predetermined time period, yet the called for current is still flowing. When these conditions are met, an overtime fault is indicated on the display For example, referring to steps 150-156 of figure 6, it is determined if the battery has been charging for over 18 hours. If so, the battery has been charging a substantial period of time, and yet the battery voltage is not over 12 volts, per step 150. Thus, a fault is detected and the process proceeds to step 152, where the charger is turned off, and then to step 154, where a fault is indicated.

If the battery has not been charging for 18 hours, the process continues with step 158. Step 158 utilizes feedback from the battery to adjust the duty cycle of the signal driving the FET 22. If the actual current being provided from the battery charger is greater than or equal to the desired current, the duty cycle of the driving signal is decreased, step 160. If the actual current is less than the desired current, then the duty cycle of the driving signal is increased, step 162.

Next, it is determined if the voltage of the battery is greater than or equal to a predetermined voltage, for example, 14 volts, for at least a predetermined period of time, for example, 2 seconds, step 164. If the voltage of the battery has not been greater than or equal to 14 volts for at least 2 seconds, the process returns to the initialization stage. On the other hand, if the voltage of the battery has been greater than or equal to 14 volts for more than 2 seconds and the battery has not been charging

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for a predetermined time, for example 15 hours (step 166), a fault is indicated, and the process proceeds to steps 152 and 154. Otherwise, the process proceeds to step 200 and the flag for the absorption stage is set. The process then returns to the initialization stage and begins again.

If a flag for the absorption stage has been set, the process proceeds from step 144 to step 168. If the battery voltage is greater than or equal to the predetermined voltage, for example, 14 volts, the duty cycle of the driving signal is decreased. If the voltage is less than 14 volts, the duty cycle of the driving signal is increased, steps 168-172. Next, it is determined if the current of the battery is greater than or equal to the bulk charging current. If the current is greater than or equal to the bulk charging current, the duty cycle of the driving signal is decreased, otherwise no change to the duty cycle is made, steps 174-176. A check is then performed to determine if the absorption charge mode is complete. If the voltage of the battery is greater than or equal to a predetermined voltage, for example 14 volts, and the battery has been charging for a predetermined time, for example 2 hours, the absorption charge mode is complete and the flag for a complete charge is set, steps 178-200. The charging process is complete, and the process then returns to the initialization stage and awaits further instructions.

The microprocessor 50 may also be used to conduct a test of an alternator of a vehicle with a depleted battery. When the alternator of a vehicle is working properly, the voltage level of the discharged battery 21 rises rapidly immediately after the battery is jump-started. The rapid rise in voltage can be detected by the microprocessor 50 based on the signals the microprocessor receives from opto-isolator circuit 62. If a rapid rise in voltage is detected, a message that the alternator is working properly

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may be shown on display 52. If no rapid rise in voltage is detected, then a message that the alternator is malfunctioning may be shown on display 52. The rapid rise in voltage may vary depending on how depleted the discharged battery is. The microprocessor should be programmed to account for this variance.

Another fault that may be detected by the microprocessor is an overheated charger. The charger may become overheated due to restricted airflow or an internal failure. A temperature sensor that measures the internal temperature of the charger can be coupled to the microprocessor. When the microprocessor detects that the temperature of the internal electronics of the battery charger is too high, a fault is detected and shown on display 52.

In a further embodiment of the invention, a method of electrically testing a connection between the battery charger and the battery to be charged is provided. The method enables this connection to be tested before high current levels that may result in a spark or arcing are available. According to this embodiment, an amount of current less than the total available charging current is initially provided from the battery charger. It is then determined if this smaller amount of current is present at the battery being charged. If so, the current level provided from the battery charger is gradually increased, for example, in a step wise manner or according to a ramp function. The current provided from the battery charger is checked at various increments to determine if the current provided from the battery charger is present at the battery being charged. If the current from the battery charger is present at the battery being charged, the increase of the current continues until the desired charging current is reached. If, at any point during the increase of current,

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the current from the battery charger is not present at the battery being charged, a fault may be detected. When a fault is detected, the current from the battery charger can be reduced to a lower, safer level that does not produce a spark or arcing.

A flow chart relating to this embodiment of the invention is illustrated in Figure 8. First, the battery charger is coupled to the battery being charged, per step 202. The battery charger may have an available output current of about 6 amps, for example. Initially, a far lower current, for example, 0.5 amp, is provided from the battery charger as a test current, step 204. In step 206, a test is performed to detect the presence of the 0.5 amp test current at the battery being charged. If the test current is not detected, a fault is indicated, and the charging process may stop, per step 208. In step 210, it is determined if the test current is equal to the desired charging current. If so, the charging continues at the desired charging current, step 212. Otherwise the process proceeds to step 214. In this case, the 0.5 amp test current is present at the battery being charged, and the current provided from the battery charger is increased to the next level, for example, 0.75 amps. The process then returns to step 206 to detect the increased current. Stepping or ramping up the current in this manner detects a faulty connection between the battery charger and the battery being charged prior to high currents that can produce sparks being provided to the battery. The microprocessor may be programmed to operate the battery charger in this manner.

Accordingly, a high frequency charger and method of operating a high frequency charger are provided. The use of high frequency transformers provides several advantages. For example, as long as the switching frequency is high

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enough, iron is not needed for the core of the transformers. A very light substance, for example, ferrite, can be used, greatly reducing the weight and unwieldiness of known devices. Additionally, the secondary winding of the transformers may have a small number of windings, for example, as few as four turns of wire. In comparison, a conventional transformer can require over 100 turns of wire. The higher the frequency, the less wire is needed, further reducing the cost required to manufacture the device.

The embodiments illustrated and discussed in this specification are intended only to teach those skilled in the art the best way known to the inventors to make and use the invention. Nothing in this specification should be considered as limiting the scope of the present invention. The above-described embodiments of the invention may be modified or varied, and elements added or omitted, without departing from the invention, as appreciated by those skilled in the art in light of the above teachings. It is therefore to be understood that, within the scope of the claims and their equivalents, the invention may be practiced otherwise than as specifically described. For example, the processes described above may be performed in an order different from that described above.

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WE CLAIM:

1. A high frequency charger, comprising:

high frequency transformer means;

a first switch switching the high frequency transformer means at a first frequency and producing a charging current for charging a battery;

a second switch switching the high frequency transformer means at a second frequency and producing a relatively high boost current compared to the charging current for jump-starting a vehicle; and

a selector switch for selectively activating at least one of the first switch and the second switch.

2. The charger of claim 1, wherein the high frequency transformer means comprises a single high frequency transformer having two separate taps on its primary side, one tap being switched by the first switch and causing the charging current to be produced, and other tap being switched by the second switch and causing the boost current to be produced.

3. The charge of claim 1, wherein the high frequency transformer means comprises:

a first high frequency transformer for providing the charging current; and

a second high frequency transformer, separate from the first high frequency transformer, for providing the boost current.

4. The charger of claim 3, wherein the first switch switches the first high frequency transformer and the second switch switches the second high frequency transformer.

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5. The charger of claim 1, further comprising:

a filter coupled to the high frequency transformer means for passing a DC voltage signal to the high frequency transformer means.

6. The charger of claim 1, further comprising:

at least one filter coupled to the output of the high frequency transformer means for passing a DC voltage signal to a charger output.

7. The charger of claim 1, wherein at least a portion of the high frequency transformer means and the first switch form a charging circuit, wherein the charging circuit has a charge mode and a pulse mode, and further comprising means for selectively activating one of the charge mode and the pulse mode.

8. The charger of claim 7, further comprising means coupled to the first switch for alternatingly enabling the first switch to switch the high frequency transformer means at the first frequency and disabling the first switch from switching the high frequency transformer means.

9. The charger of claim 1, further comprising:

a first controller providing a driving signal to the first switch; and

a second controller providing a driving signal to the second switch.

10. The charger of claim 9, wherein the selector switch is coupled to the first and second controllers for selectively activating at least one of the first and second controllers.

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11. The charger of claim 10, wherein at least a portion of the high frequency transformer means and the first switch form a charging circuit, wherein the charging circuit has a charge mode and a pulse mode and further comprising a selector coupled to the first controller for selecting between the charge mode and the pulse mode.

12. The charger of claim 11, further comprising an enable circuit coupled to the selector that selectively enables and disables the first controller at a predetermined rate when the pulse mode is selected.

13. The charger of claim 9, further comprising a feedback circuit connected between the battery and the first controller for adjusting a duty cycle of the driving signal based on charging parameters of the battery.

14. The charger of claim 1, wherein a DC signal output from the high frequency transformer means has a current of about 25-300 amps.

15. The charger of claim 1, wherein a DC signal output from the high frequency transformer means has a duration of about 3-35 seconds.

16. The charger of claim 7, wherein, in the pulse mode, the DC output signal of the charging circuit is a series of pulses.

17. The charger of claim 16, wherein the series of pulses has a rise time of less than 100 volts per microsecond.

18. The charger of claim 16, wherein the series of pulses has a frequency of about one pulse per second.

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19. The charger of claim 6, further comprising:

a pair of connectors coupled to the at least one filter and adapted for connection to a battery;

at least one switch coupled in between one of the connectors and the at least one filter;

a polarity detection circuit coupled to the connectors for determining a polarity between the connectors and providing a polarity signal representing the polarity; and

a microprocessor receiving the polarity signal and generating a signal for opening or closing the at least one switch in dependence on the polarity signal.

20. The charger of claim 19, wherein the polarity detection circuit includes an opto-isolator.

21. The charger of claim 19, wherein the at least one switch includes a transistor.

22. The charger of claim 19, further comprising means for detecting disconnection of the connectors from the battery and opening the at least one switch when disconnection is detected.

23. The charger of claim 9, further comprising a control circuit coupled to the first controller for setting a duty cycle of an output signal of the first controller.

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24. The charger of claim 23, wherein the control circuit setting a duty cycle comprises:

an integrated circuit; and

at least two reference voltage circuits developing a reference voltage and coupled between the integrated circuit and the first controller, wherein the integrated circuit selectively enables at least one of the reference voltage circuits.

25. The charger of claim 24, wherein the integrated circuit comprises a counter.

26. The charger of claim 24, wherein each of the reference voltage circuits includes a switch that can be opened and closed in dependence on an output from the counter.

27. The charger of claim 24, wherein the control circuit setting a duty cycle comprises a voltage divider network dividing a voltage applied to a reference voltage input of the first controller and a control input of the first controller, wherein the duty cycle varies based on a percentage of the reference voltage applied to the control input.

28. The charger of claim 1, further comprising a computer for controlling the operation of the first and second switches.

29. The charger of claim 28, further comprising:

a display coupled to the computer for displaying output from the computer; and

input means coupled to the computer for permitting a user to select a mode of operation.

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30. The charger of claim 28, further comprising:

means for detecting at least one of a voltage and a current at an interface of the charger with a battery; and

a feedback circuit for providing the detected voltage or current to the computer.

31. The charger of claim 30, wherein the means for detecting comprises an opto-isolator for producing a voltage representing the voltage of the battery while it is being charged by the charging current.

32. The charger of claim 1, further comprising:

means for testing for at least one fault; and

a display for displaying an alphanumeric fault code.

33. A control circuit for a high frequency charger, comprising:

a pulse width modulation controller having a reference voltage input, a control input and an output for outputting a control signal;

a switch receiving the control signal and being switched on and off in response to the control signal, the switch adapted for connection to a transformer for switching the transformer; and

a voltage divider network dividing a voltage applied to the reference voltage input and the control input, whereby a duty cycle of the control signal output from the pulse width modulation controller varies based on the percentage of the reference voltage applied to the control input.

34. The control circuit of claim 33, further comprising:

a transformer connected to the switch and being switched on and off via the switch.

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35. The control circuit of claim 33, wherein the voltage divider network comprises:

a first resistor having a first terminal connected to the reference voltage input and a second terminal connected to the control input; and

a second resistor having a first terminal connected to second terminal of the first resistor and a second terminal that is grounded.

36. The control circuit of claim 33, wherein the voltage divider network comprises:

a first resistor having a first terminal connected to the reference voltage input and a second terminal connected to the control input; and

a plurality of second resistors each having a first terminal connected to the second terminal of the first resistor and a second terminal that is selectively grounded, wherein only one of the second resistors is selectively grounded at any time.

37. The control circuit of claim 36, further comprising a switch for selectively connecting the second resistors to ground.

38. The control circuit of claim 37, wherein the switch comprises a separate transistor for each of the second resistors providing a current path to ground when the transistor is turned on.

39. The control circuit of claim 33, wherein the voltage divider network comprises:

a first resistor having a first terminal connected to the reference voltage input and a second terminal connected to the control input; and

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a plurality of second resistors each having a first terminal connected to the second terminal of the first resistor and a second terminal;

and further comprising a plurality of transistors, each having a first electrode connected to the second terminal of one the second resistors, a second electrode that is grounded, and a third electrode receiving an enable signal.

40. The control circuit of claim 39, further comprising:

an integrated circuit having outputs, each output being connected to one of the third electrodes and providing the enable signal thereto, only one of the outputs being active at any time.

41. The control circuit of claim 40, wherein the integrated circuit comprises a counter.

42. The charger of claim 28, wherein at least a portion of the high frequency transformer means and the first switch form a charging circuit, wherein the charging circuit has a charge mode and a pulse mode, and further comprising means for selectively activating one of the charge mode and the pulse mode; and a computer-readable information storage medium, the computer-readable information storage medium storing computer-readable program code for causing the computer to perform the steps of:

detecting a selected of mode of operation; and

when a pulse mode is selected:

a) generating a driving signal for the first switch for a first period of time;

b) disabling the first switch for a second period of time; and

c) returning to step a).

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43. A high frequency charger for charging a battery, comprising:

a charge circuit including a high frequency transformer;

a switch switching the high frequency transformer at a first frequency;

a filter coupled to the high frequency transformer for passing a DC voltage signal;

means for measuring a charge rate of the battery;

means for determining an amount of time the battery has been charging;

means for measuring a voltage of the battery; and

means for detecting at least one of an overtime fault, a shorted cell fault, a bad battery fault, and an open cell fault based on at least one of the charge rate, the charging time, and the battery voltage.

44. The charger of claim 43, wherein the means for detecting detects at least the overtime fault, and wherein the overtime fault is detected when the charge rate is greater than a predetermined current, the battery has been charging longer than a predetermined amount of time, and the voltage of the battery is greater than or equal to a predetermined voltage.

45. The charger of claim 43, further comprising a display that visually indicates at least one of the faults.

46. The charger of claim 44, wherein the predetermined current is 2 amps, the predetermined time is 18 hours, and the predetermined voltage is 12 volts.

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47. The charger of claim 43, wherein the means for detecting detects at least the shorted cell battery fault, and wherein the shorted cell battery fault is detected when the charge rate is greater than a predetermined current, the battery has been charging more a predetermined amount of time, and the battery voltage is less than or equal to a predetermined voltage.

48. The charger claim 47, wherein the predetermined time is 1 hour, and the predetermined voltage is 11 volts.

49. The charger of claim 43, wherein the means for detecting detects at least the bad battery fault, and wherein the bad battery fault is detected when no battery voltage is measured by the means for measuring.

50. The charger of claim 43, wherein the means for detecting detects the open cell battery fault, and wherein the open cell battery fault is detected when the charge current is less than a predetermined current, the battery has been charging more a predetermined amount of time, and the battery voltage is greater than or equal to a predetermined voltage.

51. A computer-readable information storage medium for use with a computer controlling a high frequency charger comprising a charge circuit including a first high frequency transformer; a first switch switching the first high frequency transformer at a first frequency; a boost circuit including a second high frequency transformer; a second switch switching the second high frequency transformer at a second frequency, and a selector for selecting one of a charge mode for charging a depleted battery and a boost mode for supplying a boosting current to start a vehicle with the

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depleted battery, the computer-readable information storage medium storing computer-readable program code for causing the computer to perform the steps of:

detecting a selected mode of operation;

if the boost mode is selected, controlling the boost circuit to supplying a boosting current to the depleted battery;

checking for a rapid rise in voltage after the vehicle has been started;

indicating the alternator is working properly if the rapid rise in voltage is present; and

indicating the alternator is not working properly if the rapid rise in voltage is not present.

52. A computer-readable information storage medium for use with a computer controlling a high frequency charger comprising a charge circuit including a high frequency transformer; a switch switching the high frequency transformer at a predetermined frequency, the computer-readable information storage medium storing containing software implementing a method of reducing arcing in a battery charger, the method comprising the steps of:

providing a test current that is lower than a charging current from the battery charger to a battery;

detecting if the test current is present at the battery;

indicating a fault if the test current is not detected at the battery; and

increasing the test current a predetermined amount and returning to the detecting step if the test current is detected at the battery.

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53. A computer-readable information storage medium for use with a computer controlling a high frequency charger for charging a battery, comprising a charge circuit including a first high frequency transformer; a first switch switching the first high frequency transformer at a first frequency; a filter coupled to the first high frequency transformer for passing a DC voltage signal, the computer-readable information storage medium storing computer-readable program code for causing the computer to perform the steps of:

measuring a charge rate of the battery;

determining an amount of time the battery has been charging;

measuring a battery voltage; and

detecting at least one of an overtime fault, a shorted cell fault, a bad battery fault, and an open cell fault based on at least one of the charge rate, the amount of time, and the battery voltage.

54. The computer-readable information storage medium of claim 53, further comprising code for causing the computer to perform the step of visually indicating at least one of the faults on a display.

55. The computer-readable information storage medium of claim 53, further comprising code for causing the computer to perform the step of detecting at least the overtime fault, and wherein the overtime fault is detected when the charge rate is greater than a predetermined current, the battery has been charging longer than a predetermined amount of time, and the battery voltage is greater than or equal to a predetermined voltage.

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56. The computer-readable information storage medium of claim 55, wherein the predetermined current is 2 amps, the predetermined time is 18 hours, and the predetermined voltage is 12 volts.

57. The computer-readable information storage medium of claim 53, further comprising code for causing the computer to perform the step of detecting at least the shorted cell battery fault, and wherein the shorted cell battery fault is detected when the charge rate is greater than a predetermined current, the battery has been charging more a predetermined amount of time, and the battery voltage is less than or equal to a predetermined voltage.

58. The computer-readable information storage medium of claim 57, wherein the predetermined time is 1 hour, and the predetermined voltage is 11 volts.

59. The computer-readable information storage medium of claim 53, further comprising code for causing the computer to perform the steps of:

detecting at least the bad battery fault;

indicating the bad battery fault if no battery voltage is detected; and

proceeding with a charging operation if the battery voltage is detected.

60. The computer-readable information storage medium of claim 53, further comprising code for causing the computer to perform the step of detecting at least the open cell battery fault, and wherein the open cell battery fault is detected when the charge current is less than a predetermined current, the battery has been charging more a

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predetermined amount of time, and the battery voltage is greater than or equal to a predetermined voltage.

61. The computer-readable information storage medium of claim 53, further comprising computer-readable program code for causing a computer to perform the step of turning the battery charger off if a battery to be charged is not connected to the battery charger.

62. A method of reducing arcing in a battery charger, comprising:

providing a test current that is lower than a charging current from the battery charger to a battery;

detecting if the test current is present at the battery;

indicating a fault if the test current is not detected at the battery; and

increasing the test current a predetermined amount and returning to the detecting step if the test current is detected at the battery.

63. The method of claim 62, further comprising providing a current lower than the test current to the battery and returning to the detecting step if the test current is not detected at the battery.

64. The method of claim 62, wherein the test current is increased according to a ramp function.

65. The method of claim 62, wherein the test current is increased according to a step function.

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66. The method of claim 62, further comprising the step of using pulse width modulation to control the current provided from the battery charger.

67. The method of claim 62, further comprising the step of determining if the test current equals a selected current and, if so, continuing charging at the selected current, otherwise returning to the detecting step.

68. A high frequency charger for charging a battery, comprising:

a charge circuit including a high frequency transformer;

a switch switching the high frequency transformer at a first frequency;

a filter coupled to the high frequency transformer for passing a DC voltage signal;

means for coupling a resistance in parallel with the battery;

means for measuring a voltage of the battery while the battery is coupled to the resistance; and

means for correlating the measured voltage to a CCA value.

69. The charger claim 68, further comprising a display and wherein the CCA is visually indicated on the display.

70. A computer-readable information storage medium for use with a computer controlling a high frequency charger for charging a battery, comprising a charge circuit including a high frequency transformer; a switch switching the high frequency transformer at a first frequency; a filter coupled to the high frequency transformer for passing a DC voltage signal, wherein a resistance is coupled in parallel with the

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battery, the computer-readable information storage medium storing computer-readable program code for causing the computer to perform the steps of:

measuring a voltage of the battery while the battery is coupled to the resistance; and

correlating the measured voltage to a CCA value.

71. A high frequency booster circuit for boosting a vehicle, comprising:

a high frequency transformer means;

a switch switching the high frequency transformer at a given frequency; and

a filter for passing a DC signal derived from an output of the high frequency transformer.

72. The high frequency booster circuit of claim 71, further comprising:

means for performing fault detection; and

an alphanumeric display for displaying fault codes.

73. The high frequency booster circuit of claim 71, further comprising:

means for checking for a rapid rise in voltage after the vehicle has been started; and

means for providing an indication that the vehicle's alternator is working properly if such a rapid rise in voltage is detected and for providing an indication that the vehicle's alternator is not working properly if the rapid rise in voltage is not detected.

74. The high frequency booster circuit of claim 73, further comprising:

a computer for controlling the high frequency booster circuit; and

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a computer-readable medium having software, the computer-readable medium being coupled for reading by the computer, wherein:

a first portion of the software implements at least a portion of the means for checking; and

a second portion of the software implements at least a portion of the means for providing an indication.

75. The high frequency booster circuit of claim 71, further comprising:

a pulse-width modulation controller for controlling the switch.

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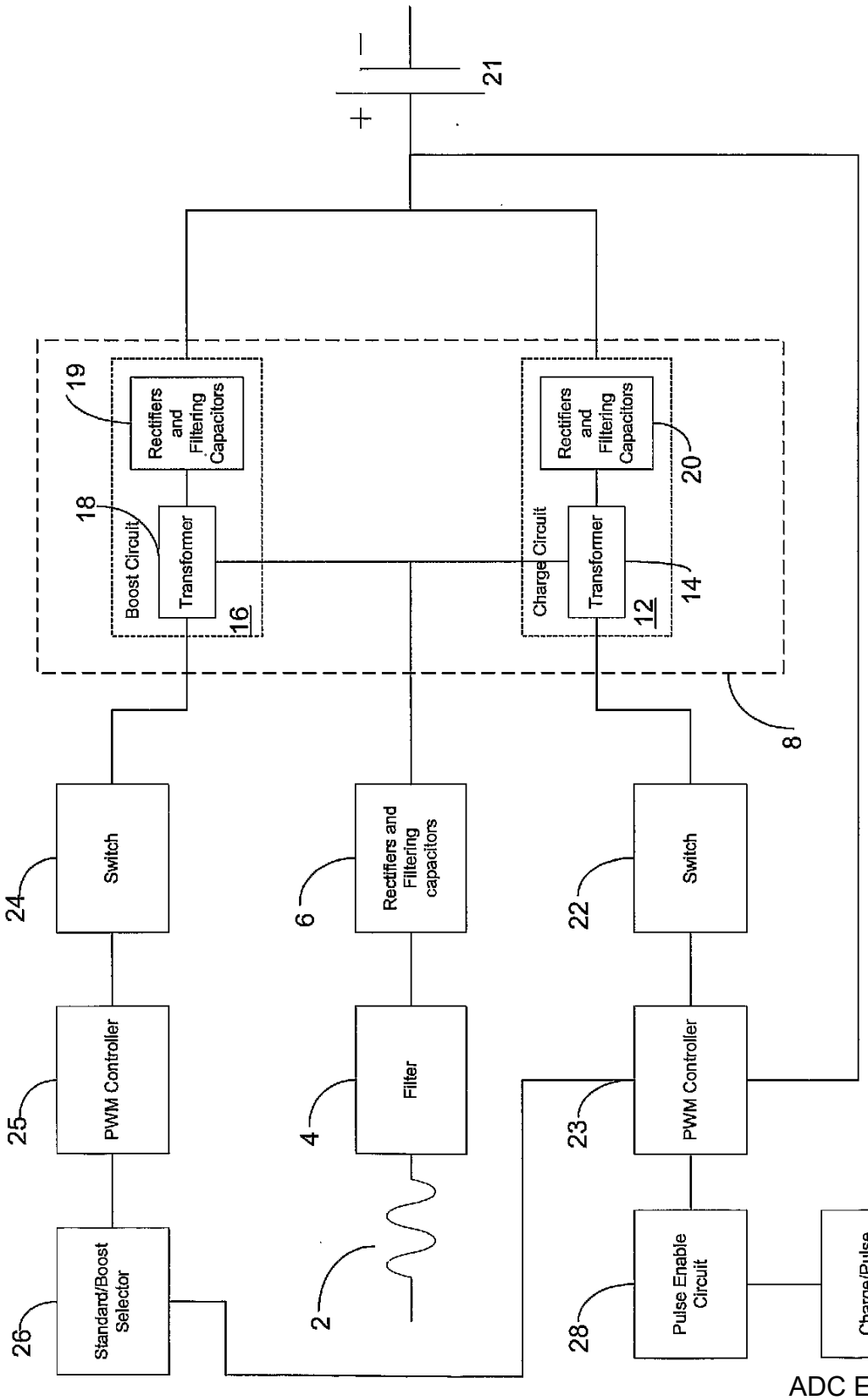

21
+
−
19
Rectifiers and Filtering Capacitors
18
Boost Circuit
Transformer
16
Charge Circuit
Rectifiers and Filtering Capacitors
20
Transformer
12
14
8
24
Switch
6
Rectifiers and Filtering capacitors
22
Switch
25
PWM Controller
4
Filter
23
PWM Controller
2
26
Standard/Boost Selector
28
Pulse Enable Circuit
30
Charge/Pulse Selector

Fig. 1

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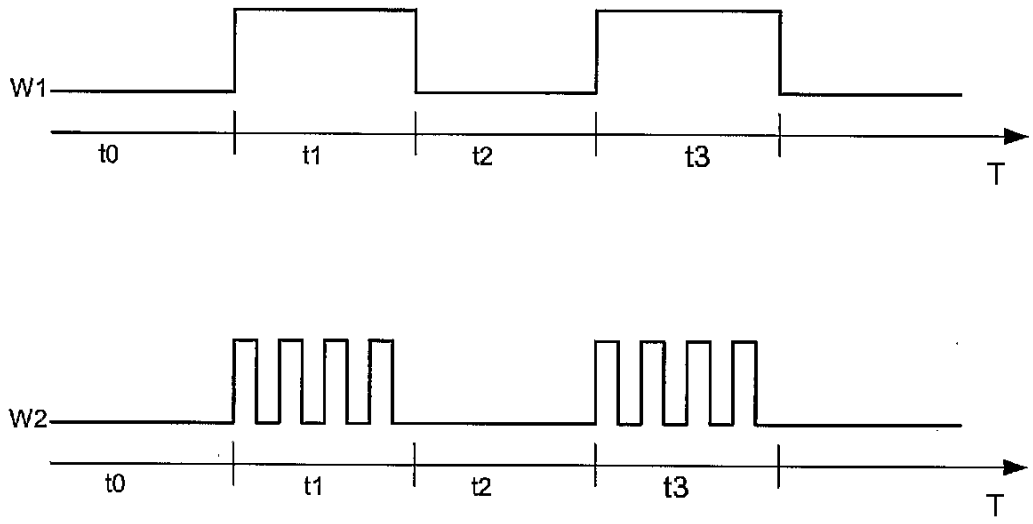


FIG. 2

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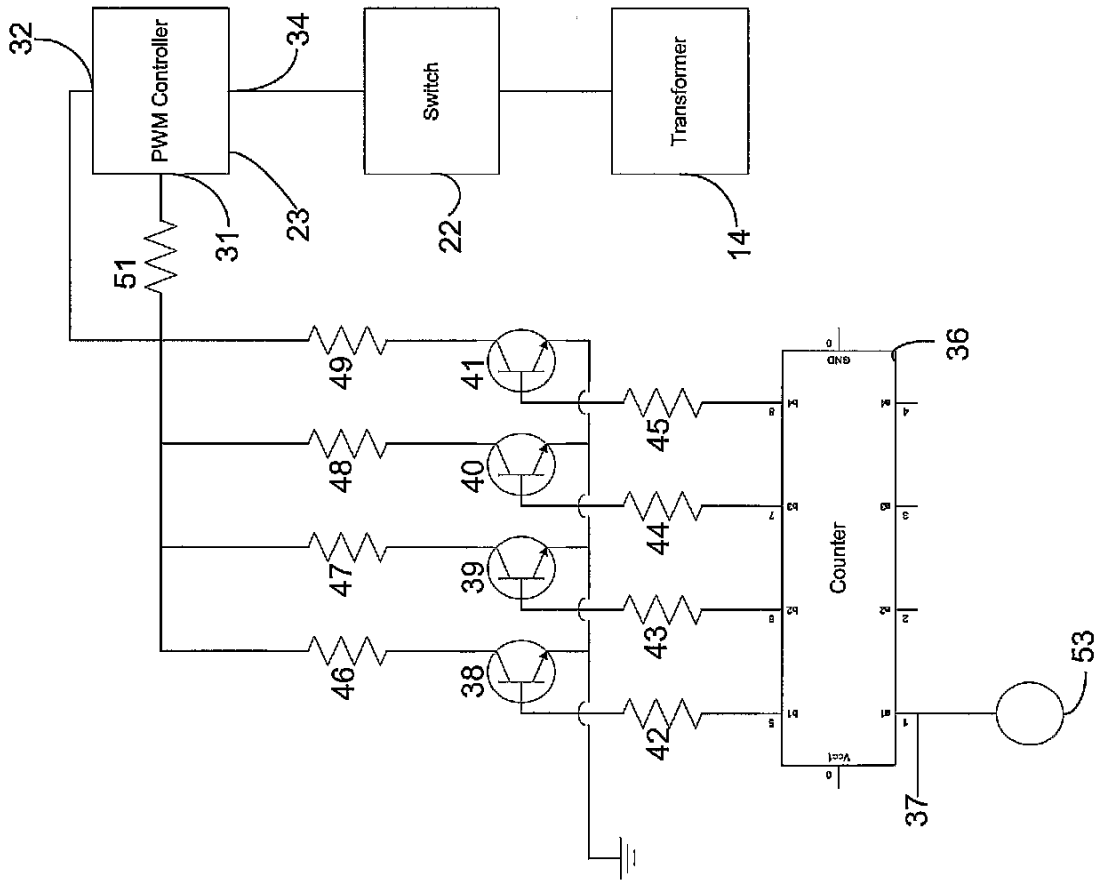

32
PWM Controller
34
Switch
Transformer
31
23
22
14
51
49
41
45
48
40
44
47
39
43
46
38
42
GND
Counter
Vcc
36
53
37

Fig. 3

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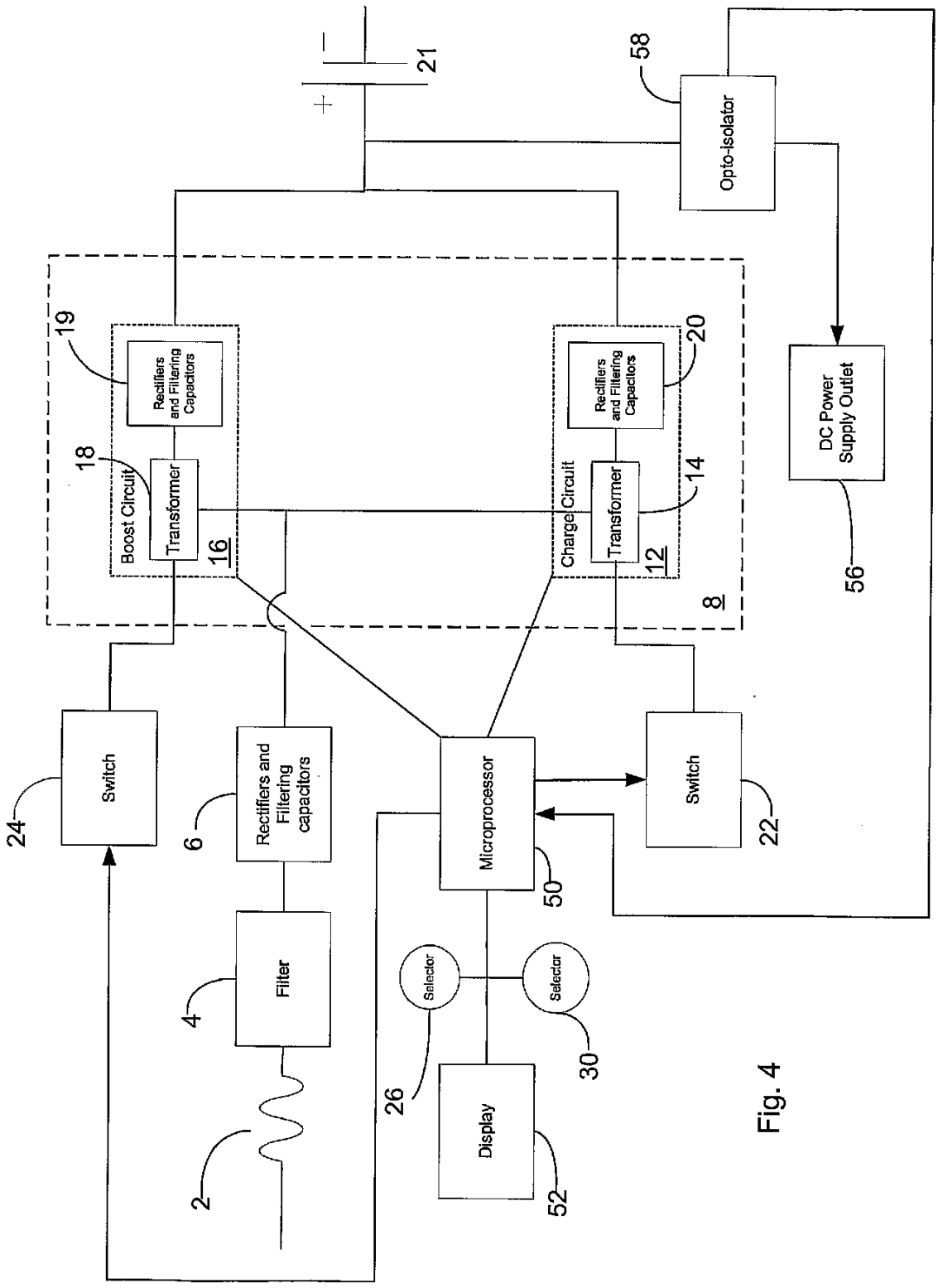

21
58
Opto-isolator
19
Rectifiers and Filtering Capacitors
20
Rectifiers and Filtering Capacitors
DC Power Supply Outlet
18
Boost Circuit
Transformer
16
Charge Circuit
Transformer
14
12
8
56
Switch
24
Rectifiers and Filtering capacitors
6
Microprocessor
50
Switch
22
Filter
4
Selector
Selector
26
30
Display
52
2

Fig. 4

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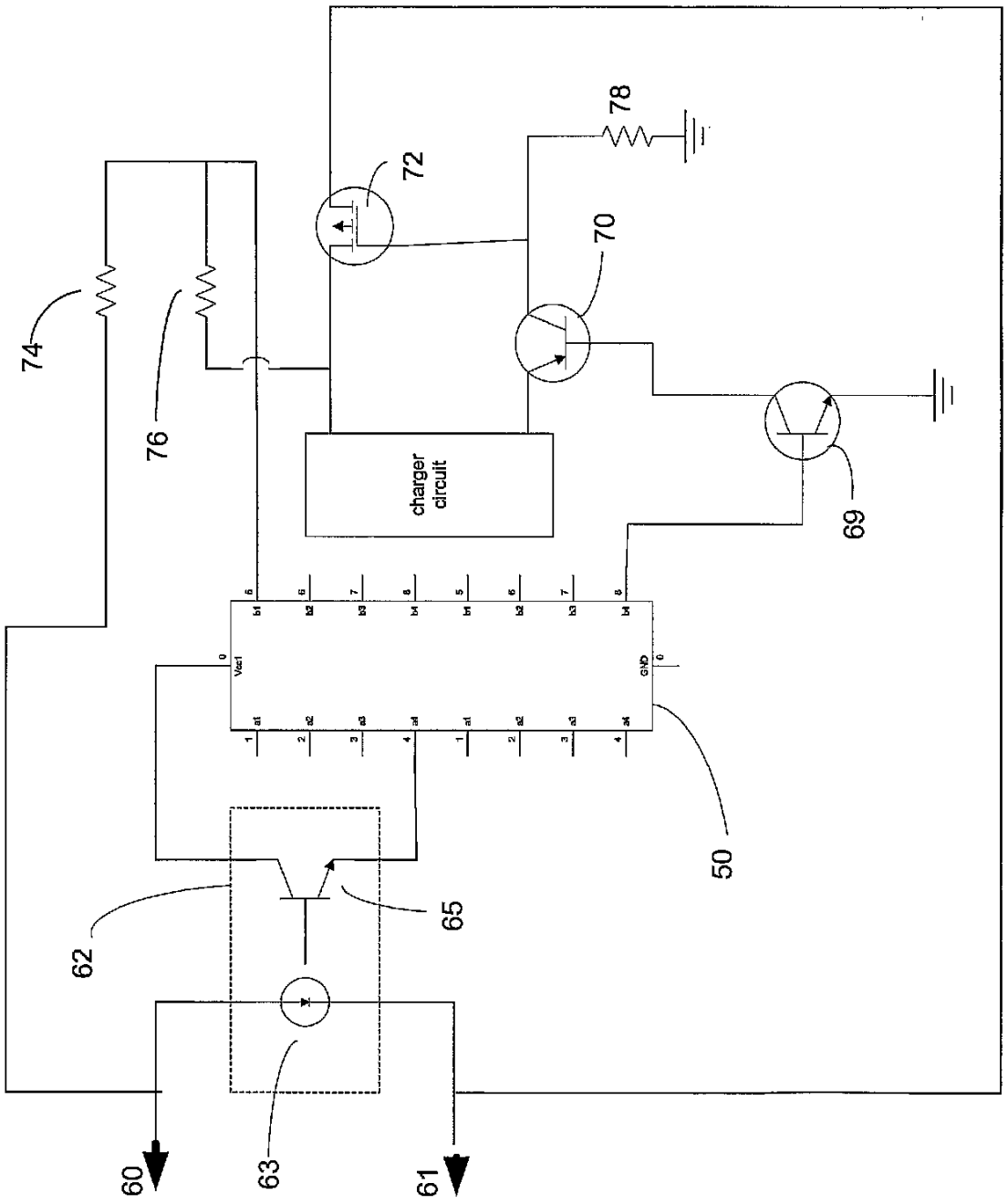


Fig. 5

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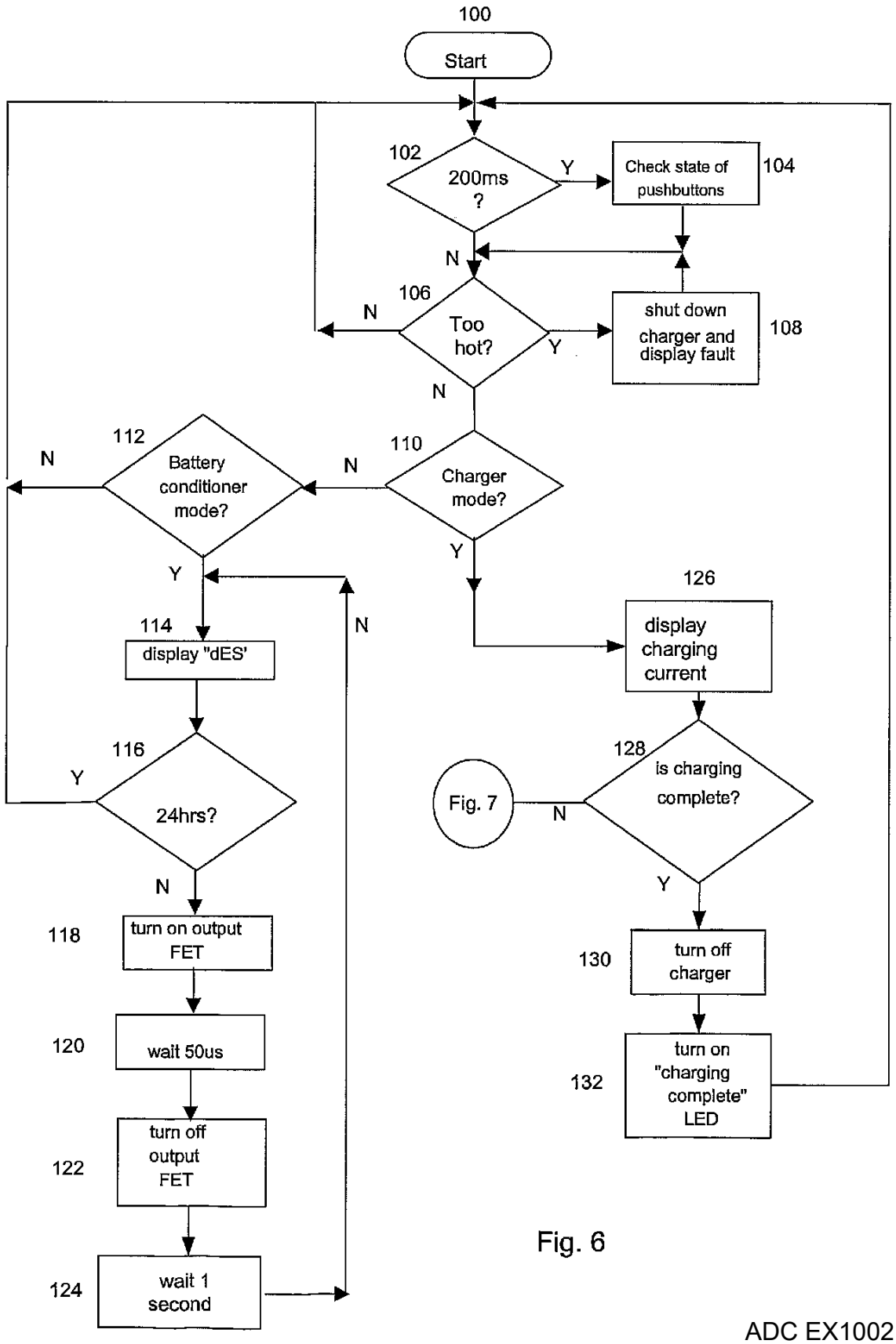

100
Start
102
200ms ?
Y
Check state of pushbuttons
104
N
106
Too hot?
N
Y
shut down charger and display fault
108
N
110
Charger mode?
N
112
Battery conditioner mode?
N
Y
Y
114
display "dES'
116
24hrs?
Y
N
118
turn on output FET
120
wait 50us
122
turn off output FET
124
wait 1 second
N
126
display charging current
128
is charging complete?
Fig. 7
N
Y
130
turn off charger
132
turn on "charging complete" LED

Fig. 6

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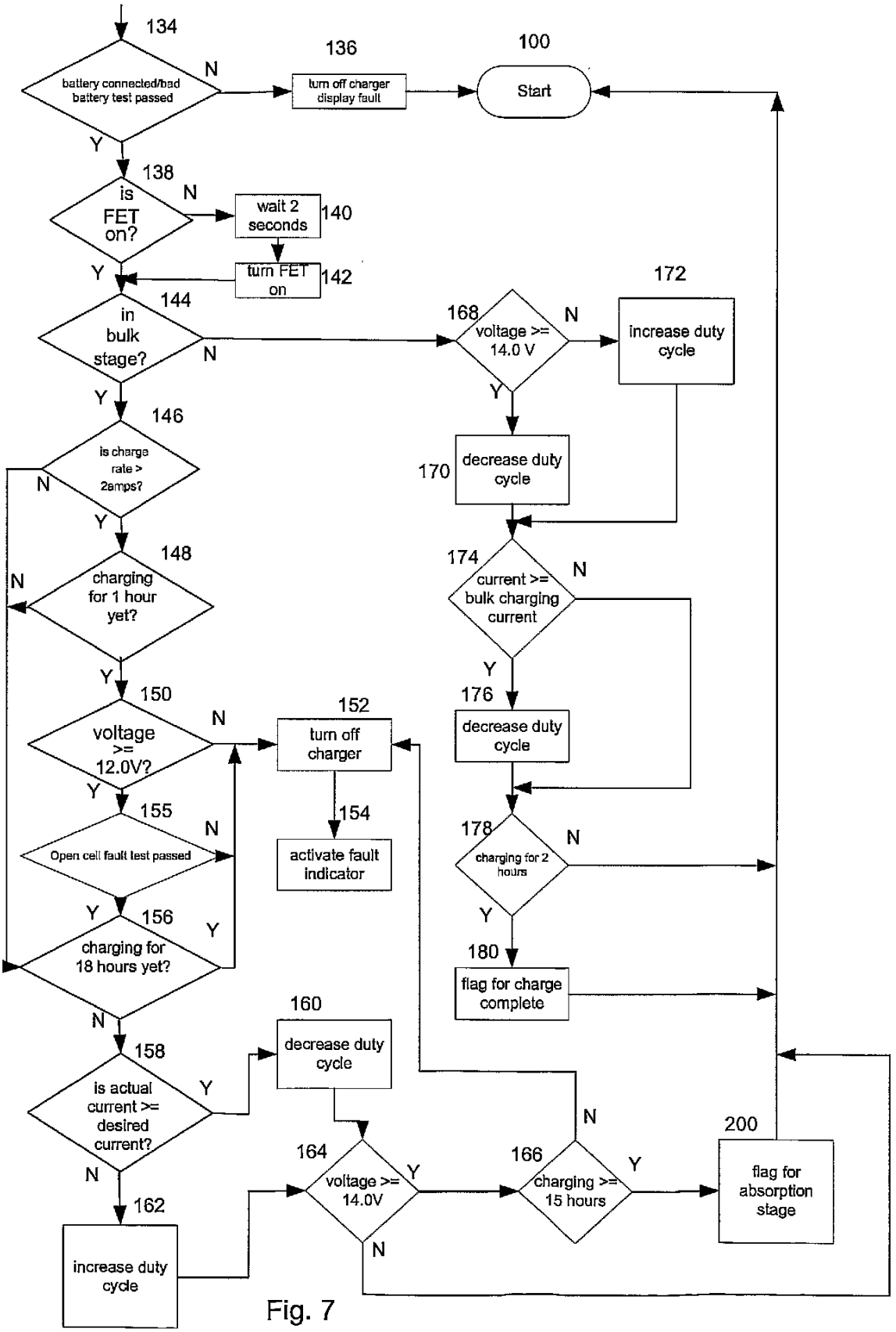

134
battery connected/bad battery test passed
N
136
turn off charger display fault
100
Start
Y
138
is FET on?
N
wait 2 seconds
140
Y
turn FET on
142
144
in bulk stage?
N
168
voltage >= 14.0 V
N
172
increase duty cycle
Y
Y
146
is charge rate > 2amps?
N
170
decrease duty cycle
Y
148
charging for 1 hour yet?
N
174
current >= bulk charging current
N
Y
Y
150
voltage >= 12.0V?
N
152
turn off charger
176
decrease duty cycle
Y
155
Open cell fault test passed
N
154
activate fault indicator
178
charging for 2 hours
N
Y
Y
156
charging for 18 hours yet?
Y
180
flag for charge complete
N
160
decrease duty cycle
158
is actual current >= desired current?
Y
N
N
200
164
voltage >= 14.0V
Y
166
charging >= 15 hours
Y
flag for absorption stage
N
162
increase duty cycle

Fig. 7

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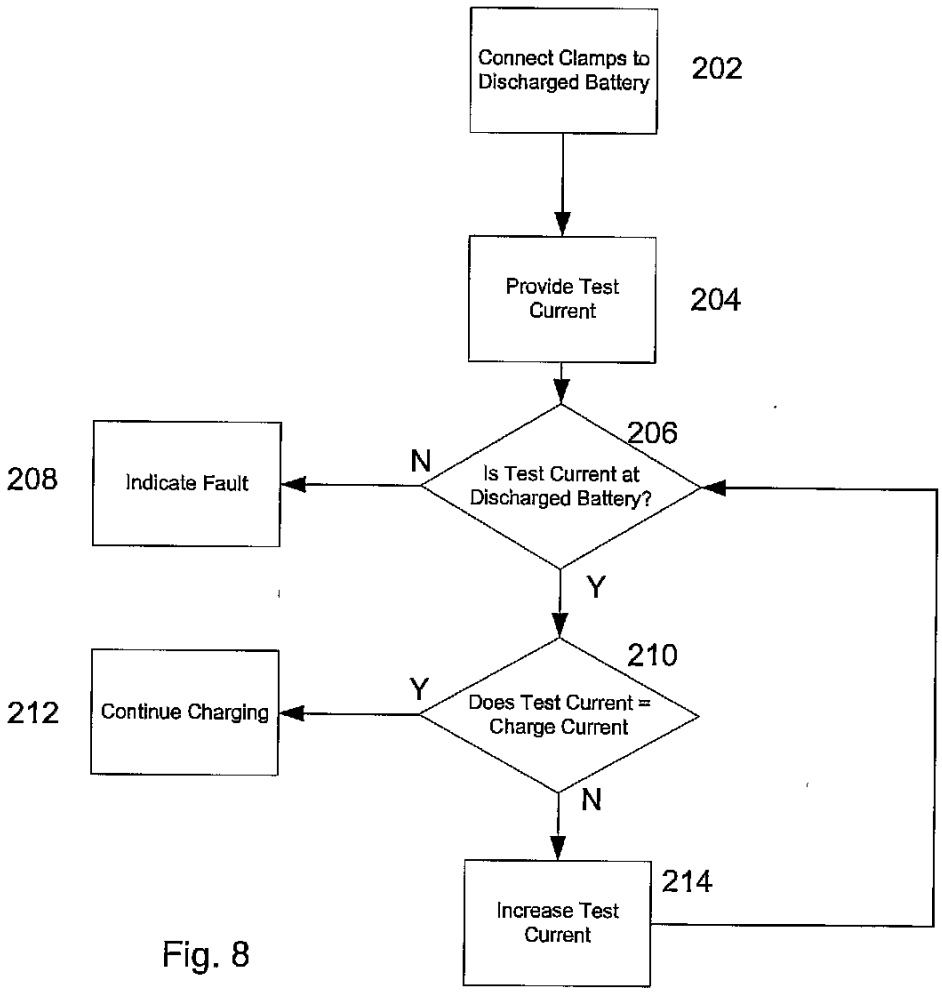

Connect Clamps to Discharged Battery
202
Provide Test Current
204
206
Is Test Current at Discharged Battery?
N
208
Indicate Fault
Y
210
Does Test Current = Charge Current
Y
212
Continue Charging
N
214
Increase Test Current

Fig. 8

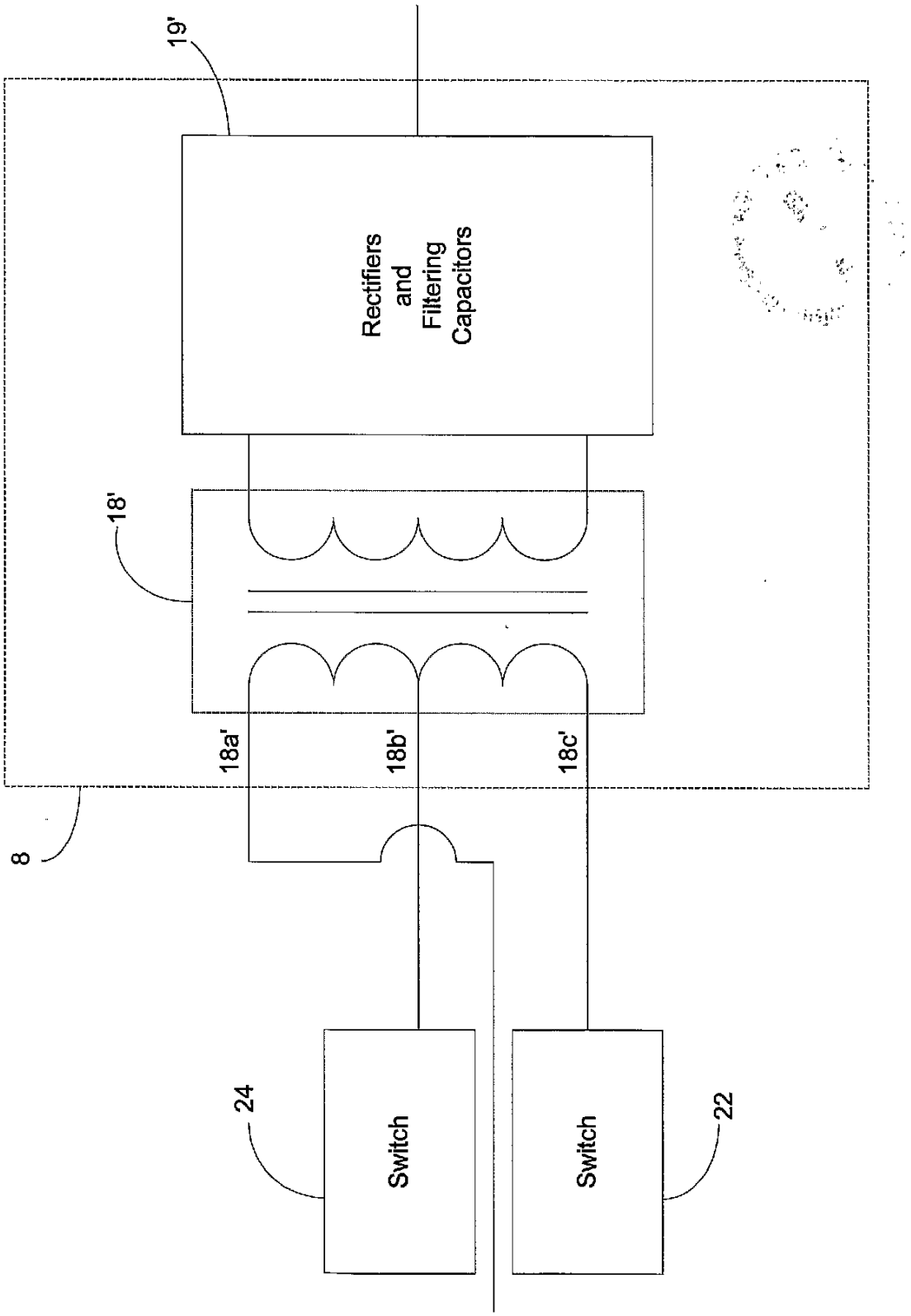

19'
Rectifiers and Filtering Capacitors
18'
18a'
18b'
18c'
8
24
Switch
Switch
22

Figure 9

AUSTRALIA

Patents Act

IN THE MATTER of Australian Patent Application No. 2016269555 in the name of The NOCO Company

- and -

Opposition thereto by Brown & Watson International Pty Ltd

ANNEXURE MD-5

The attached is **Annexure MD-5** referred to in the Declaration of Declaration of Max Dirnberger declared on 6th day of September 2019 in the above matter.

US 20070285049A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2007/0285049 A1**

Krieger et al. (43) **Pub. Date: Dec. 13, 2007**

(54) **JUMP STARTER WITH BUILT-IN BATTERY CHARGER**

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(21) Appl. No.: **11/710,611**

(22) Filed: **Feb. 26, 2007**

Related U.S. Application Data

(60) Provisional application No. 60/776,236, filed on Feb. 24, 2006.

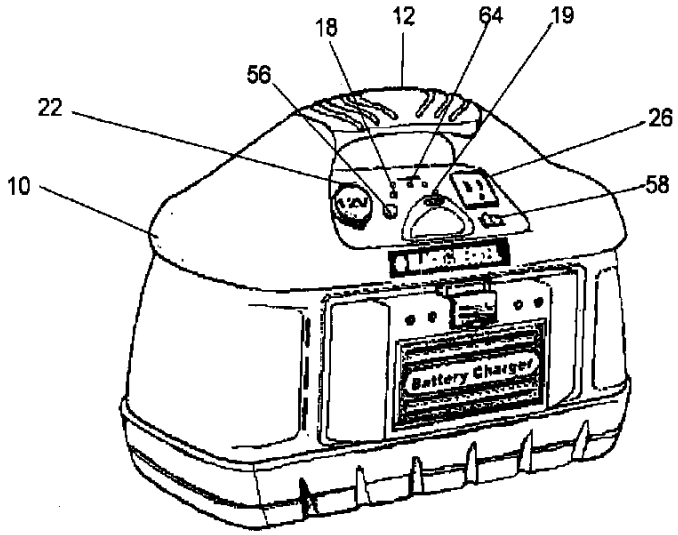
Publication Classification

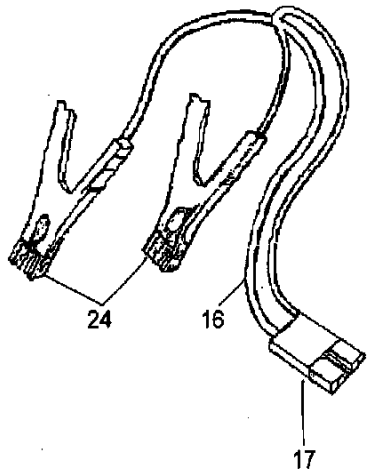
(51) **Int. Cl.**
H02J 7/00 (2006.01)
H01M 2/10 (2006.01)

(52) **U.S. Cl.** **320/105**; 320/110

(57) **ABSTRACT**

A jump starter is provided. The jump starter may be designed as a versatile, portable jump starter addressing the most common needs of power for a consumer. The jump starter may provide DC power, AC power, portable battery charging capability, and other power providing capabilities.





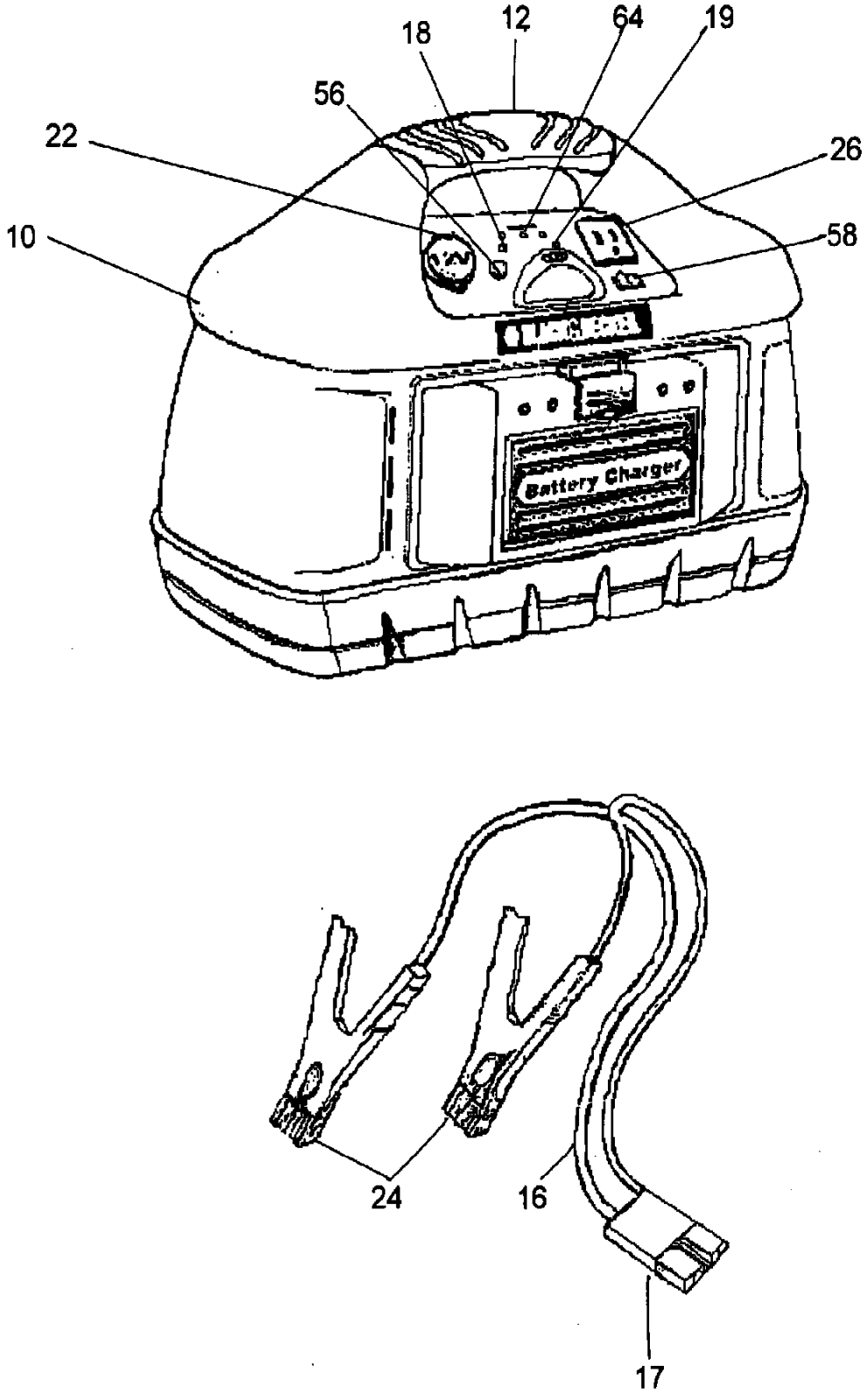


Figure 1

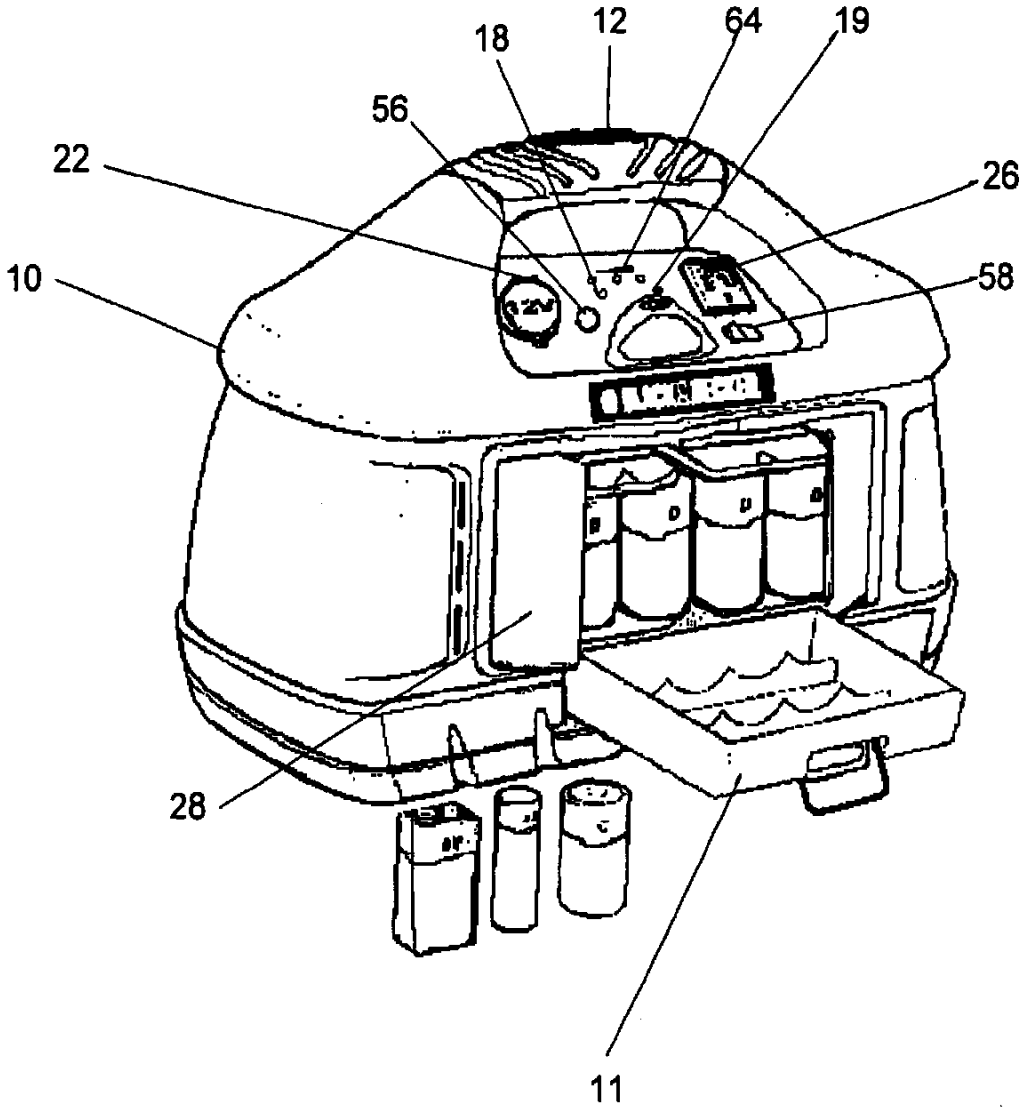


Figure 2

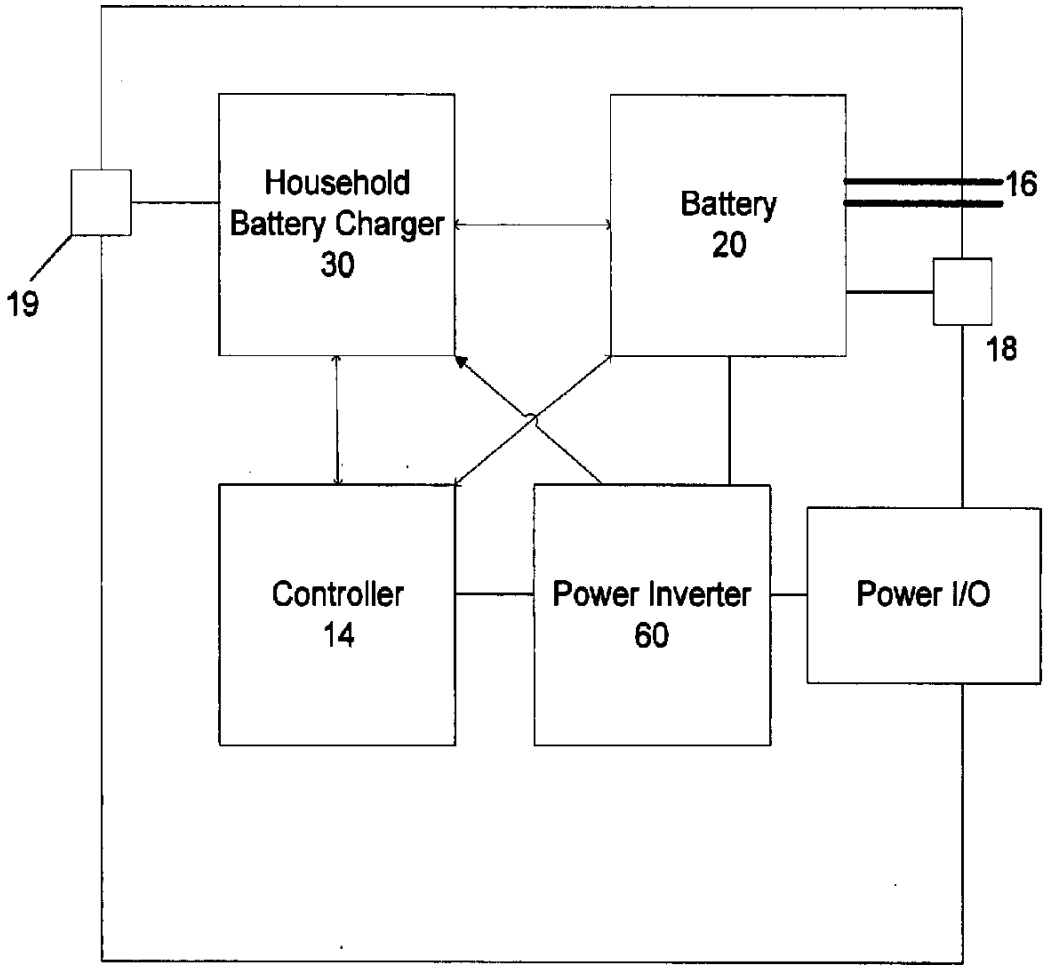

Household
Battery Charger
30
Battery
20
16
19
18
Controller
14
Power Inverter
60
Power I/O

Figure 3

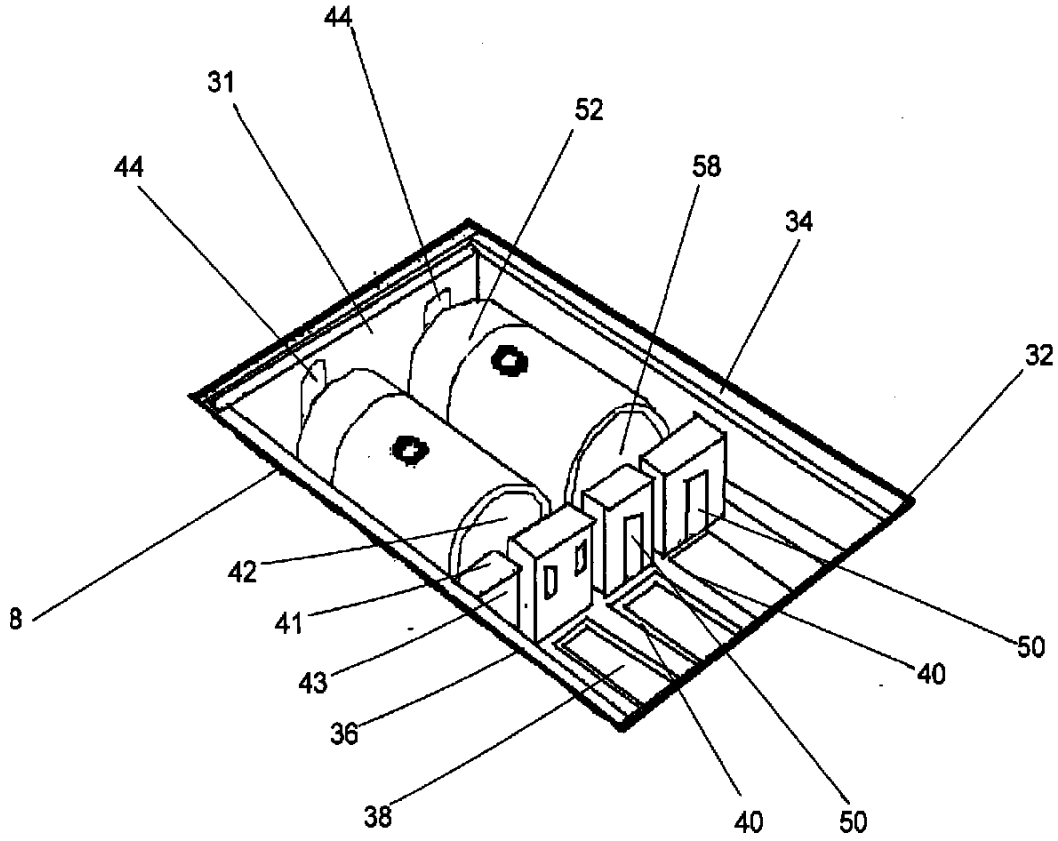


Figure 4

JUMP STARTER WITH BUILT-IN BATTERY CHARGER

BACKGROUND OF THE INVENTION

[0001] Today, people are highly mobile and require that their electronic tools with which they conduct their business be likewise mobile. Part of meeting that requiremeut is to provide portable electronic devices, sucb as cellular phones and laptop computers, with the power those devices need. Portable devices are usually equipped with rechargeable batteries, but even the most expensive and heavy batteries are rarely sufficient to deliver electrical power over a significant time period. These batteries need to be recharged periodically from various power sources, sometimes on the road.

[0002] Rechargeable cells, such as nickel-cadmium cells, have a relatively constant potential during discharge and can be recharged many times, thus extending their useful life. In general, any rechargeable cell contains a combination of active materials wbicb can be electrolytically oxidized and reduced repeatedly. In rechargeable cells, reactions at both electrodes are reversible and the input of current in the appropriate direction from an outside source will reverse the discharge reaction and, in effect, recharge the electrodes.

[0003] The rechargeable cells have been used in various type devices, sucb as toys, calculators, radios and other types of power-operated devices. Many of the power-operated devices on the market today have been designed to accommodate cylindrical cells of the "AA", "C", and "D" size. These sizes have now become standard-type cell sizes having overall dimensious which can be found in various publications, such as The American National Standard Specifications For Dry Cell Batteries—ANSI C18.1-1969 published by the American National Standards Institute, Inc., New York, N.Y.

[0004] Many portable electronic devices rely on one or more single-cell batteries for power. The plethora of different electronic devices, sucb as pagers, cellular phones, portable radios, portable CD players, flashlights, and other battery powered electronic equipment in use has created a great volume demand for single-cell battery power, resulting in the sale of both rechargeable and non-rechargeable single-cell batteries.

[0005] Rechargeable batteries, sucb as nickel cadmium (NiCd) are available in conventional and identical sizes and substantially identical voltages as the non-rechargeable single cell batteries and are often used interchangeably witb non-rechargeable batteries. The interchangeable use of either rechargeable or non-rechargeable small single cell batteries creates a problem for the user to distinguish between the rechargeable or non-rechargeable batteries, especially when dealing with a battery charger. To insert a non-rechargeable battery into a single cell battery charger creates a hazardous condition that can result in injury or damage due to leakage of chemicals from the non-rechargeable battery when recharging is accidentally attempted.

[0006] Devices with jump starting capability are available in transportable forms that allow them to be kept in a car. These devices allow a drained car battery to be recharged to a level that may allow a car to start. They are not currently suitable for the charging of other battery using devices.

SUMMARY OF THE INVENTION

[0007] In one exemplary embodiment, a jump starter is provided. The jump starter may be designed as a versatile, portable jump starter. The jump starter may provide DC power, AC power, portable battery charging capability, and other power providing capabilities.

[0008] In another embodiment, the portable jump starter may include a housing; an AC port provided on the housing; a DC port provided on the bousing; an internal battery disposed within the housing and coupled to tbe DC port; jumper cables having one end coupled to the battery and receiving charging current therefrom and a second end including battery clamps; portable battery charger circuitry disposed in the housiug and coupled to at least one of the battery or AC port, the battery charger circuitry providing charging current to the internal battery and/or to portable batteries inserted into the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a perspective view of an exemplary embodiment of a portable jump starter with a closed cover.

[0010] FIG. **2** is a perspective view of an exemplary embodiment of a portable jump starter with an open cover.

[0011] FIG. **3** is a block diagram illustrating the components of the portable jump starter according to an exemplary embodiment.

[0012] FIG. **4** is a more detailed view of the charger of FIG. **1**.

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

[0013] The portable jump starter shown in FIGS. **1-3** may include a housing **10**. The housing **10** may include a handle **12** having a contoured grip. A power source **20**, for example a battery, such as a sealed lead acid battery, a nickel cadmium battery, a nickel metal hydride battery or the like, may be disposed in the housing **10** (FIG. **3**). The battery **20** may be adapted to provide DC power for a variety of applications. A power inverter **60** may be disposed in the housing **10**. The power inverter may be adapted to convert AC power to DC power, DC power to AC power, or to step up or step down the voltage level of AC or DC power. One or more outlets **22** into which various devices may be plugged may be provided on housing **10**. The outlets **22** may be similar to, for example, a cigarette lighter outlet in a car. A charger for mobile phone or other device may be plugged into the outlet **22** for charging.

[0014] Several different types of DC power outlets may be provided. For example, USB port **18** may be provided on the housing **10**. The USB port **18** may be used to provide a USB power supply. In one embodiment, a voltage regulator optionally included may convert DC input power, for example from the battery **20**, into a USB compatible 5V/500 mA DC power output. The voltage regulator may be a component of the power inverter **60**. A charging port **19** for mobile telephones or other portable devices may also be provided. Additionally, the battery **20** may provide power for a controller **14**, such as a microprocessor or other circuitry, which may be used to control the operation of the various components described below that may be provided in the jump starter.

[0015] The battery **20** may provide a portable DC power source that may be used to operate various devices. The DC power from the battery **20** may also be converted into AC power, for example, by the power inverter **60**. Receptacles **26** that may be adapted to receive a typical AC plug are provided on the housing **10** to provide AC power to a device plugged therein. The receptacles **26** may provide access to AC power. Also, receptacle **26** may be used to receive an AC input current that may be converted to DC power, for example, by the power inverter **60**, and used to charge the internal battery **20** in a known manner. Outlet **22** may also be used to receive DC power to charge internal battery **20**.

[0016] The battery **20** may also be used to provide jump-starting power for vehicles such as cars, RVs, and the like, which cannot start due to a depleted vehicle battery. For example, a booster apparatus as described in U.S. patent application Ser. No. 10/315,061, which is incorporated herein by reference, may be provided. The jump starter therefore may include a set of jumper cables **16** that may be used to connect the battery **20** in the housing **10** to the depleted vehicle battery. Such jumper cables **16** are well known to those of ordinary skill in the art.

[0017] The jumper cables may be detachable from the housing. An end of the jumper cables may include a plug **17** that may be received in the housing **10** to connect the cables to the internal battery **20**. At an end of the cables **16** opposite the plug **17** there may be a pair of clamps **24** for connecting to the depleted battery. The housing **10** may also include clips or holsters for the jumper cables **16**. The housing **10** may also be provided with pins, guides, compartments or the like in order to allow a user to wrap the jump starter cables **16** for storage, thus keeping the cables neat and accessible.

[0018] Referring now to the embodiment illustrated in FIG. **2**, the housing may have a lid **11**. The lid **11** may be opened or closed to expose or enclose a cavity **28** within the housing **10**. Latches or other securing devices may be provided to secure the lid **11** in the closed position. The jump starter may also be provided with battery charger circuitry **30**. The battery charger circuitry **30** may he adapted to charge portable rechargeable batteries, such as, for example, NiCad batteries and the like. As defined herein, portable batteries may include any rechargeahle portable battery designated as such hy any of the American National Standard Specifications as puhlished by the American National Standards Institute, such as ANSI C18 series. Exemplary portable hatteries are designated as AAA, AA, C and D and have wide household use.

[0019] The cavity **28** may be adapted to accommodate portable batteries of different sizes and types, such as a 9 volt battery and D, C, AA, etc. size cells. As shown in FIG. **2**, the cavity **28** may have a rectangular shape. Cavity **28** may be configured to receive and charge batteries of different sizes as is known to one of ordinary skill in the art.

[0020] FIG. **4** illustrates a more detailed view of an embodiment of cavity **28**. As shown in FIG. **4**, the cavity **28** may have a rectangular shape, with a top **31**, bottom **32** and two sides **34**, **36**. A hack **38** may connect the top **30**, bottom **32** and two sides **34**, **36** together. The top **30** and bottom **32** may he provided with various contacts **44**, **46**, respectively, to connect to the contacts of different size and type batteries. Back **38** may be provided with slots **40** extending along at least part of its length. A slide member **41** may move along the slots **40**.

[0021] The slide member **41** may have a front surface **42** facing top **31** and a back surface **43** facing bottom **32**. Various sets of contacts **48**, **50** may be provided on front surface **42** and back surface **43** respectively. The contacts **48**, **44** on front surface **42** and top **31** may be adapted to connect to battery electrodes of opposite polarity. The contacts **50**, **46** on back surface **43** and bottom **32** may be adapted to connect to battery electrodes of opposite polarity. For example, positive electrodes of batteries **50** may be connected to contacts **44** and negative electrodes of batteries **52** may be connected to contacts **48** on front surface **42**. The slide member **41** may move along the slots to fit different size batteries. Cavity **28** may also be adapted to receive and charge batteries of different sizes in a variety of other ways which are known to one of ordinary skill in the art.

[0022] In a further embodiment, the portable battery charger circuitry **30** may detect if rechargeable or non-rechargeable batteries are placed in the cavity **28**. Detection may be made by controller **14**. The detection may be based on the characteristics of the portable battery, such as, for example, voltage, internal resistance, etc. If a non-rechargeable battery is detected, charging may be prevented. Detecting and preventing the charging of non-rechargeable batteries may be done in a known manner.

[0023] The portable batteries and internal battery **20** may be recharged via the DC input from the outlet **22**, or via a wall cube that converts household AC current into DC. An input port **56** may be provided on the housing to receive input from the wall cube. The internal battery **20** may provide power for the portable battery charger circuitry **30**.

[0024] An on/off switch **58** may control the operation of the jump starter. A set of indicator lights **64** may be provided to show the status of the internal battery **20** or portable batteries being charged. The controller **14** may monitor the various components of the jump starter and show results on a display. The display may include, for example, a linear meter, a digital read out or a bar graph which may allow a user to monitor the operation of the jump starter, such as the status on the internal battery, the battery in a vehicle being jump started, or the portable batteries. A battery gauge such as a linear meter for a digital read out or a bar graph may be provided to display to the user the status of the internal and/or the external battery being charged. The gauge or read out may be provided on a front surface of the housing.

[0025] Numerous different options are contemplated within the apparatus electrically, these options may include such schemes as totally enclosing the internal wiring terminating at a single point input/outlet for all charging functions or, conversely, at multiple points both internal and external. The power inverter, battery charger and other devices may be of varying watts, amperage ratings, etc. The battery configuration may include several different types of technology such as, for example, nickel cadmium, lead acid, etc. A port may be provided in the jump starter to allow for the addition of external batteries of greater capacity than the internal battery. Each of the aforementioned devices may be contained within the same housing for a portable jump starter. The jump starter may provide both DC and AC power in addition to battery charging capabilities.

We claim:

1. A portahle jump starter, comprising:

a housing defining a cavity therein, the cavity heing adapted to receive different size portable batteries;

an AC outlet provided on the housing;

a DC input port provided on the housing;

an internal battery disposed within the housing;

a power inverter disposed within the housing;

jumper cables having a first end removably coupled to the battery and adapted to receive charging current therefrom and a second end including battery clamps;

portable battery charging circuitry disposed in the housing, the battery charger circuitry coupled to at least one of the DC input and the internal battery and adapted to provide battery charging current to portable batteries in the cavity.

2. The jump starter of claim 1, wherein the battery charging circuitry is adapted to distinguish between rechargeable and non-rechargeable batteries.

3. The jump starter of claim 1, further comprising:

a lid hingedly connected to the housing and adapted to cover the cavity, the lid including contours adapted to fit the contour of different size batteries to hold the batteries within the cavity.

4. The jump starter of claim 1, further comprising:

a lid hingedly connected to the housing and adapted to cover the cavity;

a slide member disposed in the cavity, the slide member being movable to accommodate different size portable batteries;

a first set of recharging contacts disposed on a top side of the cavity and a corresponding set of battery contacts provided ou a first side of the slide member and a second set of recharging contacts disposed on a bottom side of the cavity and a corresponding set of battery contacts provided on a second side of the slide member, opposite the first side of the slide member.

5. The jump starter of claim 1, further comprising a cigarette lighter adaptor coupled to the DC input port.

6. The jump starter of claim 1, further comprising a USB port configured to output DC power.

7. The jump starter of claim 1 further comprising a set of indicator lights configured to indicate the status of the jump starter and at least one of the battery, the battery recharger, or the power inverter.

8. The jump starter of claim 1 further comprising a set of indicator lights configured to indicate the status of the internal battery or the portable batteries being charged.

9. The jump starter of claim 1 further comprising a display configured to indicate the status of the jump starter and at least one of the battery, the battery recharger, or the power inverter.

10. An apparatus, comprising:

a housing;

circuitry disposed within the housing coupled to a battery, a battery charger, a power inverter, a controller, at least one of a AC or DC input port, and at least one of an AC or DC output port;

the battery adapted to receive a DC input from the DC input port or the power inverter and provide a DC output, and coupled to the controller, the battery recharger, at least one of the DC output ports;

the power inverter adapted to receive a DC or AC input from at least one of the AC inputs, the DC inputs, or the battery, and provide a DC or AC output, and coupled to the controller, the battery charger, and at least one of the AC or DC output ports;

the battery recharger adapted to receive a DC input from at least one of the battery, the DC input port, or the power inverter, to contain at least one rechargeable battery and provide DC input to the at least one rechargeable battery;

the controller adapted to receive DC input from at least one of the battery, the DC input port, or the power inverter, regulate the operation of the battery, the battery recharger, and the power inverter.

11. The apparatus of claim 10, wherein the battery recharger is adapted to distinguish between rechargeable and non-rechargeable batteries.

12. The apparatus of claim 10, further comprising:

a lid hingedly connected to the housing and adapted to cover the cavity, the lid including contours adapted to fit the contour of different size batteries to hold the batteries within the cavity.

13. The apparatus of claim 10, further comprising:

a lid hingedly connected to the housing and adapted to cover the cavity;

a slide member disposed in the cavity, the slide member being movable to accommodate different size portable batteries;

a first set of recharging contacts disposed on a top side of the cavity and a corresponding set of battery contacts provided on a first side of the slide member and a second set of recharging contacts disposed on a bottom side of the cavity and a corresponding set of battery contacts provided on a second side of the slide member, opposite the first side of the slide member.

14. The apparatus of claim 10, further comprising a cigarette lighter adaptor coupled to the DC input port.

15. The apparatus of claim 10, further comprising a USB port configured to output DC power.

16. The apparatus of claim 10 further comprising a set of indicator lights disposed on the housing configured to indicate the status of the least one of the battery, the battery recharger, or the power inverter.

17. The apparatus of claim 10 further comprising a set of indicator lights configured disposed on the housing to indicate the status of the internal battery or the portable batteries being charged.

18. The apparatus of claim 10 further comprising a display disposed on the housing configured to indicate the status of at least one of the battery, the battery recharger, or the power inverter.

* * * * *

AUSTRALIA

Patents Act

IN THE MATTER of Australian Patent Application No. 2016269555 in the name of The NOCO Company

- and -

Opposition thereto by Brown & Watson International Pty Ltd

ANNEXURE MD-6

The attached is **Annexure MD-6** referred to in the Declaration of Declaration of Max Dirnberger declared on 6th day of September 2019 in the above matter.

US 20130154543A1

(19) **United States**

(12) **Patent Application Publication**

Richardson et al.

(10) **Pub. No.: US 2013/0154543 A1**

(43) **Pub. Date: Jun. 20, 2013**

(54) **METHOD AND APPARATUS FOR PROVIDING SUPPLEMENTAL POWER TO AN ENGINE**

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(21) Appl. No.: **13/768,534**

(22) Filed: **Feb. 15, 2013**

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/436,562, filed on May 6, 2009, which is a continuation-in-part of application No. 12/330,875, filed on Dec. 9, 2008, now abandoned.

(60) Provisional application No. 61/018,715, filed on Jan. 3, 2008.

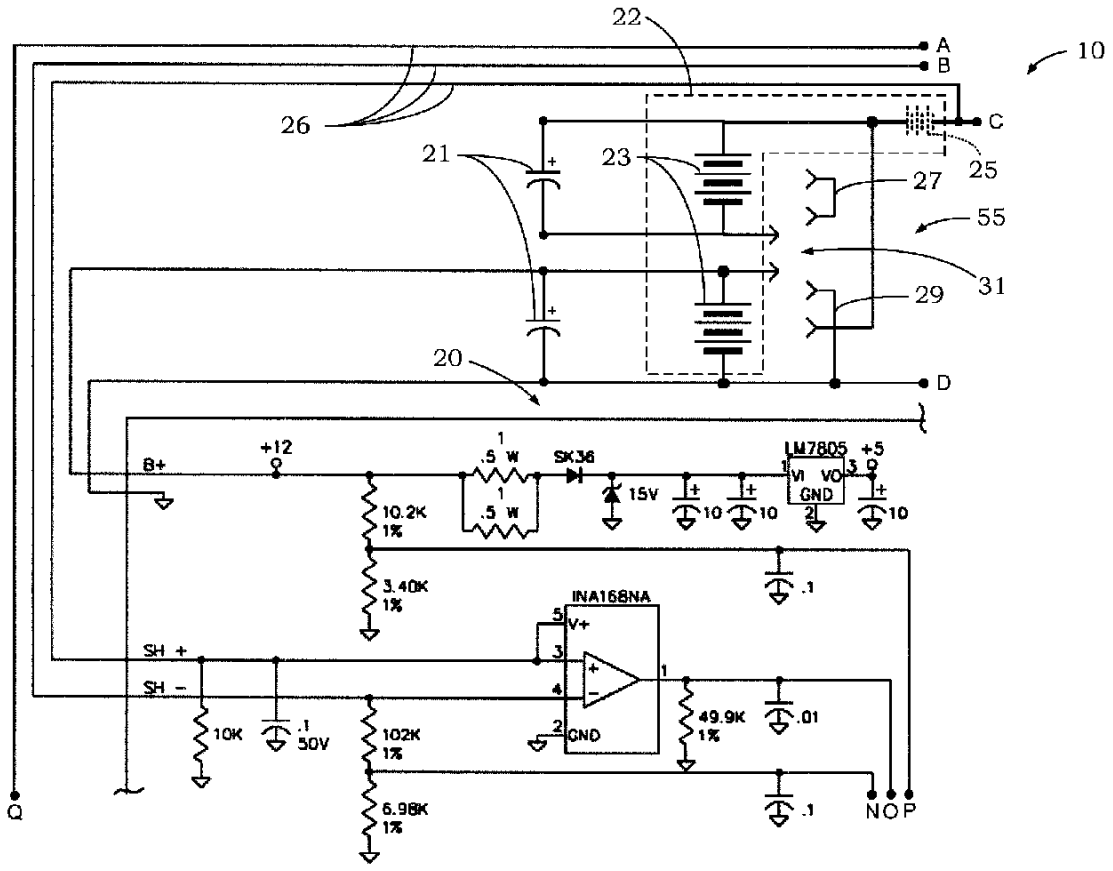
Publication Classification

(51) **Int. Cl.**
H02J 7/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H02J 7/007*** (2013.01)
USPC **320/104**; 320/136; 320/134; 320/109

(57) **ABSTRACT**

A method and apparatus provides supplemental power to an engine. The method and apparatus includes a pair of conductive leads for connecting the supplemental power to an engine electrical system, one or more batteries connected in parallel with one or more capacitors, a relay connected to the conductive leads, a shunt cable connecting the batteries and capacitors to the relay and a processor for controlling the relay to selectively apply electrical power to the engine electrical system. The method and apparatus includes safety features to reduce the risk of injury to the operator and damage to the apparatus and/or engine electrical system.



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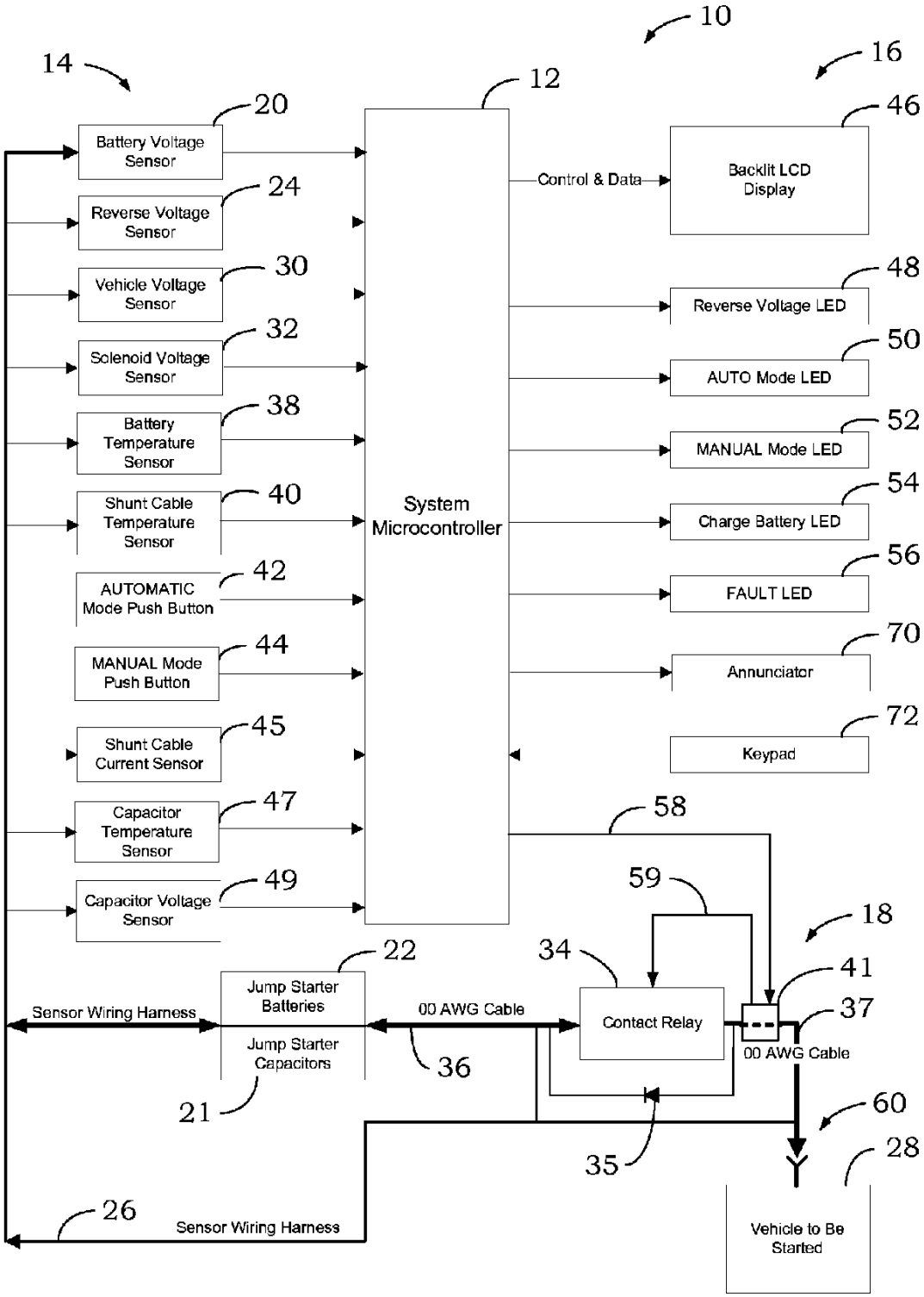

10
14
16
12
20
Battery Voltage Sensor
24
Reverse Voltage Sensor
30
Vehicle Voltage Sensor
32
Solenoid Voltage Sensor
38
Battery Temperature Sensor
40
Shunt Cable Temperature Sensor
42
AUTOMATIC Mode Push Button
44
MANUAL Mode Push Button
45
Shunt Cable Current Sensor
47
Capacitor Temperature Sensor
49
Capacitor Voltage Sensor
System Microcontroller
Control & Data
46
Backlit LCD Display
48
Reverse Voltage LED
50
AUTO Mode LED
52
MANUAL Mode LED
54
Charge Battery LED
56
FAULT LED
70
Annunciator
72
Keypad
58
59
18
22
34
41
37
Jump Starter Batteries
Jump Starter Capacitors
Sensor Wiring Harness
00 AWG Cable
Contact Relay
00 AWG Cable
36
21
35
60
28
26
Sensor Wiring Harness
Vehicle to Be Started

Fig. 1

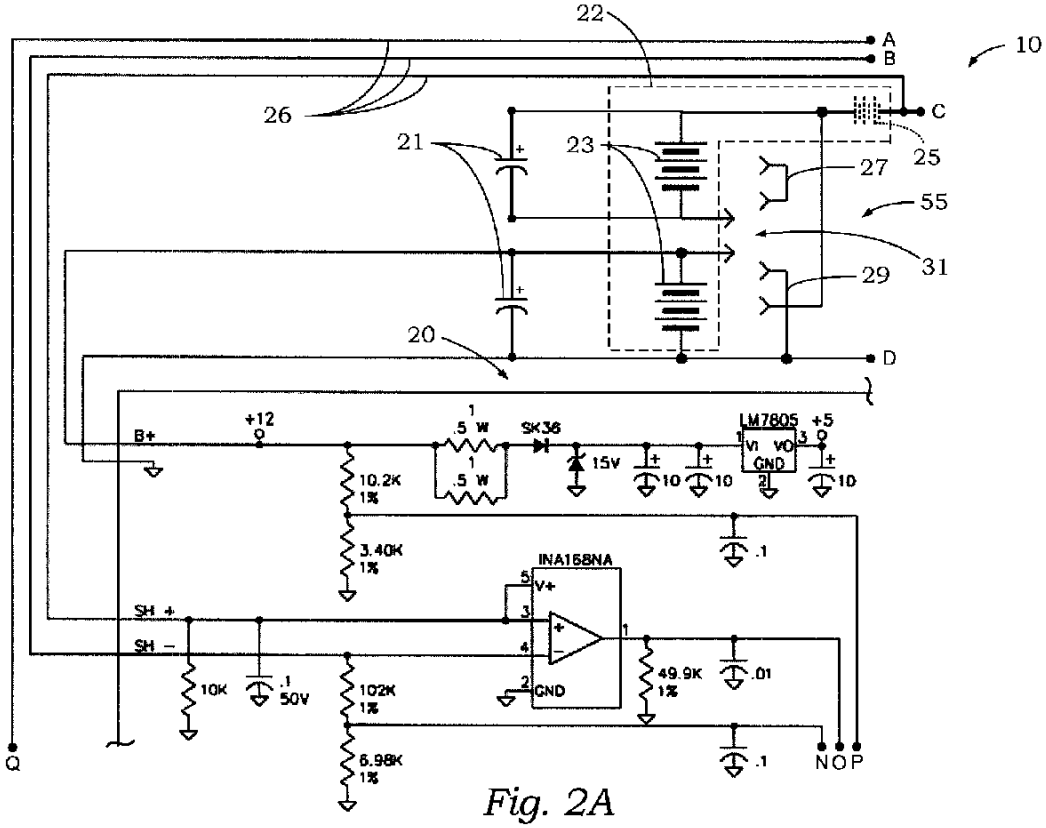

22
10
A
B
C
26
21
23
25
27
55
31
29
20
D
B+
+12
.5 W
SK36
15V
10
LM7805
+5
GND
10.2K
1%
3.40K
1%
INA168NA
V+
SH +
SH –
10K
.1
50V
102K
1%
6.98K
1%
49.9K
1%
.01
.1
GND
Q
N
O
P

Fig. 2A

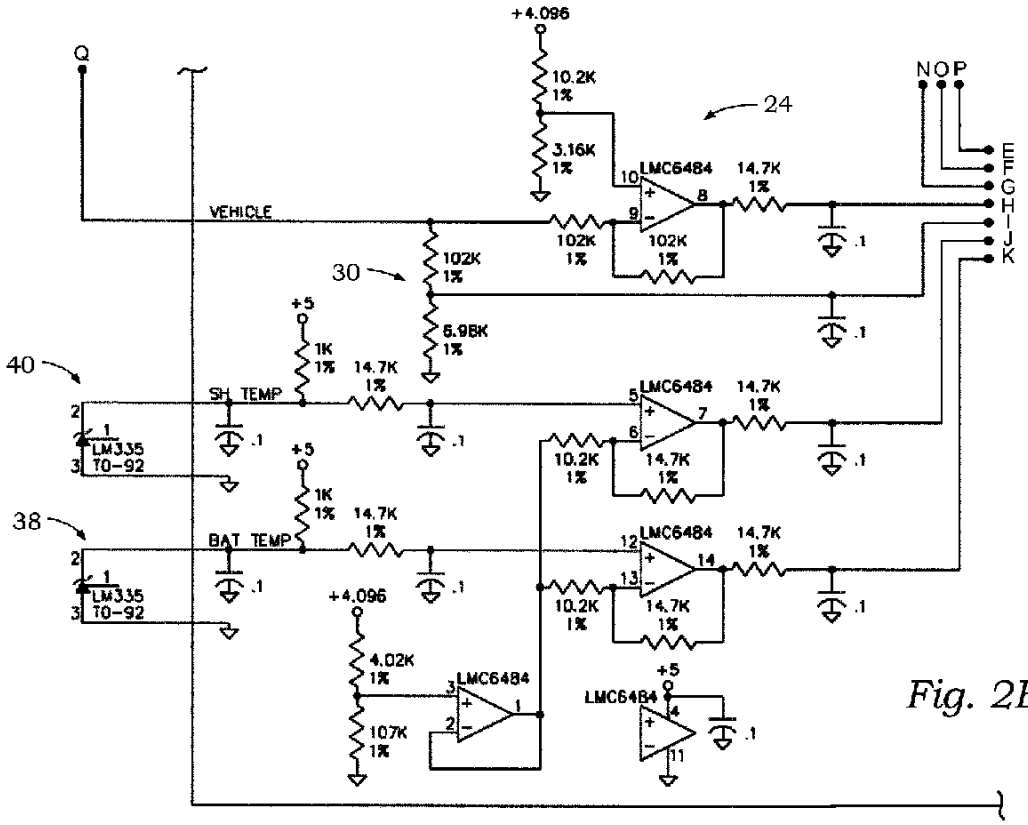

+4.096
10.2K 1%
3.16K 1%
24
Q
NOP
E
F
G
H
I
J
K
LMC6484
14.7K 1%
VEHICLE
102K 1%
102K 1%
102K 1%
30
6.98K 1%
+5
1K 1%
14.7K 1%
40
SH TEMP
LM335 TO-92
.1
10.2K 1%
38
BAT TEMP
4.02K 1%
107K 1%

Fig. 2B

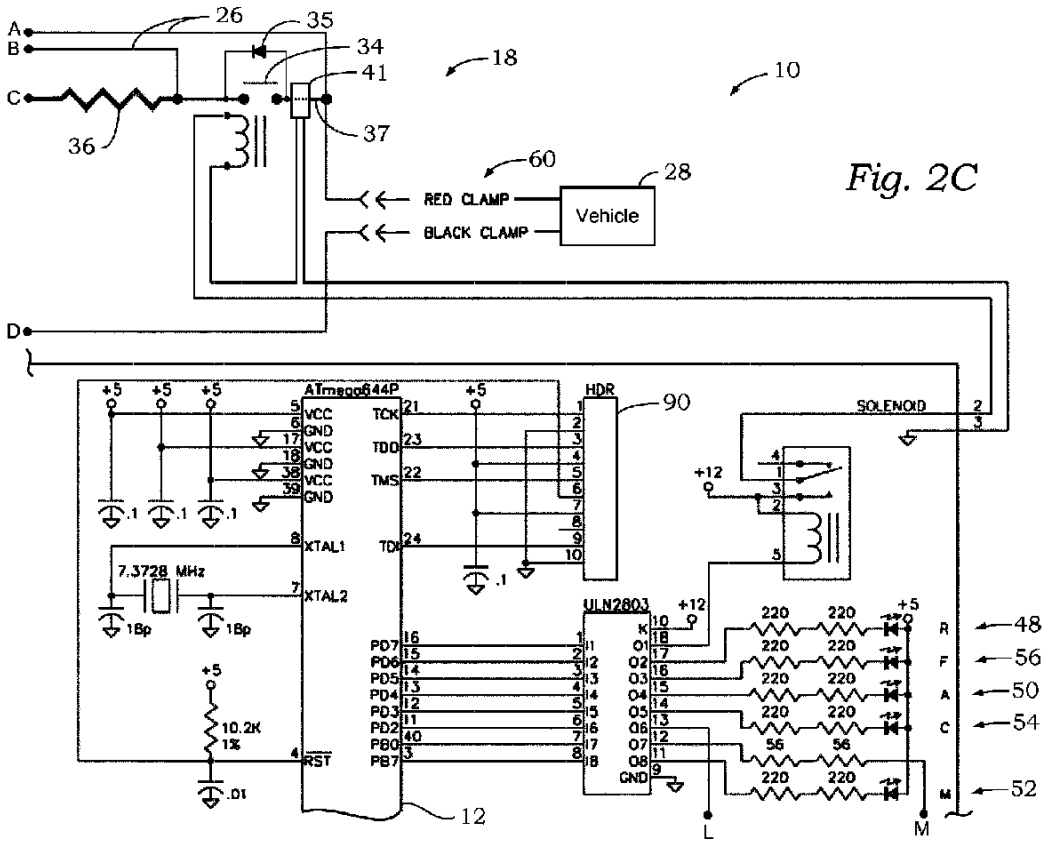

A
B
C
D
26
35
34
41
37
36
18
10
60
28
RED CLAMP
BLACK CLAMP
Vehicle
ATmega644P
HDR
90
SOLENOID
ULN2803
7.3728 MHz
10.2K
1%
.01
.1
18p
+5
+12
220
56
R
F
A
C
M
48
56
50
54
52
12
L
M

Fig. 2C

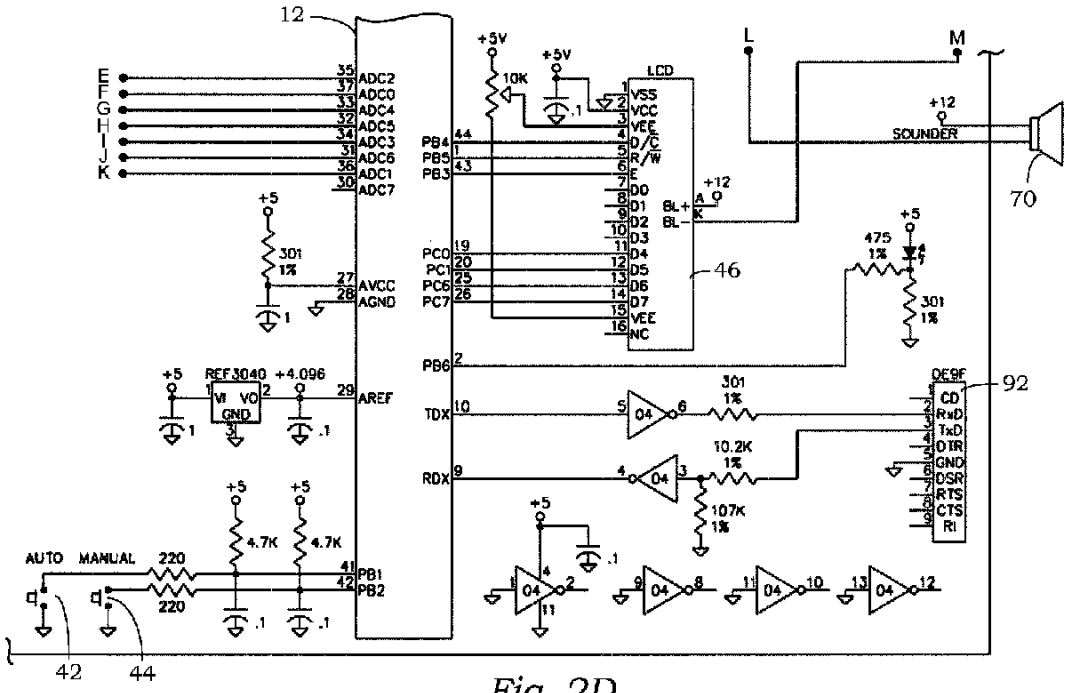

12
E
F
G
H
I
J
K
ADC2
ADC0
ADC4
ADC5
ADC3
ADC6
ADC1
ADC7
AVCC
AGND
AREF
REF3040
+4.096
PB4
PB5
PB3
PB6
PC0
PC1
PC6
PC7
TDX
RDX
PB1
PB2
AUTO
MANUAL
220
4.7K
10K
301
1%
475
10.2K
107K
LCD
VSS
VCC
VEE
D/C
R/W
E
D0
D1
D2
D3
D4
D5
D6
D7
BL+
BL-
NC
46
L
M
+12
SOUNDER
70
DE9F
CD
RxD
TxD
DTR
GND
DSR
RTS
CTS
RI
92
42
44

Fig. 2D

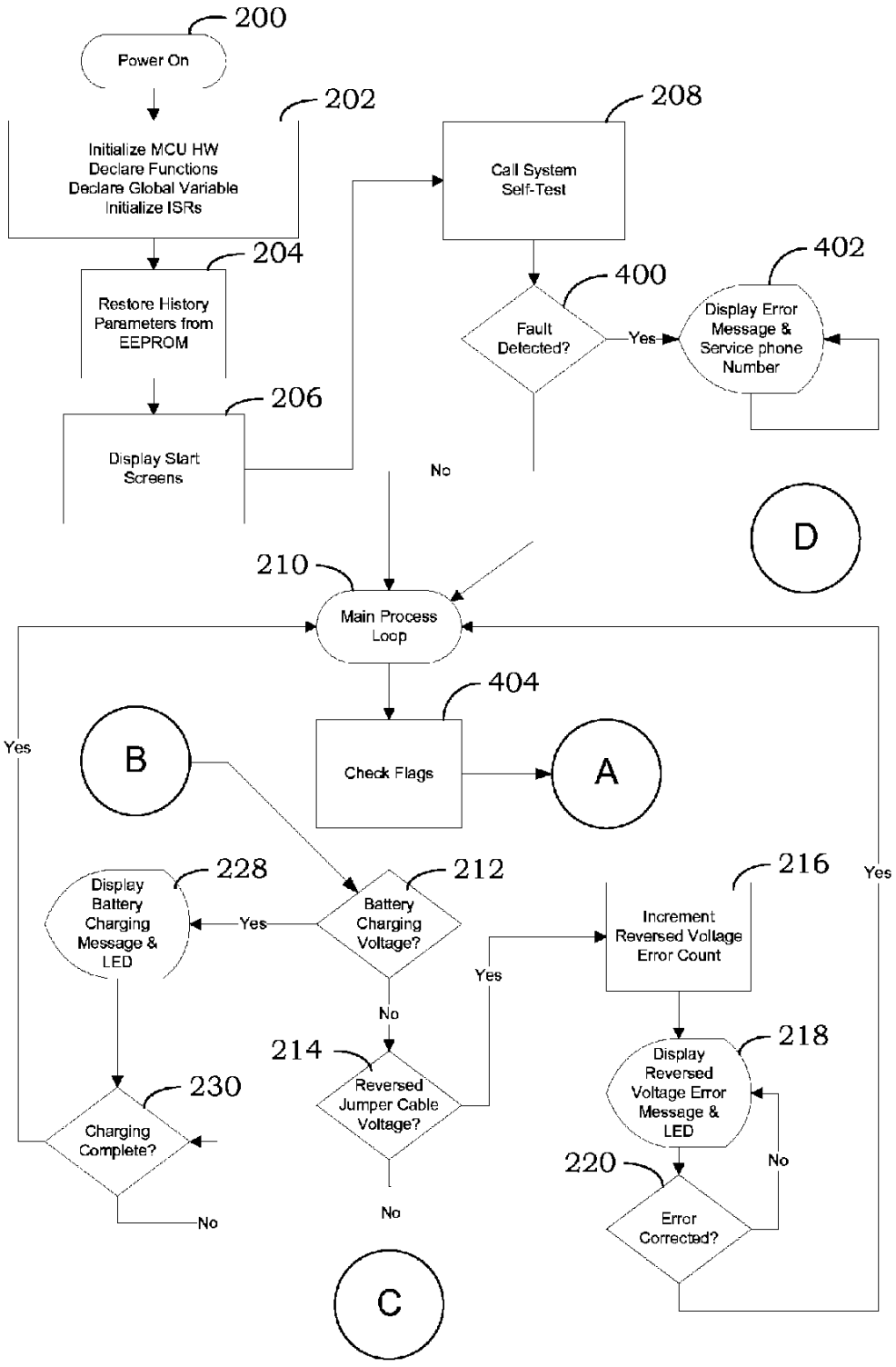

200
Power On
202
Initialize MCU HW
Declare Functions
Declare Global Variable
Initialize ISRs
204
Restore History
Parameters from
EEPROM
206
Display Start
Screens
208
Call System
Self-Test
400
Fault
Detected?
Yes
402
Display Error
Message &
Service phone
Number
No
D
210
Main Process
Loop
404
Check Flags
B
A
Yes
228
Display
Battery
Charging
Message &
LED
Yes
212
Battery
Charging
Voltage?
216
Increment
Reversed Voltage
Error Count
Yes
Yes
No
214
Reversed
Jumper Cable
Voltage?
218
Display
Reversed
Voltage Error
Message &
LED
230
Charging
Complete?
No
No
220
Error
Corrected?
No
C

Fig. 3

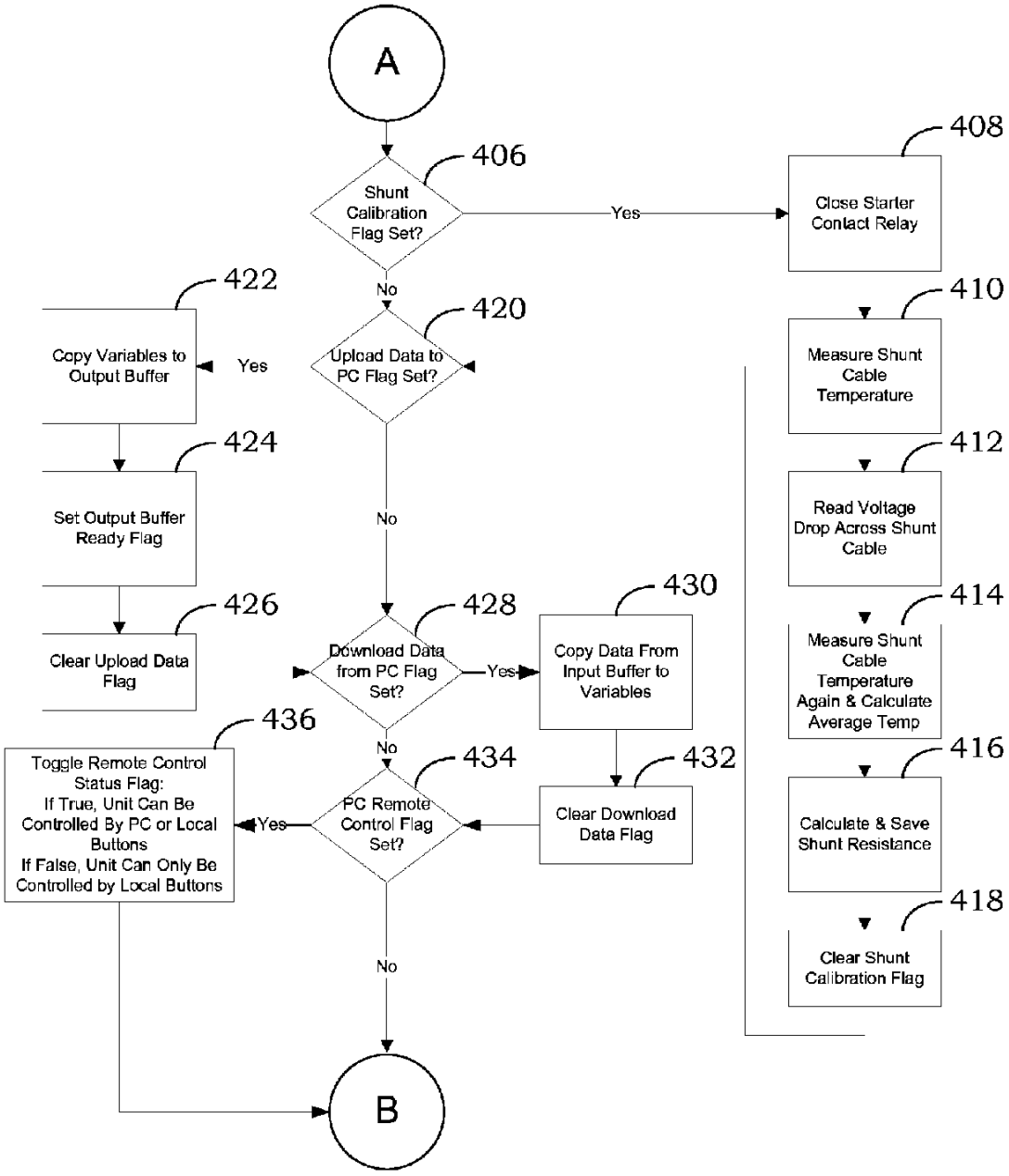

A
406
Shunt Calibration Flag Set?
Yes
408
Close Starter Contact Relay
No
422
Copy Variables to Output Buffer
Yes
420
Upload Data to PC Flag Set?
410
Measure Shunt Cable Temperature
424
Set Output Buffer Ready Flag
No
412
Read Voltage Drop Across Shunt Cable
426
Clear Upload Data Flag
428
Download Data from PC Flag Set?
Yes
430
Copy Data From Input Buffer to Variables
414
Measure Shunt Cable Temperature Again & Calculate Average Temp
No
436
Toggle Remote Control Status Flag:
If True, Unit Can Be Controlled By PC or Local Buttons
If False, Unit Can Only Be Controlled by Local Buttons
434
PC Remote Control Flag Set?
Yes
432
Clear Download Data Flag
416
Calculate & Save Shunt Resistance
No
418
Clear Shunt Calibration Flag
B

Fig. 4

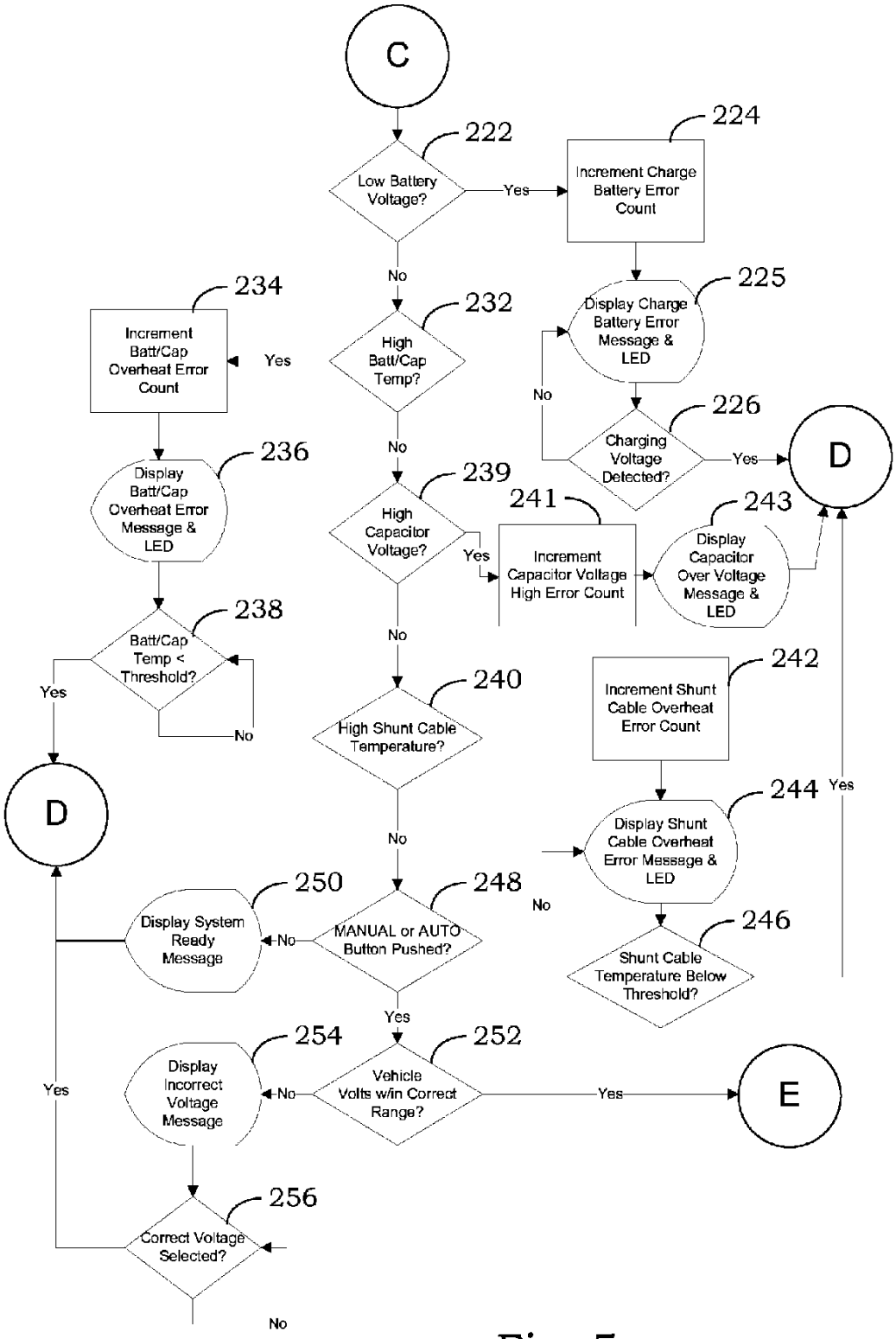

C
222
Low Battery Voltage?
Yes
224
Increment Charge Battery Error Count
No
225
Display Charge Battery Error Message & LED
232
High Batt/Cap Temp?
234
Increment Batt/Cap Overheat Error Count
Yes
No
226
Charging Voltage Detected?
Yes
D
236
Display Batt/Cap Overheat Error Message & LED
239
High Capacitor Voltage?
241
Increment Capacitor Voltage High Error Count
Yes
243
Display Capacitor Over Voltage Message & LED
238
Batt/Cap Temp < Threshold?
Yes
No
No
240
High Shunt Cable Temperature?
242
Increment Shunt Cable Overheat Error Count
D
244
Display Shunt Cable Overheat Error Message & LED
Yes
No
250
Display System Ready Message
No
248
MANUAL or AUTO Button Pushed?
246
Shunt Cable Temperature Below Threshold?
Yes
254
Display Incorrect Voltage Message
252
Vehicle Volts w/in Correct Range?
No
Yes
E
Yes
256
Correct Voltage Selected?
No

Fig. 5

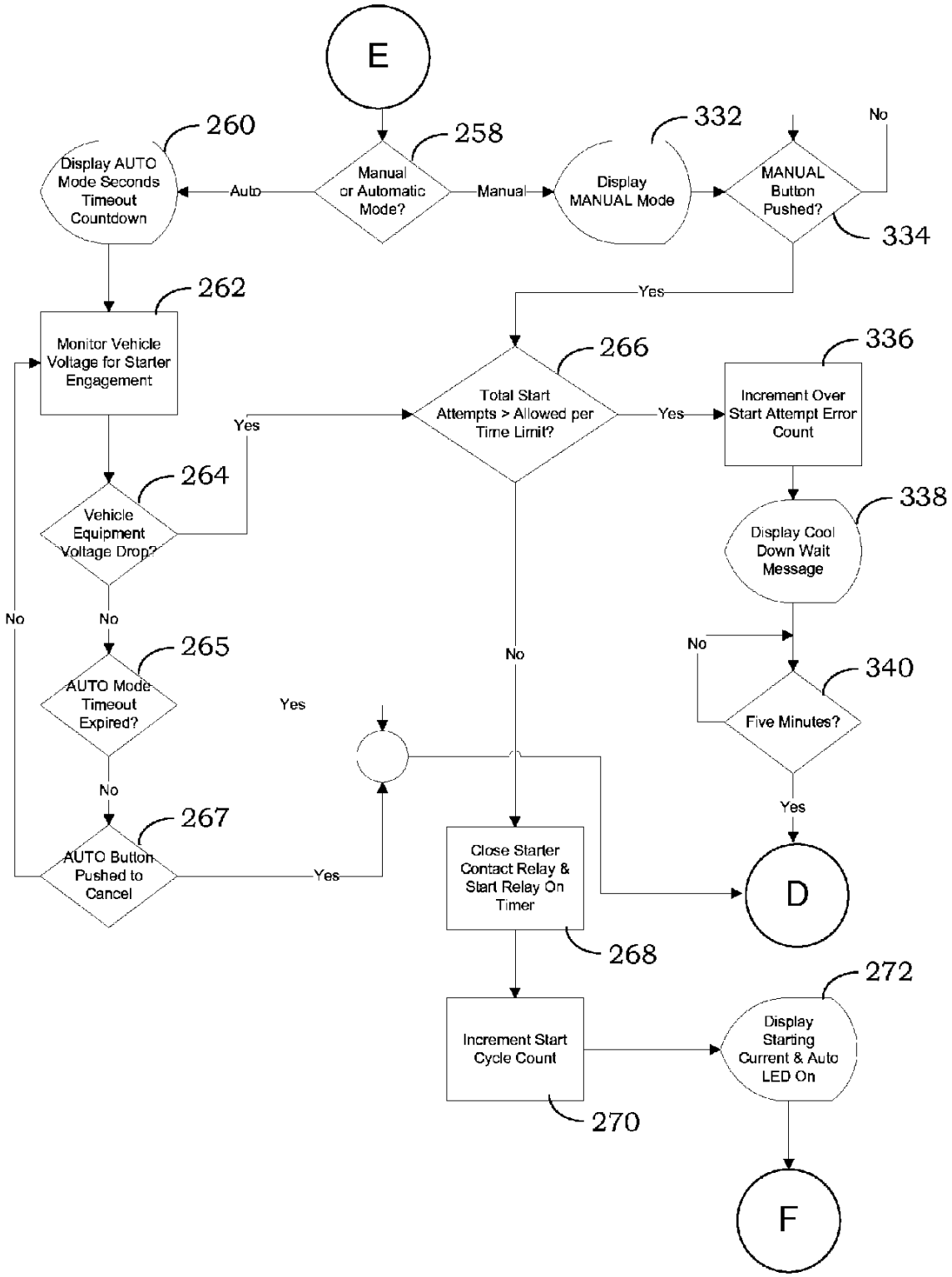

E
260
Display AUTO Mode Seconds Timeout Countdown
258
Manual or Automatic Mode?
Auto
Manual
332
Display MANUAL Mode
MANUAL Button Pushed?
No
334
Yes
262
Monitor Vehicle Voltage for Starter Engagement
266
Total Start Attempts > Allowed per Time Limit?
Yes
336
Increment Over Start Attempt Error Count
Yes
264
Vehicle Equipment Voltage Drop?
338
Display Cool Down Wait Message
No
No
265
AUTO Mode Timeout Expired?
Yes
No
No
340
Five Minutes?
No
Yes
267
AUTO Button Pushed to Cancel
Yes
Close Starter Contact Relay & Start Relay On Timer
D
268
272
Increment Start Cycle Count
Display Starting Current & Auto LED On
270
F

Fig. 6

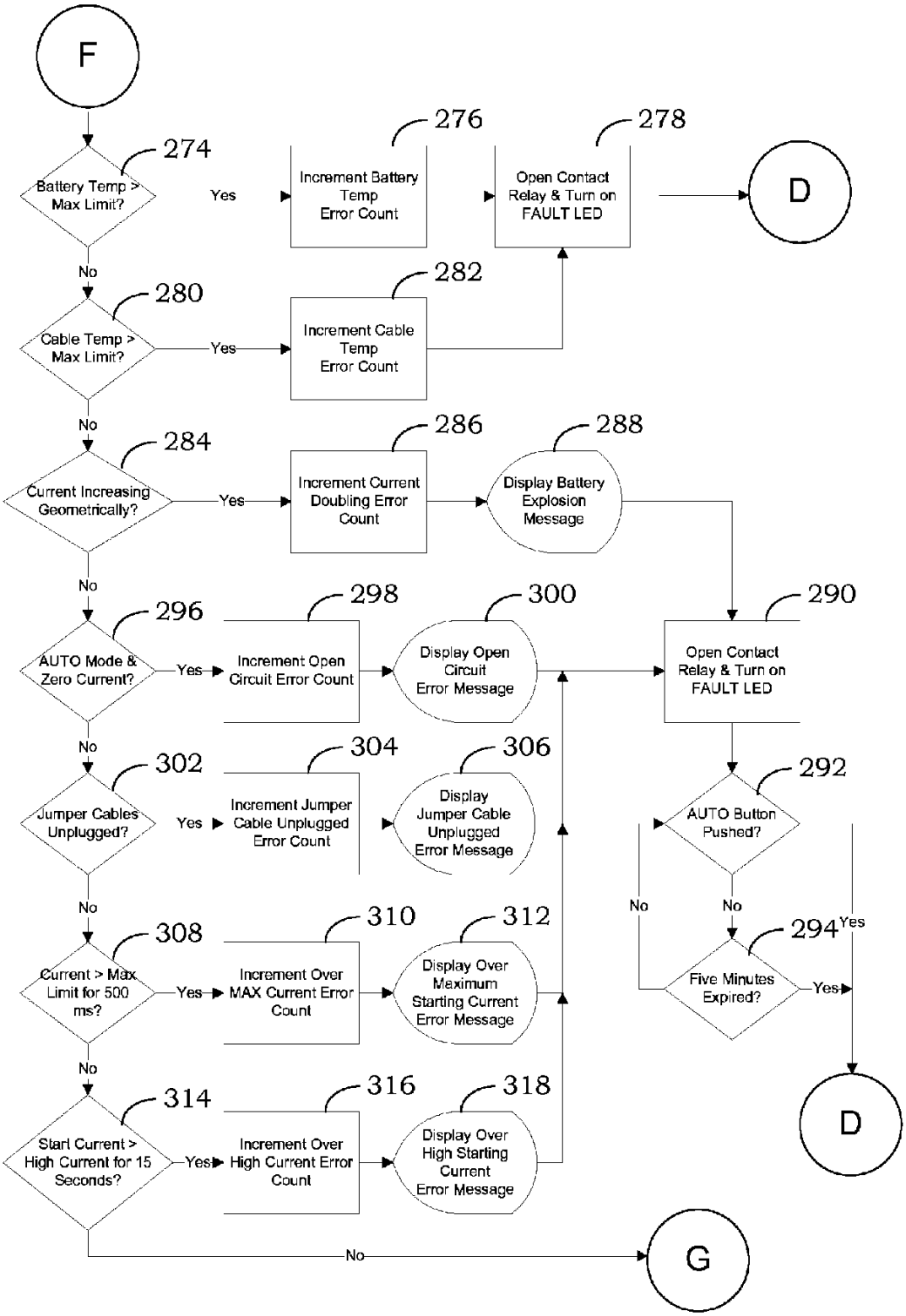

F
274
Battery Temp > Max Limit?
Yes
276
Increment Battery Temp Error Count
278
Open Contact Relay & Turn on FAULT LED
D
No
280
Cable Temp > Max Limit?
Yes
282
Increment Cable Temp Error Count
No
284
Current Increasing Geometrically?
Yes
286
Increment Current Doubling Error Count
288
Display Battery Explosion Message
No
296
AUTO Mode & Zero Current?
Yes
298
Increment Open Circuit Error Count
300
Display Open Circuit Error Message
290
Open Contact Relay & Turn on FAULT LED
No
302
Jumper Cables Unplugged?
Yes
304
Increment Jumper Cable Unplugged Error Count
306
Display Jumper Cable Unplugged Error Message
292
AUTO Button Pushed?
No
No
No
308
Current > Max Limit for 500 ms?
Yes
310
Increment Over MAX Current Error Count
312
Display Over Maximum Starting Current Error Message
294
Five Minutes Expired?
Yes
Yes
D
No
314
Start Current > High Current for 15 Seconds?
Yes
316
Increment Over High Current Error Count
318
Display Over High Starting Current Error Message
No
G

Fig. 7

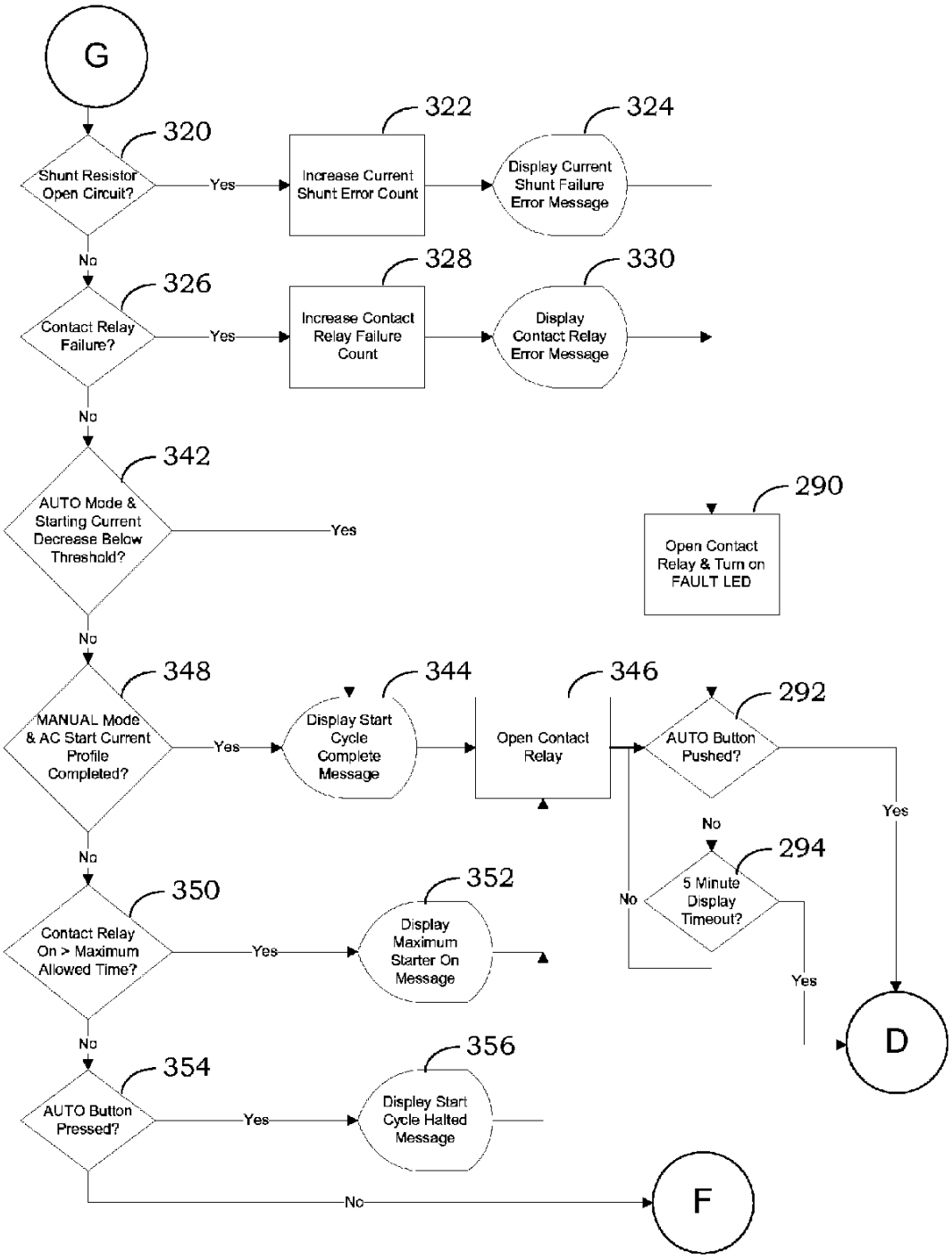

G
320
Shunt Resistor Open Circuit?
Yes
322
Increase Current Shunt Error Count
324
Display Current Shunt Failure Error Message
No
326
Contact Relay Failure?
Yes
328
Increase Contact Relay Failure Count
330
Display Contact Relay Error Message
No
342
AUTO Mode & Starting Current Decrease Below Threshold?
Yes
290
Open Contact Relay & Turn on FAULT LED
No
348
MANUAL Mode & AC Start Current Profile Completed?
Yes
344
Display Start Cycle Complete Message
346
Open Contact Relay
292
AUTO Button Pushed?
Yes
No
294
5 Minute Display Timeout?
No
Yes
No
350
Contact Relay On > Maximum Allowed Time?
Yes
352
Display Maximum Starter On Message
No
354
AUTO Button Pressed?
Yes
356
Displey Start Cycle Halted Message
No
D
F

Fig. 8

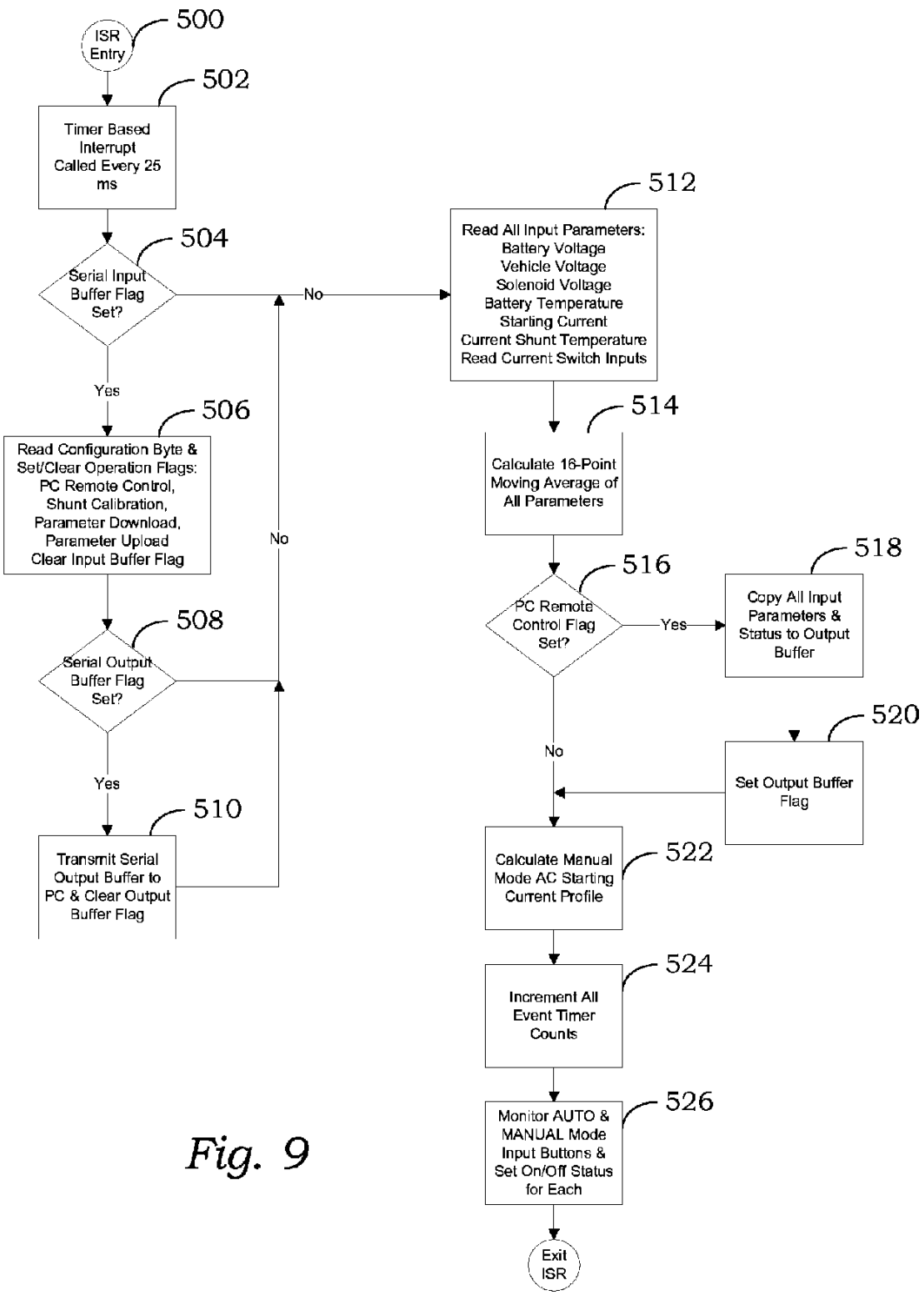

500
ISR Entry
502
Timer Based Interrupt Called Every 25 ms
504
Serial Input Buffer Flag Set?
No
Yes
506
Read Configuration Byte & Set/Clear Operation Flags: PC Remote Control, Shunt Calibration, Parameter Download, Parameter Upload Clear Input Buffer Flag
508
Serial Output Buffer Flag Set?
Yes
510
Transmit Serial Output Buffer to PC & Clear Output Buffer Flag
No
512
Read All Input Parameters: Battery Voltage Vehicle Voltage Solenoid Voltage Battery Temperature Starting Current Current Shunt Temperature Read Current Switch Inputs
514
Calculate 16-Point Moving Average of All Parameters
516
PC Remote Control Flag Set?
Yes
518
Copy All Input Parameters & Status to Output Buffer
No
520
Set Output Buffer Flag
522
Calculate Manual Mode AC Starting Current Profile
524
Increment All Event Timer Counts
526
Monitor AUTO & MANUAL Mode Input Buttons & Set On/Off Status for Each
Exit ISR

Fig. 9

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METHOD AND APPARATUS FOR PROVIDING SUPPLEMENTAL POWER TO AN ENGINE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of application Ser. No. 12/436,562, filed May 6, 2009, entitled METHOD AND APPARATUS FOR PROVIDING SUPPLEMENTAL POWER TO AN ENGINE, which is a continuation-in-part of application Ser. No. 12/330,875, filed Dec. 9, 2008, entitled METHOD AND APPARATUS FOR PROVIDING SUPPLEMENTAL POWER TO AN ENGINE, which claims the benefit of provisional patent application 61/018,715, filed Jan. 3, 2008. with the same title.

FIELD

[0002] The present invention relates to a portable power source for a motor vehicle and, more particularly, to a method and apparatus to provide supplemental power to start internal combustion and turbine engines.

BACKGROUND

[0003] Internal combustion and turbine engines require a power source to start. Commonly, this power source is in the form of a battery, which provides power to a starter motor, which in turn drives the engine. The crankshaft of the engine is rotated by the starter motor at a speed sufficient to start the engine. If the battery goes dead or otherwise lacks sufficient power for the starter motor to drive the engine, the engine won't start. Environmental factors, such as temperature, affect the output of the battery and power required to rotate the engine.

[0004] If the battery lacks sufficient power to start the engine, a supplemental power source is necessary to jump start the engine. Typically, jumper cables are used to connect the battery of one vehicle to the dead battery of another vehicle needing to be jumped. The batteries are connected in parallel using heavy cables (jumper cables) which are connected to the terminals of the batteries using conductive clamps.

[0005] Several potential problems arise from the use of conventional jumper cables. Batteries in motor vehicles are capable of producing from 2,500 to more than 45,000 watts of power. If the batteries are cross-connected or the clamps inadvertently contact each other when one end of the jumper cables is connected to a battery, sparking can occur resulting in damage to the battery, the electrical system of the vehicle, and injury to the user of the jumper cables. If the jumper cables are not properly connected, there is a potential for the batteries exploding and fire, which may result in injury to those in proximity to the vehicle being jumped. Furthermore, the user is not given any indication as to the reason the battery is dead, which may only cause additional problems when trying to jump start the dead battery.

SUMMARY

[0006] The present invention provides an apparatus and method for temporarily delivering supplemental power to the electrical system of a vehicle. The apparatus and method performs real-time monitoring of all system parameters to increase the safety and effectiveness of the unit's operation while providing additional parametric and diagnostic information obtained before, during and after the vehicle starting operation.

[0007] The present invention monitors the voltage of the battery of the vehicle to be jump started and the current delivered by the jump starter batteries and capacitors to determine if a proper connection has been established and to provide fault monitoring. For safety purposes, only if the proper polarity is detected can the system operate. The voltage is monitored to determine open circuit, disconnected conductive clamps, shunt cable fault, and solenoid fault conditions. The current through the shunt cable is monitored to determine if there is a battery explosion risk, and for excessive current conditions presenting an overheating condition, which may result in fire. The system includes one or more internal batteries and capacitors to provide the power to the battery of the vehicle to be jump started. Once the vehicle is started, the vehicle's electrical system may recharge the batteries and capacitors before the unit automatically electrically disconnects from the vehicle's battery.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a functional block diagram of the portable power source of the present invention.

[0009] FIG. **2** (divided into FIGS. **2**A, **2**B, **2**C and **2**D) is a schematic of the portable power source, control circuit and sensors of the present invention.

[0010] FIGS. **3-8** are flow charts of the processing steps of the portable power source of the present invention.

[0011] FIG. **9** is a flow chart of the interrupt service routine of the system of the portable power source of the present invention.

DESCRIPTION

[0012] As required, detailed embodiments of the present invention are disclosed herein. However, it is to be understood that the disclosed embodiments are merely exemplary of the invention that may be embodied in various and alternative forms. The figures are not necessarily to scale; some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for the claims and/or as a representative basis for teaching one skilled in the art to variously employ the present invention.

[0013] Moreover, except where otherwise expressly indicated, all numerical quantities in this description and in the claims are to be understood as modified by the word "about" in describing the broader scope of this invention. Practice within the numerical limits stated is generally preferred. Also, unless expressly stated to the contrary, the description of a group or class of materials as suitable or preferred for a given purpose in connection with the invention implies that mixtures or combinations of any two or more members of the group or class may be equally suitable or preferred.

[0014] Referring initially to FIG. **1**, the portable supplemental power source (jump starter) of the present invention is generally indicated by reference numeral **10**. Jump starter **10** includes a programmable microprocessor **12** which receives inputs **14** and produces informational outputs **16** and control outputs **18**. Microprocessor **12** provides flexibility to the system **10** to allow updates to the functionality and system parameters without changing the hardware. In the preferred

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embodiment, an 8-bit microprocessor with 64 k bytes of programmable flash memory is used to control the system **10**. One such microprocessor is the ATmega644P available from Atmel Corporation. The microprocessor **12** may be programmed via an internal connector **90**, or an external connector **92** (see FIG. **2**). It should be understood that other programming ports may be included are not limited to the two shown in the figure.

[0015] A capacitor voltage sensor **49** monitors the voltage level of one or more capacitor **21**. The capacitors **21** may include energy storage modules containing six or more ultracapacitor cells, for example. The capacitor modules **21** may be counected in series to obtain higher operating voltages or in parallel to provide additional energy storage. One such capacitor module is the Boostcap Energy Storage Module available from Maxwell Technologies, Inc.

[0016] A battery voltage sensor **20** monitors the voltage level of one or more jump starter batteries **22**. A reverse voltage sensor **24** monitors the polarity of the jumper cables on line **26** which are counected to the vehicle's electrical system **28**. A vehicle voltage sensor **30** monitors the voltage on line **37** (voltage of the vehicle). When the contacts are open, the solenoid voltage sensor **32** input to microprocessor **12** is used to measure the voltage of the jump starter capacitors **21** and batteries **22**, which may be configured for various jump starter voltages. When the contacts are closed, the voltage difference between the capacitors **21** and batteries **22**, and the contact relay **34** is used to measure the voltage drop across a temperature-and-resistance calibrated 00 AWG shunt cable **36** in order to calculate the current being delivered by the jump starter capacitors **21** and batteries **22** to the vehicle's electrical system **28**. Although the present invention is disclosed and described as temporarily connected to a vehicle, it should be understood that it is equally applicable to a stationary engine. Additionally, the connection method to the electrical system or batteries of the engine to be started is not important and may include conductive clamps, NATO connectors, or may be permanently hardwired to the system, for example.

[0017] A battery temperature sensor **38** monitors the temperature of the jump starter's batteries **22** to detect overheating due to excess current draw from the batteries during jump starting. A shunt cable temperature sensor **40** monitors the temperature of the 00 AWG shunt cable **36** in order to compensate for resistance changes of the shunt cable due to the high current passing through the shunt cable **36** and to detect overheating conditions. The unit **10** also includes automatic **42** and manual **44** pushbutton inputs to accept user input to select either automatic or manual operation.

[0018] The temperature of 00 AWG shunt cable **37** may also be monitored by a temperature sensor or thermal switch **41**. As long as the temperature of the cable **37** is below a predetermined limit, the input on line **58** is passed through sensor **41** to line **59** to enable the contact relay **34** as controlled by system microcontroller **12**. If the temperature of the cable **37** exceeds a predetermined limit, then the temperature sensor **41** presents an open circuit to control line **58** to disable contact relay **34** and not allow power to be applied to the vehicle **28**. It should be understood that the temperature sensor **41** may be coupled to cable **36**, **37** or any other cable that may become overheated. Additional temperature sensors may be used to provide additional protection of the system from overheating.

[0019] A capacitor temperature sensor **47** monitors the temperature of the jump starter capacitors **21** to detect overheating due to excess current draw from the capacitors during jump starting.

[0020] The microprocessor **12** includes several outputs **16** to provide information to the user and to control the application of power to the vehicle to be jump started. An LCD display **46** may be used to display user instructions, error messages, and real-time sensor data during operation of the jump starter **10**. A reverse voltage LED **48** is illuminated when the microprocessor **12** determines that a reverse voltage jumper cable voltage is detected by reverse voltage sensor **24**. An auto mode LED **50** is illuminated when the automatic mode pushbutton **42** is depressed. A manual mode LED **52** is illuminated when the manual mode pushbutton **44** is depressed. If the voltage level of the jump starter batteries **22** drop below a value of twenty percent of the normal level, a charge battery LED **54** is illuminated. The charge battery LED **54** remains illuminated until the batteries **22** are charged to a minimum state of charge such as fifty percent, for example. A fault LED **56** is turned on anytime the microprocessor **12** detects any operational, sensor or internal fault. An audible warning may also be provided **70**. The fault LED **56** remains illuminated until the fault condition is cleared.

[0021] A contact relay control output **58** operates the contact relay **34** through temperature sensor **41**. When the jump starter operation has been successfully initiated, the contact relay **34** is closed and the jump starter capacitors **21** and batteries **22** are connected to the starter system or batteries of the vehicle to be started **28**. The contact relay **34** is opened when a successful start cycle has been completed, a start fault has occurred or the operator interrupts the jump starter cycle. An optional key pad **72** may be included and used for entry of a passcode to operate the unit **10**, or to identify one or more users of the system which may be stored to track user operation. For example, if two different users operate the unit **10** and error conditions are recorded for one of the users, this information may be used to identify training issues that need to be addressed.

[0022] Referring to FIGS. **2A**, **2B**, **2C**, **2D** and **3-8**, when the jump starter **10** is initially powered on **200**, the microcontroller **12** initializes the hardware, reads all system parameters and variables, and initializes the interrupt service routine **202** (See FIG. **8**). All stored performance history is read from the onboard, non-volatile memory **204** and a start message is displayed **206** on the LCD display **46**. The history is saved for diagnostic, unit use and safety purposes. The microcontroller **12** then performs a system self-test operation **208** where the LCD **46**, all LEDs **48**, **50**, **52**, **54** and **56**, all sensors **20**, **24**, **30**, **32**, **38**, **40**, the push buttons **42** and **44**, and the system batteries **22** are tested and their status displayed **208** on the LCD **46**. If a fault is detected **400**, an error message is displayed **402** and system operation is halted.

[0023] Once the initialization and self-test operations are completed, the system starts into a main processing loop **210**. An interrupt service routine ("ISR") **500** (FIG. **9**) is also started which constantly monitors all input sensor values and user input buttons. The ISR **500** is periodically called by the microcontroller **502**. A check is made to determine if the serial input buffer flag is set **504**. If the flag is set **504**, then configuration information is read and flags set or cleared **506**. If the output flag is set **508**, the information is transmitted to an external PC and the output buffer flag is cleared **510**. Next, all input parameters are read **512**, and a moving average is

calculated for each parameter **514**. If the PC remote flag is set **516**, all parameters and statuses are copied to the output buffer **518** and the output buffer flag is set **520**. The manual mode AC starting current profile is calculated **522**, all event timer counts are incremented **524**, and the status of the automatic **42** and manual **44** pushbuttons is monitored and set **526**. All calculations, timer counts, and status indications (flags) are stored in the internal memory of the microprocessor **12**.

[0024] At the start of the main process loop **210**, the flags are checked **404** beginning with the shunt calibration flag **406**. If the shunt calibration flag is set **406**, the starter contact relay **34** is closed **408**. The temperature of the shunt cable is measured **410** and the voltage drop across the shunt cable is read **412**. The temperature of the shunt cable is measured a second time and averaged with the previous reading **414**. The shunt resistance is then calculated and saved **416** and the shunt calibration flag is cleared **418**.

[0025] Next, if the flag to upload data to an external PC is set **420**, the information is copied to the output buffer **422**, the output buffer ready flag is set **424**, and the upload data flag is cleared **426**. If the download data from PC flag is set **428**, data is copied from the input buffer **430**, and the download data flag is cleared **432**.

[0026] If the PC remote control flag is set **434**, the remote control status flag is toggled **436**. If the flag is true, the unit **10** can be controlled remotely by a PC or locally by the buttons. If the flag is false, the unit can only be controlled locally.

[0027] If the system does not detect a battery charging voltage **212**, once jumper cables **60** have been manually connected to the vehicle to be started **28**, the voltage is measured by the reverse voltage sensor **24** to determine if the cables have been properly connected to the vehicle **214**. If the voltage measured is significantly less than the voltage of the jump starter capacitors **21** and batteries **22**, then a reverse polarity connection of the jumper cables to the vehicle is determined and an error flag is set and the event saved in non-volatile memory **216**. A "Reverse Polarity" error message is displayed **218** on the LCD **46**, and the reverse voltage LED **48** is illuminated **216**. Any further jump starter action by the operator is ignored until the reverse polarity condition is corrected **220**, at which point processing returns to the start of the main processing loop **210**.

[0028] If the jumper cables **60** are not reverse connected **214**, then the state of charge of the capacitors **21** and batteries **22** is determined **222**. If the voltage level of the system batteries **22** measured by the voltage sensor **30** is equal to a state of charge of eighty percent or more below a fully charged voltage level **222**, an error flag is set and the event recorded in memory **224**. The charge battery LED **54** is illuminated and the LCD **46** displays a "Charge Battery" message **225**. The system stays in this condition, which prohibits any further jump starter action by the operator until a charging voltage is detected **226**, which is great enough to indicate that a battery charger (not shown) has been counected to the batteries **22**.

[0029] If the system has detected a battery charger voltage **212**, a "Battery Charging" message is displayed **228** on the LCD **46**, and the charge LED **54** is illuminated. The voltage profile of the battery **22** is monitored to determine if the charge is complete **230**. A completed charge is determined by monitoring the charging voltage rise to a threshold value then decrease by a predetermined percentage. This voltage peaking and subsequent fall-off is a characteristic of the battery chemistry indicating that the battery has reached its maximum charge capacity. Once the charging has reached a minimum charged level or is completed **230**, the processing returns to the beginning of the main processing loop **210**. The jump starter batteries **22** only need to reach a 50% charge in order for the system to attempt to start the vehicle.

[0030] If the battery or capacitor temperature measured by sensors **38** and **47** rises above a maximum safe threshold **232**, an error flag is set and the event recorded in non-volatile memory **234**. An error message "Battery Over Temperature" or "Capacitor Over Temperature" is displayed **236** on the LCD **46** and the Fault LED **56** is illuminated. The system prevents any further operation until the battery and/or capacitor temperature falls below a safe level **238**. Once a safe temperature is reached, processing returns to a ready state at the beginning of the main processing loop **210**.

[0031] If the voltage of one or more of the capacitors measured by the capacitor voltage sensor **49** exceeds a predetermined limit **239**, such as 2.8 volts, for example, an error flag is set and the event recorded in non-volatile memory **241**. An error message "Capacitor Over Voltage" is displayed **243** and the fault LED **56** is illuminated. Processing then returns to the main processing loop **210**.

[0032] If the temperature of the shunt cable **36** rises above a safe threshold temperature **240**, an error flag is set and the event recorded in memory **242**. An error message "Cable over Temperature" is displayed **244** on the LCD **46** and the Fault LED **56** is illuminated. The system prevents any further operation until the shunt cable temperature falls below a minimum safe temperature **246**. Once a safe temperature is reached, the system returns to a ready state at the beginning of the main processing loop **210**.

[0033] Next, the system checks the status of the automatic **42** and manual **44** push buttons. If neither button has been pushed **248**, a "Ready" message is displayed **250** on the LCD **46** and processing returns to the main processing loop **210**. When no error conditions are detected and no user inputs are being processed, the system remains in the ready mode, and displays a "Ready" text message on the LCD **46**. Other information such as the selected jump starter voltage, the percentage change of the batteries **22**, the temperature of the batteries, and the vehicle voltage, for example, may also be displayed on LCD **46**.

[0034] If one of the push buttons **42** or **44** has been selected, the system will compare the operator-configured starter voltage against the voltage of the vehicle to be started **28**. The jump starter **10** may be configured for 12, 18, 24, 30, 36, 42 or 48 volts, for example, using a selector jumper **55**. For example, if the batteries **23** are both 12-volt batteries, the system may be configured for 12- or 24-volt operation. For example, if jumper **27** is placed across terminals **31**, the 24-volt configuration may be selected. If jumper **29** is placed across terminals **31**, the 12-volt configuration may be selected. If the batteries **23** are 12-volt batteries and a battery **25** is a 6-volt battery, 18- or 30-volt configurations may be provided. For example, if jumper **27** is placed across terminals **31**, the 30-volt configuration may be selected. If jumper **29** is placed across terminals **31**, the 18-volt configuration may be selected. It should be understood that two or more batteries of the same or different voltage levels may be used to meet the voltage requirements of the vehicle to be started. If the difference between the voltage selected and the voltage measured is not within a predetermined range and tolerance **252**, a "Wrong Selector Volts" message is displayed **254** on the LCD **46** and further operation is prohibited until the

correct voltage is selected **256** at which point processing returns to the main processing loop **210**.

[0035] If the selected voltage is within the correct range **252**, then the system determines which button was selected **258**. If the Auto button **42** was pushed, a ninety-second count down timer is started and displayed **260** on the LCD **46**. During this time the system monitors the vehicle voltage **262**. If the system does not detect a voltage drop **264** within 90 seconds **265**, the automatic operation is cancelled and processing returns to the main processing loop **210**. The automatic operation may also be interrupted and canceled by pushing the auto button **267**. If the vehicle voltage drops by twenty percent or more from the initially measured voltage **264**, then the vehicle's starter motor is engaged and is trying to start the vehicle. If the maximum number of start attempts has not been exceeded **266**, the contact relay **34** is closed and the contact relay on timer is started **268**, connecting the jump starter's capacitors **21** and batteries **22** to the vehicle's starting system **28**. The start cycle counter is incremented **270**, a "Jump Starter On" message is displayed **272** along with the average current being drawn, and the Auto Mode LED **50** is illuminated. If the relay on timer expires indicating that the relay **34** has been closed for ninety seconds without a start complete event, the relay **34** is automatically opened by the system to reduce the probability of overheating any component in the jump starter or vehicle.

[0036] The system monitors all input sensors **14** and the current status of the jump starter for possible fault conditions. Upon detection of any fault condition, the system will open the contact relay **34** (if closed), and display a message indicating that a fault has occurred, and what action, if any, should be taken by the operator.

[0037] If the battery temperature exceeds a maximum limit **274**, a battery temperature error count is incremented **276**. The contact relay **34** is opened, a "Battery Temp" error message and temperature is displayed **278** on the LCD **46** and the fault LED **56** is illuminated. Processing returns to the main processing loop **210**.

[0038] If the shunt cable temperature exceeds a maximum limit **280**, a cable temperature error count is incremented **282**. The contact relay **34** is opened, a "Cable Temp" error message and temperature is displayed **278** on the LCD **46** and the fault LED **56** is illuminated. Processing returns to the main processing loop **210**.

[0039] If the system detects a geometric rise in the starting current **284** during the first **16** seconds after the contact relay **34** is closed, a current doubling error count is incremented **286**, a "Battery Explosion" error message is displayed **288** on the LCD **46**, the contact relay **34** is opened and the fault LED **56** is illuminated **290**. The system may be returned to the ready mode if the Automatic button **42** is pressed by the operator **292**, or automatically after five minutes **294**.

[0040] If no current flow is detected by the system **296** indicating that there is an open circuit within the system, an open circuit error count is incremented **298**, an "Open Circuit" error message is displayed **300** on the LCD **46**, the contact relay **34** is opened and the fault LED **56** is illuminated **290**. The system may be returned to the ready mode if the Automatic button **42** is pressed by the operator **292**, or automatically after five minutes **294**.

[0041] If the system detects an increase in the difference between the measured jump starter battery voltage **20** and the voltage measured **30** across the contact relay **34** indicating that one of the jump starter cables has been disconnected **302** from the vehicle's battery or starter system **28** then a jumper cable unplugged error count is incremented **304**, a "Jumper Cable Unplugged" error message is displayed **306** on the LCD **46**, the contact relay **34** is opened and the fault LED **56** is illuminated **290**. The system may be returned to the ready mode if the Automatic button **42** is pressed by the operator **292**, or automatically after five minutes **294**.

[0042] During the jump starting process if the current measured across the shunt cable **36** is greater than a preset maximum current such as **1400** amps for a short period of time such as 500 ms **308**, the over max current error count is incremented **310**, an "Over MAX Starting Current" error message is displayed **312** on LCD **46**, the contact relay **34** is opened and the fault LED **56** is illuminated **290**. The current across the shunt cable **36** is also measured to determine if it exceeds a predetermined current such as 1000 amps for more than a predetermined period of time such as 15 seconds **314**. If this over current condition is determined, an over high current error count is incremented **316**, an "Over High Crank Amps" error message is displayed **318** on the LCD **46**, the contact relay **34** is opened and the fault LED **56** is illuminated **290**. The system may be returned to the ready mode if the Automatic button **42** is pressed by the operator **292**, or automatically after five minutes **294**.

[0043] If the system detects a decrease in the jump starter battery voltage **20**, but does not detect an appreciable current flow through the jump starter, a shunt cable **36** failure is indicated **320**. The shunt cable **36** is a precisely measured and calibrated 00 AWG wire, the temperature of which is monitored **40** and used to calculate the resistance across the length of the cable **36**.

[0044] The voltage drop across the cable **36** is also measured to calculate the current through the shunt cable **36** using Ohm's Law. If the shunt cable **36** fails, the system cannot reliably measure the starting current which would present a safety hazard.

[0045] If the system detects a shunt cable failure **320**, a current shunt error count is incremented **322**, a "Current Shunt Failure" error message is displayed **324** on the LCD **46**, the contact relay **34** is opened and the fault LED **56** is illuminated **290**. The system may be returned to the ready mode if the Automatic button **42** is pressed by the operator **292**, or automatically after five minutes **294**.

[0046] If the system detects a great difference between the vehicle's voltage **30** and the contact relay **34** voltage **326**, the contact relay **34** may have failed indicating an over high starter current condition. A contact relay failure count is incremented **328**, a "Contact Relay Error" message is displayed **330** on the LCD **46**, the contact relay **34** is opened and the fault LED **56** is illuminated **290**. The system may be returned to the ready mode if the Automatic button **42** is pressed by the operator **292**, or automatically after five minutes **294**.

[0047] If manual mode is selected **258**, "Manual" is displayed **332** on the LCD **46**, the system will prompt the operator to press the manual button **44** again. If the manual button **44** is pressed a second time **334**, then the system checks the number of start attempts **266**. If the maximum number of start attempts has been exceeded **266**, an over start attempt error count is incremented **336**, a "Cool Down Unit" message is displayed **338** on the LCD **46**, and the system waits for five minutes for the system to cool **340**. Once the cool down time has expired, processing returns to the main processing loop

210. If the total start attempts have not exceeded the limit **266**, the processing continues at block **268** as described above.

[0048] If in auto mode and the starting current decreases by 20% from the maximum measured current **342**, then the start cycle is complete. A decrease in the starting current indicates that the vehicle has started and its alternator is now generating its own current reducing the demand from the jump starter batteries **22**. If the starting current is below the threshold **342**, a "Start Cycle Complete" message is displayed **344** on LCD **46**, and the contact relay is opened **346**. This message remains displayed until the operator presses the Auto button **292**, or if there is no user activity for five minutes **294**, after which the system returns to the main processing loop **210**.

[0049] If in manual mode, the jump starter **10** may be used when the battery voltage of the vehicle is below **10** volts, or if the vehicle's battery is not connected. In the situation where the vehicle's battery is present but has a voltage of less than 10 volts, the jump starter will start to charge the vehicle's battery before any starting operation begins. If the vehicle's battery is extremely low or completely dead, once the contactor is closed, the jump starter's batteries will start to charge the batteries. The current will rise sharply and then start to decrease, but this does not indicate that a start attempt has been made or that the vehicle's starter motor has been cranked. The algorithm looks for this initial increase and then decrease in the delivered current and then waits for a minimum of three alternating current cycles indicating that the vehicle's starter has been engaged. Due to the compression/decompression cycles of the pistons, the starting current will rise and fall in a generally sinusoidal pattern. The algorithm looks for this so that it knows that the vehicle's starter motor has been activated. Once this alternating current cycle has been detected, if the current then decreases by approximately twenty percent and remains low, this indicates a start complete, the contactor is opened, the start complete message is displayed and then the system waits for the Auto button to be pushed or the 5 minute timeout.

[0050] If the vehicle's battery holds the charge, then the starting cycle in manual mode is the same as described above for automatic mode. If the battery does not hold the charge or if no battery is present, the system waits until the vehicle's starter motor is engaged. Once the vehicle's starter motor is engaged and the engine is turning over, the system **10** monitors the jump starter current flow. As the engine turns over the jump starter's current increases and decreases with the compression stroke of the engine's pistons. During a piston's compression cycle, the current from the jump starter's batteries **22** increases due to the increased power demand of the starter motor. During a piston's decompression cycle, the current flow decreases due to the decreased power demand of the starter motor. This current increase and decrease is generally sinusoidal which is recognized by the system.

[0051] Once the system has detected three more sinusoidal current flow cycles, the same 20% decrease threshold in current as set forth above for the automatic mode determination, may be used to determine when the vehicle's engine has started **348**. If the engine has started, the "Start Cycle Complete" message is displayed **344** on the LCD **46** and the contact relay opened **346**.

[0052] If the engine has not been started **348**, the system next checks the relay closed time. If the maximum time set for the contact relay to be closed has expired **350**, a "Maximum Starter On" message is displayed **352** on the LCD **46** and the contact relay is opened **346**.

[0053] If the contact relay closed time has not expired, the system checks for a cycle halt flag. Any cycle may be interrupted by the Auto button being pressed by the operator. If the Auto button is pressed **354**, a "Start Cycle Halted" message is displayed **356** on the LCD **46**, and the contact relay opened **346**.

[0054] At the completion of a start cycle the jump starter **10** has opened the contact relay **34** and the message "Start complete" is displayed **46**, and the starting current is displayed for diagnostic assessment of the vehicle's starting system. At this time the voltage of the vehicle **28** is monitored. Normal vehicle charging voltages fall within certain ranges for 12, 18, 24, 30, 36, 42 and 48 volts systems. The jump starter displays the running vehicle's voltage and makes an assessment to determine if the vehicle's generated voltage is actually great enough to charge the vehicle's battery. If the voltage is below a threshold for charging the vehicle's battery, the jump starter displays "Vehicle Not Charging" message and shows the measured voltage. If the vehicle's generated voltage is great enough to charge the vehicle's battery, the jump starter displays "Vehicle Charging" showing a working vehicle charging system and displays the vehicle charging voltage.

[0055] Referring to FIGS. **1** and **2**, a diode **35** may be connected across the contact **34** to charge the capacitors **21** and jump starter batteries **22** from the vehicle charging system **28**. The charging system of the vehicle may be used to charge the capacitors **21** and jump starter batteries **22**. Whenever the vehicle has a working charging system this will occur as long as the cables are connected to the vehicle. This allows the capacitors **21** and jump starter batteries **22** to be fully recharged in about 1 to 5 minutes and can therefore start many vehicles in a row without becoming discharged. Even in situations in which the jump starter batteries **22** may be discharged to an extent that they alone may not be able to provide the necessary power to start a vehicle, the capacitors **21** may be rapidly recharged to start many vehicles in a row. This is very useful when starting fleets of vehicles with dead batteries.

[0056] It is to be understood that while certain forms of this invention have been illustrated and described, it is not limited thereto, except in so far as such limitations are included in the following claims and allowable equivalents thereof.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A method for delivering supplemental power from a portable jump starter to an engine comprising the steps of:

positioning said portable jump starter proximate the engine;

temporarily manually connecting conductive leads from said portable jump starter to the electrical system of the engine;

automatically selecting a voltage output of one or more system batteries housed in said portable jump starter and one or more system capacitors housed in said portable jump starter,

verifying the polarity of the conductive leads;

providing an alert if said polarity is incorrect;

assessing the voltage level of said electrical system;

applying power from said system batteries and said system capacitors to said electrical system;

monitoring the current output of said system batteries and said system capacitors;

measuring one or more voltage levels to determine one or more fault conditions;

examining the current through a shunt cable; and

electrically disconnecting said conductive leads from said electrical system when the engine starts.

2. The method of claim **1** including determining the temperature of said shunt cable.

3. The method of claim **2** wherein if said temperature reaches a predetermined limit, electrically disconnecting said conductive leads from said electrical system.

4. The method of claim **2** including calculating the resistance of said shunt cable.

5. The method of claim **4** including calibrating said shunt cable.

6. The method of claim **1** wherein said selecting step includes selecting a voltage from the group consisting of 12 volts, 18 volts, 24 volts, 30 volts, 36 volts, 42 volts and 48 volts.

7. The method of claim **6** wherein said voltage is 18 volts or 30 volts.

8. The method of claim **1** wherein said verifying step includes comparing the voltage level of said electrical system to the voltage level of said supplemental battery.

9. The method of claim **1** wherein said assessing step includes charging an engine battery connected to said electrical system if the voltage of said engine battery is below a predetermined level.

10. The method of claim **9** including the step of monitoring a charging voltage of said system batteries and said capacitors.

11. The method of claim **10** wherein when said charging voltage rises to a threshold value and then decreases by a predetermined percentage, charging of said engine battery is complete.

12. The method of claim **1** wherein said assessing step includes comparing the voltage level of said electrical system to a supplement power voltage setting, whereas if the difference between said electrical system voltage and said supplement power voltage setting is greater than a predetermined limit, indicating a fault condition.

13. The method of claim **1** wherein said applying step includes closing a relay.

14. The method of claim **1** wherein said applying step includes recording operational data.

15. The method of claim **1** wherein said applying step includes recording the number of start attempts.

16. The method of claim **13** wherein said applying step includes starting a timer.

17. The method of claim **16** wherein said applying step includes opening said relay upon expiration of said timer.

18. The method of claim **1** wherein said monitoring step includes monitoring the temperature of said system batteries.

19. The method of claim **18** wherein if a temperature limit is reached electrically disconnecting said conductive leads from said electrical system.

20. The method of claim **18** wherein if a temperature limit is reached electrically disconnecting said conductive leads from said electrical system to reduce the risk of fire.

21. The method of claim **1** wherein if said current through said shunt cable exceeds a first limit within a first period, electrically disconnecting said conductive leads from said electrical system.

22. The method of claim **21** wherein if said current through said shunt cable exceeds a second limit within a second period, electrically disconnecting said conductive leads from said electrical system.

23. The method of claim **1** wherein if said current through said shunt cable geometrically increases over a predetermined period, electrically disconnecting said conductive leads from said electrical system.

24. The method of claim **1** wherein said electrically disconnecting step includes opening a relay.

25. The method of claim **1** wherein said electrically disconnecting step includes recharging said system batteries and said system capacitors for a predetermined time before opening a relay to electrically disconnect said conductive leads from said electrical system.

26. A portable jump starter for delivering supplemental power to an engine comprising:

a pair of conductive leads for temporarily connecting the jump starter to an electrical system of the engine;

one or more jump starter batteries;

one or more jump starter capacitors connected in parallel to said one or more jump starter batteries;

a relay connected to said conductive leads;

a shunt cable connecting said jump starter batteries and said jump starter capacitors to said relay; and

a processor for controlling said relay to selectively apply electrical power from said jump starter batteries and said jump starter capacitors to said electrical system of the engine.

27. The jump starter of claim **26** further comprising a voltage sensor for measuring the voltage level of said one or more jump starter batteries and said one or more capacitors.

28. The jump starter of claim **26** further comprising a voltage sensor coupled to said one or more capacitors for detecting an over voltage condition of said one or more capacitors.

29. The jump starter of claim **26** further comprising a reverse voltage sensor for measuring the difference between the voltage level of said one or more jump starter batteries and said one or more capacitors and the voltage level of the electrical system.

30. The jump starter of claim **26** further comprising a relay voltage sensor for measuring the voltage across said relay.

31. The jump starter of claim **26** further comprising a battery temperature sensor for measuring the temperature of said one ore more jump starter batteries.

32. The jump starter of claim **26** further comprising a shunt cable temperature sensor for measuring the temperature of said shunt cable.

33. The jump starter of claim **26** further comprising a sensor for measuring the current through said shunt cable.

34. The jump starter of claim **26** further comprising a sensor for measuring the voltage across said shunt cable.

35. The jump starter of claim **26** further comprising a display coupled to said processor to provide instructions and status information about said jump starter.

36. The jump starter of claim **26** further comprising a plurality of indicators coupled to said processor to provide status information.

37. The jump starter of claim **26** further comprising a keypad coupled to said processor for providing input to said processor and controlling operational access to the jump starter.

38. The jump starter of claim **26** further comprising a thermal switch coupled to said shunt cable and electrically coupled to said relay, whereas if a temperature of said shunt cable exceeds a predetermined limit, said thermal switch

interrupts power to said relay thereby electrically disconnecting said conductive leads from said system batteries.

39. The jump starter of claim **26** further comprising a voltage output selector coupled to said one or more jump starter batteries and said one or more capacitors for selectively providing a voltage output of 12, 18, 24, 30, 36, 42 or 48 volts.

40. The jump starter of claim **26** further comprising a diode connected across said relay to permit charging of said one or more jump starter batteries and said one or more capacitors by said electrical system.

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AUSTRALIA

Patents Act

IN THE MATTER of Australian Patent Application No. 2016269555 in the name of The NOCO Company

- and -

Opposition thereto by Brown & Watson International Pty Ltd

ANNEXURE MD-7

The attached is **Annexure MD-7** referred to in the Declaration of Declaration of Max Dirnberger declared on 6th day of September 2019 in the above matter.

(12) STANDARD PATENT (11) Application No. **AU 2016269555 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Portable vehicle battery jump start apparatus with safety protection

(51) International Patent Classification(s)
H02J 7/14 (2006.01) ***H02J 1/00*** (2006.01)
B60R 16/00 (2006.01) ***H02J 7/00*** (2006.01)
B60R 16/03 (2006.01)

(21) Application No: **2016269555** (22) Date of Filing: **2016.12.09**

(43) Publication Date: **2017.01.05**
(43) Publication Journal Date: **2017.01.05**
(44) Accepted Journal Date: **2018.12.06**

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2015258229

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(56) Related Art
US 2004/0130298 A1
WO 2004/036714 A2

20162695555 09 Dec 2016

ABSTRACT

A handheld device for jump starting a vehicle engine includes a rechargeable lithium ion battery pack (32) and a microcontroller (1). The lithium ion battery is coupled to a power output port of the device through a power switch circuit (15) actuated by the microcontroller. A vehicle battery isolation sensor (12) connected in circuit with positive and negative polarity outputs detects the presence of a vehicle battery (72) connected between the positive and negative polarity outputs. A reverse polarity sensor (10) connected in circuit with the positive and negative polarity outputs detects the polarity of a vehicle battery connected between the positive and negative polarity outputs, such that the microcontroller will enable power to be delivered from the lithium ion power pack to the output port only when a good battery is connected to the output port and only when the battery is connected with proper polarity of positive and negative terminals.

2016269555 09 Dec 2016

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

FIELD OF THE INVENTION

[0001] The present invention relates generally to apparatus for jump-starting a vehicle having a depleted or discharged battery.

BACKGROUND TO THE INVENTION

[0002] Prior art devices are known for jump-starting a vehicle, which provide either a pair of electrical connector cables that connect a fully-charged battery of another vehicle to the engine start circuit of the dead battery vehicle, or portable booster devices which include a fully-charged battery which can be connected in circuit with the vehicle's engine starter through a pair of cables.

[0003] Problems with the prior art arose when either the jumper terminals or clamps of the cables were inadvertently brought into contact with each other while the other ends were connected to a charged battery, or when the positive and negative terminals were connected to the opposite polarity terminals in the vehicle to be jumped, thereby causing a short circuit resulting in sparking and potential damage to batteries and/or bodily injury.

[0004] Various attempts to eliminate these problems have been made in the prior art. U.S. Patent No. 6,212,054 issued April 3, 2001, discloses a battery booster pack that is polarity sensitive and can detect proper and improper connections before providing a path for electric current flow. The device uses a set of LEDs connected to optical couplers oriented by a control circuit. The control circuit controls a solenoid assembly controlling the path of power current. The control circuit causes power current to flow through the solenoid assembly only if the points of contact of booster cable clamp connections have been properly made.

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[0005] U.S. Patent No. 6,632,103 issued October 14, 2003, discloses an adaptive booster cable connected with two pairs of clips, wherein the two pairs of clips are respectively attached to two batteries to transmit power from one battery to the other battery. The adaptive booster cable includes a polarity detecting unit connected to each clip, a switching unit and a current detecting unit both provided between the two pairs of clips. After the polarity of each clip is sensed by the polarity detecting unit, the switching unit generates a proper connection between the two batteries. Therefore, the positive and negative terminals of the two batteries are correctly connected based on the detected result of the polarity detecting unit.

[0006] U.S. Patent No. 8,493,021 issued July 23, 2013, discloses apparatus that monitors the voltage of the battery of a vehicle to be jump started and the current delivered by the jump starter batteries to determine if a proper connection has been established and to provide fault monitoring. Only if the proper polarity is detected can the system operate. The voltage is monitored to determine open circuit, disconnected conductive clamps, shunt cable fault, and solenoid fault conditions. The current through the shunt cable is monitored to determine if there is a battery explosion risk, and for excessive current conditions presenting an overheating condition, which may result in fire. The system includes an internal battery to provide the power to the battery of the vehicle to be jump started. Once the vehicle is started, the unit automatically electrically disconnects from the vehicle's battery.

[0007] U.S. Patent No. 5,189,359 issued February 23, 1993, discloses a jumper cable device having two bridge rectifiers for developing a reference voltage, a four-input decoder for determining which terminals are to be connected based on a comparison of the voltage at each of the four terminals to the reference voltage, and a pair of relays for effecting the correct connection depending on the determination of the decoder. No connection will be made unless only one terminal of each battery has a higher voltage than the reference voltage, indicating "positive" terminals, and one has a lower voltage than the reference voltage, indicating "negative" terminals, and that, therefore, the two

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high voltage terminals may be connected and the two lower voltage terminals may be connected. Current flows once the appropriate relay device is closed. The relay device is preferably a MOSFET combined with a series array of photodiodes that develop MOSFET gate-closing potential when the decoder output causes an LED to light.

[0008] U.S. Patent No. 5,795,182 issued August 18, 1998, discloses a polarity independent set of battery jumper cables for jumping a first battery to a second battery. The apparatus includes a relative polarity detector for detecting whether two batteries are configured cross or parallel. A three-position high current capacity crossbar pivot switch is responsive to the relative polarity detector for automatically connecting the plus terminals of the two batteries together and the minus terminals of the two batteries together regardless of whether the configuration detected is cross or parallel, and an undercurrent detector and a delay circuit for returning the device to its ready and unconnected state after the device has been disconnected from one of the batteries. The crossbar pivot switch includes two pairs of contacts, and a pivot arm that pivots about two separate points to ensure full electrical contact between the pairs of contacts. The invention can also be used to produce a battery charger that may be connected to a battery without regard to the polarity of the battery.

[0009] U.S. Patent No. 6,262,492 issued July 17, 2001, discloses a car battery jumper cable for accurately coupling an effective power source to a failed or not charged battery, which includes a relay switching circuit connected to the power source and the battery by two current conductor pairs. First and second voltage polarity recognition circuits are respectively connected to the power source and the battery by a respective voltage conductor pair to recognize the polarity of the power source and the battery. A logic recognition circuit produces a control signal subject to the polarity of the power source and the battery, and a driving circuit controlled by the control signal from the logic recognition circuit drives the relay switching circuit, enabling the two poles of the power source to be accurately coupled to the two poles of the battery.

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[0010] U.S. Patent No. 5,635,817 issued June 3, 1997, discloses a vehicle battery charging device that includes a control housing having cables including a current limiting device to prevent exceeding of a predetermined maximum charging current of about 40 to 60 amps. The control housing includes a polarity detecting device to verify the correct polarity of the connection of the terminals of the two batteries and to electrically disconnect the two batteries if there is an incorrect polarity.

[0011] U.S. Patent No. 8,199,024 issued June 12, 2012, discloses a safety circuit in a low-voltage connecting system that leaves the two low-voltage systems disconnected until it determines that it is safe to make a connection. When the safety circuit determines that no unsafe conditions exist and that it is safe to connect the two low-voltage systems, the safety circuit may connect the two systems by way of a "soft start" that provides a connection between the two systems over a period of time that reduces or prevents inductive voltage spikes on one or more of the low-voltage systems. When one of the low-voltage systems has a completely-discharged battery incorporated into it, a method is used for detection of proper polarity of the connections between the low-voltage systems. The polarity of the discharged battery is determined by passing one or more test currents through it and determining whether a corresponding voltage rise is observed.

[0012] U.S. Patent No. 5,793,185 issued August 11, 1998, discloses a hand-held jump starter having control components and circuits to prevent overcharging and incorrect connection to batteries.

[0013] While the prior art attempted solutions to the abovementioned problems as discussed above, each of the prior art solutions suffers from other shortcomings, either in complexity, cost or potential for malfunction. Accordingly, there exists a need in the art for further improvements to vehicle jump start devices.

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SUMMARY OF THE INVENTION

[0014] In accordance with an aspect of the invention, an apparatus is provided for jump starting a vehicle engine, comprising: an internal power supply; an output port having positive and negative polarity outputs; a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs; a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port; a power switch connected between said internal power supply and said output port; and a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

[0015] In accordance with an embodiment of the invention, the internal power supply is a rechargeable lithium ion battery pack.

[0016] A jumper cable device may also be provided, having a plug configured to plug into said output port; a pair of cables integrated with the plug at one respective end thereof; said pair of cables being configured to be separately connected to terminals of a battery at another respective end thereof.

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[0017] Comprises/comprising and grammatical variations thereof when used in this specification are to be taken to specify the presence of stated features, integers, steps or components or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Fig. 1 is a functional block diagram of a handheld vehicle battery boost apparatus in accordance with one aspect of the present invention;

[0019] Figs. 2A – 2C are schematic circuit diagrams of an example embodiment of a handheld vehicle battery boost apparatus in accordance with an aspect of the invention;

[0020] Fig. 3 is a perspective view of a handheld jump starter booster device in accordance with one example embodiment of the invention; and

[0021] Fig. 4 is a plan view of a jumper cable usable with the handheld jump starter booster device in accordance with another aspect of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] FIG. 1 is a functional block diagram of a handheld battery booster according to one aspect of the invention. At the heart of the handheld battery booster is a lithium polymer battery pack 32, which stores sufficient energy to jump start a vehicle engine served by a conventional 12 volt lead-acid or valve regulated lead-acid battery. In one example embodiment, a high-surge lithium polymer battery pack includes three 3.7V, 2666 mAh lithium polymer batteries in a 3S1P configuration. The resulting battery pack provides 11.1V, 2666Ah (8000Ah at 3.7V, 29.6Wh). Continuous discharge current is 25C (or 200 amps), and burst discharge current is 50C (or 400 amps). The maximum charging current of the battery pack is 8000mA (8 amps).

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[0023] A programmable microcontroller unit (MCU) 1 receives various inputs and produces informational as well as control outputs. The programmable MCU 1 further provides flexibility to the system by allowing updates in functionality and system parameters, without requiring any change in hardware. According to one example embodiment, an 8 bit microcontroller with 2K x 15 bits of flash memory is used to control the system. One such microcontroller is the HT67F30, which is commercially available from Holtek Semiconductor Inc.

[0024] A car battery reverse sensor 10 monitors the polarity of the vehicle battery 72 when the handheld battery booster device is connected to the vehicle's electric system. As explained below, the booster device prevents the lithium battery pack from being connected to the vehicle battery 72 when the terminals of the battery 72 are connected to the wrong terminals of the booster device. A car battery isolation sensor 12 detects whether or not a vehicle battery 72 is connected to the booster device, and prevents the lithium battery pack from being connected to the output terminals of the booster device unless there is a good (e.g. chargeable) battery connected to the output terminals.

[0025] A smart switch FET circuit 15 electrically switches the handheld battery booster lithium battery to the vehicle's electric system only when the vehicle battery is determined by the MCU 1 to be present (in response to a detection signal provided by isolation sensor 12) and connected with the correct polarity (in response to a detection signal provided by reverse sensor 10). A lithium battery temperature sensor 20 monitors the temperature of the lithium battery pack 32 to detect overheating due to high ambient temperature conditions and overextended current draw during jump starting. A lithium battery voltage measurement circuit 24 monitors the voltage of the lithium battery pack 32 to prevent the voltage potential from rising too high during a charging operation and from dropping too low during a discharge operation.

[0026] Lithium battery back-charge protection diodes 28 prevent any charge current being delivered to the vehicle battery 72 from flowing back to the lithium battery pack 32 from the vehicle's electrical system. Flashlight LED circuit 36 is

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provided to furnish a flashlight function for enhancing light under a vehicle's hood in dark conditions, as well as providing SOS and strobe lighting functions for safety purposes when a vehicle may be disabled in a potentially dangerous location. Voltage regulator 42 provides regulation of internal operating voltage for the microcontroller and sensors. On/Off manual mode and flashlight switches 46 allow the user to control power-on for the handheld battery booster device, to control manual override operation if the vehicle has no battery, and to control the flashlight function. The manual button functions only when the booster device is powered on. This button allows the user to jump-start vehicles that have either a missing battery, or the battery voltage is so low that automatic detection by the MCU is not possible. When the user presses and holds the manual override button for a predetermined period time (such as three seconds) to prevent inadvertent actuation of the manual mode, the internal lithium ion battery power is switched to the vehicle battery connect port. The only exception to the manual override is if the car battery is connected in reverse. If the car battery is connected in reverse, the internal lithium battery power shall never be switched to the vehicle battery connect port.

[0027] USB charge circuit 52 converts power from any USB charger power source, to charge voltage and current for charging the lithium battery pack 32. USB output 56 provides a USB portable charger for charging smartphones, tablets, and other rechargeable electronic devices. Operation indicator LEDs 60 provide visual indication of lithium battery capacity status as well as an indication of smart switch activation status (indicating that power is being provided to the vehicle's electrical system).

[0028] Detailed operation of the handheld booster device will now be described with reference to the schematic diagrams of Figs. 2A-2C. As shown in Fig. 2A, the microcontroller unit 1 is the center of all inputs and outputs. The reverse battery sensor 10 comprises an optically coupled isolator phototransistor (4N27) connected to the terminals of vehicle battery 72 at input pins 1 and 2 with a diode D8 in the lead conductor of pin 1 (associated with the negative terminal CB-), such that if the battery 72 is connected to the terminals of the booster

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device with the correct polarity, the optocoupler LED 11 will not conduct current, and is therefore turned off, providing a "1" or high output signal to the MCU 1. The car battery isolation sensor 12 comprises an optically coupled isolator phototransistor (4N27) connected to the terminals of vehicle battery 72 at input pins 1 and 2 with a diode D7 in the lead conductor of pin 1 (associated with the positive terminal CB+), such that if the battery 72 is connected to the terminals of the booster device with the correct polarity, the optocoupler LED 11A will conduct current, and is therefore turned on, providing a "0" or low output signal to the MCU, indicating the presence of a battery across the jumper output terminals of the handheld booster device.

[0029] If the car battery 72 is connected to the handheld booster device with reverse polarity, the optocoupler LED 11 of the reverse sensor 10 will conduct current, providing a "0" or low signal to microcontroller unit 1. Further, if no battery is connected to the handheld booster device, the optocoupler LED 11A of the isolation sensor 12 will not conduct current, and is therefore turned off, providing a "1" or high output signal to the MCU, indicating the absence of any battery connected to the handheld booster device. Using these specific inputs, the microcontroller software of MCU 1 can determine when it is safe to turn on the smart switch FET 15, thereby connecting the lithium battery pack to the jumper terminals of the booster device. Consequently, if the car battery 72 either is not connected to the booster device at all, or is connected with reverse polarity, the MCU 1 can keep the smart switch FET 15 from being turned on, thus prevent sparking/short circuiting of the lithium battery pack.

[0030] As shown in Fig. 2B, the FET smart switch 15 is driven by an output of the microcontroller 1. The FET smart switch 15 includes three FETs (Q15, Q18, and Q19) in parallel, which spreads the distribution of power from the lithium battery pack over the FETs. When that microcontroller output is driven to a logic low, FETs 16 are all in a high resistance state, therefore not allowing current to flow from the internal lithium battery negative contact 17 to the car battery 72 negative contact. When the microcontroller output is driven to a logic high, the FETs 16 (Q15, Q18, and Q19) are in a low resistant state, allowing current to flow

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freely from the internal lithium battery pack negative contact 17 (LB-) to the car battery 72 negative contact (CB-). In this way, the microcontroller software controls the connection of the internal lithium battery pack 32 to the vehicle battery 72 for jumpstarting the car engine.

[0031] Referring back to Fig. 2A, the internal lithium battery pack voltage can be accurately measured using circuit 24 and one of the analog-to-digital inputs of the microcontroller 1. Circuit 24 is designed to sense when the main 3.3V regulator 42 voltage is on, and to turn on transistor 23 when the voltage of regulator 42 is on. When transistor 23 is conducting, it turns on FET 22, thereby providing positive contact (LB+) of the internal lithium battery a conductive path to voltage divider 21 allowing a lower voltage range to be brought to the microcontroller to be read. Using this input, the microcontroller software can determine if the lithium battery voltage is too low during discharge operation or too high during charge operation, and take appropriate action to prevent damage to electronic components.

[0032] Still referring to Fig. 2A, the temperature of the internal lithium battery pack 32 can be accurately measured by two negative temperature coefficient (NTC) devices 20. These are devices that reduce their resistance when their temperature rises. The circuit is a voltage divider that brings the result to two analog-to-digital (A/D) inputs on the microcontroller 1. The microcontroller software can then determine when the internal lithium battery is too hot to allow jumpstarting, adding safety to the design.

[0033] The main voltage regulator circuit 42 is designed to convert internal lithium battery voltage to a regulated 3.3 volts that is utilized by the microcontroller 1 as well as by other components of the booster device for internal operating power. Three lithium battery back charge protection diodes 28 (see Fig. 2B) are in place to allow current to flow only from the internal lithium battery pack 32 to the car battery 72, and not from the car battery to the internal lithium battery. In this way, if the car electrical system is charging from its alternator, it

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cannot back-charge (and thereby damage) the internal lithium battery, providing another level of safety.

[0034] The main power on switch 46 (Fig. 2A) is a combination that allows for double pole, double throw operation so that with one push, the product can be turned on if it is in the off state, or turned off if it is in the on state. This circuit also uses a microcontroller output 47 to "keep alive" the power when it is activated by the on switch. When the switch is pressed the microcontroller turns this output to a high logic level to keep power on when the switch is released. In this way, the microcontroller maintains control of when the power is turned off when the on/off switch is activated again or when the lithium battery voltage is getting too low. The microcontroller software also includes a timer that turns the power off after a predefined period of time, (such as, e.g. 8 hours) if not used.

[0035] The flashlight LED circuit 45 shown in Fig. 2B controls the operation of flashlight LEDs. Two outputs from the microcontroller 1 are dedicated to two separate LEDs. Thus, the LEDs can be independently software-controlled for strobe and SOS patterns, providing yet another safety feature to the booster device. LED indicators provide the feedback the operator needs to understand what is happening with the product. Four separate LEDs 61 (Fig. 2A) are controlled by corresponding individual outputs of microcontroller 1 to provide indication of the remaining capacity of the internal lithium battery. These LEDs are controlled in a "fuel gauge" type format with 25%, 50%, 75% and 100% (red, red, yellow, green) capacity indications. An LED indicator 63 (Fig. 2B) provides a visual warning to the user when the vehicle battery 72 has been connected in reverse polarity. "Boost" and on/off LEDs 62 provide visual indications when the booster device is provide jump-start power, and when the booster device is turned on, respectively.

[0036] A USB output 56 circuit (Fig. 2C) is included to provide a USB output for charging portable electronic devices such as smartphones from the internal lithium battery pack 32. Control circuit 57 from the microcontroller 1 allows the USB Out 56 to be turned on and off by software control to prevent the internal

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lithium battery getting too low in capacity. The USB output is brought to the outside of the device on a standard USB connector 58, which includes the standard voltage divider required for enabling charge to certain smartphones that require it.

[0037] The USB charge circuit 52 allows the internal lithium battery pack 32 to be charged using a standard USB charger. This charge input uses a standard micro-USB connector 48 allowing standard cables to be used. The 5V potential provided from standard USB chargers is up-converted to the 12.4VDC voltage required for charging the internal lithium battery pack using a DC-DC converter 49. The DC-DC converter 49 can be turned on and off via circuit 53 by an output from the microcontroller 1.

[0038] In this way, the microcontroller software can turn the charge off if the battery voltage is measured to be too high by the A/D input 22. Additional safety is provided for helping to eliminate overcharge to the internal lithium battery using a lithium battery charge controller 50 that provides charge balance to the internal lithium battery cells 51. This controller also provides safety redundancy for eliminating over discharge of the internal lithium battery.

[0039] Fig. 3 is a perspective view of a handheld device 300 in accordance with an exemplary embodiment of the invention. 301 is a power on switch. 302 shows the LED "fuel gauge" indicators 61. 303 shows a 12 volt output port connectable to a cable device 400, described further below. 304 shows a flashlight control switch for activating flashlight LEDs 45. 305 is a USB input port for charging the internal lithium battery, and 306 is a USB output port for providing charge from the lithium battery to other portable devices such as smartphones, tablets, music players, etc. 307 is a "boost on" indicator showing that power is being provided to the 12V output port. 308 is a "reverse" indicator showing that the vehicle battery is improperly connected with respect to polarity. 309 is a "power on" indicator showing that the device is powered up for operation.

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[0040] Fig. 4 shows a jumper cable device 400 specifically designed for use with the handheld device 300. Device 400 has a plug 401 configured to plug into 12 volt output port 303 of the handheld device 300. A pair of cables 402a and 402b are integrated with the plug 401, and are respectively connected to battery terminal clamps 403a and 403b via ring terminals 404a and 404b. The port 303 and plug 401 may be dimensioned so that the plug 401 will only fit into the port 303 in a specific orientation, thus ensuring that clamp 403a will correspond to positive polarity, and clamp 403b will correspond to negative polarity, as indicated thereon. Additionally, the ring terminals 404a and 404b may be disconnected from the clamps and connected directly to the terminals of a vehicle battery. This feature may be useful, for example, to permanently attach the cables 302a-302b to the battery of a vehicle. In the event that the battery voltage becomes depleted, the handheld booster device 300 could be properly connected to the battery very simply by plugging in the plug 401 to the port 303.

[0041] The invention having been thus described, it will be apparent to those skilled in the art that the same may be varied in many ways without departing from the spirit or scope of the invention. Any and all such variations are intended to be encompassed within the scope of the following claims.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Apparatus for jump starting a vehicle engine, comprising:

an internal power supply;

an output port having positive and negative polarity outputs;

a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs;

a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port;

a power switch connected between said internal power supply and said output port; and

a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

2. The apparatus of claim 1, wherein said internal power supply comprises a lithium ion battery.

3. The apparatus of claim 2, wherein said lithium ion battery comprises a battery pack of multiple lithium ion batteries.

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4. The apparatus of claim 1, wherein said power switch comprises a plurality of FETs in parallel.

5. The apparatus of claim 1, wherein said vehicle isolation sensor and reverse polarity sensor comprise optically coupled isolator phototransistors.

6. The apparatus of claim 1, further comprising a plurality of power diodes coupled between said output port and said internal power supply to prevent back-charging of said internal power supply from an electrical system connected to said output port.

7. The apparatus of claim 1, further comprising a temperature sensor configured to detect temperature of said internal power supply and to provide a temperature signal to said microcontroller.

8. The apparatus of claim 1, further comprising a voltage measurement circuit configured to measure output voltage of said internal power supply and to provide a voltage measurement signal to said microcontroller.

9. The apparatus of claim 1, further comprising a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus.

10. The apparatus of claim 1, further comprising a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device.

11. The apparatus of claim 1, further comprising a USB charging port configured to provide charging power from an external power source to said internal power supply.

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12. The apparatus of claim 1, further comprising a flashlight circuit configured to provide a source of light to a user.

13. The apparatus of claim 12, wherein said source of light is at least one LED.

14. The apparatus of claim 13, wherein said microcontroller is configured to control said at least one LED to provide a visual alarm indicating an emergency situation.

15. The apparatus of claim 1, further comprising a plurality of visual indicators configured to display remaining capacity status of said internal power supply.

16. The apparatus of claim 15, wherein said plurality of visual indicators comprises a plurality of LEDs providing output light of different colors.

17. The apparatus of claim 1, further comprising a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity.

18. The apparatus of claim 1, further comprising separate visual indicators configured to display the power on status of the apparatus, and the jump start boost power status of power supplied to said output port.

19. The apparatus of claim 1, further comprising a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect presence of a vehicle battery.

20. The apparatus of claim 19, wherein said microcontroller is configured to detect actuation of said manual override switch for at least a predetermined period of time before activation of said manual override mode.

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21. The apparatus of claim 1, further comprising a jumper cable device including a plug configured to plug into said output port, a pair of cables integrated with the plug at one respective end thereof and being configured to be connected to terminals of a battery at another respective end thereof.

22. The apparatus of claim 21, wherein said jumper cable device further comprises a pair of ring terminals configured to respectively connect said pair of cables at said another end thereof with one of a battery terminal and a battery terminal clamp.

23. The apparatus of claim 21, wherein said output port and said plug are dimensioned so that the plug will fit into the output port only in one specific orientation.

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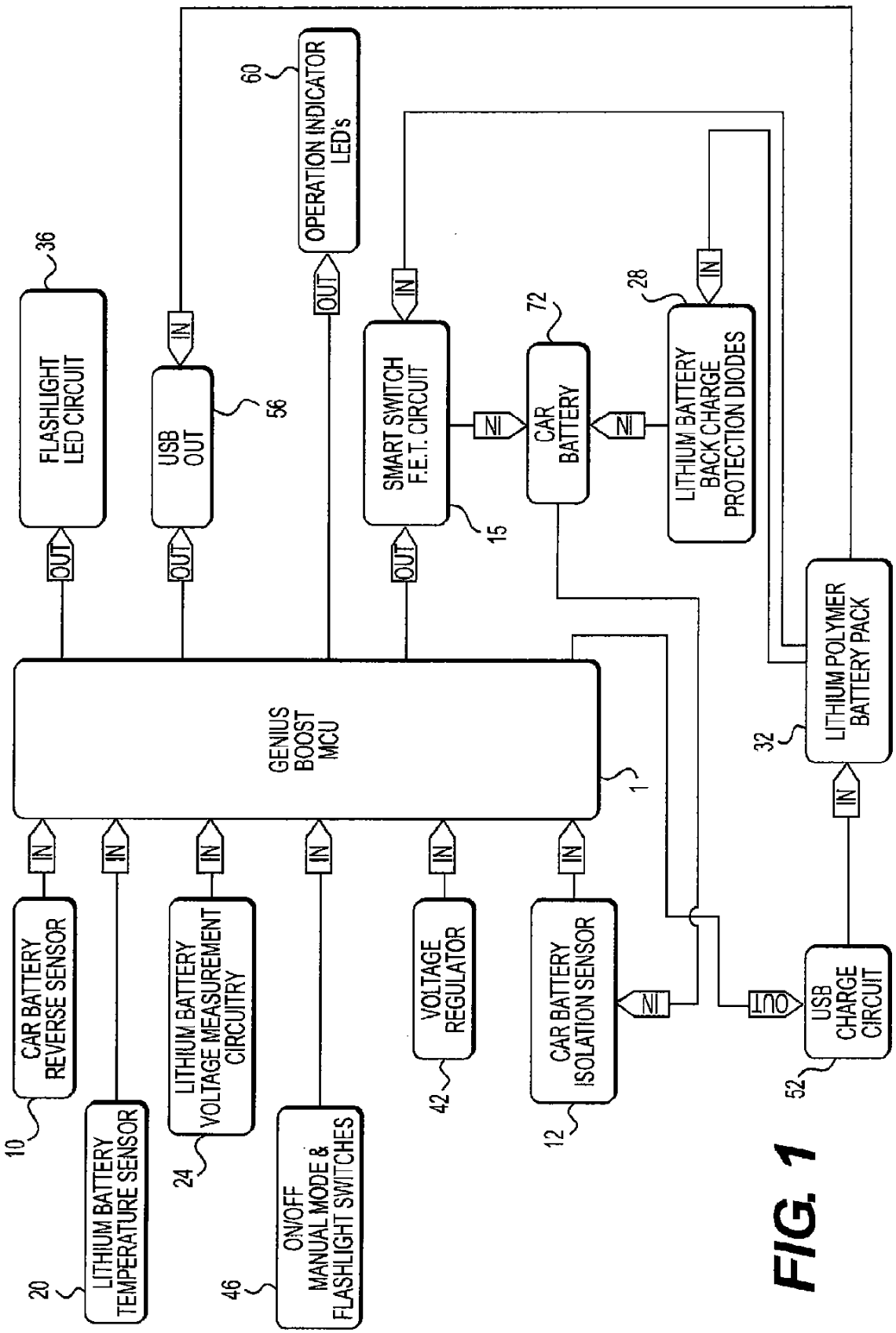


FIG. 1

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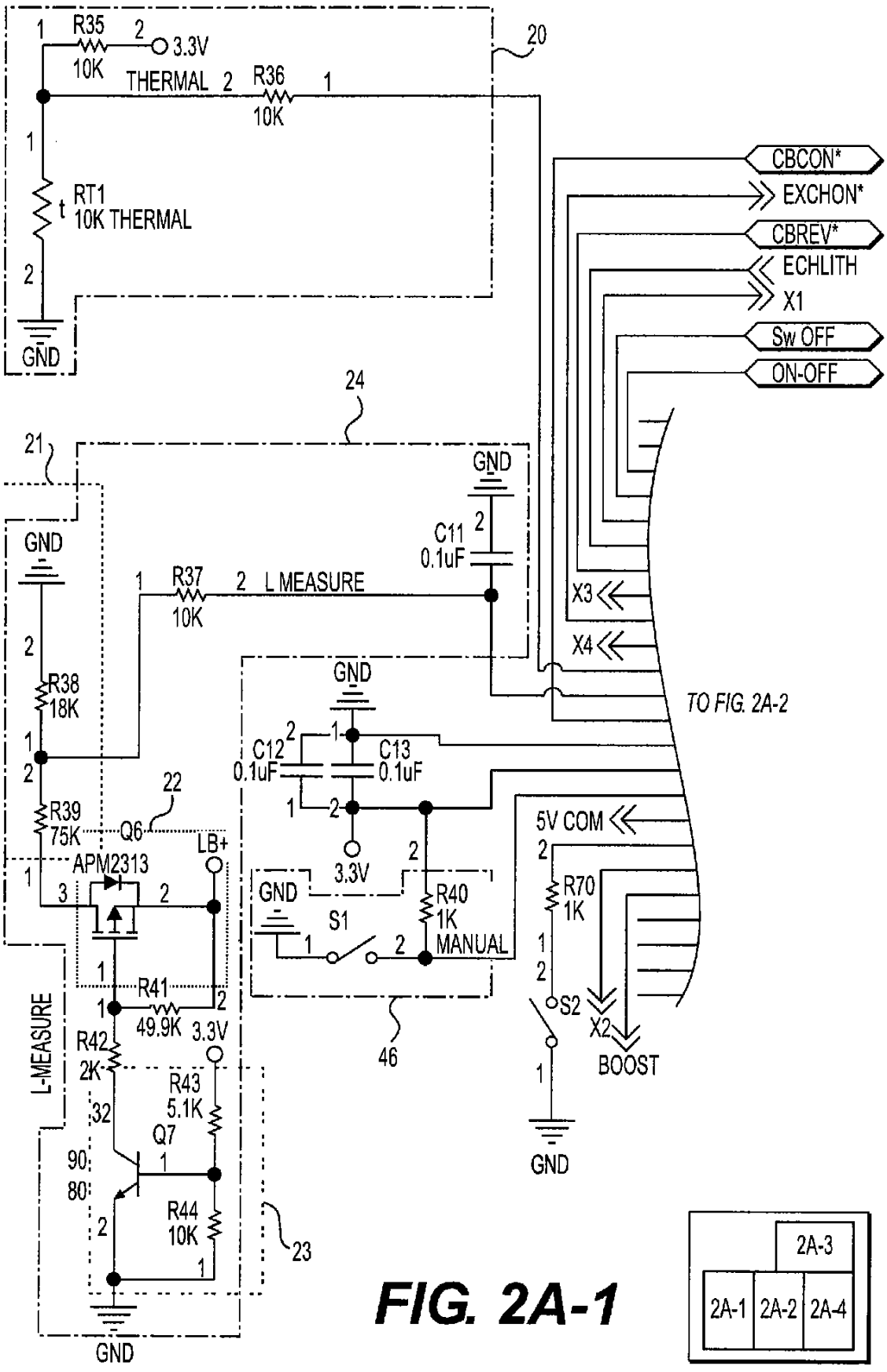
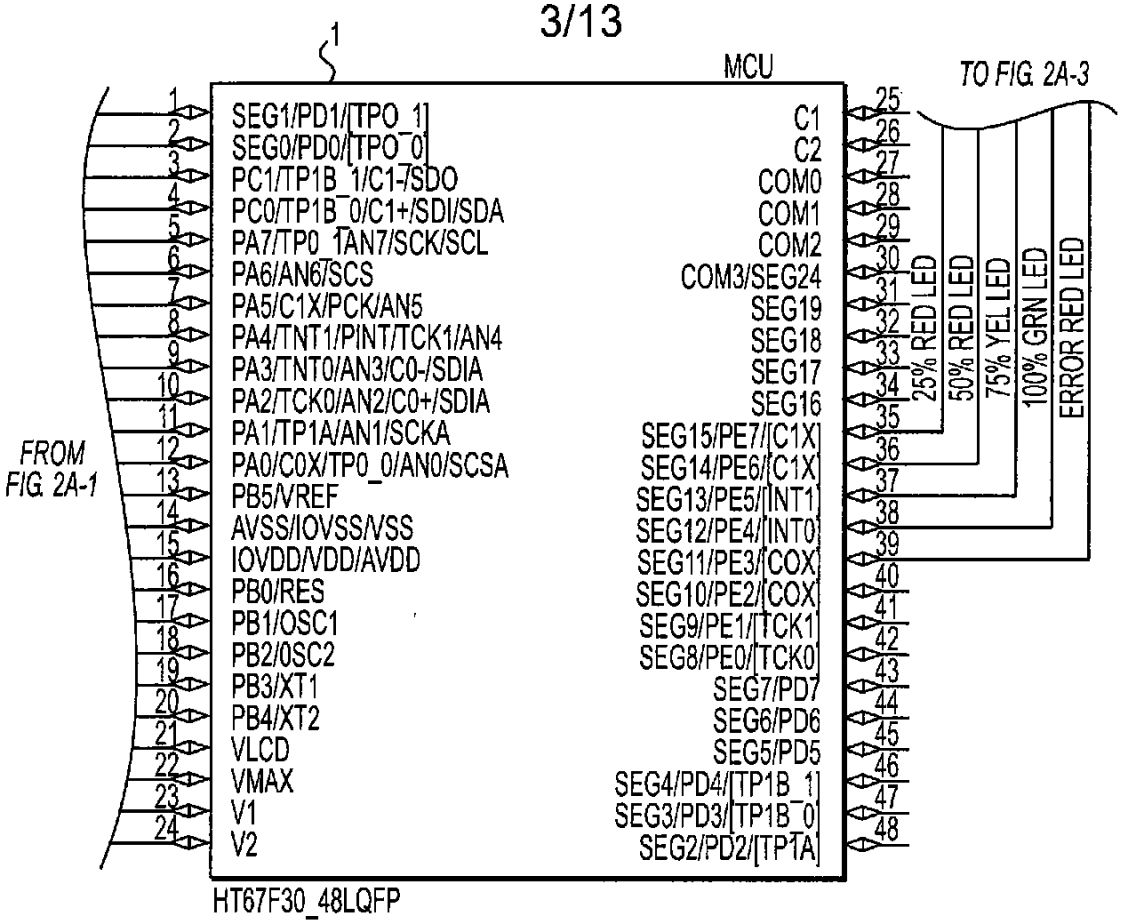
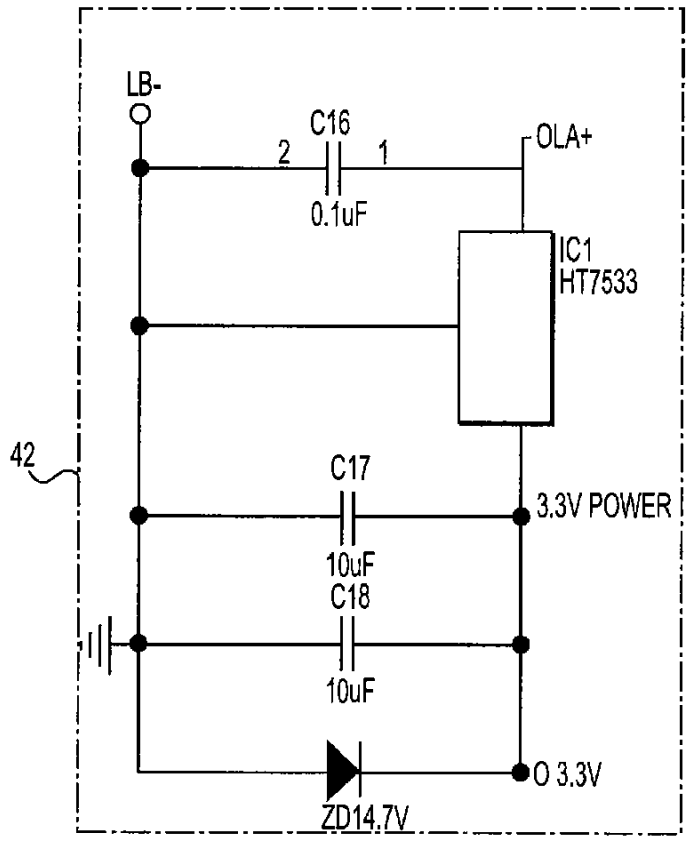


FIG. 2A-1

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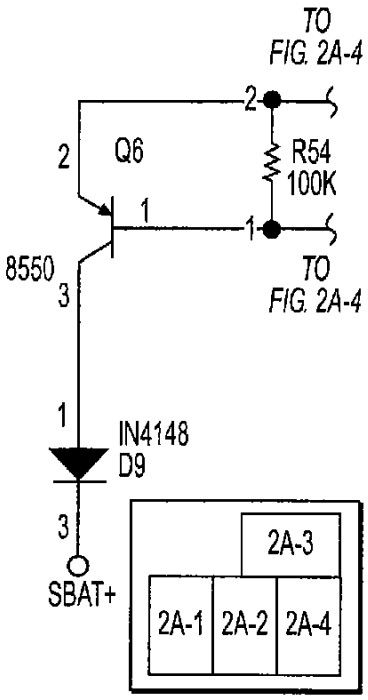


FIG. 2A-2

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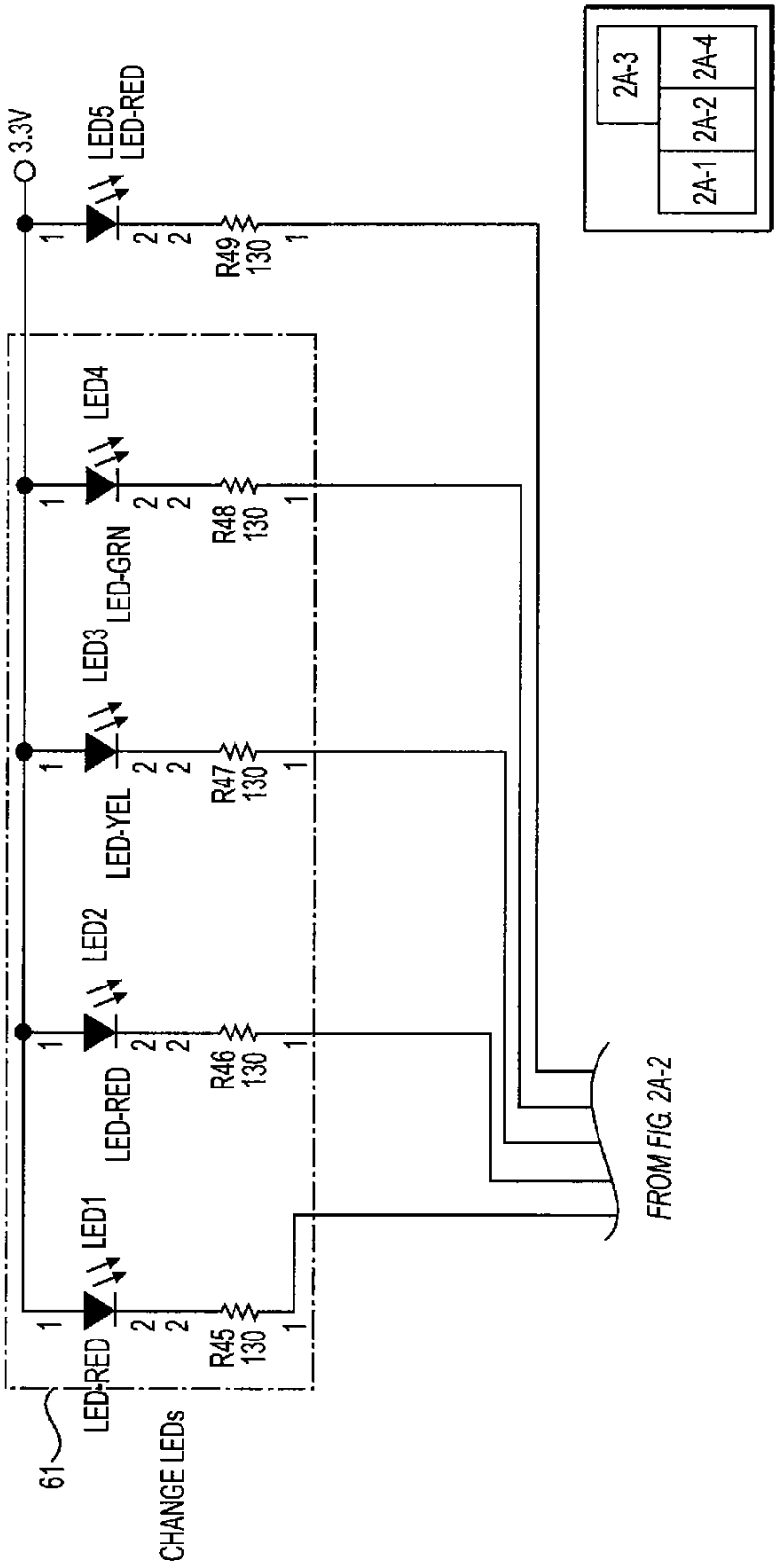


FIG. 2A-3

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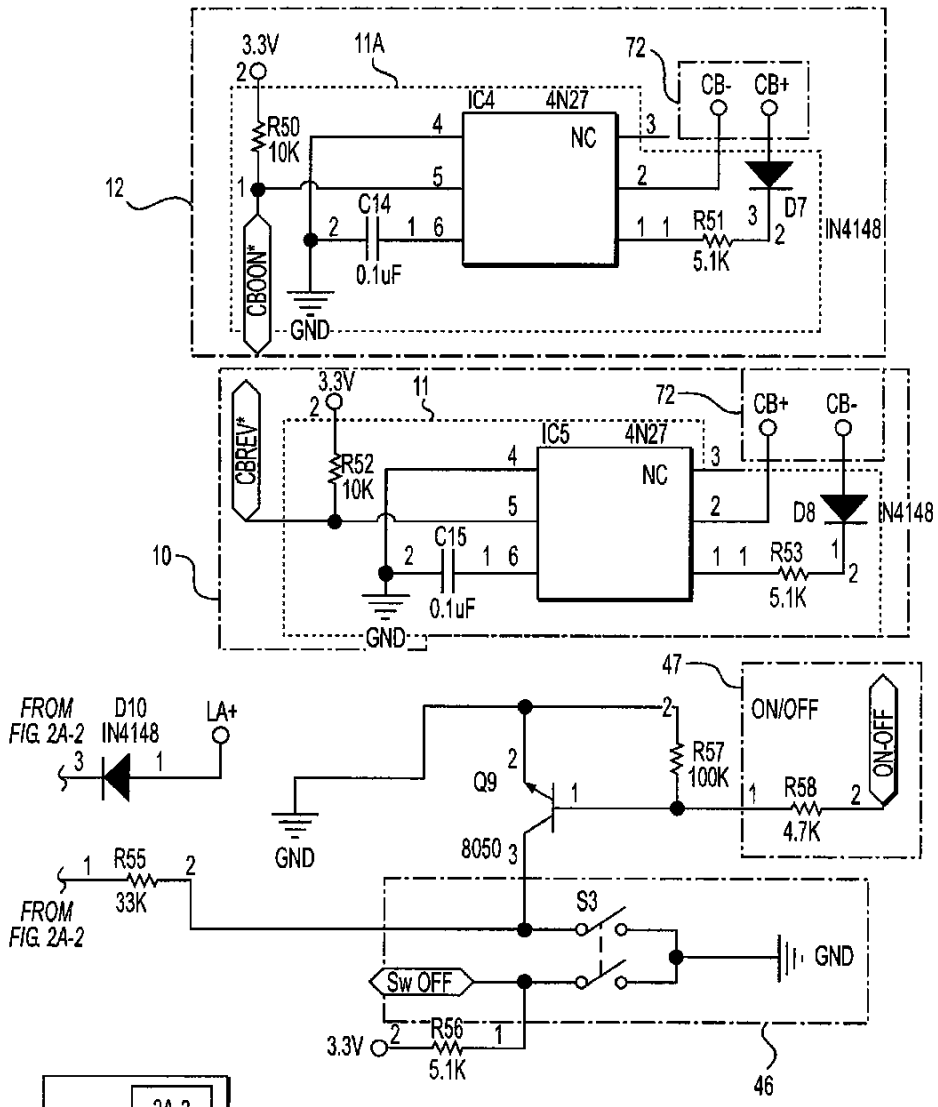


FIG. 2A-4

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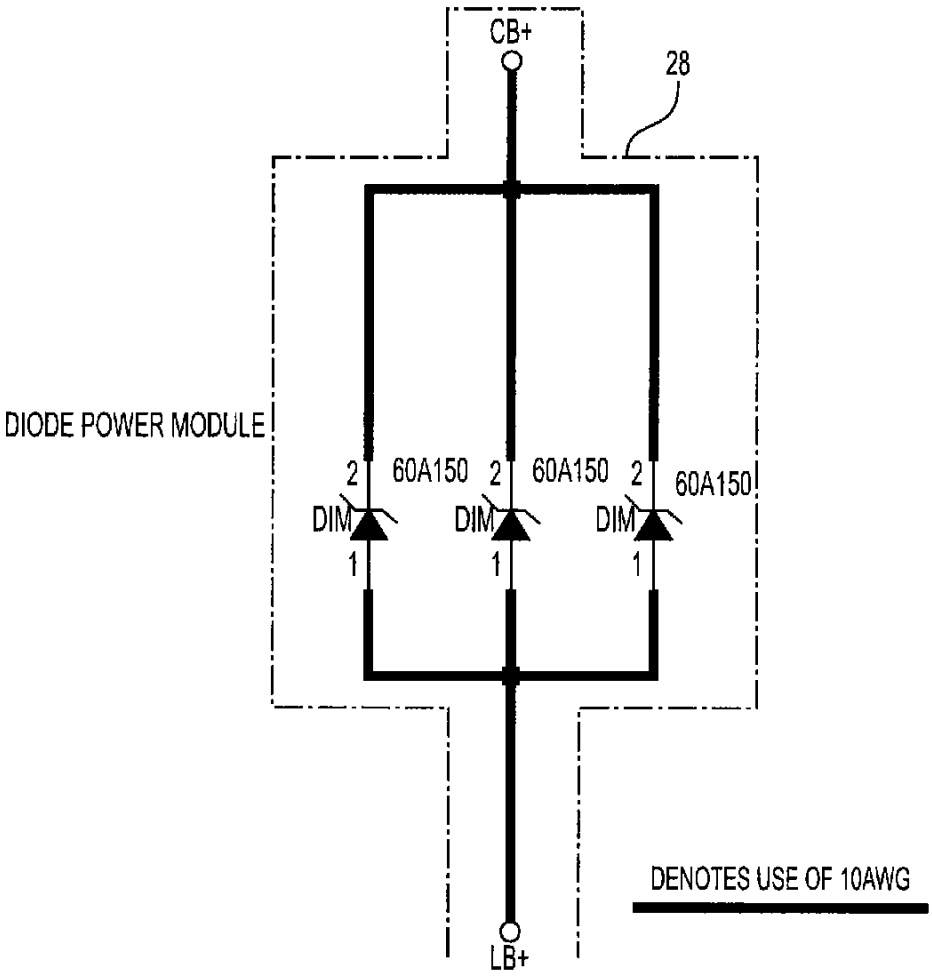
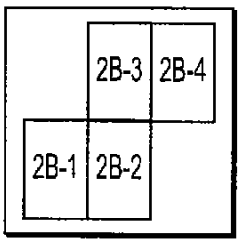


FIG. 2B-1



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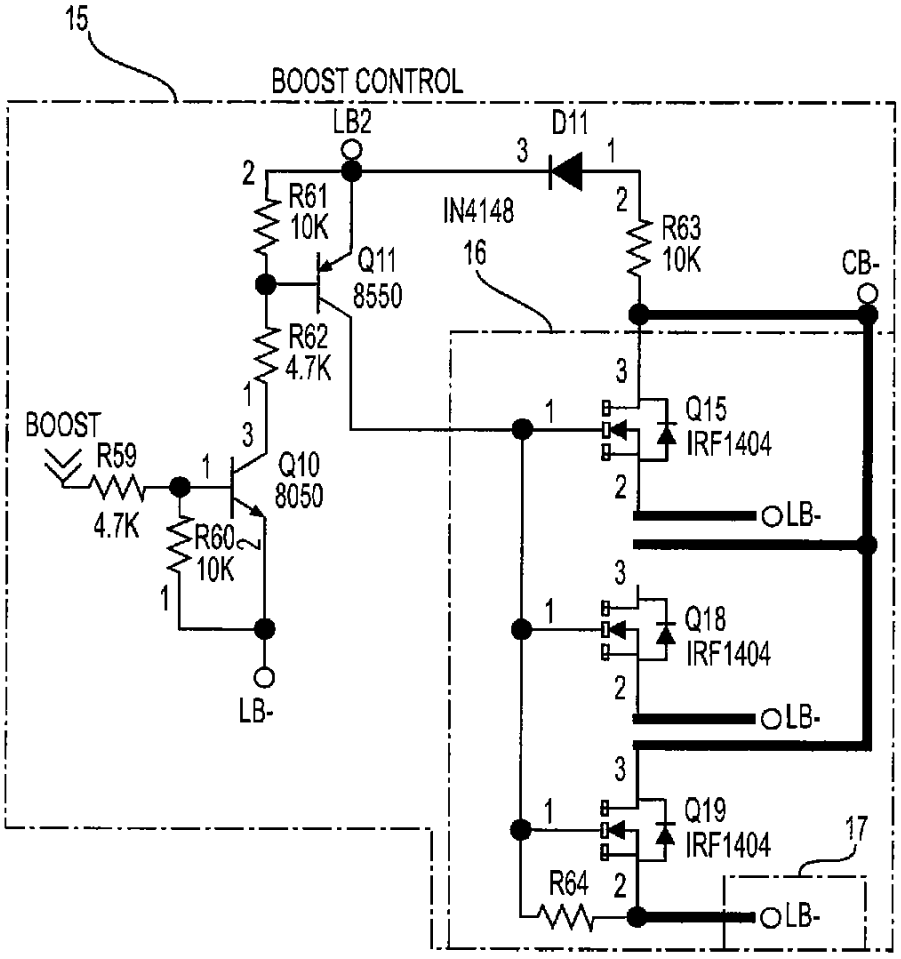
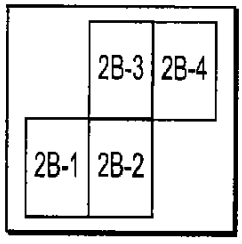


FIG. 2B-2



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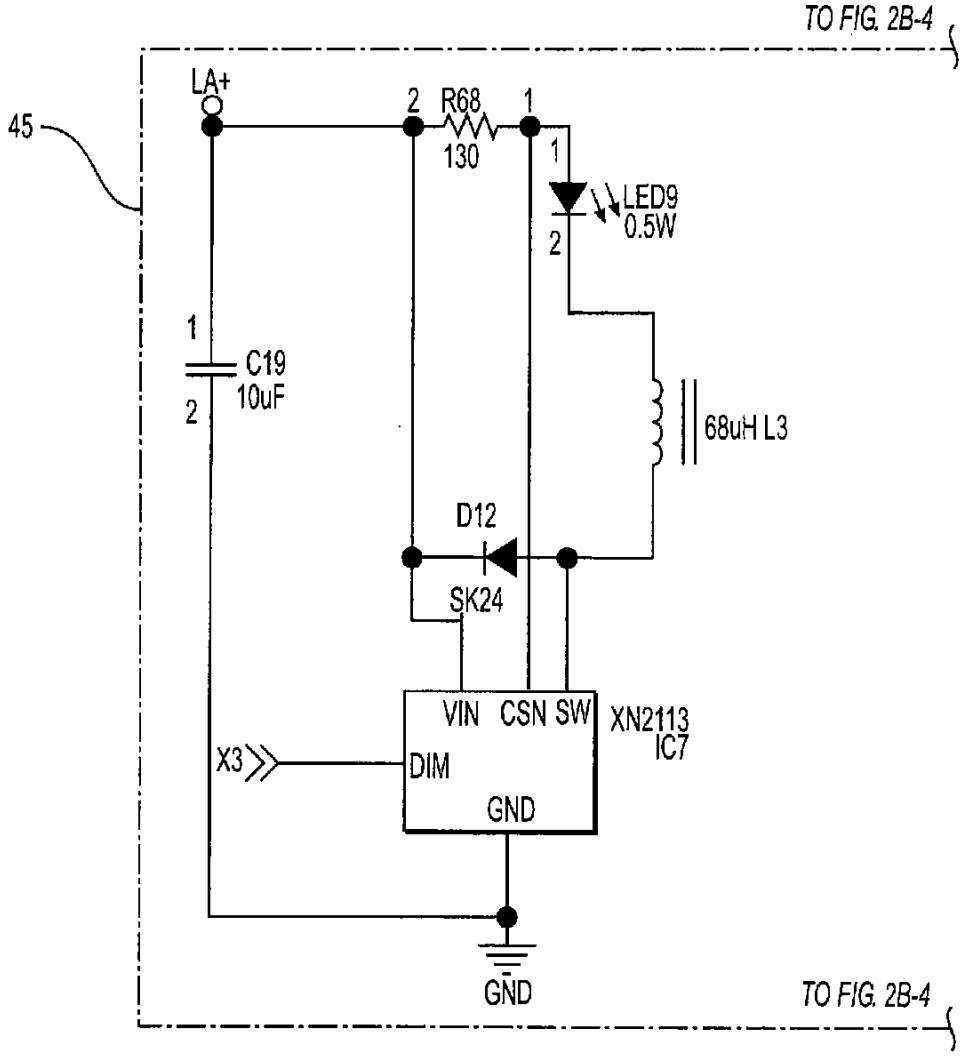
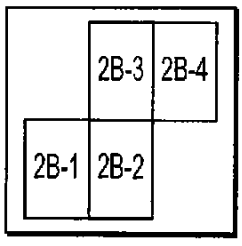


FIG. 2B-3



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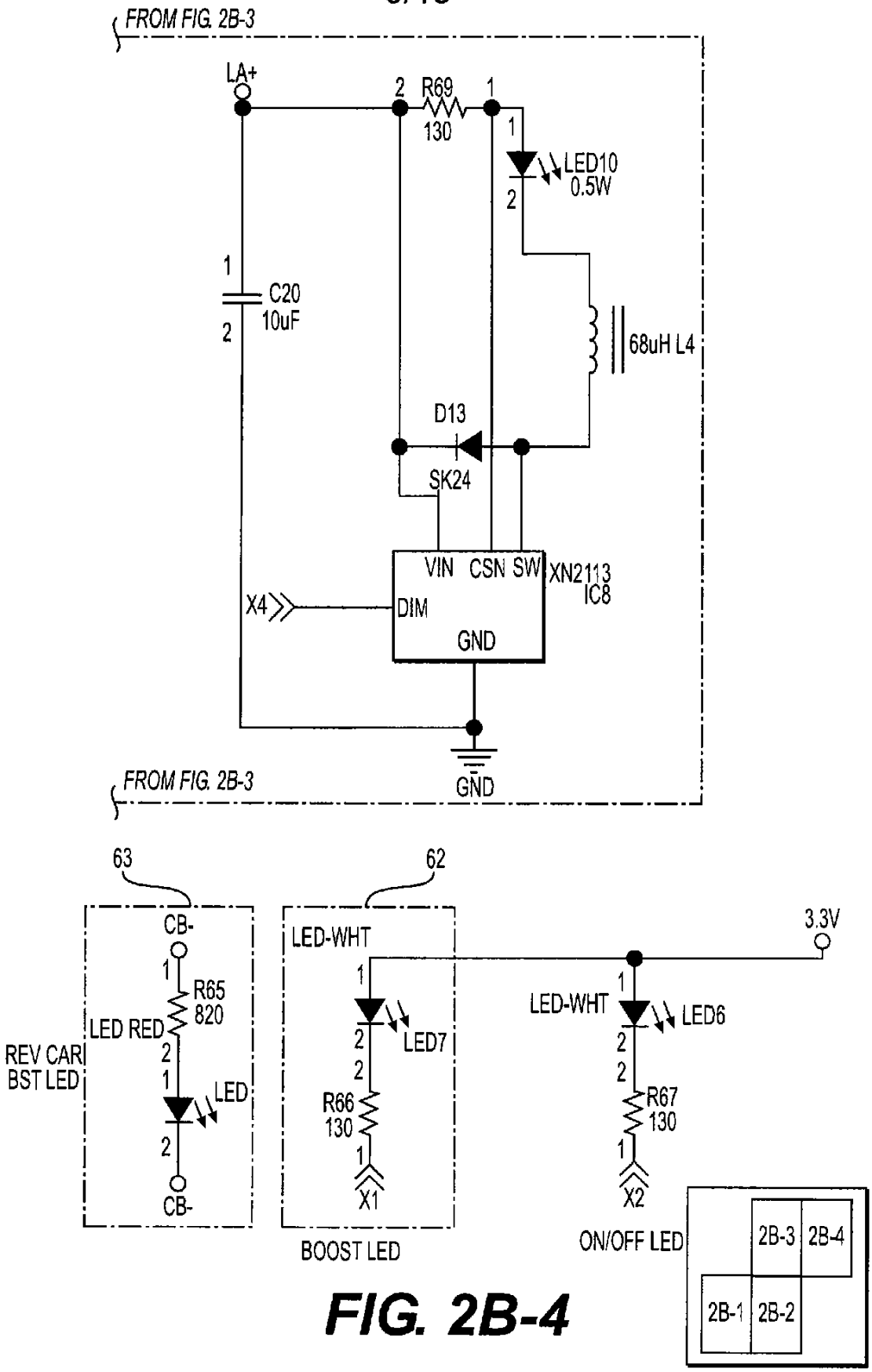


FIG. 2B-4

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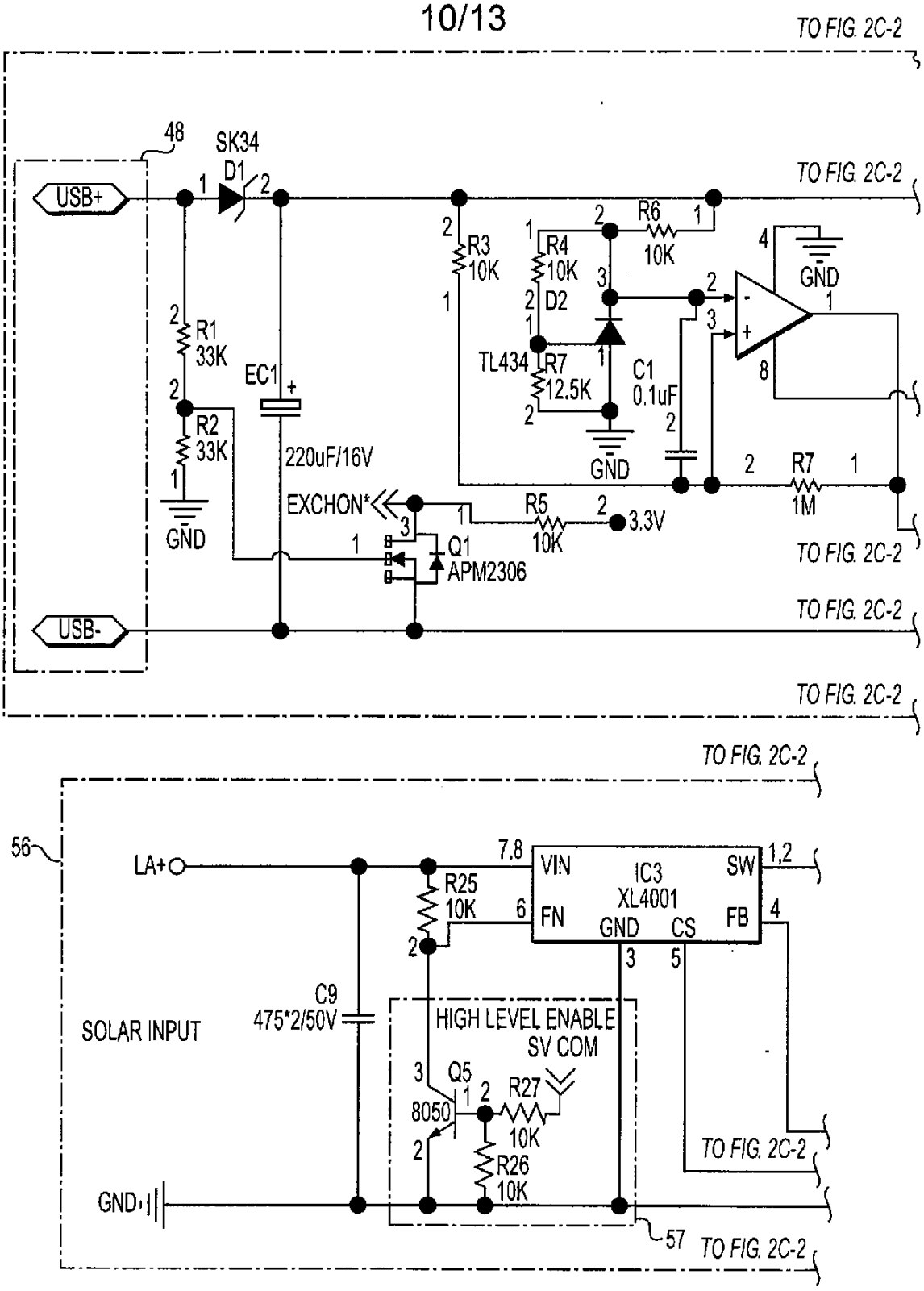
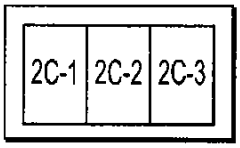


FIG. 2C-1



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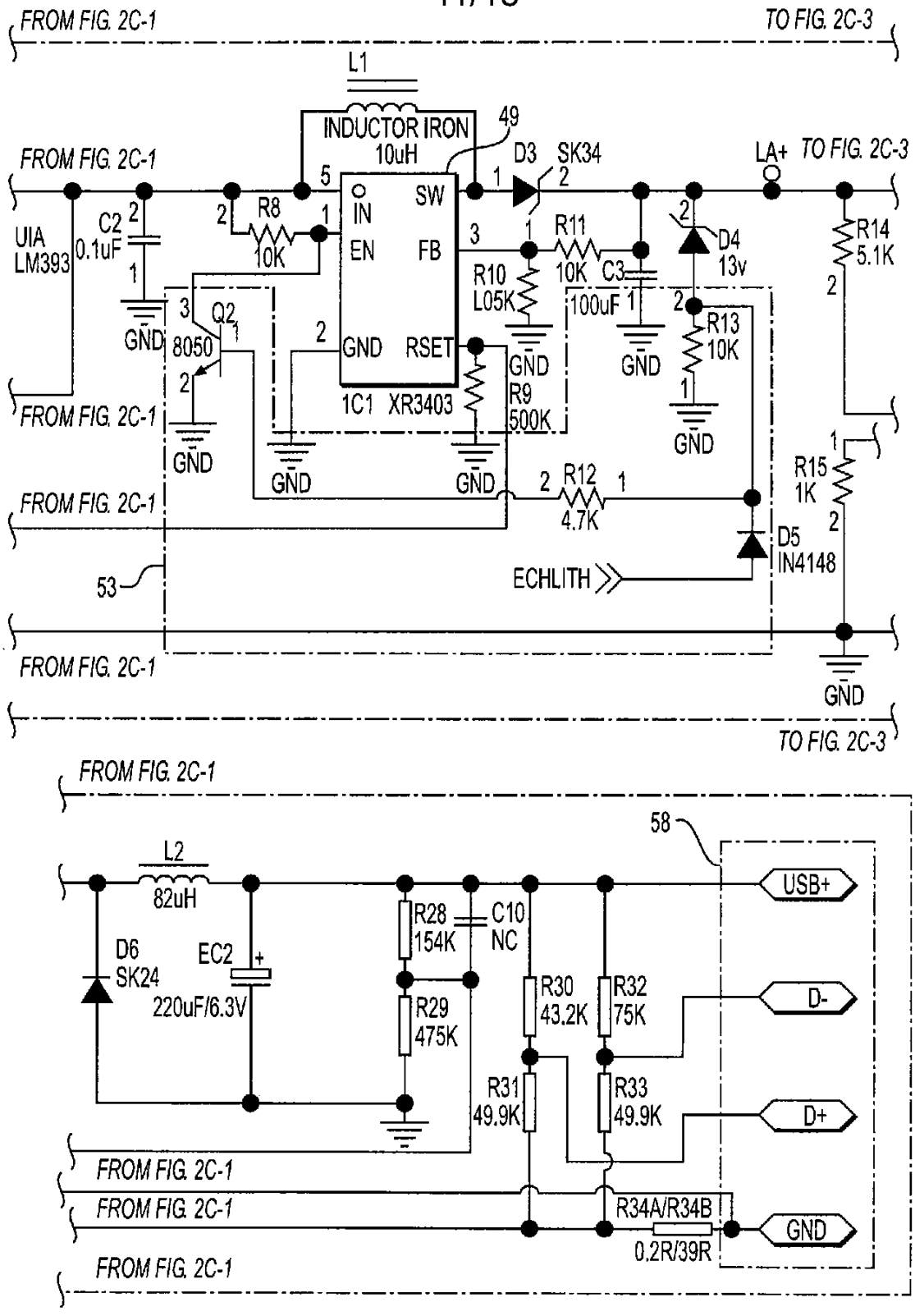
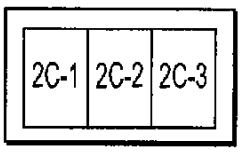
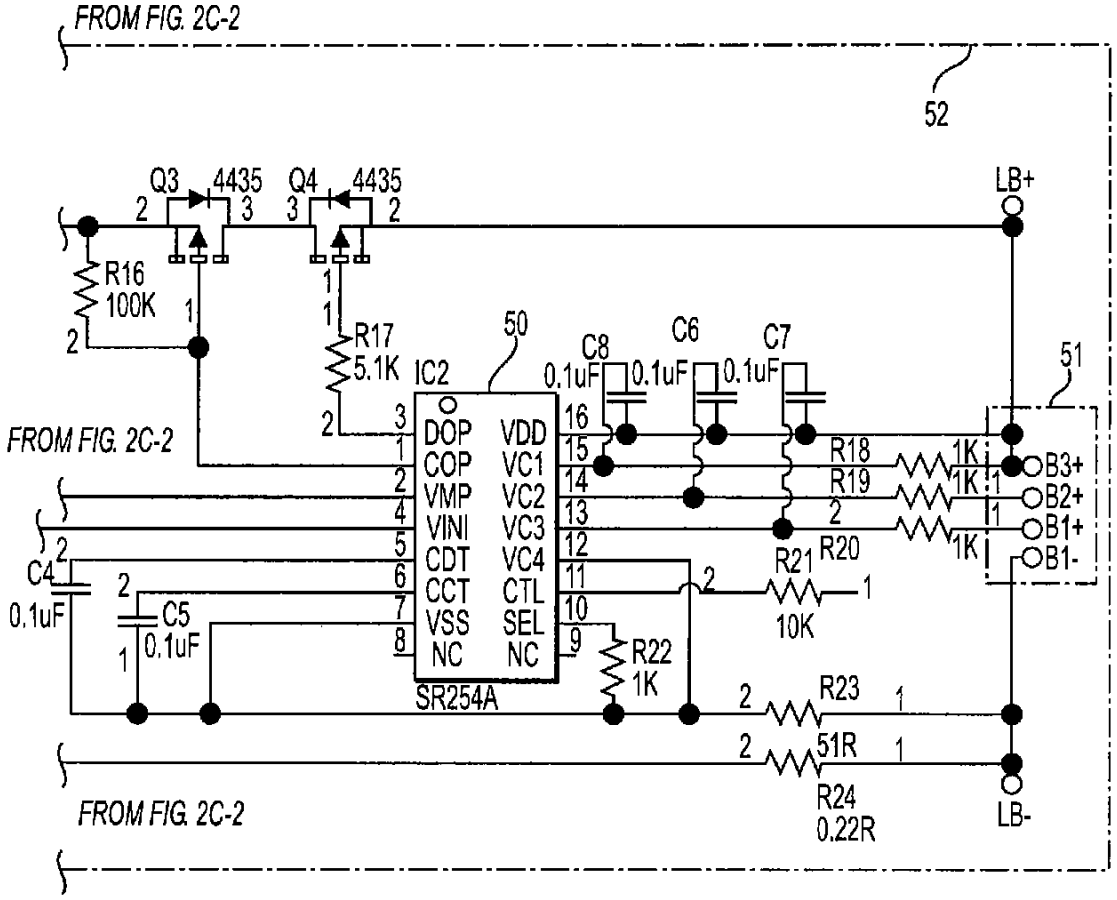


FIG. 2C-2



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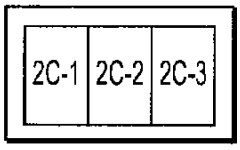


FIG. 2C-3

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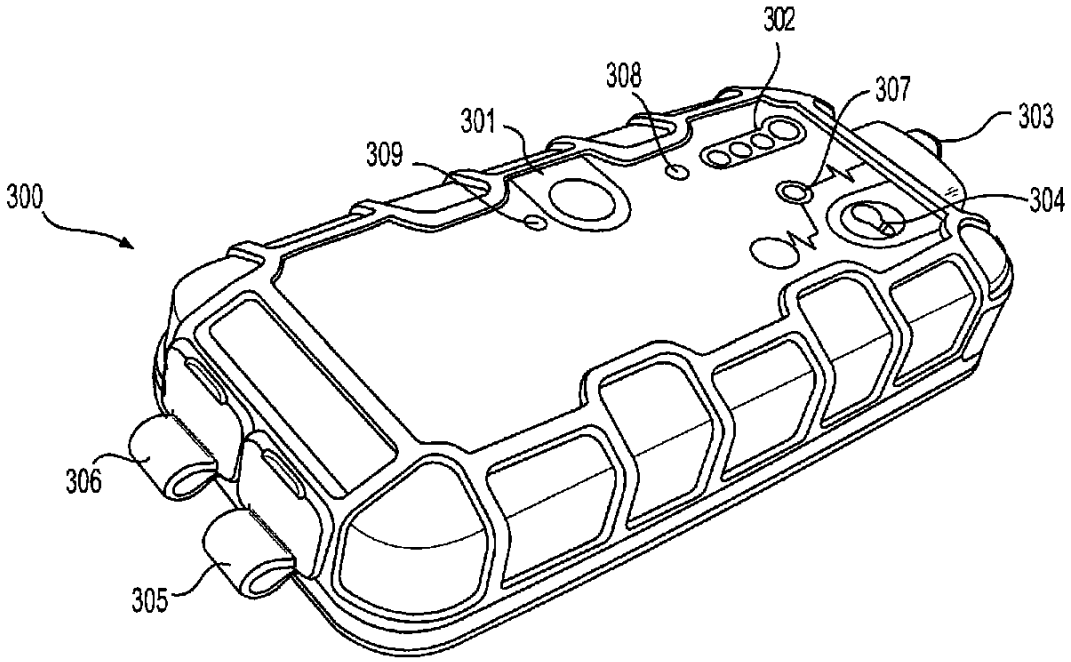


FIG. 3

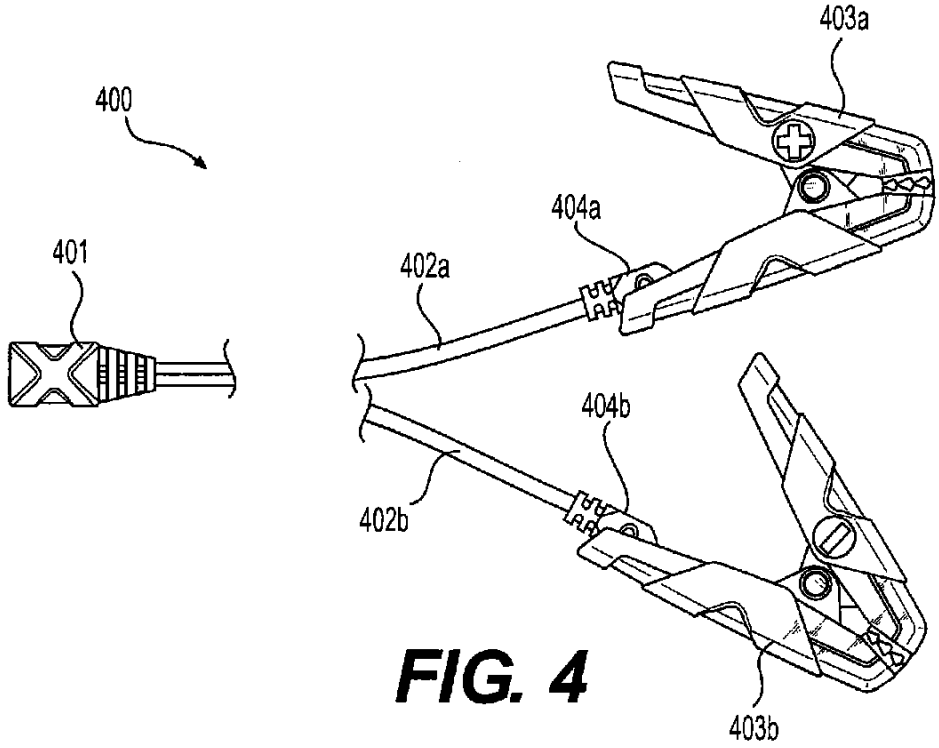


FIG. 4

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
22. September 2011 (22.09.2011)

PCT

(10) Internationale Veröffentlichungsnummer
WO 2011/113734 A1

(51) Internationale Patentklassifikation:
H02H 11/00 (2006.01) *F02N 11/08* (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2011/053575

(22) Internationales Anmeldedatum:
10. März 2011 (10.03.2011)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2010 011 276.3 13. März 2010 (13.03.2010) DE

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(81) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare nationale Schutzrechtsart)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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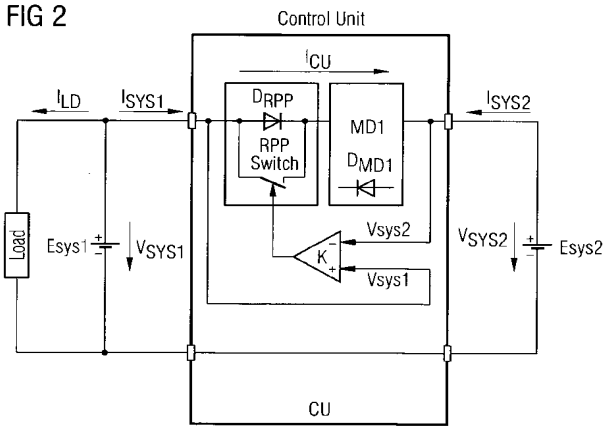
Veröffentlicht:

— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

(54) **Title**: ON-BOARD ELECTRICAL SYSTEM FOR A VEHICLE

(54) **Bezeichnung** : BORDNETZ FÜR EIN FAHRZEUG

FIG 2



(57) **Abstract**: In an on-board electrical system for a motor vehicle comprising: a first energy storage unit (Esys1) with a first voltage level (V_{SYS1}), a second energy storage unit (Esys2) with a second voltage level (V_{SYS2}); a control unit (CU) which controls the flow of current between the first energy storage unit (Esys1) and the second energy storage unit (Esys2) in both directions; a polarity-reversal protection diode (D_{RPP}) which connects the first energy storage unit (Esys1) for supplying operating voltage to the control unit (CU); and a switching element (Switch) for bridging the polarity-reversal protection diode (D_{RPP}) when the polarity of the first energy storage unit (Esys1) is correct; the first voltage level (V_{SYS1}) is compared with the second voltage level (V_{SYS2}) by means of a comparator (K) and the controllable switch (Switch) is moved to its open state when the first voltage level (V_{SYS1}) drops to a threshold voltage value (V_{sch}) which is below the second voltage level (V_{SYS2}).

(57) **Zusammenfassung**:

[Fortsetzung auf der nächsten Seite]

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ADC EX1002
IPR2025-00885

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Bei einem Bordnetz für ein Kraftfahrzeug umfassend: eine erste Energiespeichereinheit (Esys1) mit einem ersten Spannungsniveau (V_{SYS1}), eine zweite Energiespeichereinheit (Esys2) mit einem zweiten Spannungsniveau (V_{SYS2}); eine Steuereinheit (CU), die den Stromfluss zwischen der ersten Energiespeichereinheit (Esys1) und der zweiten Energiespeichereinheit (Esys2) in beiden Richtung steuert; eine Verpolschutzdiode (D_{RPP}), die die erste Energiespeichereinheit (Esys1) zur Betriebsspannungsversorgung mit der Steuereinheit (CU) verbindet; und ein Schaltelement (Switch) zur Überbrückung der Verpolschutzdiode (D_{RPP}) bei richtiger Polung der ersten Energiespeichereinheit (Esys1); wird mittels eines Komparators (K) das erste Spannungsniveau (V_{SYS1}) mit dem zweiten Spannungsniveau (V_{SYS2}) verglichen und bei Absinken des ersten Spannungsniveaus (V_{SYS1}) auf einen unter dem zweiten Spannungsniveau (V_{SYS2}) liegenden Spannungsschwellwert (V_{sch}) der steuerbare Schalter (Switch) in seinen geöffneten Zustand gesteuert.

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IPR2025-00885

Beschreibung

Bordnetz für ein Fahrzeug

Die Erfindung betrifft ein Bordnetz für ein Fahrzeug, insbesondere ein Kraftfahrzeug gemäß Oberbegriff des Patentanspruchs 1.

Bordnetze heutiger Kraftfahrzeuge umfassen einen als Drehstrommaschine mit nachgeschalteter Gleichrichterschaltung ausgebildeten Generator als Energiewandler, eine oder mehrere Energiespeichereinheiten, bspw. Batterien sowie über das Bordnetz zu versorgende elektrische Verbraucher. Ein Verpolungsschutz wird bei solchen Bordnetzen durch die Gleichrichterdioden einer nachgeschalteten Gleichrichterschaltung realisiert.

Darüber hinaus sind auch Bordnetze mit zwei Energiespeichersystemen mit unterschiedlichen Nominalspannungen als Systemspannungen ohne Potentialtrennung bekannt, so zum Bsp. ein Energiespeichersystem, bspw. eine 12V-Batterie für Normalverbraucher des Kraftfahrzeugs und ein weiteres Energiespeichersystem, bspw. bestehend aus Doppelschichtkondensatoren (Ultra-caps) für Hochstromverbraucher.

Ein Batteriemanagement für Energiefluß- und Ruhestrommanagement zwischen diesen beiden Energiespeichersystemen wird von einer Steuereinheit bzw. einem Steuergerät bewirkt, wobei diese Steuereinheit von der 12V-Batterie mit einer Betriebsspannung versorgt wird. Als Verpolschutz dient ein Ventil, bspw. eine Verpolschutzdiode, die die 12V-Batterie mit der Steuereinheit verbindet.

Nachteilig an einem solchen Bordnetz mit zwei Energiespeichersystemen ist ein Zustand, bei dem die Systemspannung der 12V-Batterie unter die Spannung der weiteren Energiespeichereinheit fällt und damit die Gefahr eines Ladungsabflusses in Richtung der 12V-Batterie aufgrund parasitärer Effekte in Halbleiter-Bauelementen der Steuereinheit besteht.

Aufgabe der Erfindung ist es daher, ein Bordnetz für ein Fahrzeug zu schaffen, bei dem ein solcher Ladungsabfluss verhindert wird.

Diese Aufgabe wird gelöst durch ein Bordnetz mit den Merkmalen des Patentanspruchs 1.

Hiernach ist bei einem Bordnetz für ein Fahrzeug, insbesondere ein Kraftfahrzeug, das
- eine erste Energiespeichereinheit mit einem ersten Spannungsniveau,
- eine zweite Energiespeichereinheit mit einem zweiten Spannungsniveau,
- eine Steuereinheit, die den Stromfluss zwischen der ersten Energiespeichereinheit und der zweiten Energiespeichereinheit in beiden Richtungen steuert, falls das zweite Spannungsniveau unter dem ersten Spannungsniveau liegt,
- eine Verpolschutzdiode, die die erste Energiespeichereinheit zur Betriebsspannungsversorgung mit der Steuereinheit verbindet, und
- ein Schaltelement zur Überbrückung der Verpolschutzdiode bei richtiger Polung der ersten Energiespeichereinheit umfasst,
erfindungsgemäß vorgesehen, dass

- mittels einer Vergleichsschaltung, insbesondere eines Komparators das erste Spannungsniveau mit dem zweiten Spannungsniveau verglichen wird, und
- mittels Steuermittel, vorzugsweise des Komparators bei Absinken des ersten Spannungsniveaus auf einen unter dem zweiten Spannungsniveau liegenden Spannungsschwellwert der steuerbare Schalter in seinen geöffneten Zustand gesteuert wird.

Damit wird in einfacher und überraschender Weise der Verpolschutz für die Steuereinheit auch zur Verhinderung eines unerwünschten Ladungsaustausches zwischen den beiden Energiespeichereinheiten erzielt. Insbesondere sind keine zusätzlichen Leistungsbauelemente erforderlich. Ferner ist gemäß einer Weiterbildung der Erfindung mittels des vorgeschlagenen Komparators eine leichte Einstellmöglichkeit des Spannungsschwellwertes möglich.

Weitere vorteilhafte Ausgestaltungen der Erfindung sind mit den Merkmalen der abhängigen Patentansprüche gegeben.

Die Erfindung wird nachfolgend unter Bezugnahme auf die beigefügten Figuren näher erläutert. Es zeigen:

Figur 1 ein schematisches Blockschaltbild eines Ausführungsbeispiels des erfindungsgemäßen Bordnetzes für ein Kraftfahrzeug, und

Figur 2 ein detailliertes Blockschaltbild des Bordnetzes gemäß Figur 1.

Figur 1 zeigt ein Bordnetz, bestehend aus einer ersten Energiespeichereinheit Esys1 mit einer Nominalspannung V_{SYS1}, hier

eine 12V-Batterie und einer zweiten Energiespeichereinheit Esys2 mit einer Nominalspannung V_{SYS2}, die ebenfalls eine Batterie, ein Doppelschichtkondensator oder ein anderes Speichermedium sein kann.

Die Nominalspannung V_{SYS1} der ersten Energiespeichereinheit Esys1, also deren Systemspannung ist größer als die Nominalspannung V_{SYS2} bzw. Systemspannung der zweiten Energiespeichereinheit Esys2: $V_{SYS1} > V_{SYS2}$.

Eine Steuereinheit CU verbindet die beiden nicht potentialgetrennten Energiespeichereinheiten Esys1 und Esys2 und steuert den Energieaustausch im Sinne eines Energiemanagements zwischen diesen beiden Energiespeichereinheiten Esys1 und Esys2, d. h. im Nominalzustand der beiden Systemspannungen ist sowohl ein Energieaustausch von der ersten Energiespeichereinheit Esys1 in Richtung der zweiten Energiespeichereinheit Esys2 als auch umgekehrt, von der zweiten Energiespeichereinheit Esys2 in Richtung der ersten Energiespeichereinheit Esys1 möglich.

Gemäß der detaillierten Darstellung nach Figur 2 sind an die erste Energiespeichereinheit Esys1 elektrische Verbraucher des Kraftfahrzeug angeschlossen, dargestellt als Systemlast Load, die von einem Laststrom I_{LD} versorgt werden. Der von der Steuereinheit CU gemanagte Energieaustausch zwischen den beiden Energiespeichereinheiten Esys1 und Esys2 erfolgt mittels der Systemströme I_{SYS1} und I_{SYS2}. Bei diesem Ausführungsbeispiel sind die beiden Energiespeichersysteme Esys1 und Esys2 nicht potentialgetrennt.

Die erste Energiespeichereinheit Esys1 liefert auch die Betriebsspannungsversorgung für die Steuereinheit CU, der zuge-

hörige Laststrom ist mit I_{CU} bezeichnet, wobei zwischen der ersten Energiespeichereinheit Esys1 und der Steuereinheit CU eine Verpolschutzschaltung RPP (Reverse Polarity Protection) geschaltet ist, die bspw. aus einer Verpolschutzdiode D_{RPP} besteht und von einem steuerbaren Schalter Switch, bspw. einem Transistor oder einem mechanischen Schalter, wie einem Relais kurzgeschlossen werden kann.

Dieser Schalter Switch wird von einer Vergleichsschaltung, hier ein Komparator K angesteuert. Hierzu wird die Spannung V_{SYS1} der ersten Energiespeichereinheit Esys1 dem nicht invertierenden Eingang des Komparators K und die Spannung Esys2 der zweiten Energiespeichereinheit Esys2 dem invertierenden Eingang des Komparators K zugeführt.

Befinden sich die beiden Systemspannungen V_{SYS1} und V_{SYS2} auf ihrem Nominalwert, d.h. gilt $V_{SYS1} > V_{SYS2}$, so wird der Schalter Switch durch entsprechende Steuerung des Komparators K geschlossen, d.h. der Transistor in seinen leitenden Zustand gesteuert. So dass die Verpolschutzdiode D_{RPP} überbrückt wird.

Falls die Spannung V_{SYS1} der ersten Energiespeichereinheit Esys1 also bspw. eine 12V-Batterie aufgrund einer starken Entladung auf einen Spannungsschwellwert V_{sch} absinkt, der unter dem Spannungswert der Spannung V_{SYS2} der zweiten Energiespeichereinheit Esys2 liegt, also wenn $V_{SYS1} \leq V_{sch} < V_{SYS2}$ gilt, wird der Schalter Switch von dem Komparator K in seinen geöffneten Zustand gesteuert, so dass aufgrund der Verpolschutzdiode D_{RPP} ein Ladungsabfluss aus der zweiten Energiespeichereinheit Esys2 in Richtung der ersten Energiespeichereinheit Esys1 verhindert wird.

Ein solcher Ladungsabfluss könnte aufgrund von parasitären Halbleiterelementen in der Steuereinheit CU entstehen, die in Figur 2 stellvertretend durch eine Diode D_{MD1} dargestellt sind. Ein solches parasitäres Halbleiterbauelement kann bspw. auch in einem von der Steuereinheit CU angesteuerten DC/DC-Wandler MD1 entstehen, bspw. als Bulk- oder Body-Diode eines High-Side-Transistors.

Der Spannungsschwellwert V_{sch} ist über die Steuereinheit CU einstellbar.

Falls die erste Energiespeichereinheit Esys1 mit falscher Polung an die Steuereinheit CU angeschlossen wird, ergibt sich für die Spannung V_{SYS1} der Energiespeichereinheit Esys1: $V_{SYS1} < 0$. Auch in diesem Zustand würde der Komparator K den Schalter Switch öffnen, d.h. den Transistor in seinen gesperrten Zustand steuern, so dass die Verpolschutzdiode D_{RPP} wirksam wird.

Der Komparator K kann mit einem zeitverzögerten Ansprechen ausgebildet werden, indem er bspw. mit einem Zeitglied verbunden wird. So erfolgt sowohl das Schließen des Schalters Switch als auch dessen Öffnen durch den Komparator K zeitverzögert.

Das oben erläuterte Ausführungsbeispiel zeigt ein erfindungsgemäßes Bordnetz ohne Potentialtrennung zwischen den beiden Energiespeichersystemen Esys1 und Esys2. Die Erfindung ist darauf natürlich nicht beschränkt, sondern kann ebenso für potentialgetrennte Systeme eingesetzt werden.

Patentansprüche

1. Bordnetz für ein Fahrzeug, insbesondere ein Kraftfahrzeug umfassend
- eine erste Energiespeichereinheit (Esys1) mit einem ersten Spannungsniveau (V_{SYS1}),
- eine zweite Energiespeichereinheit (Esys2) mit einem zweiten Spannungsniveau (V_{SYS2}),
- eine Steuereinheit (CU), die den Stromfluss zwischen der ersten Energiespeichereinheit (Esys1) und der zweiten Energiespeichereinheit (Esys2) in beiden Richtungen steuert, falls das zweite Spannungsniveau (V_{SYS2}) unter dem ersten Spannungsniveau (V_{SYS1}) liegt,
- eine Verpolschutzdiode (D_{RPP}), die die erste Energiespeichereinheit (Esys1) zur Betriebsspannungsversorgung mit der Steuereinheit (CU) verbindet, und
- ein Schaltelement (Switch) zur Überbrückung der Verpolschutzdiode (D_{RPP}) bei richtiger Polung der ersten Energiespeichereinheit (Esys1),
dadurch gekennzeichnet dass,
- mittels einer Vergleichsschaltung (K), insbesondere eines Komparators das erste Spannungsniveau (V_{SYS1}) mit dem zweiten Spannungsniveau (V_{SYS2}) verglichen wird, und
- mittels Steuermittel (K), vorzugsweise des Komparators bei Absinken des ersten Spannungsniveaus (V_{SYS1}) auf einen unter dem zweiten Spannungsniveau (V_{SYS2}) liegenden Spannungsschwellwert (V_{sch}) der steuerbare Schalter (Switch) in seinen geöffneten Zustand gesteuert wird.

2. Bordnetz nach Anspruch 1,
dadurch gekennzeichnet, dass

der Spannungsschwellwert (V_{sch}) einstellbar ist.

3. Bordnetz nach Anspruch 1 oder 2,
dadurch gekennzeichnet, dass
der Komparator (K) ein zeitverzögertes Ansprechverhalten aufweist.

4. Bordnetz nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass
der steuerbare Schalter (Switch) als Halbleiterschalter, insbesondere als Transistor oder als elektromechanischer Schalter ausgeführt ist.

5. Bordnetz nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass
das Bordnetz hinsichtlich der ersten und zweiten Energiespeichereinheit (Esys1, Esys2) ohne Potenzialtrennung ausgeführt ist.

6. Bordnetz nach einem der Ansprüche 1 bis 4,
dadurch gekennzeichnet, dass
das Bordnetz hinsichtlich der ersten und zweiten Energiespeichereinheit (Esys1, Esys2) mit Potenzialtrennung ausgeführt ist.

7. Bordnetz nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass
der erste Energiespeicher (Esys1) als Betriebsspannungsquelle für einen Laststromkreis mit elektrischen Verbrauchern (Load) dient.

8. Bordnetz nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass

das erste bzw. zweite Spannungsniveau (V_{SYS1}, V_{SYS2}) jeweils die Nominalspannung der ersten bzw. zweiten Energiespeichereinheit (Esys1, Esys2) ist.

9. Bordnetz nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Steuereinheit (CU) mindestens ein elektrisches und/oder elektronisches Bauelement mit Durchlasseigenschaften umfasst.

10. Bordnetz nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Steuereinheit (CU) ein Batteriemanagement durchführt.

1/1

FIG 1

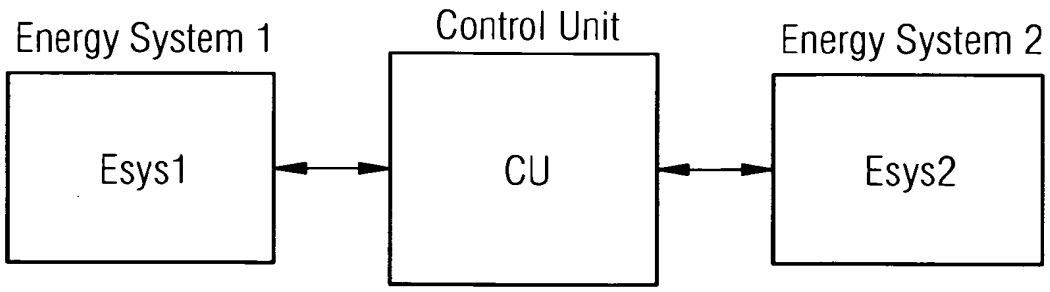
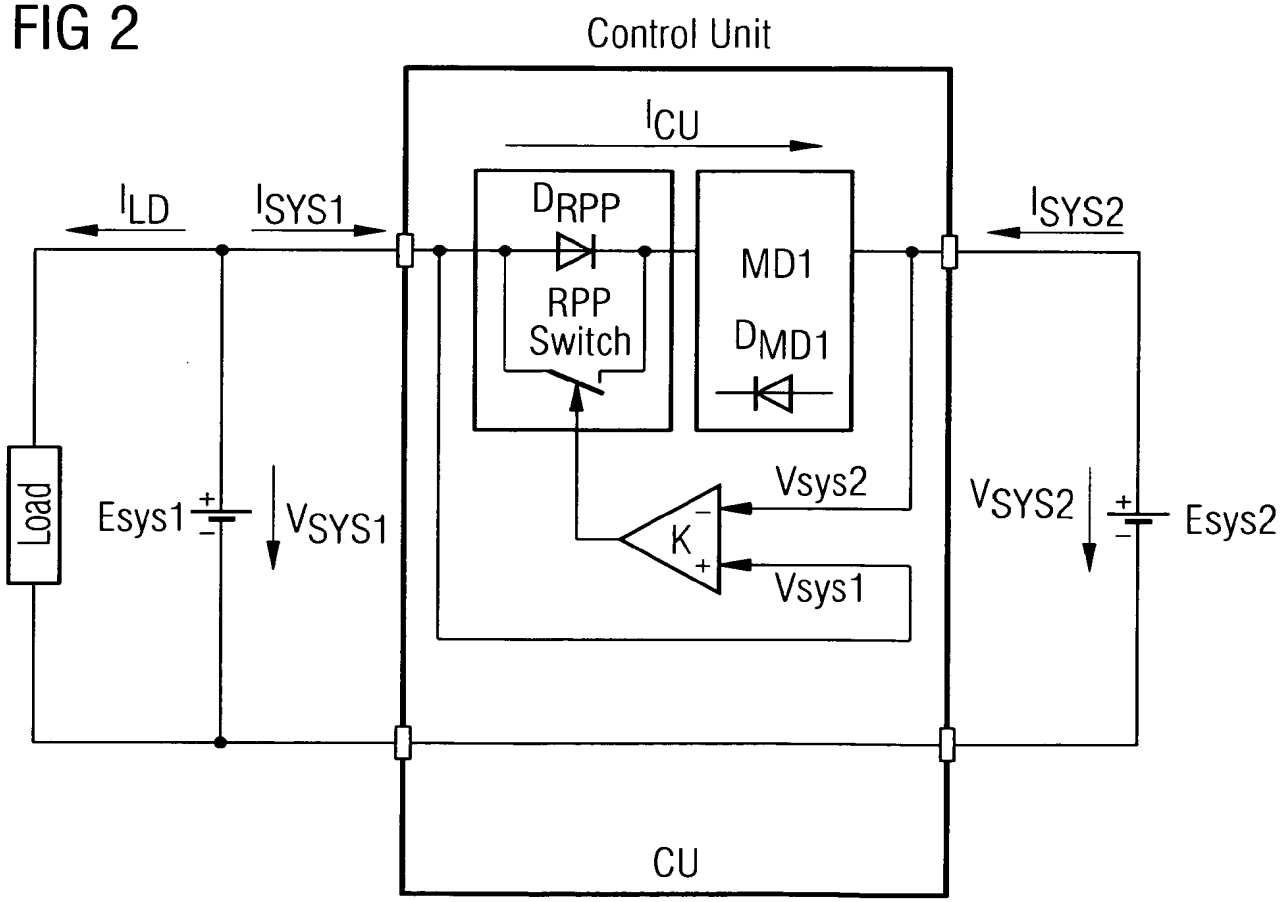


FIG 2



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IPR2025-00885

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/053575

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02H11/00 F02N11/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02H F02N B60L H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 39 30 091 A1 (STANDARD ELEKTRIK LORENZ AG [DE]) 14 March 1991 (1991-03-14) column 2, line 65 - column 3, line 51; figure	1,4
A	DE 10 2005 015993 A1 (BOSCH GMBH ROBERT [DE]) 19 October 2006 (2006-10-19) paragraphs [0013], [0014]; figure	1,5,7,8, 10
A	DE 41 38 943 C1 (BOSCH) 27 May 1993 (1993-05-27) abstract; figures 7,8	1,2,4,5, 7,10
A	DE 10 2006 036425 A1 (BAYERISCHE MOTOREN WERKE AG [DE]) 7 February 2008 (2008-02-07) the whole document	1,5,7,10

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 May 2011	08/06/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Krieger, Philippe

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IPR2025-00885

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/053575

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 102 22 149 A1 (SIEMENS AG [DE]) 11 December 2003 (2003-12-11) abstract; figures -----	1,3,4
A	DE 100 01 485 A1 (DAIMLER CHRYSLER AG [DE]) 26 July 2001 (2001-07-26) abstract; figures 1,5 -----	1
A	DE 10 2007 027498 A1 (DAIMLER CHRYSLER AG [DE]) 24 January 2008 (2008-01-24) the whole document -----	1

1

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IPR2025-00885

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/053575

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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DE 102005015993 A1	19-10-2006	NONE	
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		EP 0568655 A1	10-11-1993
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DE 10222149 A1	11-12-2003	WO 03098765 A1	27-11-2003
		US 2005094332 A1	05-05-2005
DE 10001485 A1	26-07-2001	NONE	
DE 102007027498 A1	24-01-2008	NONE	

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IPR2025-00885

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP2011/053575

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
INV. H02H11/00 F02N11/08
ADD.

Nach der Internationalen Patentklassifikation (IPC) oder nach der nationalen Klassifikation und der IPC

B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
H02H F02N B60L H02J

Recherchierte, aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)
EPO-Internal

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie*	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	DE 39 30 091 A1 (STANDARD ELEKTRIK LORENZ AG [DE]) 14. März 1991 (1991-03-14) Spalte 2, Zeile 65 - Spalte 3, Zeile 51; Abbildung	1,4
A	DE 10 2005 015993 A1 (BOSCH GMBH ROBERT [DE]) 19. Oktober 2006 (2006-10-19) Absätze [0013], [0014]; Abbildung	1,5,7,8, 10
A	DE 41 38 943 C1 (BOSCH) 27. Mai 1993 (1993-05-27) Zusammenfassung; Abbildungen 7,8	1,2,4,5, 7,10
A	DE 10 2006 036425 A1 (BAYERISCHE MOTOREN WERKE AG [DE]) 7. Februar 2008 (2008-02-07) das ganze Dokument	1,5,7,10

-/--

[X] Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen [X] Siehe Anhang Patentfamilie

* Besondere Kategorien von angegebenen Veröffentlichungen :
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"&" Veröffentlichung, die Mitglied derselben Patentfamilie ist

Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
27. Mai 2011	08/06/2011

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Krieger, Philippe

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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP2011/053575

C. (Fortsetzung) ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie*	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	DE 102 22 149 A1 (SIEMENS AG [DE]) 11. Dezember 2003 (2003-12-11) Zusammenfassung; Abbildungen -----	1,3,4
A	DE 100 01 485 A1 (DAIMLER CHRYSLER AG [DE]) 26. Juli 2001 (2001-07-26) Zusammenfassung; Abbildungen 1,5 -----	1
A	DE 10 2007 027498 A1 (DAIMLER CHRYSLER AG [DE]) 24. Januar 2008 (2008-01-24) das ganze Dokument -----	1

1

Formblatt PCT/ISA/210 (Fortsetzung von Blatt 2) (April 2005)

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INTERNATIONALER RECHERCHENBERICHT

Angaben zu Veröffentlichungen, die zur selben Patentfamilie gehören

Internationales Aktenzeichen
PCT/EP2011/053575

Im Recherchenbericht angeführtes Patentdokument	Datum der Veröffentlichung	Mitglied(er) der Patentfamilie	Datum der Veröffentlichung
DE 3930091 A1	14-03-1991	KEINE	
DE 102005015993 A1	19-10-2006	KEINE	
DE 4138943 C1	27-05-1993	WO 9311003 A1	10-06-1993
		EP 0568655 A1	10-11-1993
		JP 3553932 B2	11-08-2004
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		EP 2047580 A2	15-04-2009
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		US 2005094332 A1	05-05-2005
DE 10001485 A1	26-07-2001	KEINE	
DE 102007027498 A1	24-01-2008	KEINE	

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 March 2012 (22.03.2012)

PCT

(10) International Publication Number
WO 2012/036556 A1

(51) International Patent Classification:
H02J 7/00 (2006.01) *H01R 13/72* (2006.01)
H01R 13/60 (2006.01)

(21) International Application Number:
PCT/NO2011/000245

(22) International Filing Date:
13 September 2011 (13.09.2011)

(25) Filing Language: Norwegian

(26) Publication Language: English

(30) Priority Data:
20101286 13 September 2010 (13.09.2010) NO

(71) Applicant *(for all designated States except US)*: **DEFA AS AUTOMOTIVE DIVISION** [NO/NO]; P.O. Box 370, N-1301 Sandvika (NO).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **EIDSVIG, Didrik** [NO/NO]; c/o Defa AS, Postboks 370, N-1301 Sandvika (NO).

(74) Agent: **PROTECTOR IP CONSULTANTS AS**; Oscarsgate 20, N-0352 Oslo (NO).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

[Continued on next page]

(54) **Title**: DEVICE FOR CHARGING OF RECHARGEABLE BATTERIES

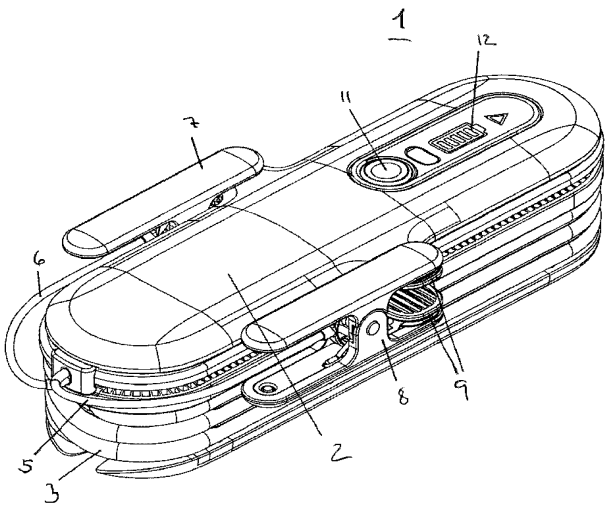


FIG. 1

(57) **Abstract**: Present invention relates to a device (1) for charging of rechargeable batteries, comprising a house (2) with a transformer, cable (3) with a plug (4) for mains input, cables (5, 6) for supplying electric power to the battery, clamping devices (7, 8) for connection to the poles of a battery, switch (11) for activation and deactivation of the charging device (1) and at least one visual indicator (12) to give the user an indication of the charging progress, said house (2) has such a design that the cables (3,5,6) and the plug (4) are completely or partially situated in the house (2), and the clamping devices (7, 8) are attached to holding means (9, 10) which protrude from the house (2), said holding means (9, 10) comprise two protruding elements, said cables (5, 6) for are winded around the circumference of the house (2) between each of the protruding elements of respective holding means.

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IPR2025-00885

WO 2012/036556 A1

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

DEVICE FOR CHARGING OF RECHARGEABLE BATTERIES

The present invention relates to a charging device for charging of lead batteries and other rechargeable battery types. The invention relates in particular to so called "domestic chargers" which can be used especially for the charging of lead batteries for vehicles.

Many different types of devices for charging of lead batteries and other batteries are known. What is common for many of these chargers is that the charging device is fitted with a long row of buttons/switches, where the user is faced with a number of choices that must be made to start the charging process. Furthermore, a well known problem with many chargers is that sparks are generated when making the connection to the battery. Another problem is that the cable ends, both for connection to the battery and to the mains, are not easily handled in a simple and sensible way when the product shall be tidied away and be stored after use.

Therefore, the inventor has provided a charging device where focus is given to the user and to the ease of operation. The charging device is characterised in that a simple, clean and functional design which takes into consideration that the connection cables are coiled and fastened to the product housing. The coiling and fastening steps are integrated in a new and innovative way. The user only needs to uncoil the cables and then to connect the crocodile clamps to the battery and make the connection to the mains. Thereafter the charging is initiated by pushing the on/off button. This will be regarded as very safe as the user is not exposed to unnecessary sparks and the like in the connection process. The charger will itself detect and adjust the charging process according to the size of the battery and the surrounding temperature. During charging and after completion of the charging the indicator on the charger will, at any time, give the status of the charging. The charging will finish on its own or in that the user presses stop to terminate.

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For this purpose a software program is developed that is adapted to a charging process for batteries of any size and condition. In addition, attention is given to a simple, clear and, not least, user-friendly interface with the help of the on/off button of the unit and the display.

The form of the charging device and the mechanical design of its components are very demanding as both the mains cable and the battery cables are easily coiled round after use and fastened to the product so that these are firmly secured during storage. Both the clamps and the mains plug are fastened to the housing. These considerations mean that special adaptations are made on the electronic components and the edb board.

It has also been an assumption that in the design a compact unit is made with corresponding layout and choice of components so that the unit is as small as possible. This means that the heat loss through the housing of the product has been a critical parameter. The collaboration between electronics and mechanics is carried out in such a way that it does not lead to overheating of the electronic parts.

In addition, some extra equipment for connecting has been developed. For this purpose a watertight plug that can be taken out and inserted again is formed on the battery cable. This gives the possibility of connection of the additional equipment that, among other things, comprises cables with eyelet terminals and a plug to the battery charger. This means that the user can fit a series of permanent cables, with a corresponding plug on the batteries, to a part of the motorised equipment that requires regular charging. The charger can then be easily transported from location to location to carry out the charging job. A small, removable battery indicator is also developed that can be connected to this equipment to indicate whether a battery needs charging or not.

These, and other aims and advantages are achieved with a charging device for charging of lead batteries and other rechargeable battery types, encompassing

a housing with a transformer, cable with a plug for connection to the mains, cables for supply of electric power to the battery, clamping means for connection to the poles of a battery, a switch for the activation and deactivation of the charging device and at least one visual indicator to give the user an indication of the charging progress, characterised in that the housing has a shape so that the cables and the plug are completely, or partly, lying in the housing and the clamping devices are fastened to the holding means that protrudes from the housing, when the device is not in use, as each holding means comprises two protruding elements, that the cables for the connection of the battery are coiled around the circumference of the housing between each of the protruding elements of the respective holding means.

The cable for connection to the mains is preferably coiled around the periphery of the housing and the plug is preferably placed in a recess in the housing when the device is not in use.

The paths of the coiling of the cable with the plug and the cables for connection to the battery are preferably, in the main, in parallel and axially displaced in relation to each other.

Furthermore, the device preferably comprises an electronic unit that measures/senses which type of battery that is to be charged, the surrounding temperature and the battery capacity.

The electronic unit preferably controls the charging voltage and the charging process as a function of the measured parameters.

The device comprises an indicator that gives the user a visual indication of the charging process.

The charging device is preferably adapted to charging open and closed lead batteries, AMG batteries and gel batteries with a capacity of 4-225 Ah.

The indicator preferably comprises at least one LED.

The invention will now be explained in more detail with the help of an embodiment example with reference to the enclosed figures, where:

Figs. 1-3 show a charging device according to the present invention, seen in perspective from different directions.

Fig. 4 shows an example of a typical course of charging at a charge current of 4 A.

An embodiment of the charging unit according to the present invention is shown in the figures 1-3.

The charging unit, referred to as 1, comprises a housing 2, connected to said housing 2 is a mains cable 3 with a plug 4 for connection to a mains socket, and two cables 5, 6, for connection to respective battery poles. The cables 5, 6 are connected to their own clamping device 7, 8. The clamping devices 7, 8 are shaped so that they can engage with respective poles on a battery. Furthermore, the clamping devices 7, 8 are formed so that they can be fastened to respective holding means 9, 10 on the housing 2 when the charging unit 1 is not in use. Each holding means 9, 10 comprises two protruding elements, to which elements respective clamping devices can be fastened when the device is not in use. The cable 3 for connection to the mains is coiled around the periphery of the housing 2 and the plug 4 is placed in a recess in the housing 2 when the device is not in use. The coil paths of the cable 3 for connection to the mains and the cables 5, 6 for connection to the battery are, in the main, in parallel and axially displaced with respect to each other.

This means that the device will be very compact and all cables will be kept in place when the device is not in use, so that it is simple to store the device and it

will be very simple to remove the cables and the clamping devices when the charging unit is to be used.

Furthermore, a switch 11 is arranged on the housing 2 with which the charging unit can be activated. Furthermore, the charging unit 2 is fitted with an indicator 12 that shows the operating state of the charging device.

Furthermore, an electronic unit (not shown) is placed in the housing 2 that measures/senses the type of battery which is to be charged, controls the charging process and switches off the device after the charging is completed.

The electronic unit will automatically detect the size of the battery (battery capacity) and find a suitable charge voltage. Furthermore, the surrounding temperature will be detected and the electronic unit will compensate the charge voltage accordingly.

The charging device can be used for batteries with a capacity of 4 – 225 Ah and battery types that can be charged with the help of the device are open and closed lead batteries, so called AGM batteries and gel batteries.

The charging device according to the invention functions as follows:

The charger is connected to the battery that is to be charged with the help of the clamping devices 8, 9 and the plug 4 is placed in a wall socket or the like, which supplies a voltage of 230V. The charging commences when the switch 11 is activated. The charging device can also be used as a current supply for a limited period, and this time period is determined by the electronic unit.

Example

A typical course of charging at 4 A is shown in fig. 4.

The X-axis gives the different steps described below, while the Y-axis gives the current in A.

	4 amp
Charging step	
1) Analyse the state	Measure the voltage at I=0 1 second 5 sec. Batt. Stat. ind. Time
2) Soft start Find battery size (Ah capacity)	Start charging at constant current 1, 2, 4 A measure voltage Increase current if $\Delta V < 0.2V$ 15 sec on (always wait 15 sec to the next current level) 15 sec off x3 If $\Delta V >= 0.2V$ charge directly with existing current 1-2-4 A
3) Main charging	Start main charging at correct current level according to battery size. Max time 4 amp 12 h 2 amp 8 h 1 amp 2 h
4) Top charging	Constant. Voltage 14.4 V until I<1A Max time 4 amp 6 h 2 amp 4 h 1 amp 3 h
5) Maintenance charging	13.8 V min at 4 h max 24 h from step 1
6) Analyse	Turn off charging measure voltage
7) Rest mode	Rest until next week If Vbat < 12.7 V go to step 8
8) Waking	Waking, start new charge cycle

In this embodiment example the indicator comprises five LED lamps and one warning lamp. These will give the user the following indications:

Step 0 Check output charge line
1st the crocodile
2nd the 12 V plug

Step 1 Analyse
Start timer counter
Measure battery voltage
Indicate battery status green light

>12.65 V	all five segments light up
12.55 V -12.65 V	four segments light up
12.45 V - 12.55 V	three segments light up
12.35 V - 12.45 V	two segments light up
3.5 V - 12.35 V	one segment lights up

< 3.5 V Error mode Warning Triangle red light

Step 2 Soft Start
LED indication
1 amp: one LED blinking
2 amp: two LEDs blinking
4 amp: three LEDs blinking

Step 3 Main Charge
1st, 2nd, 3rd LEDs/charging indication

If battery not connected the warning light will light up.
If wrong polarity the warning light will light up.

Step 4 Top Charge
1st, 2nd, 3rd, 4th LEDs/charging indication

Step 5 Maintain charge

All five segments light Green (no blinking)
After 24 h Go to sleep I=0A Step 7

All segments pulsing from low to high intensity.
2 sec increase intensity
Turn off 1sec
and so on

Step 6 Analyse

1st, 2nd 3rd, 4th, 5th LEDs/charging indication

Measure the voltage after 2 mins, I=0A
If Vbat > 13.0 V after 2 mins OK Go to step 6

If Vbat < 13.0 V after 2 mins OK Go to Error RED warning

turns on (no blinking)

Step 7 Sleep

No special indication

Step 8 Wake up

Go to Step 1 for new charging cycle.

14.7 V Button

Claims

1.

Charging device (1) for charging of lead batteries and other rechargeable battery types, encompassing a housing (2) with a transformer, cable (3) with a plug (4) for connecting to the mains, cables (5, 6) for supply of electric power to a battery, clamping devices (7, 8) for connection to the poles of a battery, switch (11) for the activation and deactivation of the charging device (1) and at least one visual indicator (12) to give the user an indication of the charging progress, characterised in that the housing (2) is of such design that the cables (3, 5, 6) and the plug (4) are completely or partly lying inside the housing (2) and the clamping devices (7, 8) are fastened to the holding means (9, 10) that protrude from the housing when the device is not in use, as each holding means (9, 10) encompasses two protruding elements, that the cables (5, 6) for connection to the battery are coiled around the circumference of the housing (2) between each of the protruding elements of the respective holding means (9, 10).

2.

Charging device according to claim 1,
characterised in that the cable (3) for connecting to the mains is coiled around the periphery of the housing (2) and that the plug (4) is placed in a recess in the housing (2) when the device is not in use.

3.

Charging device (1) according to any of the preceding claims,
characterised in that the path of the coiling of the cable (3) with the plug (4) and the cables (5, 6) for connection to the battery are, in the main, in parallel and axially displaced in relation to each other.

4.

Charging device (1) according to any of the preceding claims,

characterised in that the device (1) further incorporates an electronic unit that measures/senses which type of battery that is to be charged, the surrounding temperature and the capacity of the battery.

5. Charging device (1) according to claim 3, characterised in that the electronic unit controls the charging voltage and the charging process as a function of the measured parameters.

6. Charging device (1) according to any of the preceding claims, characterised in that the device (1) encompasses an indicator (12) that gives the user a visual indication of the charging process.

7. Charging device (1) according to any of the preceding claims, characterised in that it is adapted to charging of open and closed lead batteries, AMG batteries and gel batteries with a capacity of 4-225 Ah.

8. Charging device (1) according to any of the preceding claims, characterised in that the indicator (12) comprises at least one LED.

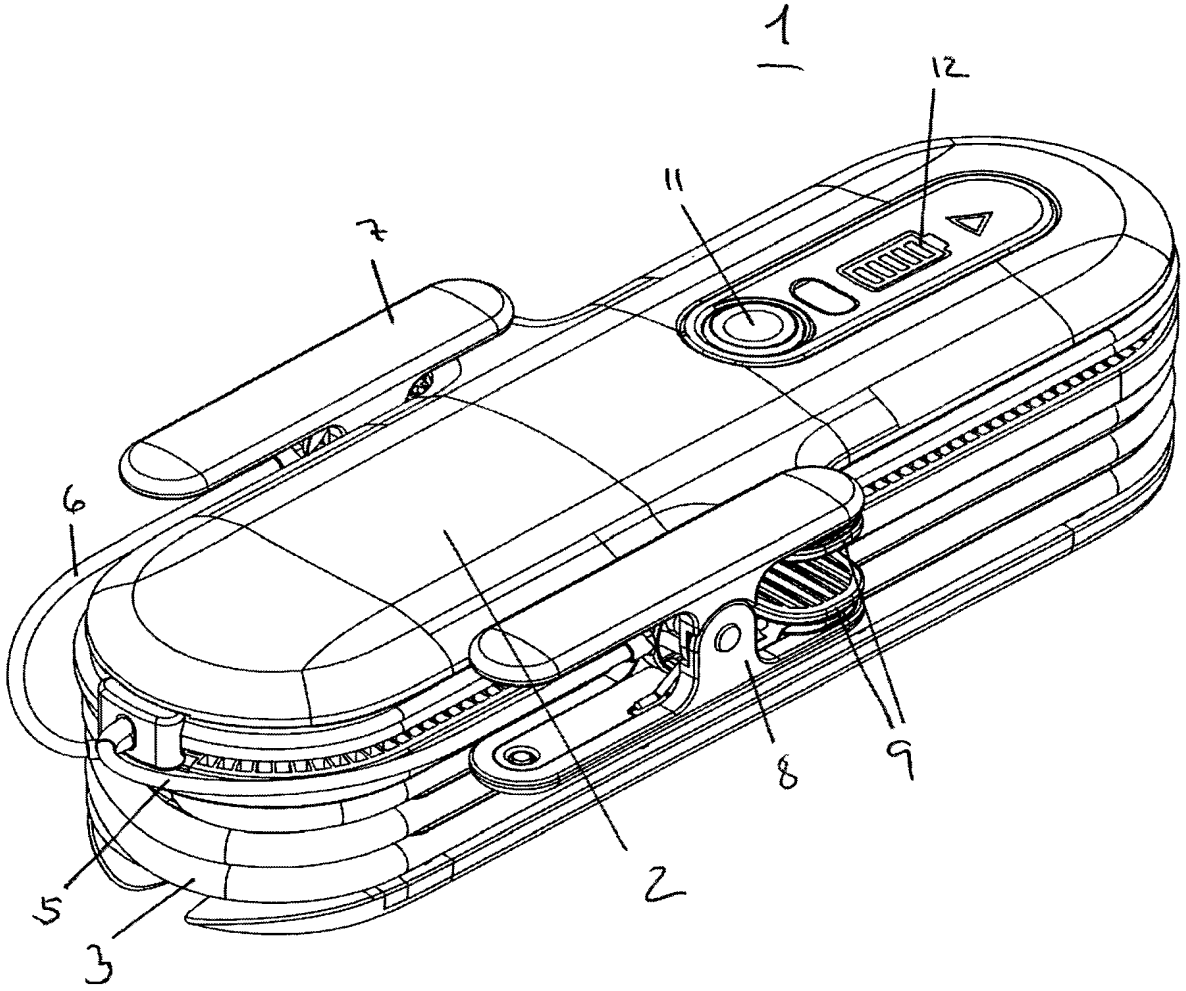


FIG. 1

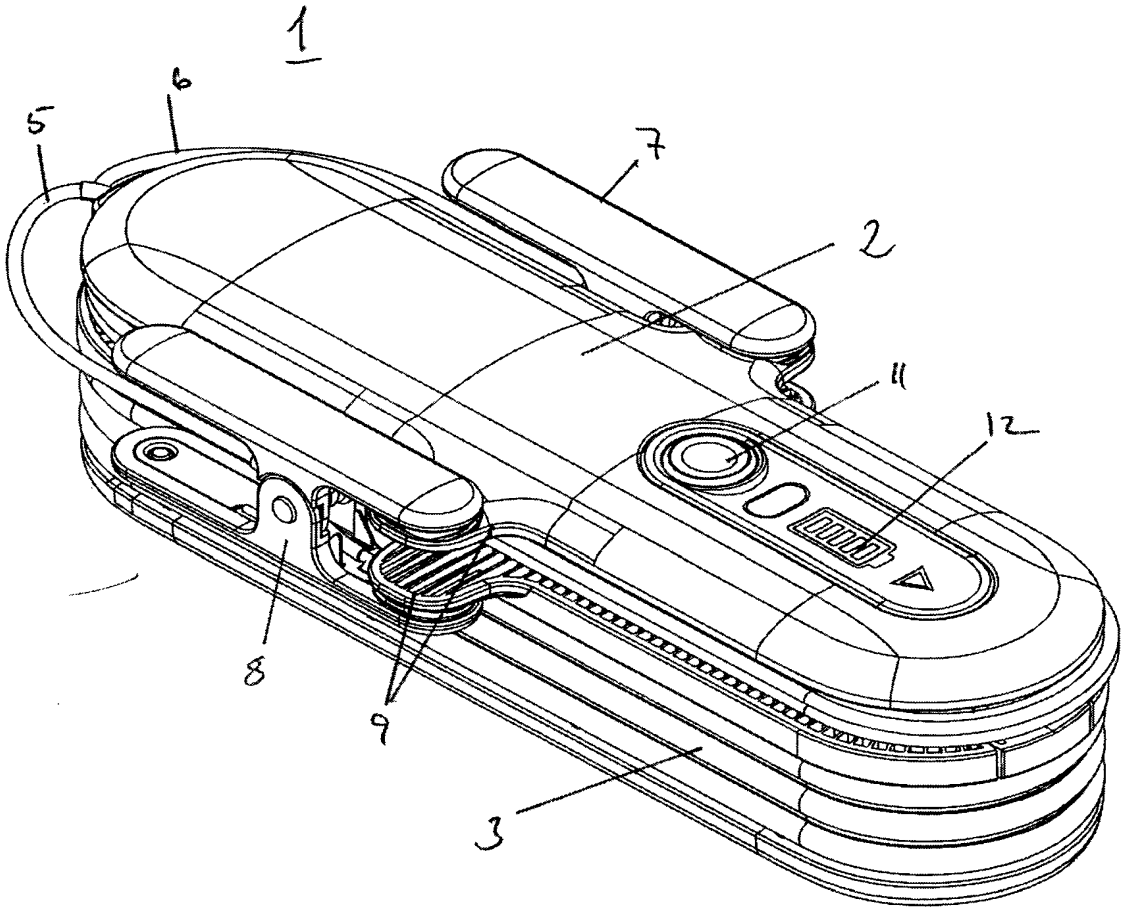


FIG. 2

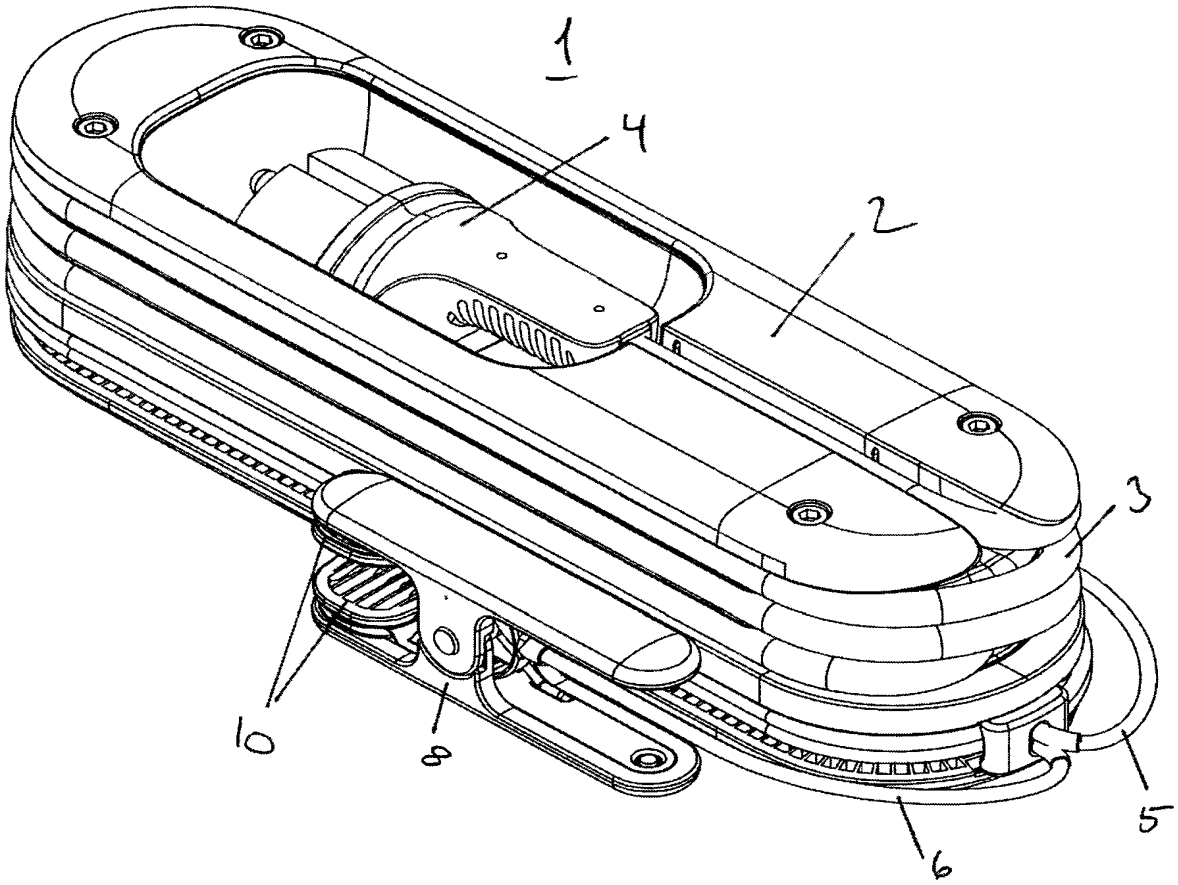


FIG. 3

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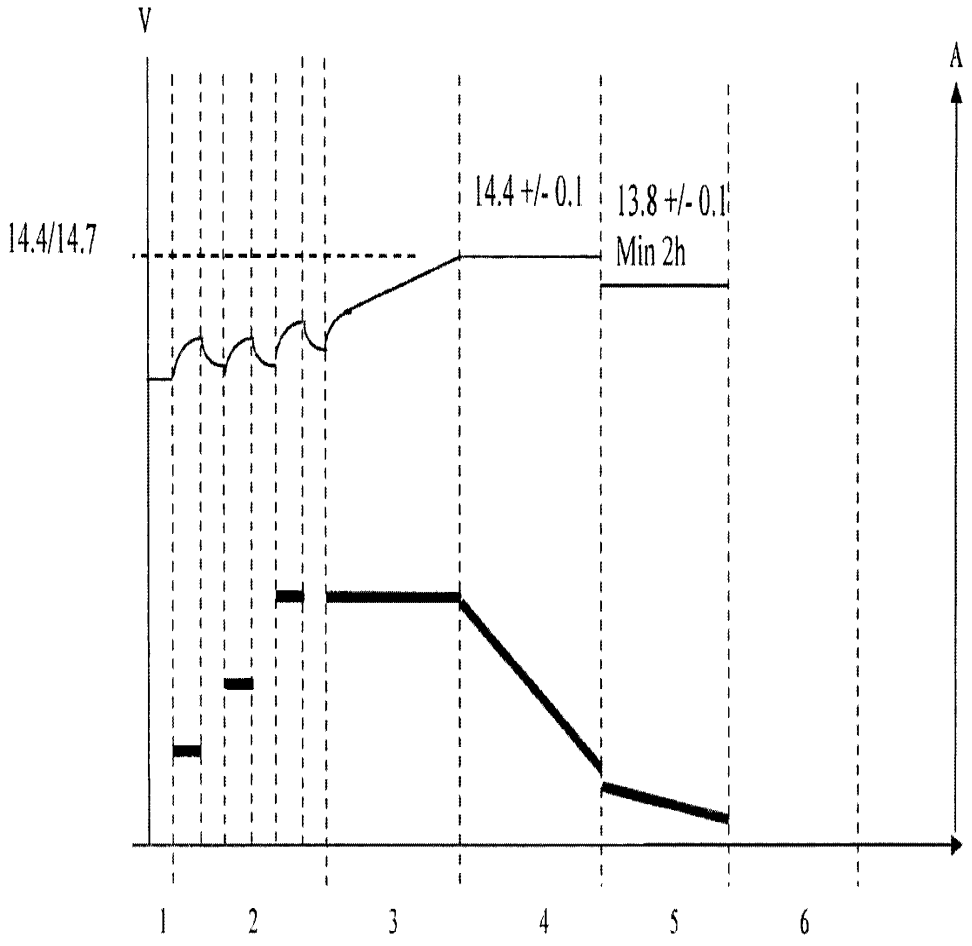


FIG. 4

WO 2012/036556

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO2011/000245

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01R, H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 4026020 C (HELLA KG HUECK & CO), 12 December 1991 (1991-12-12); abstract; figures 1-3 --	1-8
A	FR 2501932 A (BOSCH GMBH ROBERT), 17 September 1982 (1982-09-17); abstract; figure 1 --	1-8
A	US 4396881 A (COOK GARY L ET AL), 2 August 1983 (1983-08-02); figure 1 --	1-8
A	EP 0293664 A (POWER TECH SYSTEMS CORP), 7 December 1988 (1988-12-07); abstract -- --------	4-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
09-12-2011	15-12-2011

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Tomas Erlandsson Telephone No. + 46 8 782 25 00

ADC EX1002
IPR2025-00885

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO2011/000245

Continuation of: second sheet

International Patent Classification (IPC)

H02J 7/00 (2006.01)
H01R 13/60 (2006.01)
H01R 13/72 (2006.01)

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Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

ADC EX1002
IPR2025-00885

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/NO2011/000245

DE	4026020	C	12/12/1991	NONE			
FR	2501932	A	17/09/1982	DE	8107234	U1	02/09/1982
				ES	263872	U	01/11/1982
				IT	8221016	V0	03/03/1982
US	4396881	A	02/08/1983	NONE			
EP	0293664	A	07/12/1988	AU	596341	B2	26/04/1990
				AU	1690188	A	01/12/1988
				BR	8802655	A	27/12/1988
				JP	63305721	A	13/12/1988
				US	4843299	A	27/06/1989

ADC EX1002
IPR2025-00885

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 June 2012 (21.06.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/080996 A1

(51) International Patent Classification:
H01M 2/20 (2006.01) *H01M 10/052* (2010.01)
H01M 10/44 (2006.01) *H01R 11/24* (2006.01)
H01M 10/46 (2006.01) *H01M 4/58* (2010.01)

(21) International Application Number:
PCT/IE2011/000066

(22) International Filing Date:
14 December 2011 (14.12.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2010/0785 16 December 2010 (16.12.2010) IE

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH,

[Continued on next page]

(54) Title: A JUMP STARTER

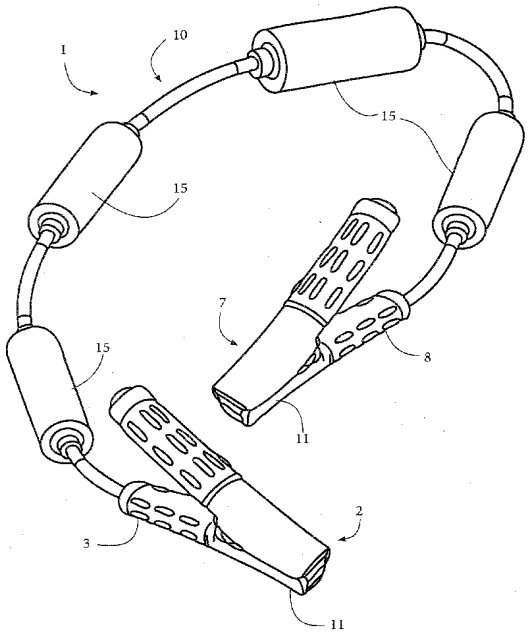


Fig.1

(57) Abstract: A jump starter (1, 30, 50) for a flat battery, such as a vehicle battery has a first clip (2, 20) having. a first handle (3, 25) for connection to one terminal (4) of a battery (5); a second clip (7, 21) having a second handle (15, 25) for connection to a second terminal of a battery, The clips are interconnected (10, 28, 53) and on-board starter batteries (15, 26) are provided along the interconnecting cable (10) and/or at least one of the clips (20, 21). The on-board starter battery (15, 26) may comprise a lithium iron phosphate battery. There may be a control circuit (100, 200) to prevent damage from events such as accidental shorting of the clips.

WO 2012/080996 A1

ADC EX1002
IPR2025-00885

GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

"A Jump Starter"

INTRODUCTION

Field of the Invention

This invention relates to a jump starter system for a battery, especially a vehicle battery.

Prior Art Discussion

Jump starter systems for jump starting a flat vehicle battery comprise a pair of leads, each with a clip such as a crocodile clip at each end to connect with the terminals of the flat battery and a charged battery of another vehicle. One lead connects the positive terminal of the flat battery to the positive terminal of a charged battery and a second lead connects the negative terminal of the flat battery to the negative terminal of the charged battery.

Such systems are effective. However in many cases a vehicle with a charged battery is required and it is often difficult to arrange the vehicles to allow the leads to safely extend between the batteries.

It is also known to provide starter packs comprising a lead acid battery within a battery housing and leads for extending from the battery housing to the terminal of the flat battery. Such units are costly, bulky, and heavy, and can generally only be used for large scale commercial applications. Very often, the unit is not used for some time and the battery charge diminishes so that it is not effective when required.

US5607794, US6002235, US2006/0128209, and US2008/0241653 describe various portable starter systems. In these arrangements, starter cables are connected to a battery.

This invention is directed towards providing an engine jump starter system which will address these issues.

SUMMARY OF THE INVENTION

According to the invention, there is provided a jump starter for a battery such as a vehicle battery, the jump starter comprising:-

a first clip having a first handle for connection to one terminal of a battery;

a second clip having a second handle for connection to a second terminal of a battery;

an interconnection means extending between the first clip and the second clip; and

an on-board starter battery means provided along the interconnection means and/or adjacent at least one of the clips.

In one embodiment, the on-board starter battery means comprises a lithium iron phosphate battery.

In one embodiment, there is a plurality of on-board starter batteries along the interconnection means.

In one embodiment, the on-board starter battery means comprises a plurality of separate batteries which are electrically interconnected.

In one embodiment, at least some of the battery means comprises batteries housed within at least one of the first and second handles.

Preferably, said batteries are housed within both the first handle and the second handle.

In one embodiment, the first clip and the second clip are configured to nest together for storage in compact manner.

In one embodiment, the first clip has a housing within which there is a battery, and a pair of jaws linked with the housing; and the second clip is configured to fit alongside the jaws of the first clip in a manner without protruding parts.

Preferably, the first clip has a groove to accommodate the interconnection means during storage.

In one embodiment, the jump starter further comprises a control circuit having positive and negative leads connected between the on-board starter battery and the clips, and protection means to provide over-voltage and/or over-current protection.

In one embodiment, the protection means comprises a current-limiting component.

In one embodiment, the control circuit further comprises a switch in the negative lead which is turned on for use. In one embodiment, the switch is a solid state switch. In one embodiment, the switch comprises a MOSFET switch. In one embodiment, the switch is an SCR. In one embodiment, there is a plurality of switches arranged in parallel.

In one embodiment, a gate of the switch is connected to the positive lead by a user-activated switch. In one embodiment, the user-activated switch is of the type for momentary closing. In one embodiment, the user-activated switch is connected to the gate via a diode, preferably a Zener diode. In one embodiment, the switch is solid state and is reverse biased to prevent current flow if a system to which the clamps are connected attempts to return charge.

In one embodiment, the protection means comprises a circuit to short gate current to ground in the event of accidental reverse polarity connection.

In one embodiment, the positive lead includes one or more positive thermal coefficient fuses protecting against short circuit conditions and excessive power demands by achieving a very high resistance, thus limiting current flow, and once normal conditions are restored dropping to a low resistance.

In one embodiment, there is a resistor and an LED in parallel with the fuse such that if the fuse resistance goes high almost all of the battery voltage will appear across the resistor thus providing a current flow to illuminate the LED, and when the fuse is in a low resistance state and operating normally the resistor and the fuse are effectively short circuited, providing a visual indication of overload conditions.

In one embodiment, the positive lead includes a bank of switches connected in such a way as to utilise their intrinsic diodes for the purposes of reverse blocking of current, in which gate to source is short circuited, thus holding the switches in a permanent OFF state.

In one embodiment, an RC time constant circuit is linked with the negative lead switch or switches, said time constant circuit being arranged to set the run time of the jump starter and preventing the jump starter from being left in a constant ON condition.

In one embodiment, the time constant circuit is arranged to provide a soft turn on of the jump starter power, preventing transient voltage damage as a result of arcing or high di/dt induced voltages in an electrical system to which the starter is connected.

DETAILED DESCRIPTION OF THE INVENTION

Brief Description of the Drawings

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings in which:-

Fig. 1 is a perspective view of an engine jump starter system according to the invention;

Fig. 2 is an elevational view of the jump starter system of Fig. 1, in use;

Fig. 3 is a perspective view of another engine jump starter system according to the invention;

Fig. 4 is an enlarged view of the battery connection clips of the jump starter system of Fig. 3;

Fig. 5 is an elevational view of the starter system of Figs. 3 and 4, in use;

Figs. 6 and 7 are perspective views of an alternative starter system ready for use;

Figs. 8 and 9 are perspective views of this system when in the storage position; and

Figs. 10 to 12 are circuit diagrams for circuits of starter systems of various embodiments.

Description of the Embodiments

Referring to Figs. 1 and 2 there is illustrated a jump starter system 1 according to the invention. The jump starter system comprises a first crocodile clip 2 having a first handle 3 for connection to one terminal 4 of a flat vehicle battery 5. The system also comprises a second crocodile clip 7 having a second handle 8 for connection to another terminal 9 of the flat vehicle battery 5. An electrical interconnection lead 10 extends between the first clip 2 and the second clip 7. Each clip has spring biased jaws 11. In the invention there is an on-board starter battery which comprises a plurality of interconnected batteries 15 which may be of the lithium iron phosphate type. The battery cells can be of either cylindrical, prismatic or pouch type. The voltage is between 3.2 and 3.7 V nominal and of lithium iron chemistry.

As illustrated, the on-board starter batteries 15 extend along the interconnection lead 10. They are relatively small and lightweight and can be readily interconnected to form the jump starter system as illustrated.

To jump start a flat battery only one jump lead is required with two simple clip connections 2, 7 to the flat battery 5. Immediate power is supplied to the flat battery 5 without the requirement of another vehicle with a charged battery. The unit is lightweight and easily stored, for example, in a vehicle boot or glove compartment. The system has superior starting ability, lifespan, and energy retention than other jump starter systems.

Referring now to Figs. 3 to 5 there is illustrated another jump starter system, 30, according to the invention. In this case, clips 20, 21 have the clip jaws 11 and have handles 25 of cylindrical shape. In this embodiment there are two batteries 26 housed within each handle 25, and finger-gripping features 27 are provided to aid user operation. The clips are interconnected by a cable 28, with no need for batteries along the length of the cable in this case.

Referring to Figs. 6 to 9 an alternative jump starter, 50, is shown. The jump starter 50 comprises a first clip 51 and a second clip 52 interconnected by a power cable 53. The first clip 51 has a

housing 55 for a battery of sufficient capacity to provide the full starting power, in this embodiment of the lithium iron phosphate type. Also, the first clip 51 comprises a pair of jaws 56 having finger grips 57 for pressing together for opening and closing. The housing 55 has a groove along one side to accommodate the cable 53 during storage. The clip 52 has a similar pair of jaws 56 with finger grips 57.

The starter 50 is used with the clips 51 and 52 separate as shown in Figs. 6 and 7. Power is provided by the batteries within the housing 55. When not being used, the second clip 52 nests into the first clip 51 alongside the jaws 56 of the first clip 51, as shown in Figs. 8 and 9.

The jump starter 50 involves use of close-proximity high-power batteries of the lithium iron phosphate type. In this case it is more important to provide safety controls, and this is achieved by use of a control circuit in the housing 55. Figs. 10, 11, and 12 illustrate circuits 100, 200, and 300 respectively which may be used in the starter of any embodiment. In this case the starter 50 employs the circuit 300, however it may employ a different circuit depending on the safety requirements and battery types and capacities.

Referring to Fig. 10 the circuit 100 comprises batteries 102, a positive lead 103 with a clamp conductor 104, and a negative lead 105 with a clamp conductor 106. In the positive lead there is a light emitting diode LED2 and a resistor R3 in parallel with a positive thermal coefficient (PTC) resettable fuse 110.

An integrated circuit IC1 is connected via a resistor R2 to the positive lead 103 and is connected to the negative lead 105 via reverse polarity indicator (LED1). Also, a manual contact switch 115 (SW1) is connected on one side to the positive lead 3, and on the other to a Zener diode ZD1, a resistor R1, in turn linked with a bank of MOSFET switches Q1, Q2, and Q3.

The circuit of the jump starter circuit 100 protects from voltage mismatch, reverse polarity, short circuit, over-discharge, and over-use.

The over-current protection element PTC 110 comprises a number of parallel connected positive thermal coefficient PCB mounted resettable fuses. The number and type thereof is determined by the power output requirement. The PTC 110 enables normal usage but protects against short circuit conditions and excessive power demands by achieving a very high resistance, thus

limiting current flow. Once normal conditions are restored, the PTC 110 drops to a low resistance. Light emitting diode LED2 and 1k 0.25w resistor R3 provide an over-current indicator. When the PTC 110 goes high resistance, almost all of the jump starter battery 102 voltage will appear across this device thus providing a current flow to illuminate LED2. When the PTC 110 is in a low resistance state and operating normally, R3 and LED2 are effectively short circuited.

The battery 102 positive terminal is also connected to the momentary action single pole normally open switch SW1 115. This switch, the Zener diode ZD1, the resistor R1 and Metal Oxide Semiconductor Field Effect Transistors (MOSFETS) Q1 to Q3 comprise the power-switching and over-discharge elements.

To activate the jump-starter system it must be connected to a vehicle battery by means of the positive and negative jaws 56 linked to the conductors 104 and 106. The activation switch 115 (SW1) is then briefly depressed. This switch may be located at any convenient location of the housing Current flows from the battery (BAT) via ZD1 and R1 to the gates of International Rectifier IRF1324s MOSFETS (or alternates) Q1, Q2 and Q3 via their respective gate resistors R4, R5 and R6. Capacitor C1 is also charged. Once a Vgs of 10V is applied to the MOSFETS Q1, Q2, and Q3 they begin conducting from drain to source with a very low ON state resistance, typically about 0.00033 Ohms for three parallel connected parts.

After the PTC, the positive supply lead 103 is connected to another trio of International Rectifier IRF1324s MOSFETS (or alternates) Q4, Q5 and Q6. These devices are connected in such a way as to utilise their intrinsic diodes for the purposes of reverse blocking of current. The gate to source is short circuited, thus holding the devices in a permanent OFF state. Should the jump starter circuit 100 be connected to a vehicle with a greater voltage than the unit is intended for, the diodes become reverse biased and no current may flow. This feature protects the jump-starter's internal battery 102 from potentially dangerous overcharge conditions.

Once a successful start has been achieved, the vehicle alternator or charging system will attempt to return charge to the still-connected jump-starter battery 102 (BAT) via the crocodile clamp jaws 56. This could be undesirable for certain battery types. Should this situation occur, the intrinsic diodes in Q4, Q5 and Q6 will become reverse biased, thus preventing this condition

A resistor R7 and a capacitor C1 form an RC time constant circuit. When the switch 15 (SW1) is depressed, C1 rapidly charges via R1. Once in an ON state the gate to source resistance of the MOSFETS is very high, in the order of tens of mega Ohms. Thus the run time of the jump starter circuit 100 can be configured by choice of C1 and R7. Once SW1 is released, C1 begins to discharge via R7. When the voltage across C1 drops below the gate threshold voltage of the MOSFETS, they will rapidly come out of conduction and switch off the output. This auto – off feature prevents the unit from being left in a constant ON condition with resultant live crocodile clamps.

The RC circuit of R7 and C1 provides another important element. As the voltage across C1 will require a certain time to reach the gate threshold voltage of the MOSFETS Q1, Q2, and Q3, they will spend a small amount of time in their active region and provide a soft turn on of the jump starter circuit 100 power. This prevents transient voltage damage as a result of arcing or high di/dt induced voltages in the vehicle electrical system.

The circuit also protects against accidental reverse polarity connection. Should the operator inadvertently connect the jump starter circuit 100 backwards to the vehicle battery (i.e. positive clamp 4 to negative terminal and vice versa), the system offers two levels of protection. The first level is passive. As the MOSFETS Q1 through Q3 are non-conductive, no current flow takes place upon connection. This eliminates any potentially dangerous and destructive electrical arcing at the vehicle battery terminals. Such arcing conditions have been linked with the destruction of modern vehicle electronic controls. Secondly, current from the vehicle battery flows via the resistor R2, reverse polarity indicator LED1 and the input side of the semiconductor photo-relay type TLP222 (IC1) thus illuminating LED1 and the input photo LED in IC1. Even if the vehicle battery is severely discharged, the current requirement of IC1 is very small and will in most cases be less than 5 mA. Should the user ignore the reverse polarity indicator LED1 and depress SW1, MOSFET gate current is shunted to ground via an output MOSFET in IC1 thus preventing the successful triggering of Q1-Q3 and damage to the vehicle or to the jump starter 1.

The Zener diode ZD1 in the gate trigger circuit protects against excessive discharge of the jump starter battery 102 (BAT). If the battery has been drained past an acceptable point its potential is no longer sufficient to overcome ZD1 and thus no gate current reaches the MOSFETS Q1-Q3.

The jump starter circuit 100 may not then be used until it has been recharged, thus preserving the life of the battery 102.

Unlike other jump starter protection circuits that require a vehicle battery to be present for correct operation, this jump starter circuit 100 can operate with a completely dead battery or none at all. However in this case, reverse polarity detection is not available.

The following are advantageous aspects of the invention.

- Solid state switching. There are no contacts to weld, burn out, or arc.
- Soft switching.
- Electrical transient protection for modern motor vehicle electronics.
- Operator protection from arcing, explosion etc.
- Jump starter product protection from misuse.
- Battery protection. Ensures long life.
- Low component count
- Cost effective
- Passive safety
- Visual indicators of fault conditions
- No possibility of damage through operator error such as short circuit etc.
- Low power dissipation. Can be used with traditional lead acid batteries without power loss.

In other embodiments the role of the switches Q1-Q3 may alternatively be performed by a device such as s silicon controlled rectifier for example. This is a simpler circuit, and also would have the benefit of automatic power off upon disconnection and automatic reverse blocking. Referring to Fig. 11 a circuit 200 has a positive lead 203 with a clamp conductor 204 and a negative lead 205 with a clamp conductor 206. There are a PTC fuse 210, a battery 212, and a momentary switch 215 for performing the same functions as for the circuit 100. However, in this case the switch 215 is linked with an SCR. Other alternatives may include use of insulated gate bipolar transistors (IGBTs) or standard bipolar transistors.

In a still further embodiment, referring to Fig. 12, a 4-cell Lithium iron battery is connected to a positive jump-starter clamp by means of a number of parallel connected positive thermal coefficient (PTC) type resettable fuses. The negative battery lead is directly connected to the

negative jump starter clamp. A warning light emitting diode LED1 and its associated series limiting resistor are connected in parallel with the PTC devices. During normal engine starting operation the PTC devices are cold and exhibit a low resistance thus permitting normal current flow. As there is little voltage drop across the devices in this state, LED1 is extinguished.

Should any of the following fault conditions occur: clamp short circuit, reverse connection to vehicle or incorrect voltage selection, then a larger than normal current flow will result causing the PTC devices to rapidly warm up and exhibit a high resistance thus limiting current flow to a very low level and preventing damage to the jump starter unit or the flat battery. As most of the battery (BAT1) voltage will now be developed across the PTC devices, LED1 is illuminated thus informing the user that a fault condition has occurred. Once the fault is removed, LED1 is extinguished and after a short delay the PTCs return to normal temperature and resistance and normal operation is resumed.

Transient voltage suppression diodes (TVS) D1 and D2 are connected across the output leads. These devices (typical rating of 5kW each) prevent any transient or induced voltages from damaging the vehicle or the starter. Unlike the typical sure protection employed in a traditional jump starter which employs voltage dependent resistor (VDR) type devices, the TVS can respond much quicker and quench much more energy thus providing a better solution.

It will be appreciated that the invention provides for much more convenient jump starting. It allows a user to carry the starter in the vehicle, and avoids need to hook up to another vehicle and all of the attendant disadvantages.

The invention is not limited to the embodiments described but may be varied in construction and detail.

Claims

1. A jump starter for a battery such as a vehicle battery, the jump starter comprising:-

a first clip (2, 20) having a first handle (3, 25) for connection to one terminal (4) of a battery (5);

a second clip (7, 21) having a second handle (15, 25) for connection to a second terminal of a battery;

an interconnection means (10, 28) extending between the first clip and the second clip; and

an on-board starter battery means (15, 26) provided along the interconnection means (10) and/or adjacent at least one of the clips (20, 21).

2. A jump starter as claimed in claim 1, wherein the on-board starter battery means (15, 26) comprises a lithium iron phosphate battery.

3. A jump starter as claimed in claims 1 or 2, wherein there is a plurality of on-board starter batteries (15) along the interconnection means.

4. A jump starter as claimed in claim 1 or 2 or 3, wherein the on-board starter battery means (15, 26) comprises a plurality of separate batteries which are electrically interconnected.

5. A jump starter as claimed in claim 4, wherein at least some of the battery means comprises batteries (26) housed within at least one of the first and second handles.

6. A jump starter as claimed in claim 5, wherein said batteries are housed within both the first handle (25) and the second handle (25).

7. A jump starter as claimed in claims 5 or 6, wherein the first clip (56) and the second clip (56) are configured to nest together for storage in compact manner.

8. A jump starter as claimed in claim 7, wherein the first clip (51) has a housing (55) within which there is a battery, and a pair of jaws (56) linked with the housing; and the second clip (52) is configured to fit alongside the jaws of the first clip in a manner without protruding parts.

9. A jump starter as claimed in claim 8, wherein the first clip (51) has a groove (60) to accommodate the interconnection means (53) during storage.

10. A jump starter as claimed in any preceding claims, further comprising a control circuit having positive and negative leads connected between the on-board starter battery and the clips, and protection means to provide over-voltage and/or over-current protection.

11. A jump starter as claimed in claim 10, wherein the protection means comprises a current-limiting component.

12. A jump starter as claimed in claims 10 or 11, wherein the control circuit further comprises a switch (Qi-Q3) in the negative lead which is turned on for use.

13. A jump starter as claimed in claim 12, wherein the switch is a solid state switch.

14. A jump starter as claimed in claims 12 or 13, wherein the switch comprises a MOSFET switch.

15. A jump starter as claimed in claim 13, wherein the switch is an SCR.

16. A jump starter as claimed in any of claims 12 to 15, wherein there is a plurality of switches (Q1-Q3) arranged in parallel.

17. A jump starter as claimed in any of claims 12 to 16, wherein a gate of the switch is connected to the positive lead by a user-activated switch (115, 215).

18. A jump starter as claimed in claim 17, wherein the user-activated switch is of the type for momentary closing.

19. A jump starter as claimed in claims 17 or 18, wherein the user-activated switch is connected to the gate via a diode (ZD1), preferably a Zener diode.

20. A jump starter as claimed in any of claims 12 to 19, wherein the switch is solid state and is reverse biased to prevent current flow if a system to which the clamps are connected attempts to return charge.

21. A jump starter as claimed in any of claims 17 to 20, wherein the protection means comprises a circuit to short gate current to ground in the event of accidental reverse polarity connection.

22. A jump starter as claimed in any of claims 10 to 21, wherein the positive lead includes one or more positive thermal coefficient fuses (10, 110) protecting against short circuit conditions and excessive power demands by achieving a very high resistance, thus limiting current flow, and once normal conditions are restored dropping to a low resistance.

23. A jump starter as claimed in claim 22, wherein there is a resistor and an LED in parallel with the fuse such that if the fuse resistance goes high almost all of the battery voltage will appear across the resistor thus providing a current flow to illuminate the LED, and when the fuse is in a low resistance state and operating normally the resistor and the fuse are effectively short circuited, providing a visual indication of overload conditions.

24. A jump starter as claimed in any of claims 10 to 23, wherein the positive lead includes a bank of switches connected in such a way as to utilise their intrinsic diodes for the purposes of reverse blocking of current, in which gate to source is short circuited, thus holding the switches in a permanent OFF state.

25. A jump starter as claimed in any of claims 10 to 24, wherein an RC time constant circuit is linked with the negative lead switch or switches, said time constant circuit being arranged to set the run time of the jump starter and preventing the jump starter from being left in a constant ON condition.

26. A jump starter as claimed in claim 25, wherein the time constant circuit is arranged to provide a soft turn on of the jump starter power, preventing transient voltage damage as a result of arcing or high di/dt induced voltages in a electrical system to which the starter is connected.

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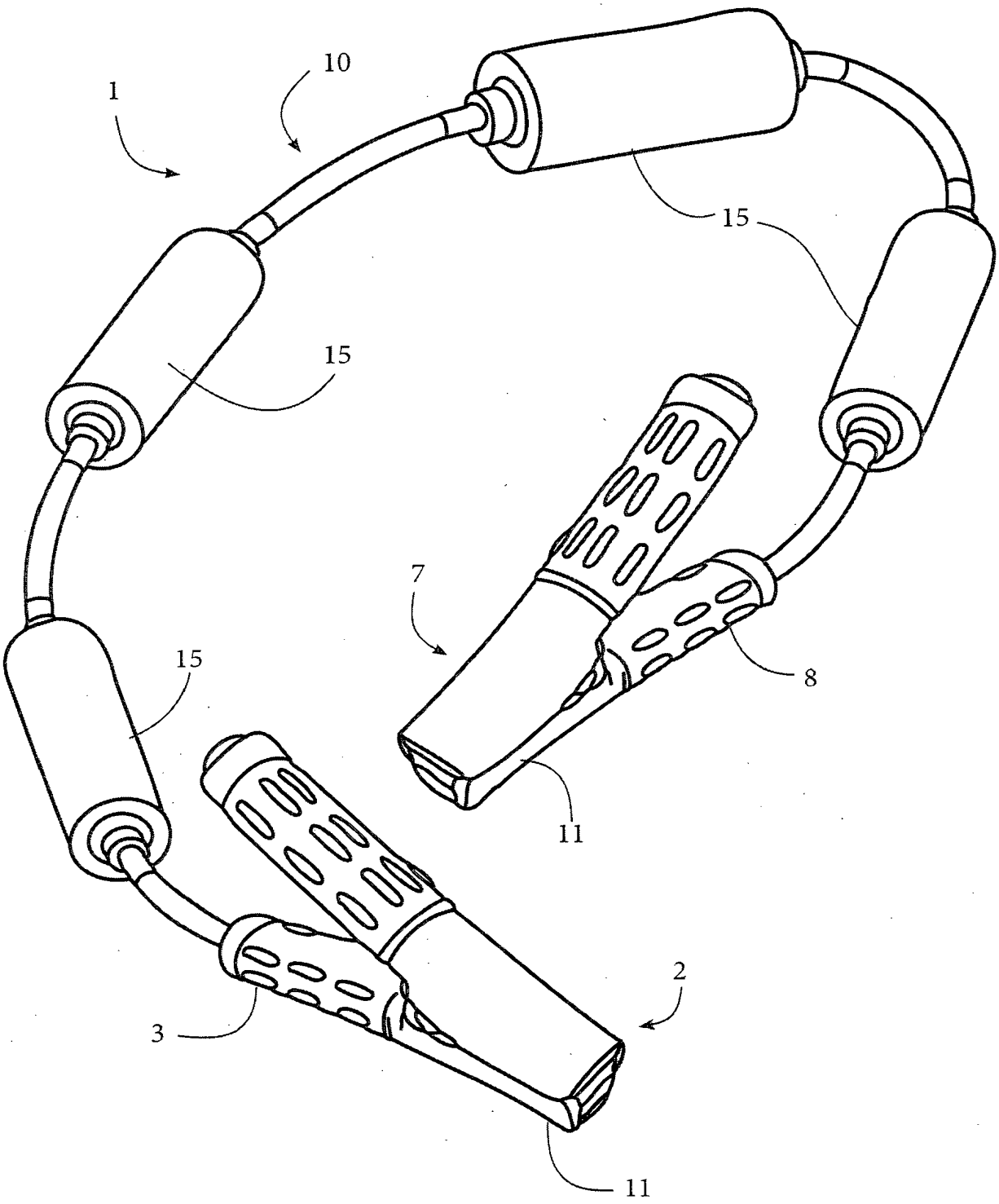


Fig.1

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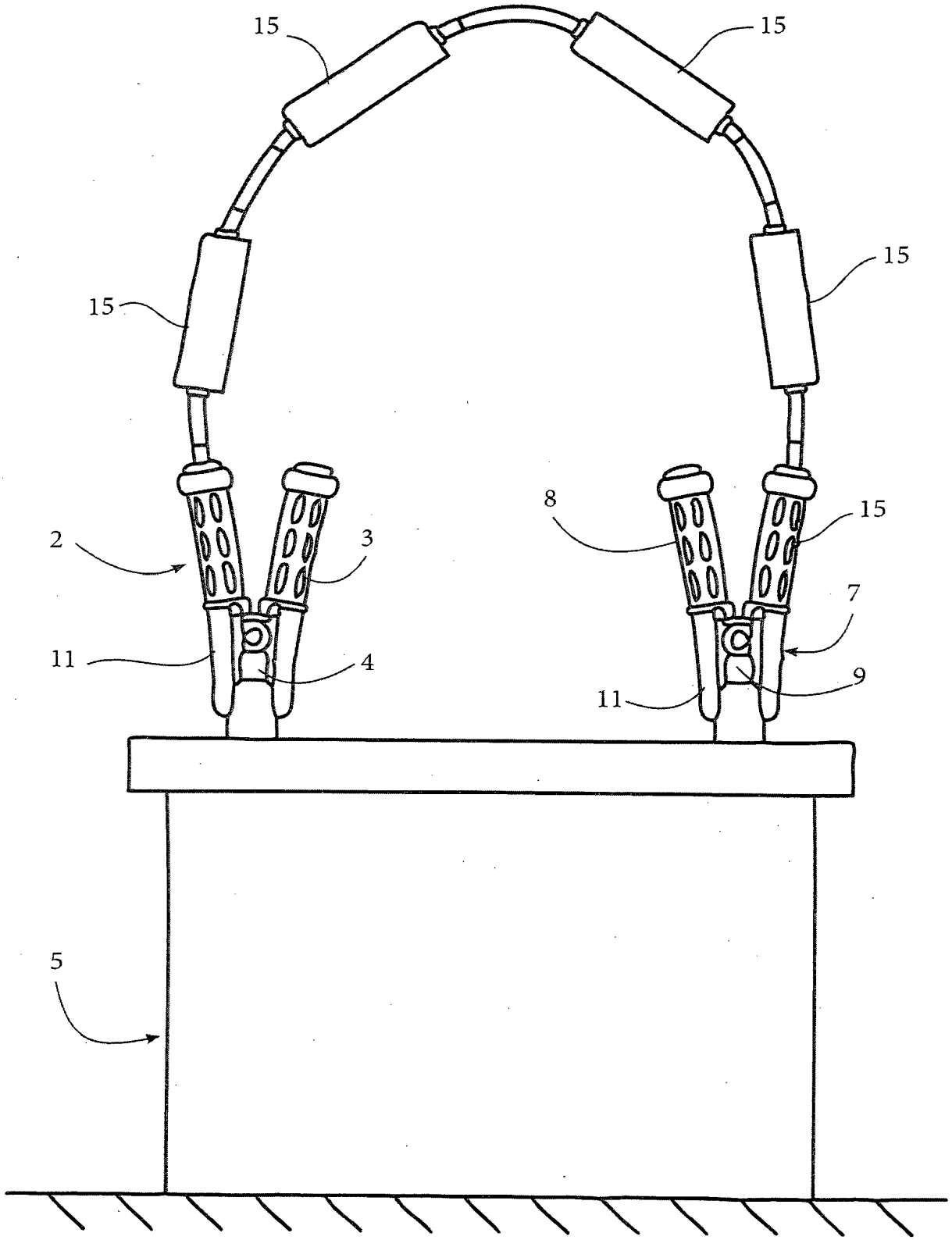


Fig.2

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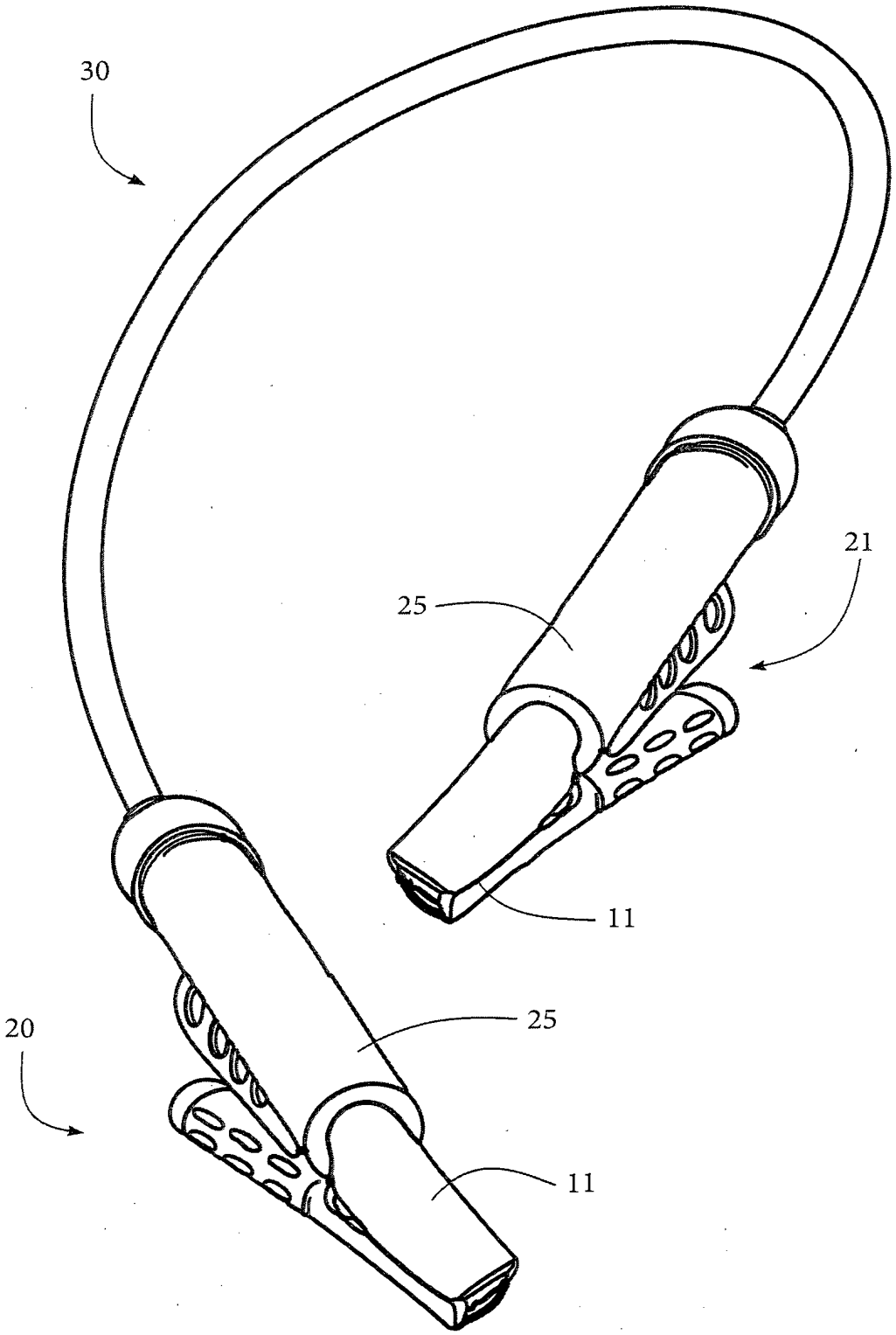


Fig.3

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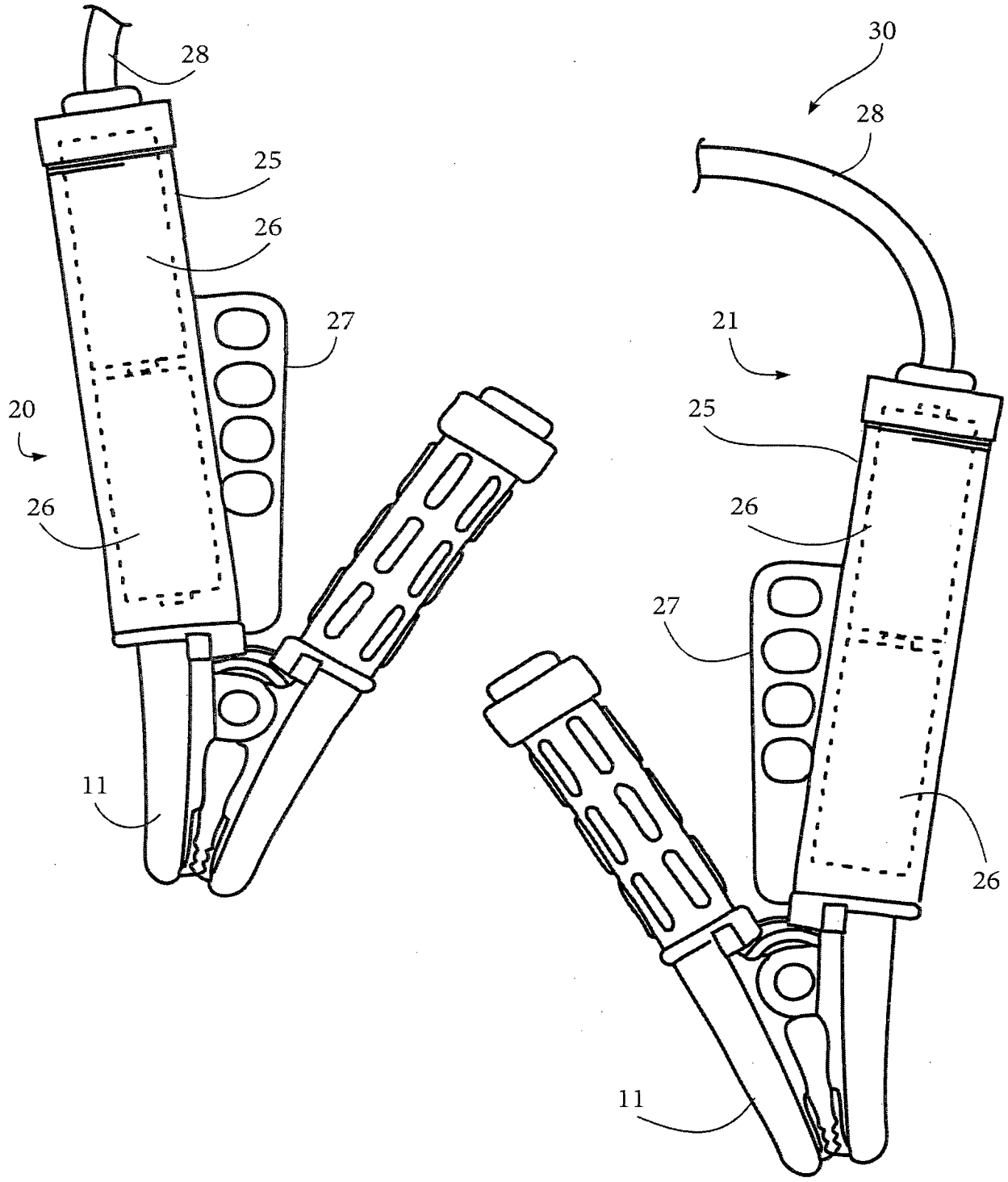


Fig.4

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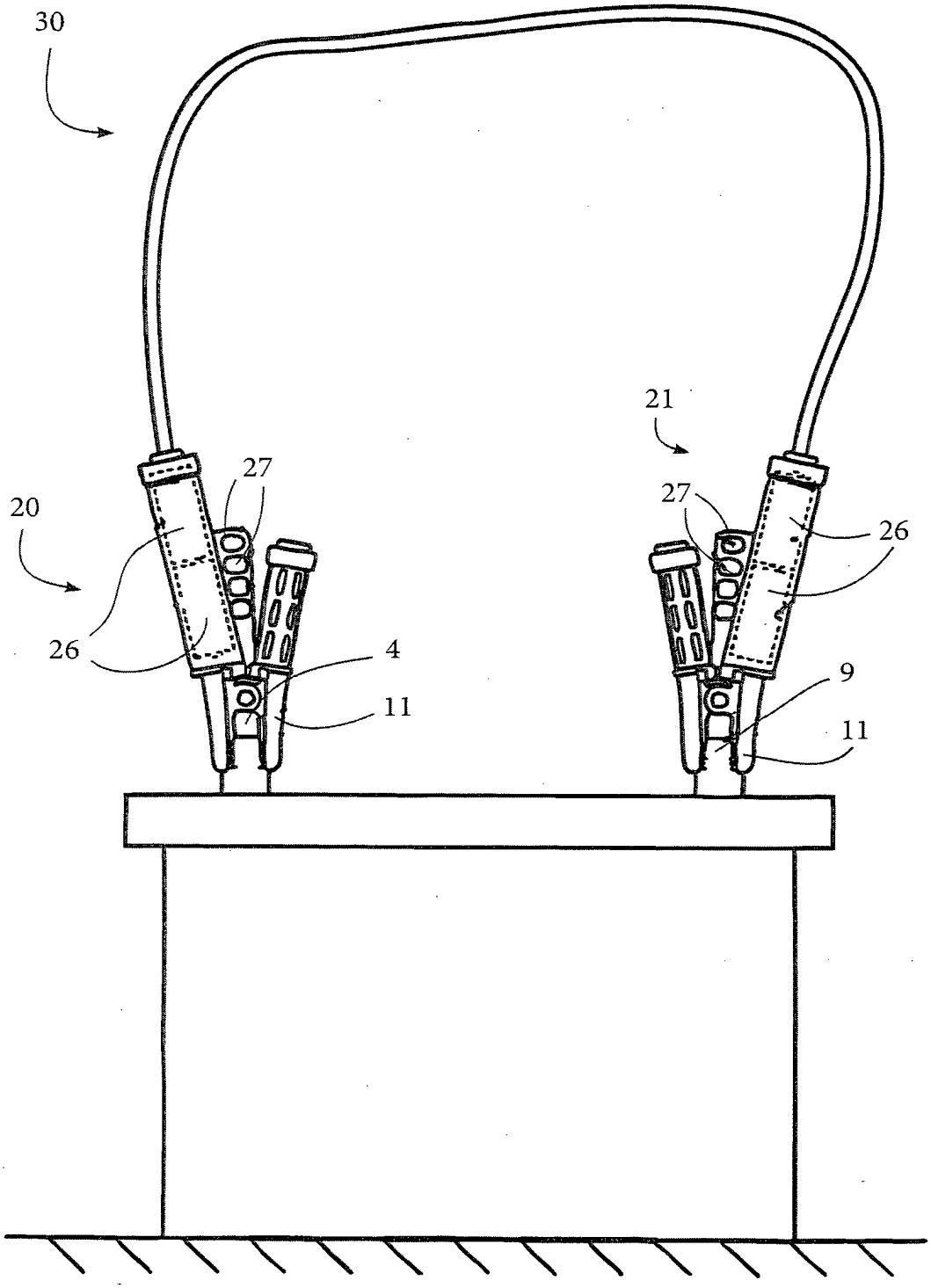


Fig.5

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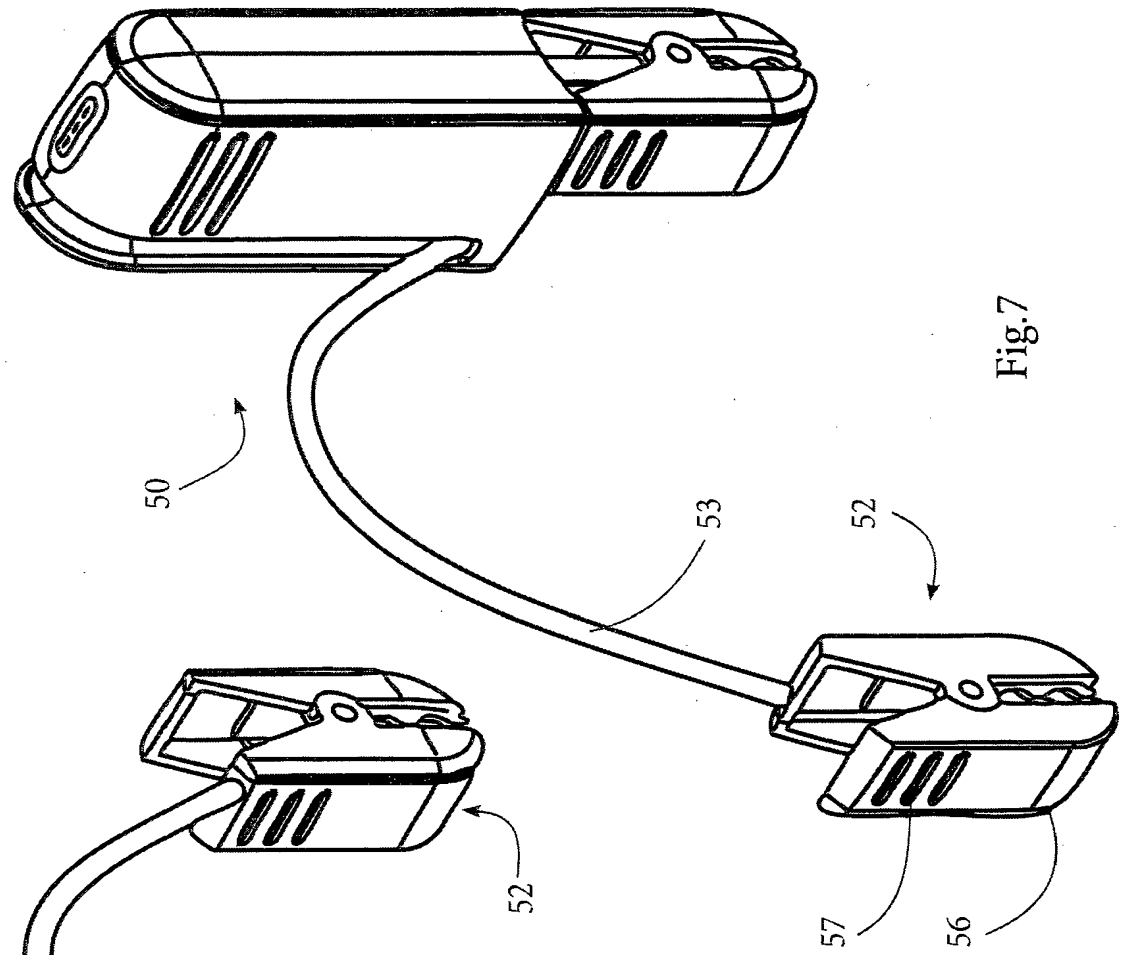


Fig.7

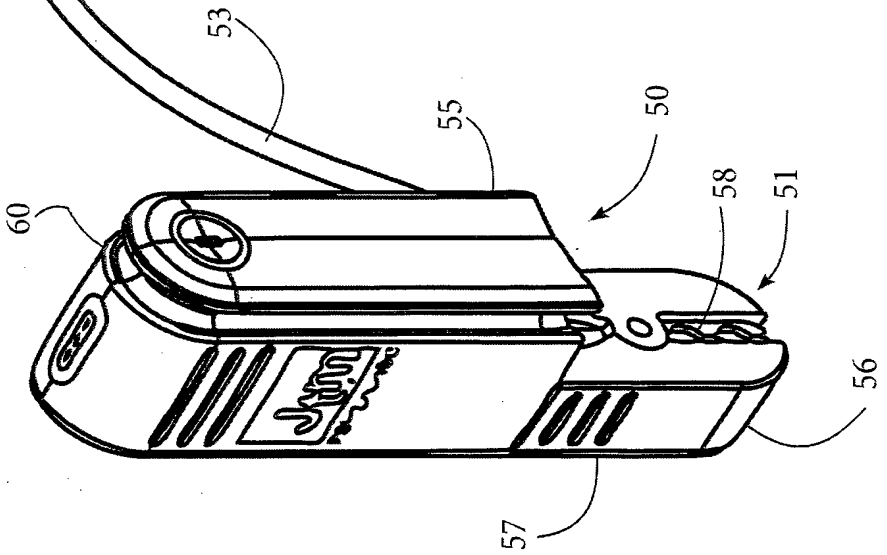


Fig.6

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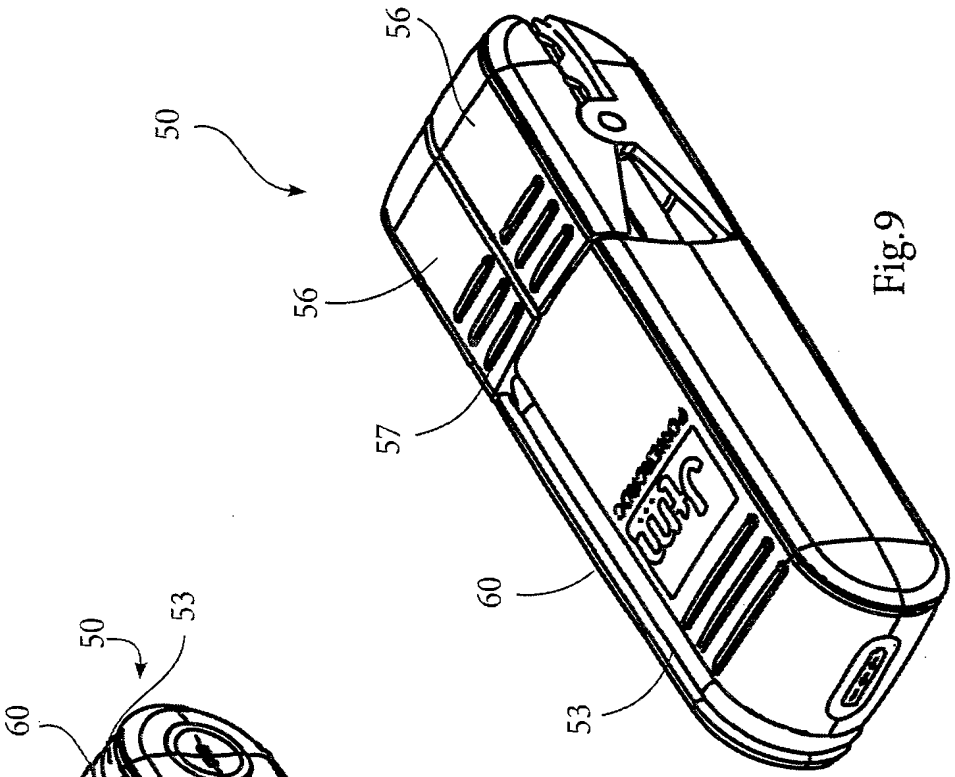


Fig.9

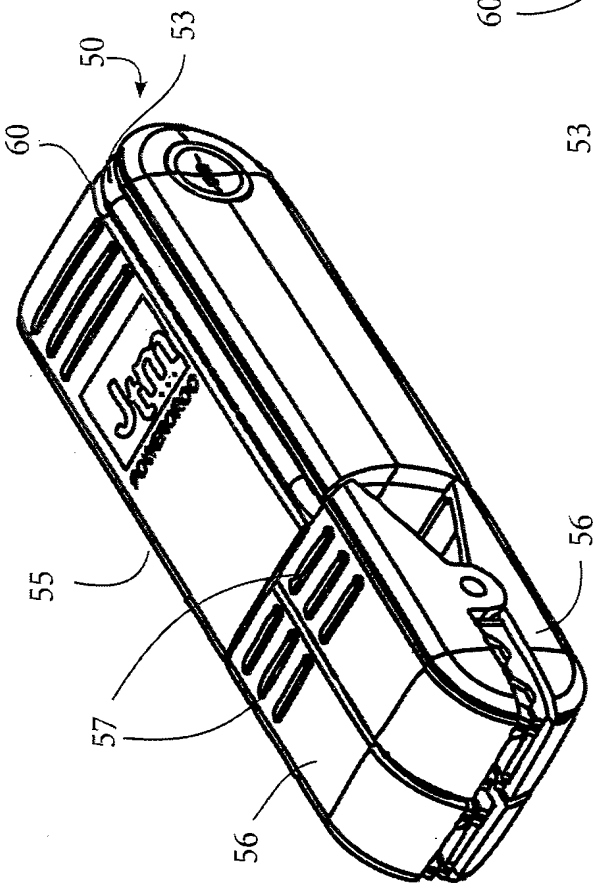


Fig.8

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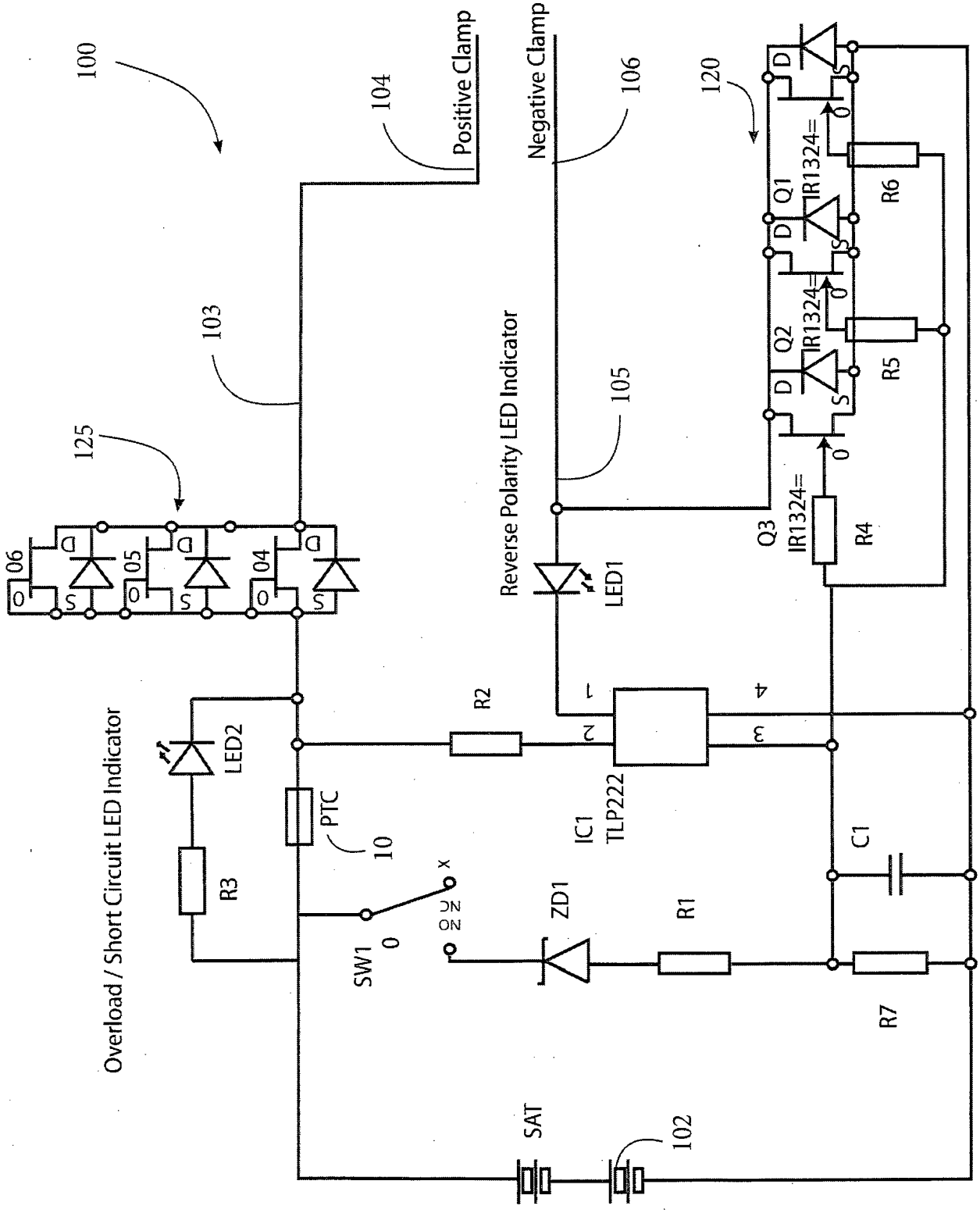

100
104
Positive Clamp
Negative Clamp
106
120
103
125
105
Reverse Polarity LED Indicator
Overload / Short Circuit LED Indicator
LED1
LED2
R2
R3
PTC
10
SW1
ZD1
R1
IC1
TLP222
C1
R7
R4
R5
R6
Q1
Q2
Q3
IR1324=
SAT
102
06
05
04

Fig.10

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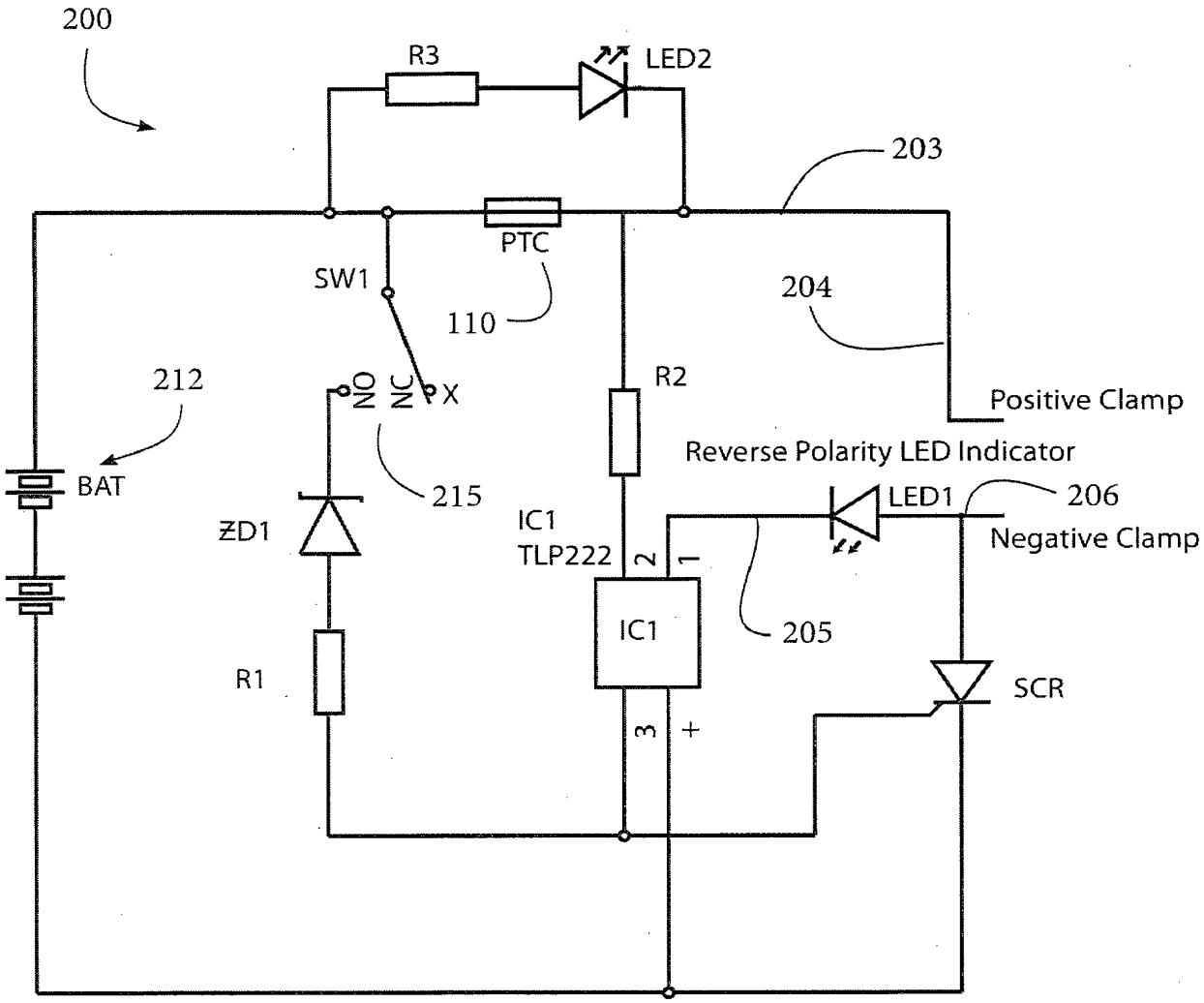

200
R3
LED2
203
PTC
SW1
110
204
212
NO
NC
X
R2
Positive Clamp
Reverse Polarity LED Indicator
BAT
215
LED1
206
ZD1
IC1
TLP222
Negative Clamp
2
1
IC1
205
R1
SCR
3
+

Fig.11

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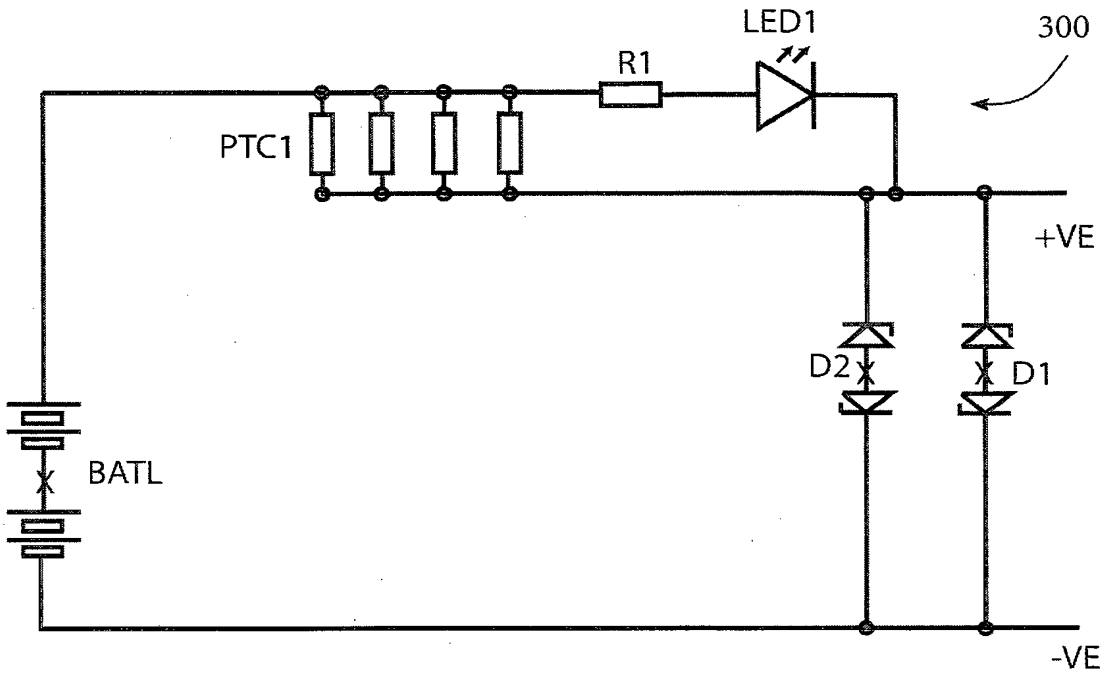


Fig.12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IE2011/000066

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M2/20 H01M10/44 H01M10/46 H01M10/052 H01R11/24
H01M4/58
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01R H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 002 235 A (CLORE KEVIN L [US]) 14 December 1999 (1999-12-14) cited in the application	1-4, 10-26
A	abstract column 2, lines 23-59 figures 1-6	5-9

X	US 5 985 481 A (CHAMPAGNE RICHARD F [US] ET AL) 16 November 1999 (1999-11-16)	1-4, 10-26
A	column 2, line 39 - column 4, line 55 figures 1-10	5-9

A	US 5 083 076 A (SCOTT CLYDE A [US]) 21 January 1992 (1992-01-21) abstract figures 1-9 column 1, line 45 - column 2, line 29	1-26

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 February 2012	29/02/2012

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 4 163 134 A (BUDROSE CHARLES R [US]) 31 July 1979 (1979-07-31) abstract figures 1-9 column 1, line 43 - column 2, line 29	1-26
A	EP 2 209 153 A1 (HENGDIAN GROUP DMEGC MAGNETIC [CN] HENGDIAN GROUP DMEGC MAGNETIC LTD C) 21 July 2010 (2010-07-21) page 2, paragraph 0001-0005	1-26
A	US 6 254 426 B1 (IACOVELLI MARC [US] ET AL) 3 July 2001 (2001-07-03) column 1, line 48 - column 3, line 14 figures 1-2	1-26

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
16/819,831	07/23/2020 09:23:14 PM ET	054985-000055-US-02-01

Title of Invention

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	1630	FILED BY	Lisa Elliott
PATENT CENTER #	60058514	FILING DATE	03/16/2020
CUSTOMER #	20230	FIRST NAMED INVENTOR	Jonathan Lewis NOOK
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	William Klima

Documents

TOTAL DOCUMENTS: 38

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04_npl_10-19-17.PDF	1	Non Patent Literature	31 KB
11_npl_11-03-2014.PDF	2	Non Patent Literature	95 KB
18_npl_statement of grounds and particulars_australian opposition #2.PDF	8	Non Patent Literature	244 KB
22_npl_deltran USA LLC_s invalidity contentions_06-19-2019.PDF	8	Non Patent Literature	159 KB

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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EX 1009

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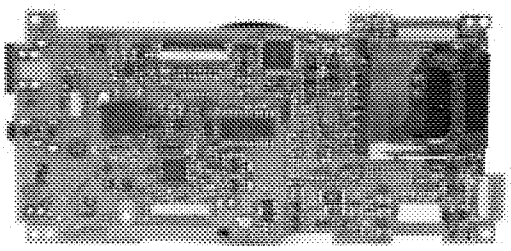
Difference Between Microprocessor and Microcontroller

MAY 29, 2015 BY ADMINISTRATOR — 6 COMMENTS

The introduction of a piece of technology called "Microprocessor" has changed the way in which we view, analyze and control the world surrounding us over the past two decades. The first commercial microprocessor is 4-bit 4004 developed by Intel and was made available in 1971.

Since then, it took a phenomenal success in its development and usage. Microprocessor is considered a product of combined developments in the fields of computer architecture and Integrated Circuit (IC) fabrication. It has made the concept of personal computing very feasible.

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The Microcontroller is often considered as a byproduct in the development of microprocessor. The fabrication process and programming technique which are responsible in the development of microprocessors has also lead to the development of microcontrollers.

Until a decade ago, the microcontrollers are less popular in both the technical community and general public even though most of the consumer electronics like televisions, video games, video cassette recorders, telephones, elevators etc. comprise of them.

Before going to the differences between microprocessor and microcontroller or tabulating microcontroller vs. microprocessor, let's see the brief introduction of microprocessor and microcontroller.

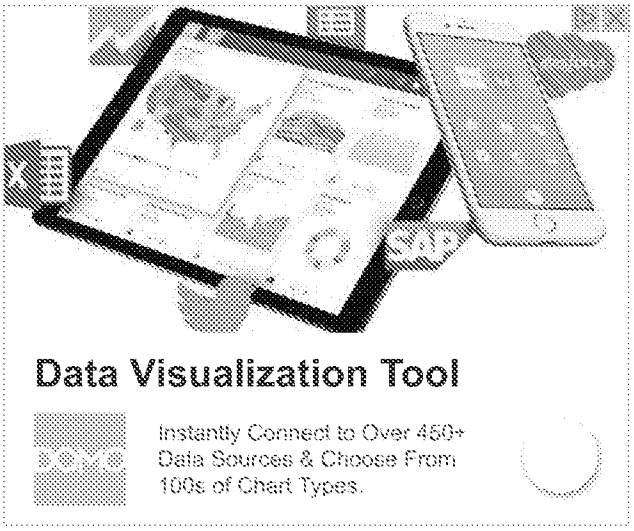
Microprocessor

A Microprocessor, popularly known as "computer on a chip" in its early days, is a general purpose central processing unit (CPU) fabricated on a single integrated circuit (IC) and is a complete digital computer (later microcontroller is considered to be more accurate form of complete computer). It is a small but very powerful electronic brain that operates at a blistering speed and is often used to carry out instructions of a computer program in order to perform arithmetic and logical operations, storing the data, system control, input / output operations etc. as per the instructions. The key term in the definition of a microprocessor is "general purpose".

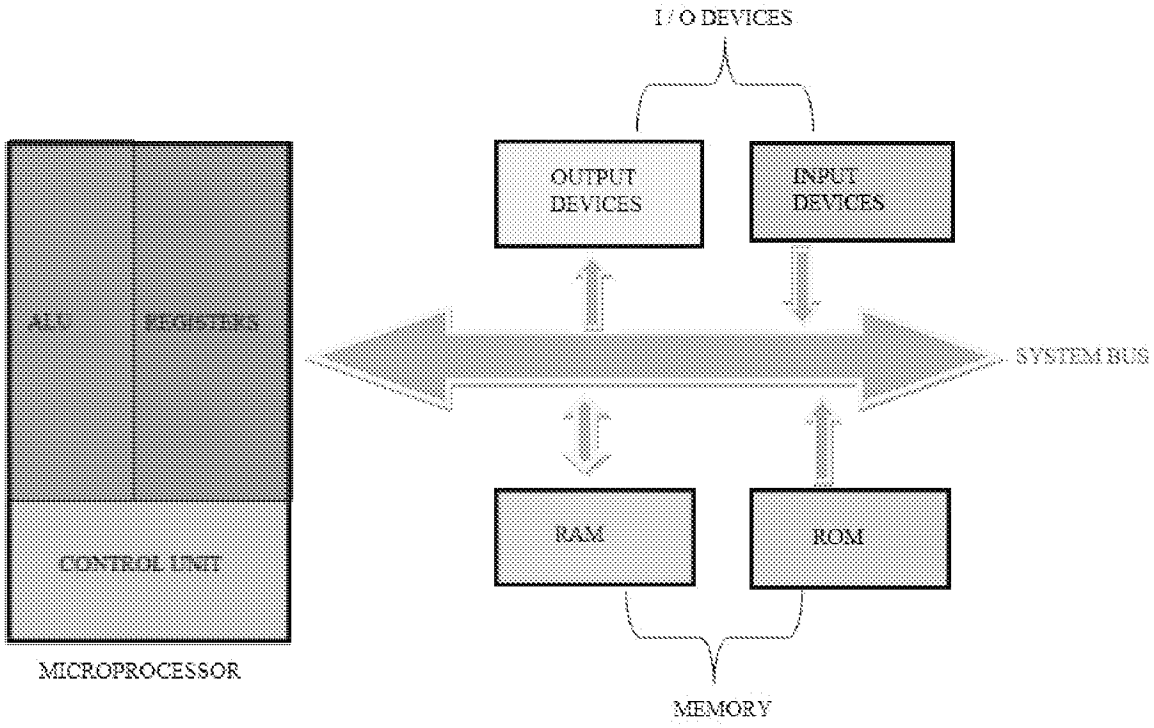
It means that, with the help of a microprocessor, one can build a simple system or a large and complex machine around it with a few extra components as per the application. The main task of a microprocessor is to accept data as input from input devices then process this data according to the instructions and provide the result of these instructions as output through output devices. Microprocessor is an example of sequential logic device as it has memory internally and uses it to store instructions.

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The first commercial Microprocessor was released by Intel in year 1971 November named as 4004 (four – thousand – four). It is 4-bit microprocessor

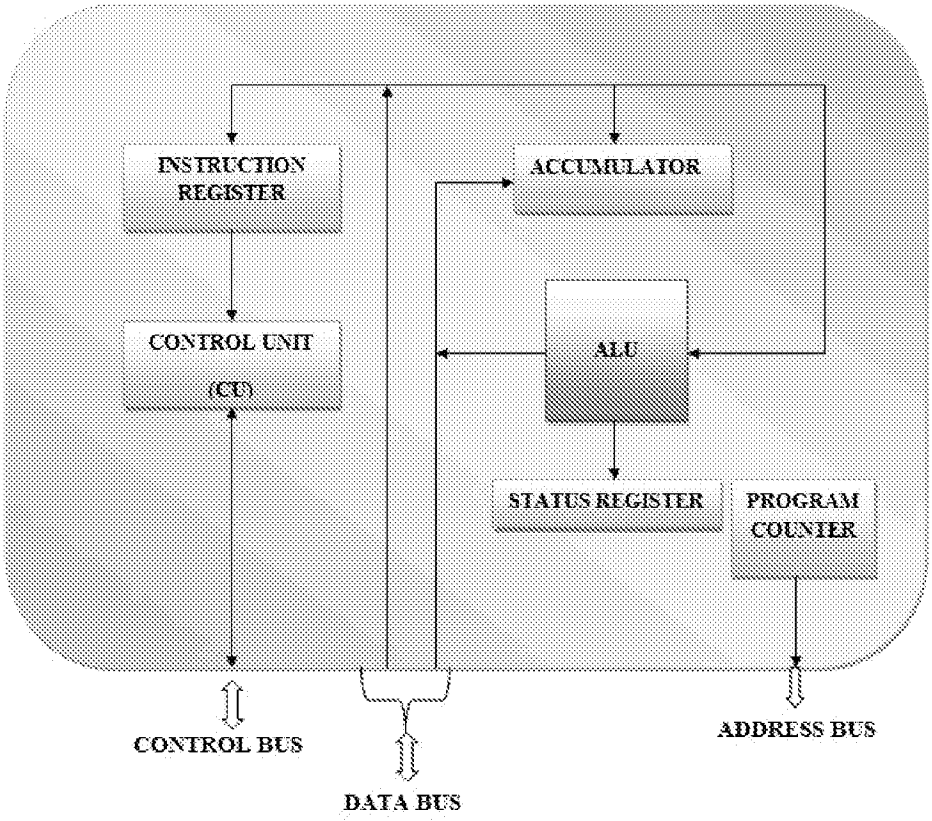


There are five important components in a microprocessor. They are Arithmetic and Logic Unit (ALU), Control Unit, Registers, Instruction Decoder and Data Bus but the first three are considered significant components. The block diagram of a microprocessor with these basic components is shown below.



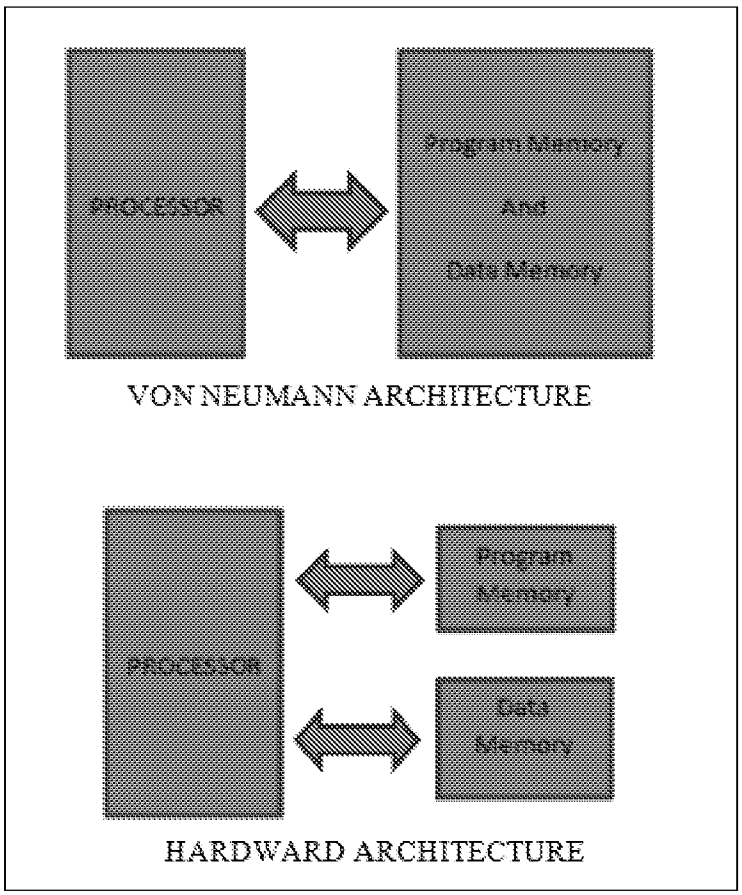
The internal structure of a microprocessor is shown below.

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Earlier microprocessors made use of Von Neumann architecture where the data and instructions (programs) are stored in the same memory. Even though this architecture is simple, there are many draw backs. One of the major drawbacks is that instruction and data cannot be accessed at the same time as they share a single data bus. This often degrades the overall performance of the device. Later, Harvard architecture is introduced which makes use of separate program and data memories with separate buses so that both data and instructions can be accessed at the same time. Later Modified Harvard Architecture is developed in which the program memory is accessed as if it were data memory.

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There are three basic characteristics used to differentiate microprocessors. They are instruction set, bandwidth and clock speed. Instruction set is related to programming of the microprocessor which mainly consists of instructions that a microprocessor can execute. Bandwidth indicates maximum number of bits processed in a single instruction. Clock speed gives no. of instructions a processor can execute per second. Usually clock speed is in MHz (Mega Hertz) or GHz (Giga Hertz). Generally the characteristics bandwidth and clock speed are looked together. The higher the values of both these characteristics, the more powerful the processor is.

Instruction set or instruction set architecture (ISA) also plays an important role in the design and functioning of a processor. Microprocessors are classified as either CISC (Complex Instruction Set Computer) or RISC (Reduced Instruction Set Computer).

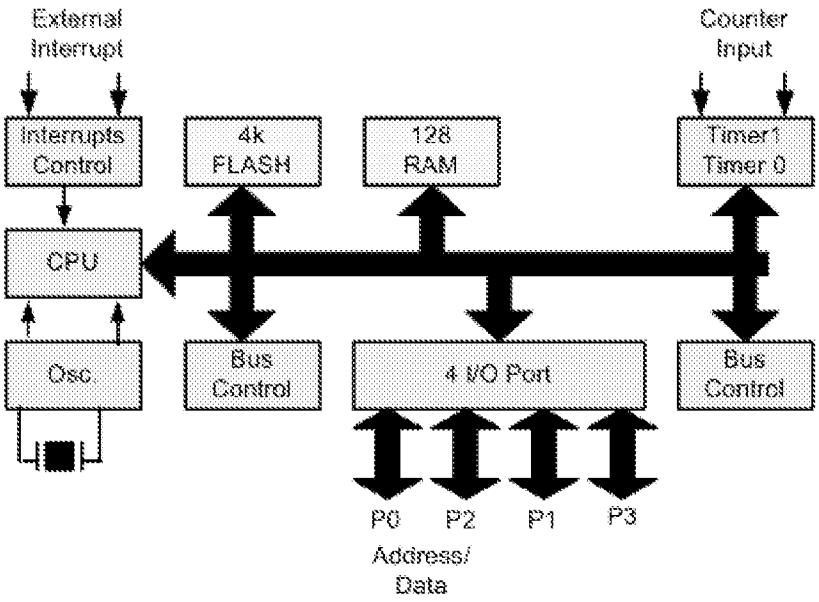
CISC architecture consists of full set of instructions that are complex, larger, have more computational power and so on. A single CISC instruction can be used to execute several low-level operations, multi-step operations and multiple addressing modes. The execution time of these instructions is long. Intel's X86 is an example of CISC architecture.
RISC architecture was developed by realizing that instead of using full set of instructions, only the frequently used instructions are sufficient. In this architecture, the instructions are small and highly optimized. RISC processors are used where execution time of the instruction should

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be less and cost of development is less. The ARM devices are based on ARM architecture which is a subset of RISC.

Microcontroller

The main reason for the development of microcontroller is to overcome the only drawback of the microprocessor. Even though microprocessors are powerful devices, they require external chips like RAM, ROM, Input / Output ports and other components in order to design a complete working system. This made it economically difficult to develop computerized consumer appliances on a large scale as the system cost is very high. Microcontrollers are the devices that actually fit the profile "Computer – on – a chip" as it consists of a main processing unit or processor along with some other components that are necessary to make it a complete computer. The components that are present on a typical microcontroller IC are CPU, memory, input / output ports and timers. The first microcontroller was developed in 1971 by Texas Instruments and is called TMS 1000. It was made available for commercial use in 1974. The block diagram of a microcontroller is shown below.



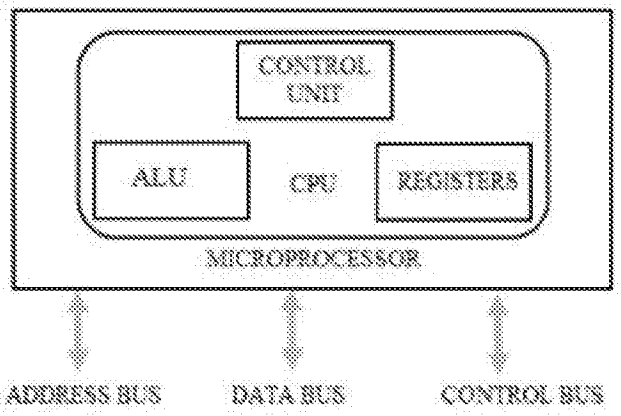
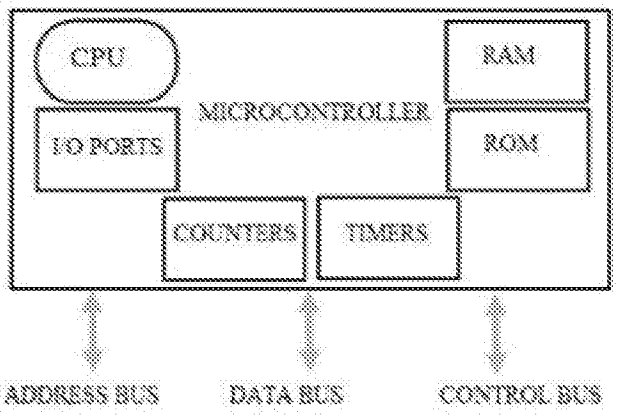
Microcontrollers are basically used in embedded systems. Computerized or digital control of devices is made plausible with the development of microcontrollers. The development process of microcontroller is similar to that of a microprocessor.

Microcontrollers can be classified based on bus width, memory structure and instruction set. Bus width indicates the size of the data bus. Microcontrollers can be classified as 8 – bit, 16 – bit or 32 – bit based on the bus width. Higher bus widths often result in better performance. Microcontrollers can be divided into two types based on their memory structures: Embedded Memory and External Memory. In case of embedded memory microcontrollers, the required data and program memory is embedded into the IC. Whereas external memory

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microcontrollers do not have program memory embedded on them and require an external chip for the same. Now a day, all microcontrollers are embedded memory microcontrollers. The classification based on instruction set is similar to that of a microprocessor. They can be either CISC or RISC. Majority of microcontrollers follow CISC architecture with over 80 instructions. Microcontrollers can also be divided based on their computer architecture into von Neumann and Harvard.

The following table epitomizes some of the differences between microprocessors and microcontrollers.

MICROPROCESSOR	MICROCONTROLLER
	
Microprocessor assimilates the function of a central processing unit (CPU) on to a single integrated circuit (IC).	Microcontroller can be considered as a small computer which has a processor and some other components in order to make it a computer.
Microprocessors are mainly used in designing general purpose systems from small to large and complex systems like super computers.	Microcontrollers are used in automatically controlled devices.
Microprocessors are basic components of personal computers.	Microcontrollers are generally used in embedded systems
Computational capacity of microprocessor is very high. Hence can perform complex tasks.	Less computational capacity when compared to microprocessors. Usually used for simpler tasks.

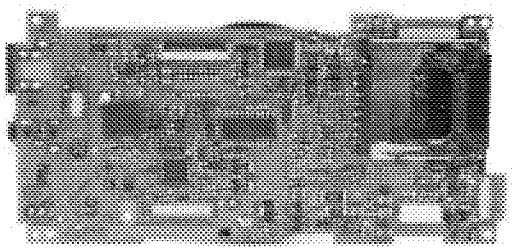
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MICROPROCESSOR	MICROCONTROLLER
A microprocessor based system can perform numerous tasks.	A microcontroller based system can perform single or very few tasks.
Microprocessors have integrated Math Coprocessor. Complex mathematical calculations which involve floating point can be performed with great ease.	Microcontrollers do not have math coprocessors. They use software to perform floating point calculations which slows down the device.
The main task of microprocessor is to perform the instruction cycle repeatedly. This includes fetch, decode and execute.	In addition to performing the tasks of fetch, decode and execute, a microcontroller also controls its environment based on the output of the instruction cycle.
In order to build or design a system (computer), a microprocessor has to be connected externally to some other components like Memory (RAM and ROM) and Input / Output ports.	The IC of a microcontroller has memory (both RAM and ROM) integrated on it along with some other components like I / O devices and timers.
The overall cost of a system built using a microprocessor is high. This is because of the requirement of external components.	Cost of a system built using a microcontroller is less as all the components are readily available.
Generally power consumption and dissipation is high because of the external devices. Hence it requires external cooling system.	Power consumption is less.
The clock frequency is very high usually in the order of Giga Hertz.	Clock frequency is less usually in the order of Mega Hertz.
Instruction throughput is given higher priority than interrupt latency.	In contrast, microcontrollers are designed to optimize interrupt latency.

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MICROPROCESSOR	MICROCONTROLLER
Have few bit manipulation instructions	Bit manipulation is powerful and widely used feature in microcontrollers. They have numerous bit manipulation instructions.
Generally microprocessors are not used in real time systems as they are severely dependent on several other components.	Microcontrollers are used to handle real time tasks as they are single programmed, self sufficient and task oriented devices.

Setting aside the differences between the microprocessor and microcontroller, it is clear that a microprocessor cannot replace a microcontroller and vice versa. Both pieces of technology have their unique way of usage in applications.



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Comments

Arjun says

SEPTEMBER 25, 2013 AT 7:42 PM



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Reply



Giri says
NOVEMBER 16, 2015 AT 8:40 AM

Its Awsome..nice Article....can u give some references iam intresting in embeded system coading...to my mail..basically iam a computer sceince student ..

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Jagruk says
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Your article is very good so thanks give this article it is an one of the most important I like it

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hossam el din says
MARCH 27, 2016 AT 10:25 PM

YOU VERY HELPFUL articeL.. thank you

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DECEMBER 14, 2017 AT 11:12 AM

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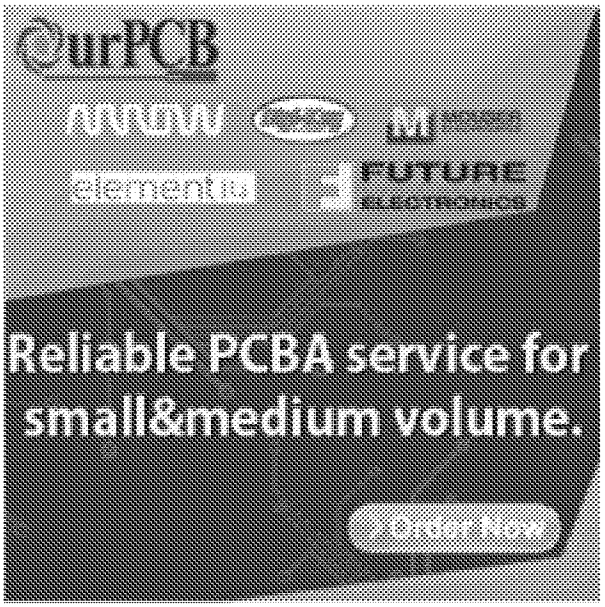
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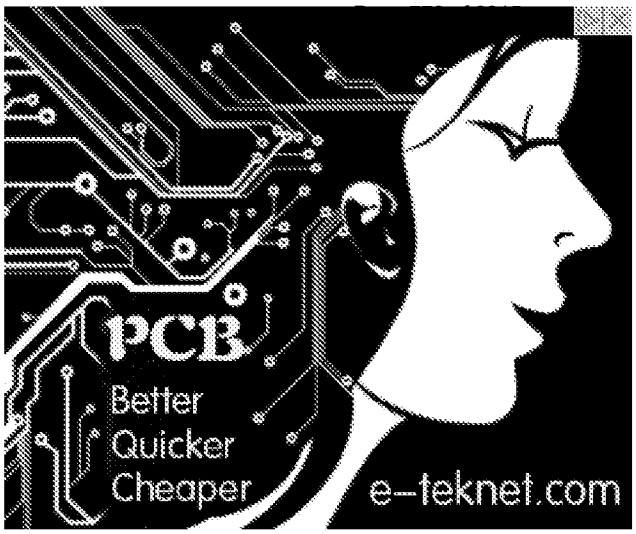


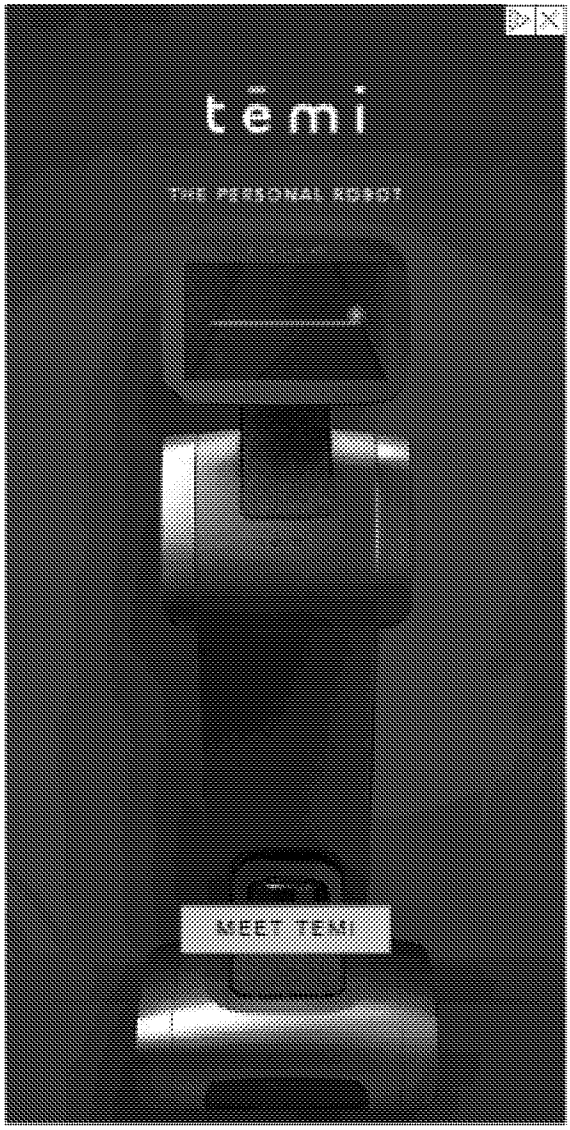
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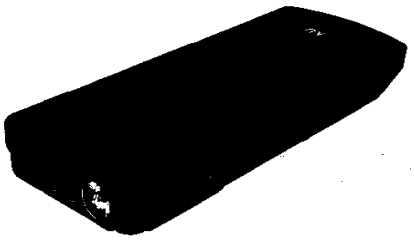
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Start Current	300A
Peak Current	600A
Operation Temp.	-20℃~60℃/-4℉~140℉



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Cigar Socket Cable	12V10Aoutput switch cable	

Individual Packing : PU Bag + Color box Size：250*267*62mm Whole set Weight: 1.5KG	
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☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
1:17-cv-02210	10/19/2017	for the Northern District of Ohio, Eastern Division

PLAINTIFF	DEFENDANT
The NOCO Company, Inc.	Shenzhen Valuelink E-Commerce Co., Ltd.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	9,007,015	4/14/2015	The NOCO Company
2			
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
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DECISION/JUDGEMENT

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A petition has been filed in Patent Number 9007015, Application Number 14/325938 on 01/15/2018.

The Case Number is IPR2018-00503.

To view the documents filed in this petition, go to http://www.uspto.gov/ip/boards/bpai/prps.jsp and click on the Direct Link.

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Questions regarding this notice should be directed to the Patent Trial and Appeal Board at 571-272-7822.

P/00/016
Section 59, 104(4)

AUSTRALIA
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Statement of Grounds and Particulars

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Address 1500 Ferntree Gully Road, Knoxfield, Victoria 3180

Address for service and correspondence in Australia is:

Phillips Ormonde Fitzpatrick
333 Collins Street
Melbourne Victoria 3000
Telephone No.: (03) 9614 1944 Facsimile No.: (03) 9614 1867

Reference: 2016269555

We provide the following information in support of the notice of opposition in relation to Patent Application No. 2016269555

The grounds and particulars of our opposition are as follows:

Lack of Novelty

1. The alleged invention so far as claimed in each of the said claims is not an invention within the meaning of section 18(1)(b)(i) of the *Patents Act 1990* (Cth) in that, so far as claimed in each claim, it was not novel when compared with the prior art base as it existed before the priority date of each claim.

Particulars

(a) United States Patent Publication US20040130298 in the name of Krieger et al (published 8 July 2004).

(b) International Patent Application WO2004036714 in the name of Vector Products, Inc (published 29 April 2004).

(c) United States Patent Publication US20070285049 in the name of Krieger et al (published 13 December 2007).

(d) United States Patent Publication US20130154543 in the name of Richardson et al (published 20 June 2013).

(e) The offering for sale and sale by Asia Bright Industrial (Hong Kong) Co, Ltd of products identified as the JPS Jump Starter and the JPR Jump Starter prior to July 2014.

Lack of Inventive Step

2. The alleged invention is not an invention within the meaning of section 18(1)(b)(ii) of the *Patents Act 1990* (Cth) in that, so far as claimed in each claim, the Opposed Application did not involve an inventive step when compared with the prior art base as it existed before the priority date of each claim.

Particulars

(a) The Opponent will rely upon the common general knowledge as it existed in the patent area before the priority date of each claim. The common general knowledge included the following:

(i) A portable booster device or jump starter for jump-starting a vehicle having a depleted or discharged battery, including an internal power supply which can be connected in circuit with the vehicle's engine starter through a pair of cables.

(ii) It is undesirable for a jump starter to allow electrical connection between the internal power supply and the jumper cables if the cables are not connected to a vehicle battery.

(iii) It is undesirable for a jump starter to allow electrical connection between the internal power supply and the jumper cables if the polarity of the connection between cables and the vehicle battery is incorrect.

(iv) A jump starter can include a switch such as a relay or MOSFET switch which can switch the electrical connection between the internal power supply and the jumper cables on or off.

(v) A jump starter can include a microprocessor to receive input signals and to output information and control signals to provide information and control the status and operation of the jump starter.

(vi) A jump starter can include a means for determining whether the connector cables are connected to a vehicle battery and to send a signal to a microprocessor indicating the determined condition so that the microprocessor can prevent electrical connection between the internal power supply and the connector cables if the cables are not connected to a battery.

(vii) A jump starter can include a means for determining the polarity of a connection between the connector cables and the vehicle battery and to send a signal to a microprocessor indicating the determined polarity so that the microprocessor can prevent electrical connection between the internal power supply and the connector cables if the polarity of the connection between the cables and the vehicle battery is incorrect.

(viii) The jumper cables can be permanently connected to the jump starter or can be a separate component which is detachably connected to the jump starter via an electrical outlet.

(ix) The internal power supply of a jump starter may be in the form of a lithium ion battery.

(x) A jump starter can include a means for determining the operating temperature of one or more components of the device and sending a signal to the microprocessor indicating the determined temperature.

(xi) A jump starter can include one or more USB ports for charging the internal power supply and or providing power from the internal power supply to the USB port.

(xii) A jump starter can include a light powered by the internal power supply to provide illumination for a user of the device.

(xiii) A jump starter can include one or more visual indicators such as LED lights or an LCD display to convey information outputs from the microprocessor to a user of the device.

(xiv) The disclosure in each of the documents described in paragraphs 1(a) to 1(d) above, taken separately.

(xv) The information disclosed by the sale described in paragraph 1(e) above.

(b) As an alternative to paragraphs 2(a)(xiv) and 2(a)(xv), the Opponent will rely upon the common general knowledge as it existed in the patent area before the priority date of each claim, together with:

(i) Any single disclosure described in paragraphs 2(a)(xiv) and 2(a)(xv); or

(ii) the disclosure of a combination of the documents described in paragraphs 2(a)(xiv);

being information made publically available before the priority date of the claim, and in the case of information mentioned in paragraphs 2(b)(ii), information that the skilled person would be reasonably expected to have combined.

Not a Manner of Manufacture

3. The alleged invention, so far as is claimed in each claim, is not a patentable invention within the meaning of section 18(1)(a) of the *Patents Act 1990* (Cth) in that it is not a manner of manufacture within the meaning of section 6 of the Statute of Monopolies.

Particulars

(a) The alleged invention consists of merely the use of known integers, (being, for example an internal battery, an output port, status sensors and a microcontroller), the known properties of which made them suitable for use and/or for combination.

Lack of Utility

4. The alleged invention, so far as is claimed in each claim, is not an invention within the meaning of section 18(1)(a) of the Patents Act 1990 (Cth) because it is not useful.

Particulars

(a) An objective of the alleged invention is to provide further improvements to vehicle jump start devices which address the problems identified in paragraph [0003] without the purported shortcomings of the prior art associated with complexity, cost or potential for malfunction. The specification provides no indication as to how the invention provides an apparatus which improves on the prior art with respect to complexity, cost or potential for malfunction. There is no aspect of the invention as claimed which inherently provides an apparatus which improves on the prior art with respect to complexity, cost or potential for malfunction. Accordingly, the invention as claimed fails to meet the promise of the invention.

Disclosure not Clear or Complete Enough, including Best Method

5. The complete specification of the Opposed Application does not comply with the requirements of sections 40(2)(a) and 40(2)(aa) of the *Patents Act 1990* (Cth) in that the complete specification does not disclose the invention in a manner which is clear enough and complete enough for the invention to be performed by a person skilled in the relevant art, and the complete specification does not disclose the best method known to the Applicant of performing the invention.

Particulars

(a) The specification does not include details of the invention necessary to work the invention. The apparatus of claim 1 defines an output port having positive and negative polarity outputs and describes a vehicle battery connected between those outputs. Claim 1 does not define any means by which a vehicle battery is connected between the outputs of the output port. The specification fails to provide a clear and complete disclosure of a means for connecting a battery between the outputs of the output port other than by the specific jumper cable device described in paragraph [0040] by reference to figure 4.

Lack of Clarity and Succinctness

6. The complete specification of the Opposed Application does not comply with the requirements of section 40(3) of the *Patents Act 1990* (Cth) in that the claims of the complete specification are not clear and succinct.

Particulars

(a) Claim 1 defines that the vehicle battery isolation sensor is configured to detect presence of a vehicle battery connected between the positive and negative polarity outputs. Claim 1 also defines that the microcontroller provides an output signal, inter alia, in response to a signal from a sensor indicating the presence of a vehicle battery at said output port. It is unclear whether presence of a vehicle battery connected between the positive and negative polarity outputs is the same as or different to presence of a vehicle battery at said output port.

Lack of Support

7. The complete specification of the Opposed Application does not comply with the requirements of section 40(3) of the *Patents Act 1990* (Cth) in that the claims are not supported by the matter disclosed in the complete specification.

Particulars

(a) Claim 1 is not supported by the matter disclosed in the specification. The apparatus of claim 1 defines an output port having positive and negative polarity outputs and describes a vehicle battery connected between those outputs. Claim 1 does not define any means by which a vehicle battery is connected between the outputs of the output port. The specification provides no support for any means of connecting a battery between the outputs of the output port other than by the specific jumper cable device described in paragraph [0040] by reference to figure 4.

Document ID e.g. D1, D2 etc	**Document Citation**	**Document accompanies the Statement**	**S 101 M only** The document has been provided in evidence	**Document is OPI***
	US20040130298	Y		
	WO2004036714	N		X
	US20070285049	Y		
	US20130154543	Y		

*a) If the document is an AU or WO patent that is OPI, place a cross in this column
b) If the document is already on the file of an OPI AU application, list the number of that application

Dated: 6 June 2019

PHILLIPS ORMONDE FITZPATRICK

Attorneys for:
Brown & Watson International Pty Ltd

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF OHIO
EASTERN DIVISION

THE NOCO COMPANY, INC., Plaintiff, v. SHENZHEN DIKA NA'ER E-COMMERCE CO., LTD., Defendant.	Lead Case No. 1:17-cv-02282 Judge Christopher A. Boyko
THE NOCO COMPANY, INC., Plaintiff, v. SHENZHEN CHANGXINYANG TECHNOLOGY CO., LTD., Defendant.	Case No. 1:17-cv-02209 Judge Christopher A. Boyko
THE NOCO COMPANY, INC., Plaintiff, v. SHENZHEN VALUELINK E-COMMERCE CO., LTD., Defendant.	Case No. 1:17-cv-02210 Judge Christopher A. Boyko

DEFENDANTS' AMENDED FINAL INVALIDITY AND UNENFORCEABILITY CONTENTIONS

Pursuant to L.P.R. 3-5, 3-6, 3-10, and the Court's order on September 17, 2019 (Dkt. No. 67), Defendants Shenzhen Dika Na'er E-Commerce Co., Ltd., Shenzhen Changxinyang

ADC EX1002
IPR2025-00885

Technology Co., Ltd., and Shenzhen Valuelink E-Commerce Co., Ltd. (collectively, "Defendants") provides the following amended joint final invalidity and unenforceability contentions with respect to U.S. Patent No. 9,007,015 (the "'015 Patent).

L.P.R. 3-5(a)

Defendants identify the follow prior art reference which anticipate and/or render obvious claims 1, 2, 3, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21 and 23 of the '015 Patent:

U.S. Patent No. 7,345,450 to Krieger ("Krieger"), issued March 18, 2008.
U.S. Patent No. 9,506,446 to Xinfang ("Xinfang"), issued November 29, 2016.
U.S. Patent No. 6,426,606 to Purkey ("Purkey"), issued July 30, 2002.
U.S. Patent No. 8,072,900 to Brown ("Brown"), issued December 13, 2011.
U.S. Patent No. 9,525,297 to Wang ("Wang'), issued December 20, 2011.
U.S. Patent No. 5,650,974 to Yoshimura ("Yoshimura") issued July 22, 1997.
The Powerall PBJS12000RD Jump Starter ("Powerall Jump Starter"), offered for sale by Gryphon Mobile Electronics at least as early as November 5, 2013.
The Lightning 12V Jump Starter ("Lightning Jump Starter"), offered for sale by Pilot, Inc. at least as early as March 2014.
The L3 Model Jump Starter, offered for sale by Shenzhen Tsevie Company at as early as May 19, 2019.

L.P.R. 3-5(b)

As per L.P.R. 3-5(b), Defendants identify the following claims as being anticipated or rendered obvious by the prior art cited herein, the grounds for which are cited fully in the accompanying exhibits. Claims 1, 2, 3, 9, 10, 12, 13, 14, 15, 17, 21 and 23 are anticipated under 35 U.S.C. § 102 by the Lightning 12V Jump Starter ("Lightning Jump Starter) made and offered for sale by Pilot, Inc. before the effective filing date of the '015 Patent. In the alternative, claims 1, 2, 3, 9, 10, 12, 13, 14, 15, 17, 21 and 23 are rendered obvious under 35. U.S.C. § 103 by the

Lightning Jump Starter itself or by the Lightning Jump Starter in view of Krieger. Claims Claim 11 is rendered obvious under 35. U.S.C. § 103 by Lightning Jump Starter in view of Xinfang. Claims 19 and 20 are rendered obvious under 35. U.S.C. § 103 by Lightning Jump Starter in view of Purkey. *See* Ex. A. Claims 1, 2, 3, 9, 10, 11, 12, 13, 14, 15, 17, 21 and 23 are rendered obvious under 35. U.S.C. § 103 by Krieger in view of Xinfang. Claims 19 and 20 are rendered obvious under 35. U.S.C. § 103 by Krieger in view of Xinfang and Purkey. *See* Ex. B. Claims 1, 2, 3, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21, and 23 are rendered obvious under 35 U.S.C. § 103 by Purkey in view of Xinfang. *See* Ex. C. Claims 1, 2, 3, 10, 11, 12, 13, 14, 15, 20 and 23 are rendered obvious under 35 U.S.C. § 103 by Brown in view of Wang and Xinfang. *See* Ex. D. Claims 1, 2, 3, 9, 10, 12, 13, 14, 15, 17, 19, 20, 21, and 23 are anticipated under 35 U.S.C. § 102 by the Powerall PBJS12000RD. In the alternative, claims 1, 2, 3, 9, 10, 12, 13, 14, 15, 17, 19, 20, 21, and 23 are rendered obvious under 35 U.S.C. § 103 by the Powerall PBJS12000RD. *See* Ex. E. Claims 1, 9, and 17 are obvious under 35 U.S.C. § 103 by Krieger in view of Yoshimura. *See* Ex. F. Claims 1, 2, 3, 9, 10, 11, 12, 13, 14, 15, 17, 21 and 23 are rendered obvious under 35. U.S.C. § 103 by Krieger in view of Xinfang and in view of Yoshimura. *See* Ex. G.

L.P.R. 3-5(c)

As per L.P.R. 3-5(c), Defendants hereby produce the attached charts marked Exhibits A – G.

L.P.R. 3-5(d)

Defendants state that claim 3 is invalid as indefinite under 35 U.S.C. § 112(b). In addition, claims 1, 2, 3, 9, 10, 12, 13, 14, 15, 17, 19, 20, 21 and 23 are invalid under 35 U.S.C. § 112(a) as they all fail to meet the written description and enablement requirement. More specifically, the reverse polarity sensor circuitry disclosed in the '015 is erroneous and will not enable a person of

ordinary skill in the art to practice the disclosed inventions. For example, due to the presence of diode D8, the optocoupler LED 11 of the reverse sensor 10 will provide a "1" or high output signal to the MCU 1 even if the car battery 72 is connected to the handheld booster device with reverse polarity.

L.P.R. 3-5(e)

Defendants do not assert that the '015 Patent is unenforceable at this time. However, Defendants reserve the right to assert such should any facts come to light during the course of discovery.

L.P.R. 3-6(a)

Defendants have produced documents bates labeled DNIC - 000039 through DNIC - 000610. Additional documents have been produced by Pilot, Inc. (bates labeled Pilot_Shen_00000001 through Pilot_Shen_00001441) and Gryphon Mobile Electronics, LLC.

L.P.R. 3-6(b)

Defendants state that they currently have no documents relevant to L.P.R. 3-5(e).

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Dated: September 23, 2019

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CERTIFICATE OF SERVICE

I hereby certify that all counsel of record are being served today with a copy of this document via electronic mail.

September 23, 2019 */s/ Timothy Wang*
Timothy Wang

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IPR2025-00885

(12) STANDARD PATENT APPLICATION (11) Application No. **AU 2015258229 A1**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Portable vehicle battery jump start apparatus with safety protection

(51) International Patent Classification(s)
H02J 7/14 (2006.01) ***H02J 1/00*** (2006.01)
B60R 16/00 (2006.01) ***H02J 7/00*** (2006.01)
B60R 16/03 (2006.01)

(21) Application No: **2015258229** (22) Date of Filing: **2015.11.18**

(43) Publication Date: **2016.01.28**
(43) Publication Journal Date: **2016.01.28**

(62) Divisional of:
PCT/US2014/045434

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ABSTRACT

A handheld device for jump starting a vehicle engine includes a rechargeable lithium ion battery pack (32) and a microcontroller (1). The lithium ion battery is coupled to a power output port of the device through a power switch circuit (15) actuated by the microcontroller. A vehicle battery isolation sensor (12) connected in circuit with positive and negative polarity outputs detects the presence of a vehicle battery (72) connected between the positive and negative polarity outputs. A reverse polarity sensor (10) connected in circuit with the positive and negative polarity outputs detects the polarity of a vehicle battery connected between the positive and negative polarity outputs, such that the microcontroller will enable power to be delivered from the lithium ion power pack to the output port only when a good battery is connected to the output port and only when the battery is connected with proper polarity of positive and negative terminals.

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PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

FIELD OF THE INVENTION

[0001] The present invention relates generally to apparatus for jump-starting a vehicle having a depleted or discharged battery.

BACKGROUND TO THE INVENTION

[0002] Prior art devices are known for jump-starting a vehicle, which provide either a pair of electrical connector cables that connect a fully-charged battery of another vehicle to the engine start circuit of the dead battery vehicle, or portable booster devices which include a fully-charged battery which can be connected in circuit with the vehicle's engine starter through a pair of cables.

[0003] Problems with the prior art arose when either the jumper terminals or clamps of the cables were inadvertently brought into contact with each other while the other ends were connected to a charged battery, or when the positive and negative terminals were connected to the opposite polarity terminals in the vehicle to be jumped, thereby causing a short circuit resulting in sparking and potential damage to batteries and/or bodily injury.

[0004] Various attempts to eliminate these problems have been made in the prior art. U.S. Patent No. 6,212,054 issued April 3, 2001, discloses a battery booster pack that is polarity sensitive and can detect proper and improper connections before providing a path for electric current flow. The device uses a set of LEDs connected to optical couplers oriented by a control circuit. The control circuit controls a solenoid assembly controlling the path of power current. The control circuit causes power current to flow through the solenoid assembly only if the points of contact of booster cable clamp connections have been properly made.

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[0005] U.S. Patent No. 6,632,103 issued October 14, 2003, discloses an adaptive booster cable connected with two pairs of clips, wherein the two pairs of clips are respectively attached to two batteries to transmit power from one battery to the other battery. The adaptive booster cable includes a polarity detecting unit connected to each clip, a switching unit and a current detecting unit both provided between the two pairs of clips. After the polarity of each clip is sensed by the polarity detecting unit, the switching unit generates a proper connection between the two batteries. Therefore, the positive and negative terminals of the two batteries are correctly connected based on the detected result of the polarity detecting unit.

[0006] U.S. Patent No. 8,493,021 issued July 23, 2013, discloses apparatus that monitors the voltage of the battery of a vehicle to be jump started and the current delivered by the jump starter batteries to determine if a proper connection has been established and to provide fault monitoring. Only if the proper polarity is detected can the system operate. The voltage is monitored to determine open circuit, disconnected conductive clamps, shunt cable fault, and solenoid fault conditions. The current through the shunt cable is monitored to determine if there is a battery explosion risk, and for excessive current conditions presenting an overheating condition, which may result in fire. The system includes an internal battery to provide the power to the battery of the vehicle to be jump started. Once the vehicle is started, the unit automatically electrically disconnects from the vehicle's battery.

[0007] U.S. Patent No. 5,189,359 issued February 23, 1993, discloses a jumper cable device having two bridge rectifiers for developing a reference voltage, a four-input decoder for determining which terminals are to be connected based on a comparison of the voltage at each of the four terminals to the reference voltage, and a pair of relays for effecting the correct connection depending on the determination of the decoder. No connection will be made unless only one terminal of each battery has a higher voltage than the reference voltage, indicating "positive" terminals, and one has a lower voltage than the reference voltage, indicating "negative" terminals, and that, therefore, the two

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high voltage terminals may be connected and the two lower voltage terminals may be connected. Current flows once the appropriate relay device is closed. The relay device is preferably a MOSFET combined with a series array of photodiodes that develop MOSFET gate-closing potential when the decoder output causes an LED to light.

[0008] U.S. Patent No. 5,795,182 issued August 18, 1998, discloses a polarity independent set of battery jumper cables for jumping a first battery to a second battery. The apparatus includes a relative polarity detector for detecting whether two batteries are configured cross or parallel. A three-position high current capacity crossbar pivot switch is responsive to the relative polarity detector for automatically connecting the plus terminals of the two batteries together and the minus terminals of the two batteries together regardless of whether the configuration detected is cross or parallel, and an undercurrent detector and a delay circuit for returning the device to its ready and unconnected state after the device has been disconnected from one of the batteries. The crossbar pivot switch includes two pairs of contacts, and a pivot arm that pivots about two separate points to ensure full electrical contact between the pairs of contacts. The invention can also be used to produce a battery charger that may be connected to a battery without regard to the polarity of the battery.

[0009] U.S. Patent No. 6,262,492 issued July 17, 2001, discloses a car battery jumper cable for accurately coupling an effective power source to a failed or not charged battery, which includes a relay switching circuit connected to the power source and the battery by two current conductor pairs. First and second voltage polarity recognition circuits are respectively connected to the power source and the battery by a respective voltage conductor pair to recognize the polarity of the power source and the battery. A logic recognition circuit produces a control signal subject to the polarity of the power source and the battery, and a driving circuit controlled by the control signal from the logic recognition circuit drives the relay switching circuit, enabling the two poles of the power source to be accurately coupled to the two poles of the battery.

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[0010] U.S. Patent No. 5,635,817 issued June 3, 1997, discloses a vehicle battery charging device that includes a control housing having cables including a current limiting device to prevent exceeding of a predetermined maximum charging current of about 40 to 60 amps. The control housing includes a polarity detecting device to verify the correct polarity of the connection of the terminals of the two batteries and to electrically disconnect the two batteries if there is an incorrect polarity.

[0011] U.S. Patent No. 8,199,024 issued June 12, 2012, discloses a safety circuit in a low-voltage connecting system that leaves the two low-voltage systems disconnected until it determines that it is safe to make a connection. When the safety circuit determines that no unsafe conditions exist and that it is safe to connect the two low-voltage systems, the safety circuit may connect the two systems by way of a "soft start" that provides a connection between the two systems over a period of time that reduces or prevents inductive voltage spikes on one or more of the low-voltage systems. When one of the low-voltage systems has a completely-discharged battery incorporated into it, a method is used for detection of proper polarity of the connections between the low-voltage systems. The polarity of the discharged battery is determined by passing one or more test currents through it and determining whether a corresponding voltage rise is observed.

[0012] U.S. Patent No. 5,793,185 issued August 11, 1998, discloses a hand-held jump starter having control components and circuits to prevent overcharging and incorrect connection to batteries.

[0013] While the prior art attempted solutions to the abovementioned problems as discussed above, each of the prior art solutions suffers from other shortcomings, either in complexity, cost or potential for malfunction. Accordingly, there exists a need in the art for further improvements to vehicle jump start devices.

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SUMMARY OF THE INVENTION

[0014] In accordance with an aspect of the invention, an apparatus is provided for jump starting a vehicle engine, comprising: an internal power supply; an output port having positive and negative polarity outputs; a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs; a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port; a power switch connected between said internal power supply and said output port; and a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

[0015] In accordance with an embodiment of the invention, the internal power supply is a rechargeable lithium ion battery pack.

[0016] A jumper cable device may also be provided, having a plug configured to plug into said output port; a pair of cables integrated with the plug at one respective end thereof; said pair of cables being configured to be separately connected to terminals of a battery at another respective end thereof.

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[0017] Comprises/comprising and grammatical variations thereof when used in this specification are to be taken to specify the presence of stated features, integers, steps or components or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Fig. 1 is a functional block diagram of a handheld vehicle battery boost apparatus in accordance with one aspect of the present invention;

[0019] Figs. 2A – 2C are schematic circuit diagrams of an example embodiment of a handheld vehicle battery boost apparatus in accordance with an aspect of the invention;

[0020] Fig. 3 is a perspective view of a handheld jump starter booster device in accordance with one example embodiment of the invention; and

[0021] Fig. 4 is a plan view of a jumper cable usable with the handheld jump starter booster device in accordance with another aspect of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] FIG. 1 is a functional block diagram of a handheld battery booster according to one aspect of the invention. At the heart of the handheld battery booster is a lithium polymer battery pack 32, which stores sufficient energy to jump start a vehicle engine served by a conventional 12 volt lead-acid or valve regulated lead-acid battery. In one example embodiment, a high-surge lithium polymer battery pack includes three 3.7V, 2666 mAh lithium polymer batteries in a 3S1P configuration. The resulting battery pack provides 11.1V, 2666Ah (8000Ah at 3.7V, 29.6Wh). Continuous discharge current is 25C (or 200 amps), and burst discharge current is 50C (or 400 amps). The maximum charging current of the battery pack is 8000mA (8 amps).

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[0023] A programmable microcontroller unit (MCU) 1 receives various inputs and produces informational as well as control outputs. The programmable MCU 1 further provides flexibility to the system by allowing updates in functionality and system parameters, without requiring any change in hardware. According to one example embodiment, an 8 bit microcontroller with 2K x 15 bits of flash memory is used to control the system. One such microcontroller is the HT67F30, which is commercially available from Holtek Semiconductor Inc.

[0024] A car battery reverse sensor 10 monitors the polarity of the vehicle battery 72 when the handheld battery booster device is connected to the vehicle's electric system. As explained below, the booster device prevents the lithium battery pack from being connected to the vehicle battery 72 when the terminals of the battery 72 are connected to the wrong terminals of the booster device. A car battery isolation sensor 12 detects whether or not a vehicle battery 72 is connected to the booster device, and prevents the lithium battery pack from being connected to the output terminals of the booster device unless there is a good (e.g. chargeable) battery connected to the output terminals.

[0025] A smart switch FET circuit 15 electrically switches the handheld battery booster lithium battery to the vehicle's electric system only when the vehicle battery is determined by the MCU 1 to be present (in response to a detection signal provided by isolation sensor 12) and connected with the correct polarity (in response to a detection signal provided by reverse sensor 10). A lithium battery temperature sensor 20 monitors the temperature of the lithium battery pack 32 to detect overheating due to high ambient temperature conditions and overextended current draw during jump starting. A lithium battery voltage measurement circuit 24 monitors the voltage of the lithium battery pack 32 to prevent the voltage potential from rising too high during a charging operation and from dropping too low during a discharge operation.

[0026] Lithium battery back-charge protection diodes 28 prevent any charge current being delivered to the vehicle battery 72 from flowing back to the lithium battery pack 32 from the vehicle's electrical system. Flashlight LED circuit 36 is

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provided to furnish a flashlight function for enhancing light under a vehicle's hood in dark conditions, as well as providing SOS and strobe lighting functions for safety purposes when a vehicle may be disabled in a potentially dangerous location. Voltage regulator 42 provides regulation of internal operating voltage for the microcontroller and sensors. On/Off manual mode and flashlight switches 46 allow the user to control power-on for the handheld battery booster device, to control manual override operation if the vehicle has no battery, and to control the flashlight function. The manual button functions only when the booster device is powered on. This button allows the user to jump-start vehicles that have either a missing battery, or the battery voltage is so low that automatic detection by the MCU is not possible. When the user presses and holds the manual override button for a predetermined period time (such as three seconds) to prevent inadvertent actuation of the manual mode, the internal lithium ion battery power is switched to the vehicle battery connect port. The only exception to the manual override is if the car battery is connected in reverse. If the car battery is connected in reverse, the internal lithium battery power shall never be switched to the vehicle battery connect port.

[0027] USB charge circuit 52 converts power from any USB charger power source, to charge voltage and current for charging the lithium battery pack 32. USB output 56 provides a USB portable charger for charging smartphones, tablets, and other rechargeable electronic devices. Operation indicator LEDs 60 provide visual indication of lithium battery capacity status as well as an indication of smart switch activation status (indicating that power is being provided to the vehicle's electrical system).

[0028] Detailed operation of the handheld booster device will now be described with reference to the schematic diagrams of Figs. 2A-2C. As shown in Fig. 2A, the microcontroller unit 1 is the center of all inputs and outputs. The reverse battery sensor 10 comprises an optically coupled isolator phototransistor (4N27) connected to the terminals of vehicle battery 72 at input pins 1 and 2 with a diode D8 in the lead conductor of pin 1 (associated with the negative terminal CB-), such that if the battery 72 is connected to the terminals of the booster

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device with the correct polarity, the optocoupler LED 11 will not conduct current, and is therefore turned off, providing a "1" or high output signal to the MCU 1. The car battery isolation sensor 12 comprises an optically coupled isolator phototransistor (4N27) connected to the terminals of vehicle battery 72 at input pins 1 and 2 with a diode D7 in the lead conductor of pin 1 (associated with the positive terminal CB+), such that if the battery 72 is connected to the terminals of the booster device with the correct polarity, the optocoupler LED 11A will conduct current, and is therefore turned on, providing a "0" or low output signal to the MCU, indicating the presence of a battery across the jumper output terminals of the handheld booster device.

[0029] If the car battery 72 is connected to the handheld booster device with reverse polarity, the optocoupler LED 11 of the reverse sensor 10 will conduct current, providing a "0" or low signal to microcontroller unit 1. Further, if no battery is connected to the handheld booster device, the optocoupler LED 11A of the isolation sensor 12 will not conduct current, and is therefore turned off, providing a "1" or high output signal to the MCU, indicating the absence of any battery connected to the handheld booster device. Using these specific inputs, the microcontroller software of MCU 1 can determine when it is safe to turn on the smart switch FET 15, thereby connecting the lithium battery pack to the jumper terminals of the booster device. Consequently, if the car battery 72 either is not connected to the booster device at all, or is connected with reverse polarity, the MCU 1 can keep the smart switch FET 15 from being turned on, thus prevent sparking/short circuiting of the lithium battery pack.

[0030] As shown in Fig. 2B, the FET smart switch 15 is driven by an output of the microcontroller 1. The FET smart switch 15 includes three FETs (Q15, Q18, and Q19) in parallel, which spreads the distribution of power from the lithium battery pack over the FETs. When that microcontroller output is driven to a logic low, FETs 16 are all in a high resistance state, therefore not allowing current to flow from the internal lithium battery negative contact 17 to the car battery 72 negative contact. When the microcontroller output is driven to a logic high, the FETs 16 (Q15, Q18, and Q19) are in a low resistant state, allowing current to flow

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freely from the internal lithium battery pack negative contact 17 (LB-) to the car battery 72 negative contact (CB-). In this way, the microcontroller software controls the connection of the internal lithium battery pack 32 to the vehicle battery 72 for jumpstarting the car engine.

[0031] Referring back to Fig. 2A, the internal lithium battery pack voltage can be accurately measured using circuit 24 and one of the analog-to-digital inputs of the microcontroller 1. Circuit 24 is designed to sense when the main 3.3V regulator 42 voltage is on, and to turn on transistor 23 when the voltage of regulator 42 is on. When transistor 23 is conducting, it turns on FET 22, thereby providing positive contact (LB+) of the internal lithium battery a conductive path to voltage divider 21 allowing a lower voltage range to be brought to the microcontroller to be read. Using this input, the microcontroller software can determine if the lithium battery voltage is too low during discharge operation or too high during charge operation, and take appropriate action to prevent damage to electronic components.

[0032] Still referring to Fig. 2A, the temperature of the internal lithium battery pack 32 can be accurately measured by two negative temperature coefficient (NTC) devices 20. These are devices that reduce their resistance when their temperature rises. The circuit is a voltage divider that brings the result to two analog-to-digital (A/D) inputs on the microcontroller 1. The microcontroller software can then determine when the internal lithium battery is too hot to allow jumpstarting, adding safety to the design.

[0033] The main voltage regulator circuit 42 is designed to convert internal lithium battery voltage to a regulated 3.3 volts that is utilized by the microcontroller 1 as well as by other components of the booster device for internal operating power. Three lithium battery back charge protection diodes 28 (see Fig. 2B) are in place to allow current to flow only from the internal lithium battery pack 32 to the car battery 72, and not from the car battery to the internal lithium battery. In this way, if the car electrical system is charging from its alternator, it

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cannot back-charge (and thereby damage) the internal lithium battery, providing another level of safety.

[0034] The main power on switch 46 (Fig. 2A) is a combination that allows for double pole, double throw operation so that with one push, the product can be turned on if it is in the off state, or turned off if it is in the on state. This circuit also uses a microcontroller output 47 to "keep alive" the power when it is activated by the on switch. When the switch is pressed the microcontroller turns this output to a high logic level to keep power on when the switch is released. In this way, the microcontroller maintains control of when the power is turned off when the on/off switch is activated again or when the lithium battery voltage is getting too low. The microcontroller software also includes a timer that turns the power off after a predefined period of time, (such as, e.g. 8 hours) if not used.

[0035] The flashlight LED circuit 45 shown in Fig. 2B controls the operation of flashlight LEDs. Two outputs from the microcontroller 1 are dedicated to two separate LEDs. Thus, the LEDs can be independently software-controlled for strobe and SOS patterns, providing yet another safety feature to the booster device. LED indicators provide the feedback the operator needs to understand what is happening with the product. Four separate LEDs 61 (Fig. 2A) are controlled by corresponding individual outputs of microcontroller 1 to provide indication of the remaining capacity of the internal lithium battery. These LEDs are controlled in a "fuel gauge" type format with 25%, 50%, 75% and 100% (red, red, yellow, green) capacity indications. An LED indicator 63 (Fig. 2B) provides a visual warning to the user when the vehicle battery 72 has been connected in reverse polarity. "Boost" and on/off LEDs 62 provide visual indications when the booster device is provide jump-start power, and when the booster device is turned on, respectively.

[0036] A USB output 56 circuit (Fig. 2C) is included to provide a USB output for charging portable electronic devices such as smartphones from the internal lithium battery pack 32. Control circuit 57 from the microcontroller 1 allows the USB Out 56 to be turned on and off by software control to prevent the internal

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lithium battery getting too low in capacity. The USB output is brought to the outside of the device on a standard USB connector 58, which includes the standard voltage divider required for enabling charge to certain smartphones that require it.

[0037] The USB charge circuit 52 allows the internal lithium battery pack 32 to be charged using a standard USB charger. This charge input uses a standard micro-USB connector 48 allowing standard cables to be used. The 5V potential provided from standard USB chargers is up-converted to the 12.4VDC voltage required for charging the internal lithium battery pack using a DC-DC converter 49. The DC-DC converter 49 can be turned on and off via circuit 53 by an output from the microcontroller 1.

[0038] In this way, the microcontroller software can turn the charge off if the battery voltage is measured to be too high by the A/D input 22. Additional safety is provided for helping to eliminate overcharge to the internal lithium battery using a lithium battery charge controller 50 that provides charge balance to the internal lithium battery cells 51. This controller also provides safety redundancy for eliminating over discharge of the internal lithium battery.

[0039] Fig. 3 is a perspective view of a handheld device 300 in accordance with an exemplary embodiment of the invention. 301 is a power on switch. 302 shows the LED "fuel gauge" indicators 61. 303 shows a 12 volt output port connectable to a cable device 400, described further below. 304 shows a flashlight control switch for activating flashlight LEDs 45. 305 is a USB input port for charging the internal lithium battery, and 306 is a USB output port for providing charge from the lithium battery to other portable devices such as smartphones, tablets, music players, etc. 307 is a "boost on" indicator showing that power is being provided to the 12V output port. 308 is a "reverse" indicator showing that the vehicle battery is improperly connected with respect to polarity. 309 is a "power on" indicator showing that the device is powered up for operation.

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[0040] Fig. 4 shows a jumper cable device 400 specifically designed for use with the handheld device 300. Device 400 has a plug 401 configured to plug into 12 volt output port 303 of the handheld device 300. A pair of cables 402a and 402b are integrated with the plug 401, and are respectively connected to battery terminal clamps 403a and 403b via ring terminals 404a and 404b. The port 303 and plug 401 may be dimensioned so that the plug 401 will only fit into the port 303 in a specific orientation, thus ensuring that clamp 403a will correspond to positive polarity, and clamp 403b will correspond to negative polarity, as indicated thereon. Additionally, the ring terminals 404a and 404b may be disconnected from the clamps and connected directly to the terminals of a vehicle battery. This feature may be useful, for example, to permanently attach the cables 302a-302b to the battery of a vehicle. In the event that the battery voltage becomes depleted, the handheld booster device 300 could be properly connected to the battery very simply by plugging in the plug 401 to the port 303.

[0041] The invention having been thus described, it will be apparent to those skilled in the art that the same may be varied in many ways without departing from the spirit or scope of the invention. Any and all such variations are intended to be encompassed within the scope of the following claims.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Apparatus for jump starting a vehicle engine, comprising:

an internal power supply;

an output port having positive and negative polarity outputs;

a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs;

a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port;

a power switch connected between said internal power supply and said output port; and

a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch, such that said power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

2. The apparatus of claim 1, wherein said internal power supply comprises a lithium ion battery.

3. The apparatus of claim 2, wherein said lithium ion battery comprises a battery pack of multiple lithium ion batteries.

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4. The apparatus of claim 1, wherein said power switch comprises a plurality of FETs in parallel.

5. The apparatus of claim 1, wherein said vehicle isolation sensor and reverse polarity sensor comprise optically coupled isolator phototransistors.

6. The apparatus of claim 1, further comprising a plurality of power diodes coupled between said output port and said internal power supply to prevent back-charging of said internal power supply from an electrical system connected to said output port.

7. The apparatus of claim 1, further comprising a temperature sensor configured to detect temperature of said internal power supply and to provide a temperature signal to said microcontroller.

8. The apparatus of claim 1, further comprising a voltage measurement circuit configured to measure output voltage of said internal power supply and to provide a voltage measurement signal to said microcontroller.

9. The apparatus of claim 1, further comprising a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus.

10. The apparatus of claim 1, further comprising a USB output port configured to provide charging power from said internal power supply to a USB-chargeable device.

11. The apparatus of claim 1, further comprising a USB charging port configured to provide charging power from an external power source to said internal power supply.

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12. The apparatus of claim 1, further comprising a flashlight circuit configured to provide a source of light to a user.

13. The apparatus of claim 12, wherein said source of light is at least one LED.

14. The apparatus of claim 13, wherein said microcontroller is configured to control said at least one LED to provide a visual alarm indicating an emergency situation.

15. The apparatus of claim 1, further comprising a plurality of visual indicators configured to display remaining capacity status of said internal power supply.

16. The apparatus of claim 15, wherein said plurality of visual indicators comprises a plurality of LEDs providing output light of different colors.

17. The apparatus of claim 1, further comprising a visual indicator configured to warn a user when a vehicle battery is connected with reverse polarity.

18. The apparatus of claim 1, further comprising separate visual indicators configured to display the power on status of the apparatus, and the jump start boost power status of power supplied to said output port.

19. The apparatus of claim 1, further comprising a manual override switch configured to activate a manual override mode to enable a user to connect jump start power to said output port when said vehicle battery isolation sensor is unable to detect presence of a vehicle battery.

20. The apparatus of claim 19, wherein said microcontroller is configured to detect actuation of said manual override switch for at least a predetermined period of time before activation of said manual override mode.

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21. The apparatus of claim 1, further comprising a jumper cable device including a plug configured to plug into said output port, a pair of cables integrated with the plug at one respective end thereof and being configured to be connected to terminals of a battery at another respective end thereof.

22. The apparatus of claim 21, wherein said jumper cable device further comprises a pair of ring terminals configured to respectively connect said pair of cables at said another end thereof with one of a battery terminal and a battery terminal clamp.

23. The apparatus of claim 21, wherein said output port and said plug are dimensioned so that the plug will fit into the output port only in one specific orientation.

THE NOCO COMPANY

WATERMARK PATENT AND TRADE MARKS ATTORNEYS

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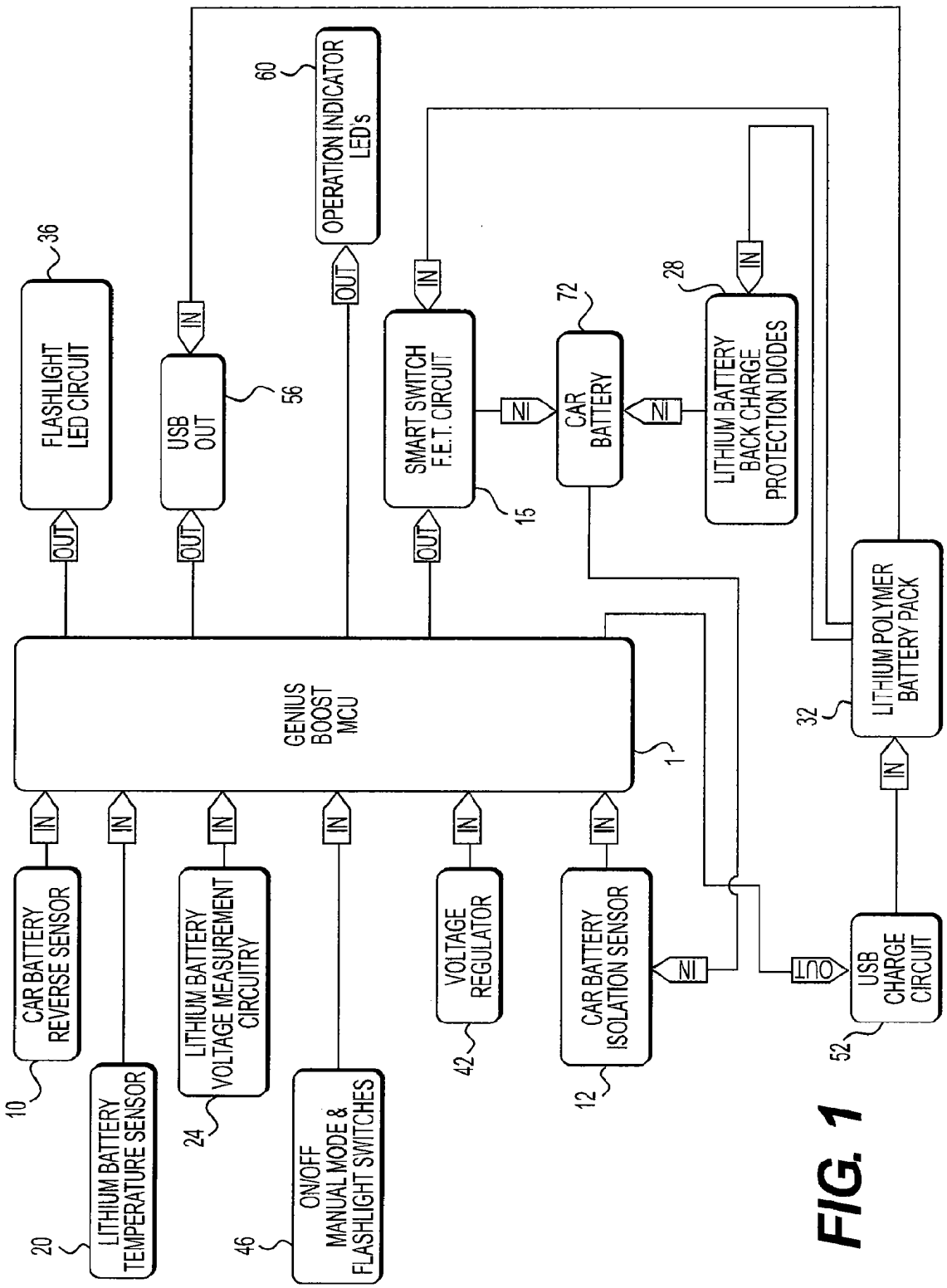


FIG. 1

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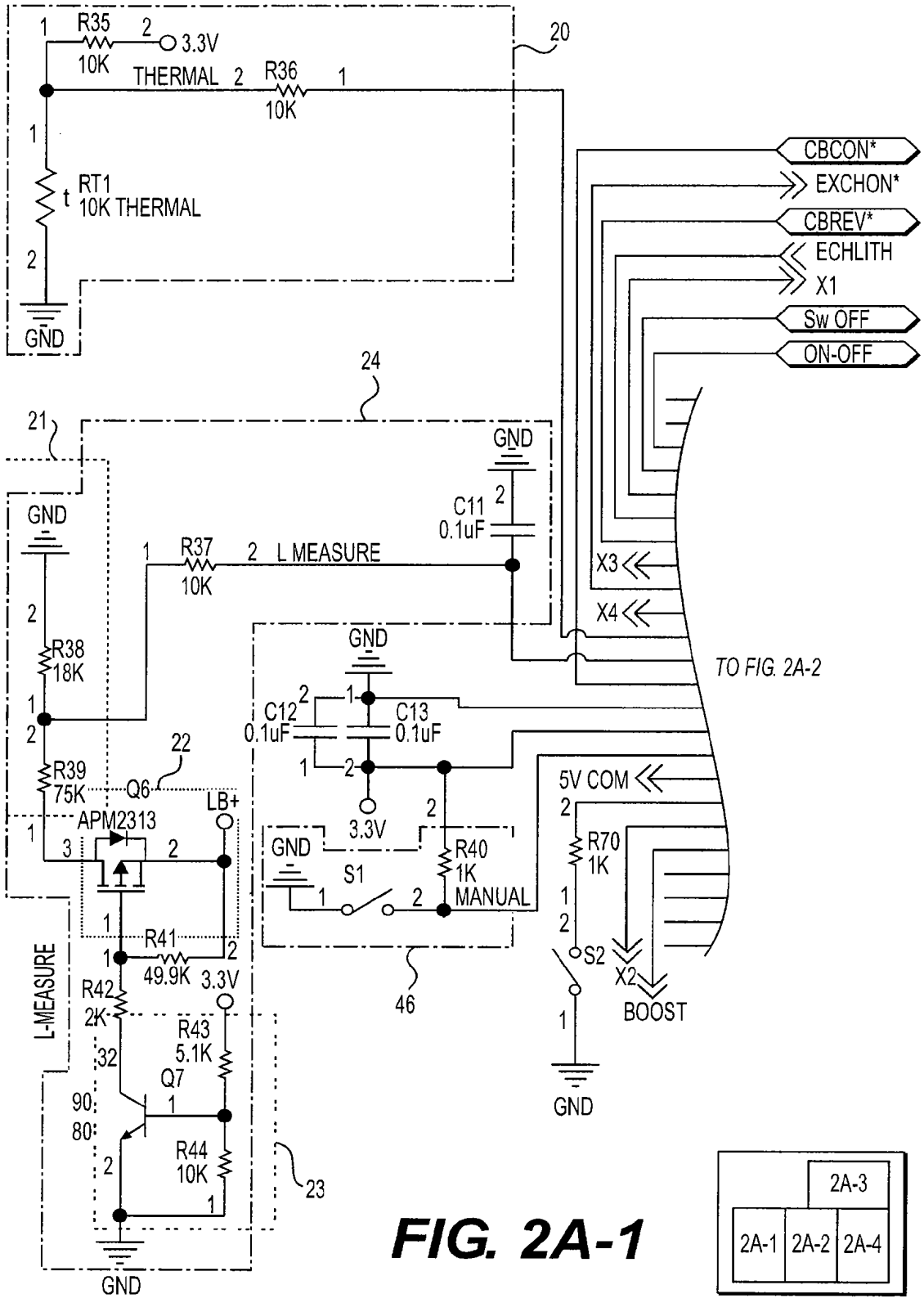
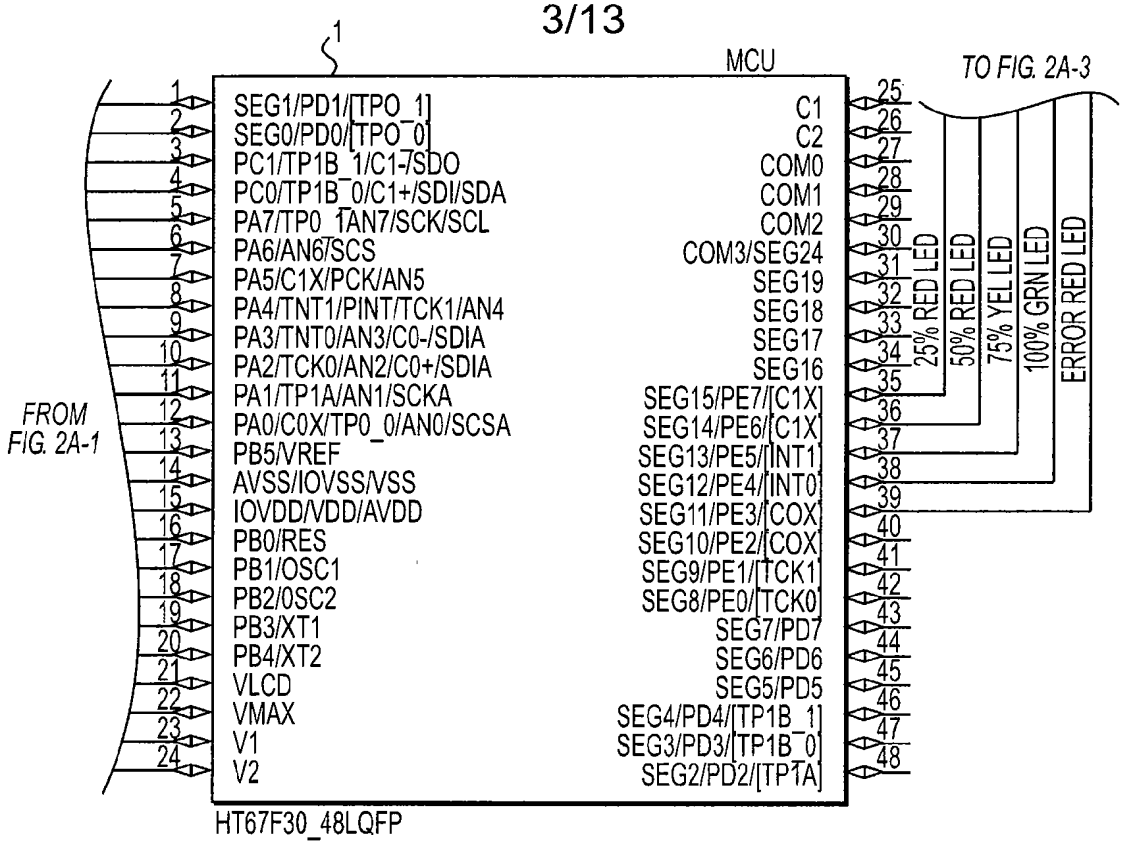
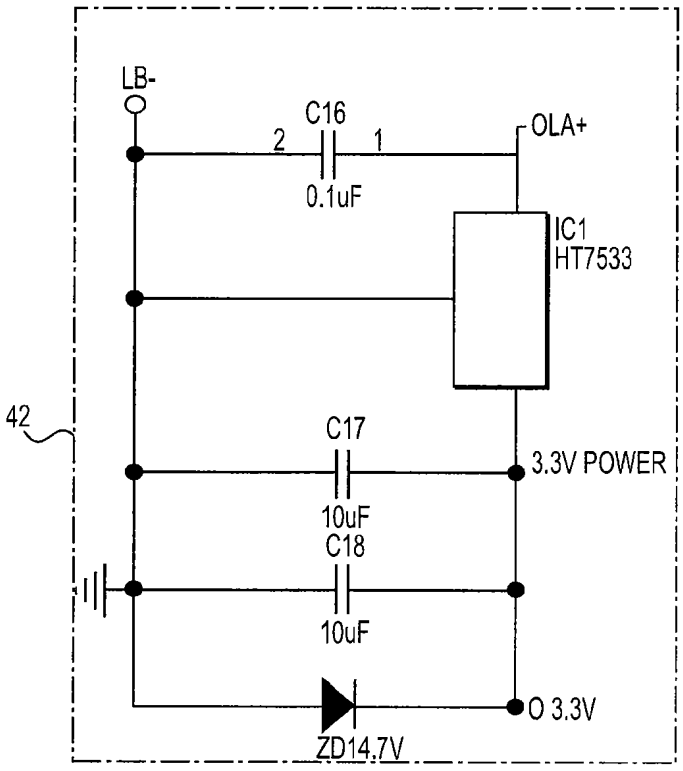


FIG. 2A-1

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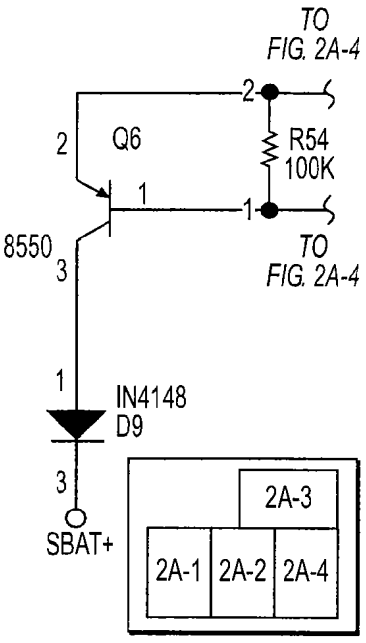


FIG. 2A-2

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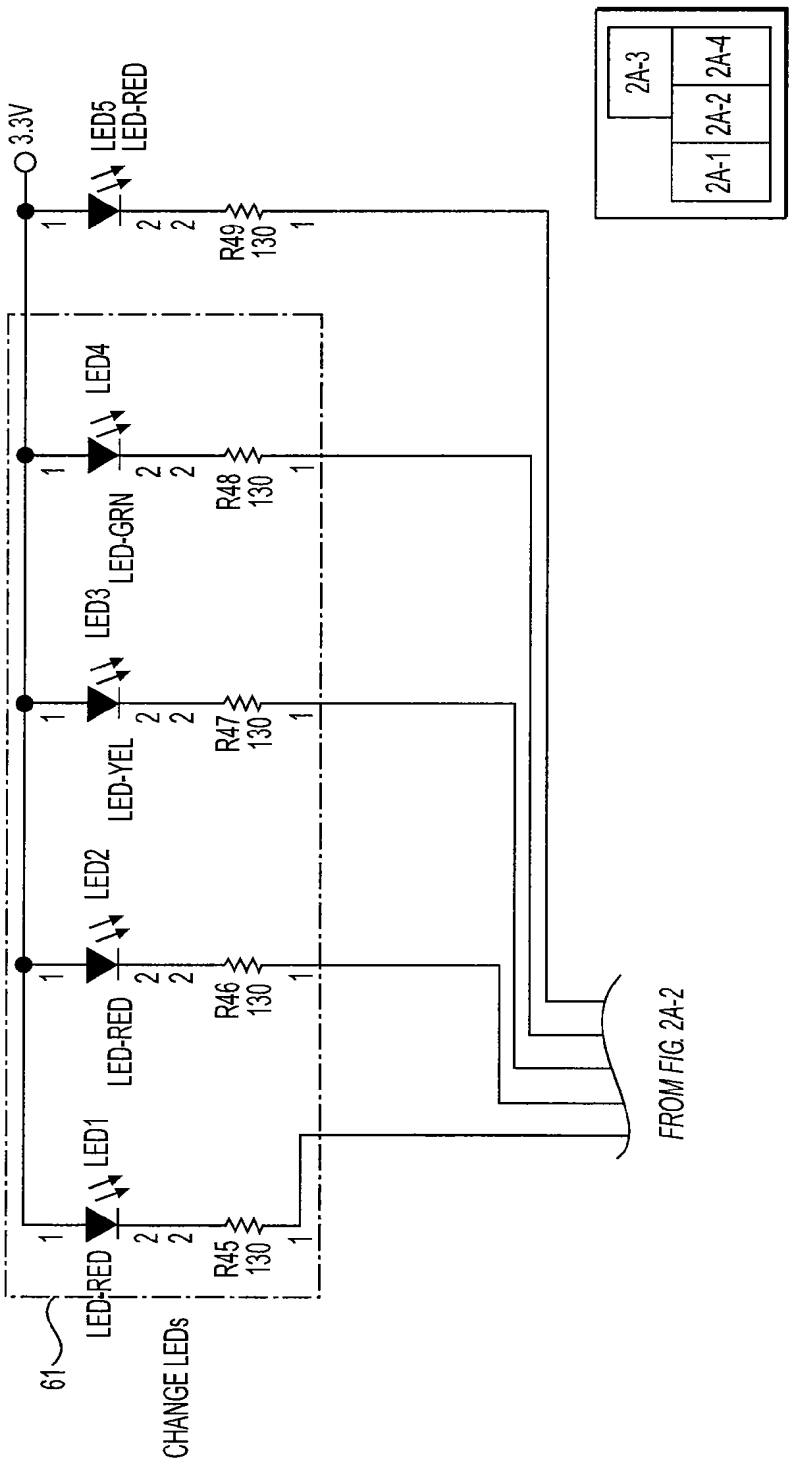


FIG. 2A-3

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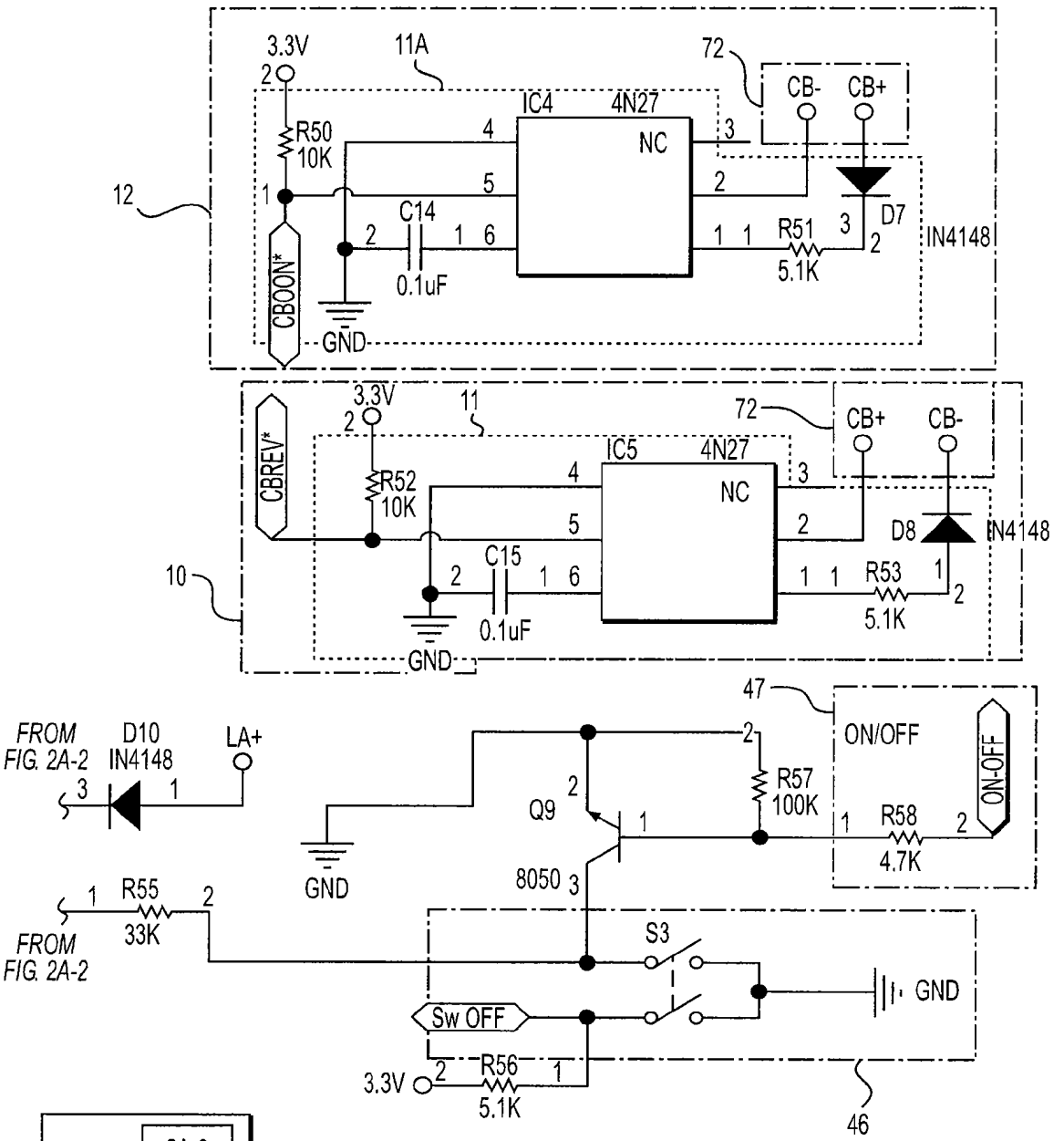


FIG. 2A-4

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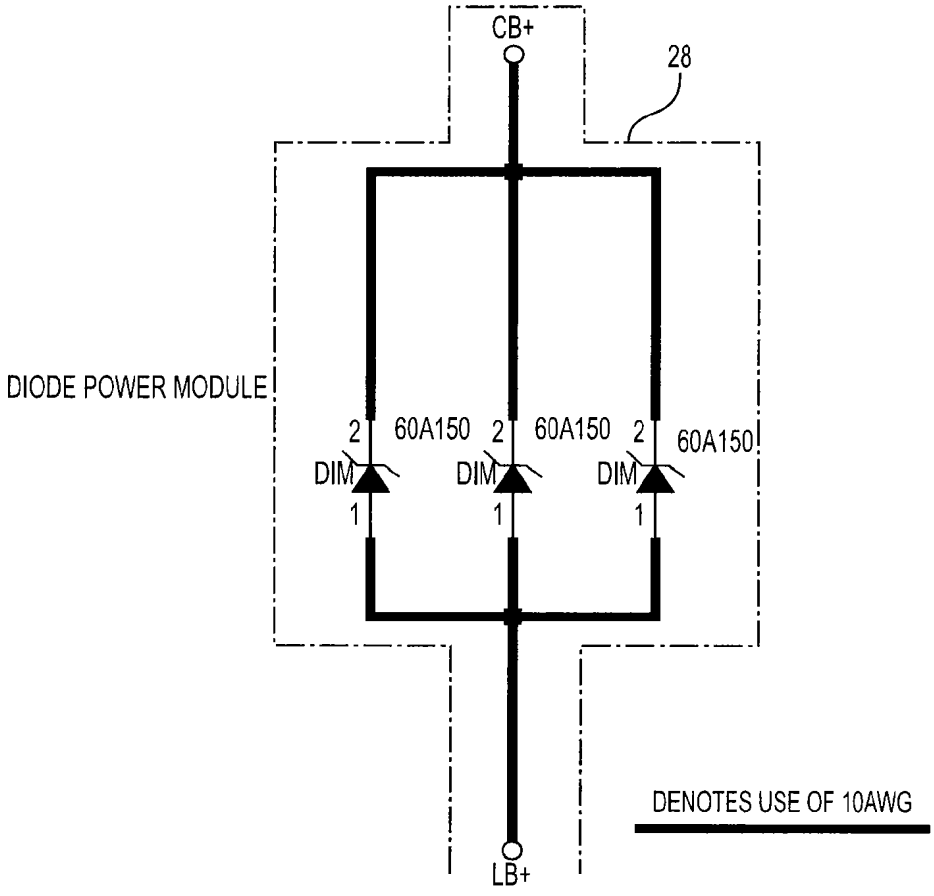
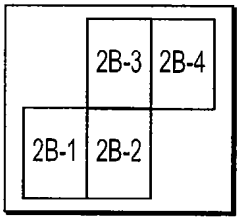


FIG. 2B-1



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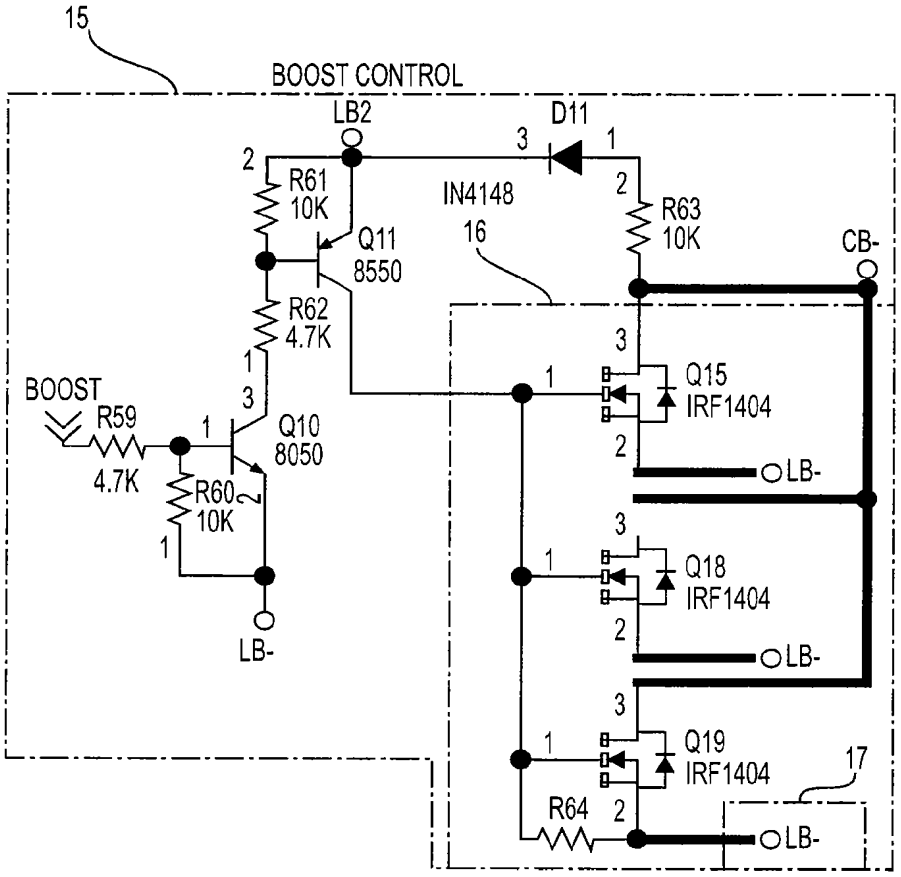
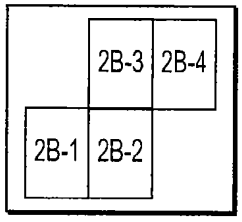


FIG. 2B-2



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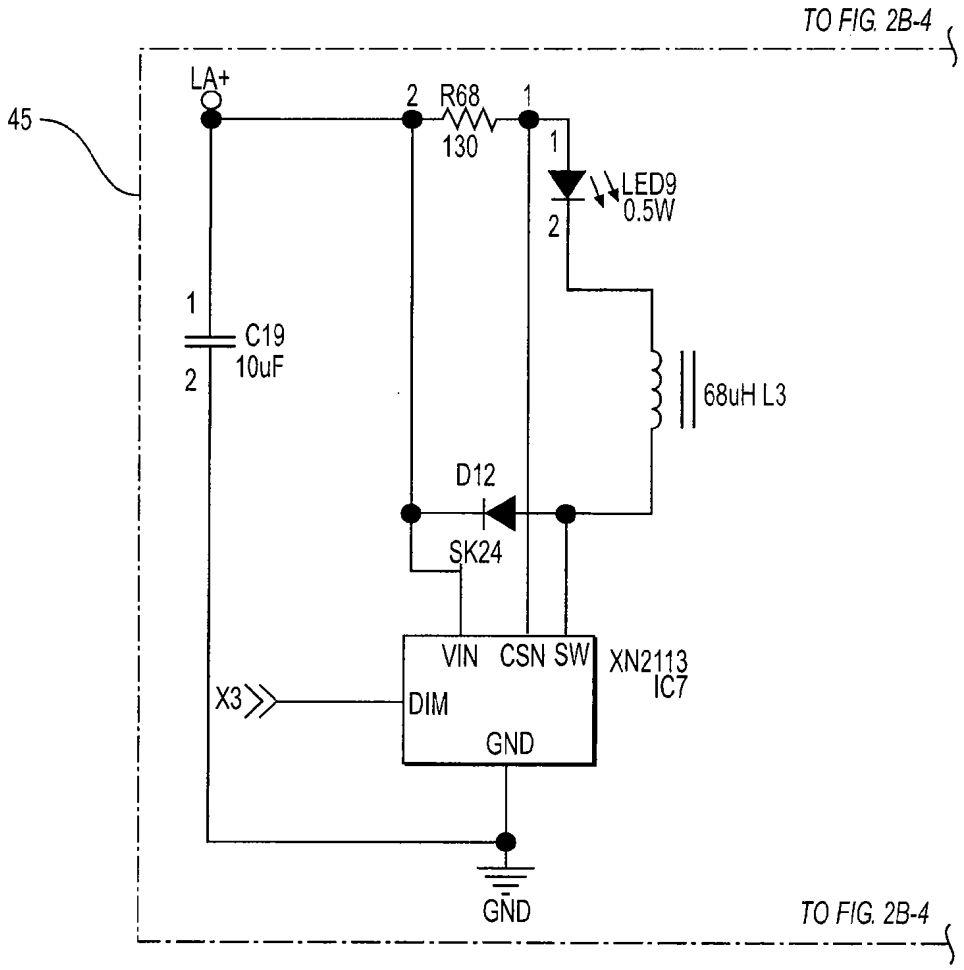
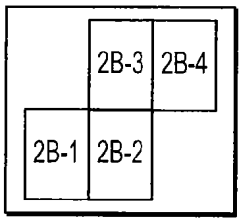


FIG. 2B-3



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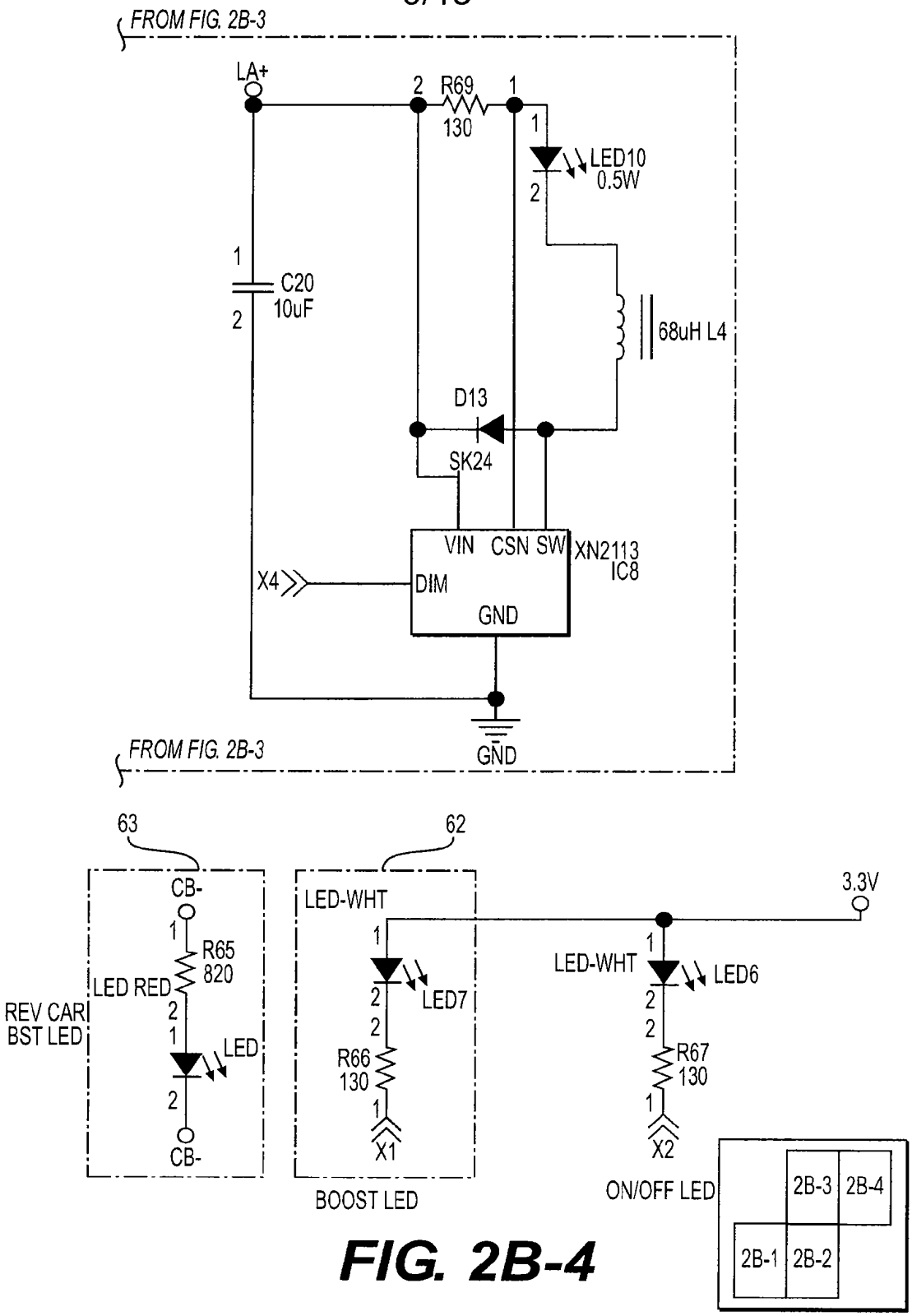


FIG. 2B-4

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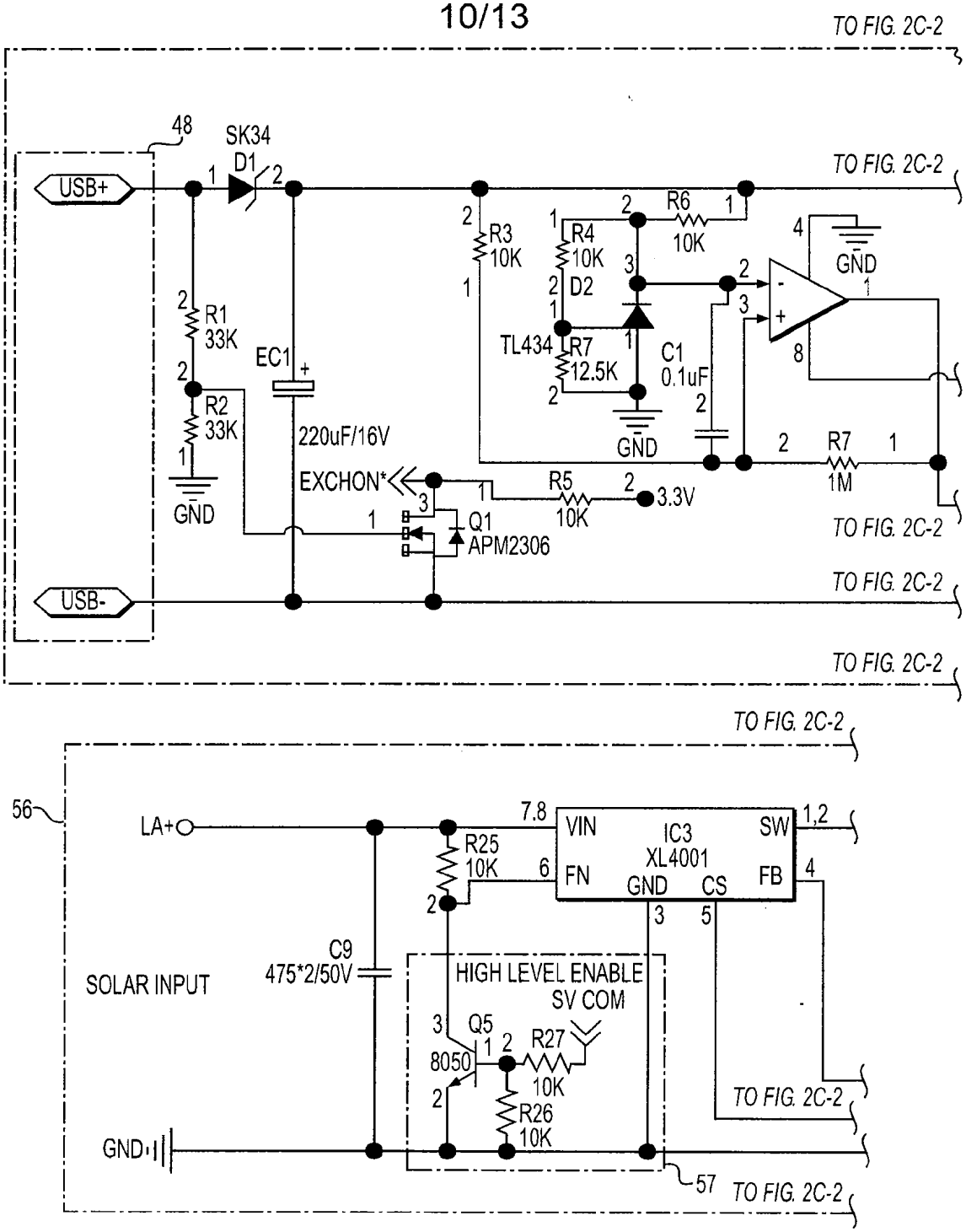
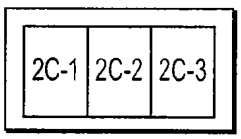


FIG. 2C-1



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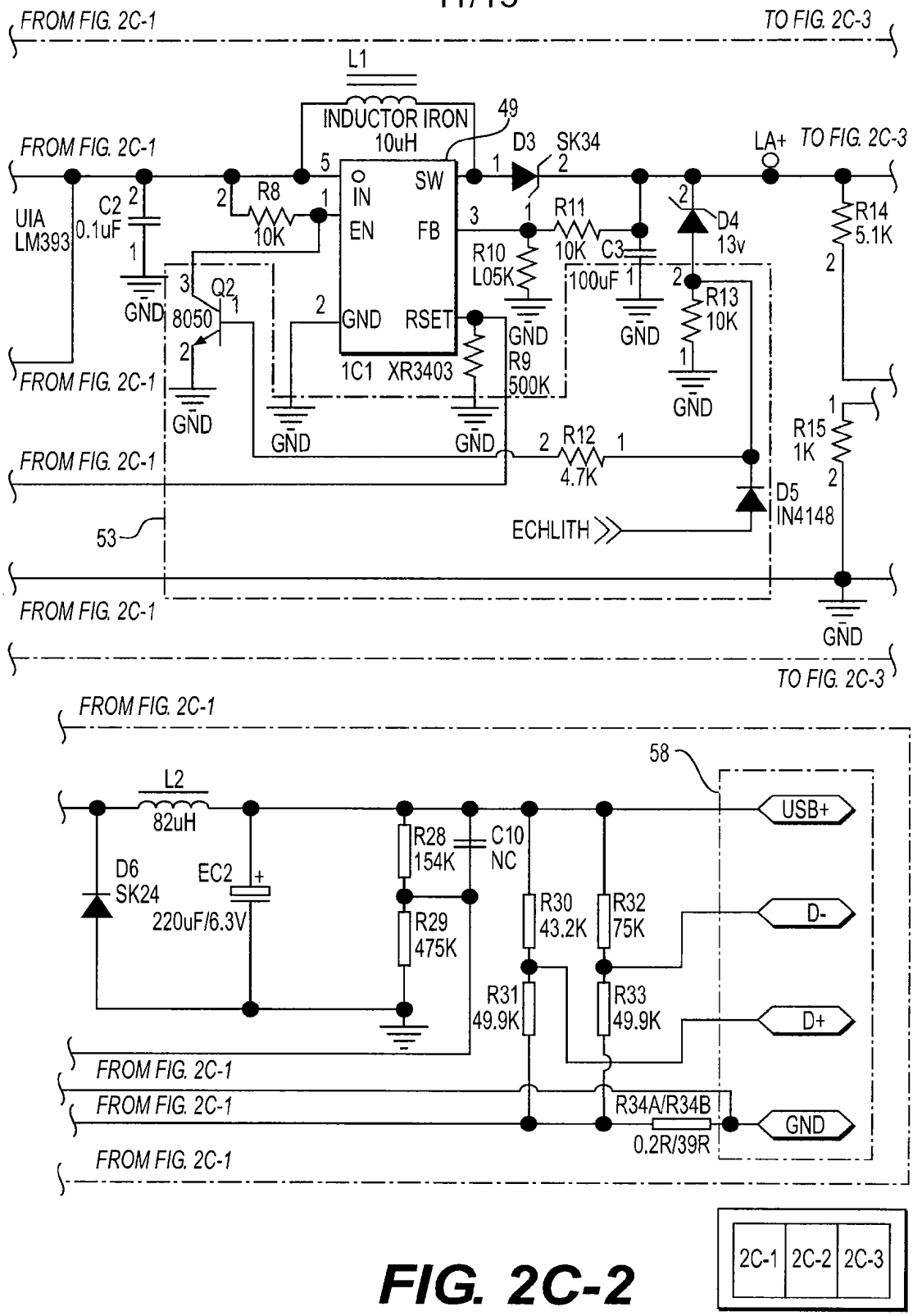
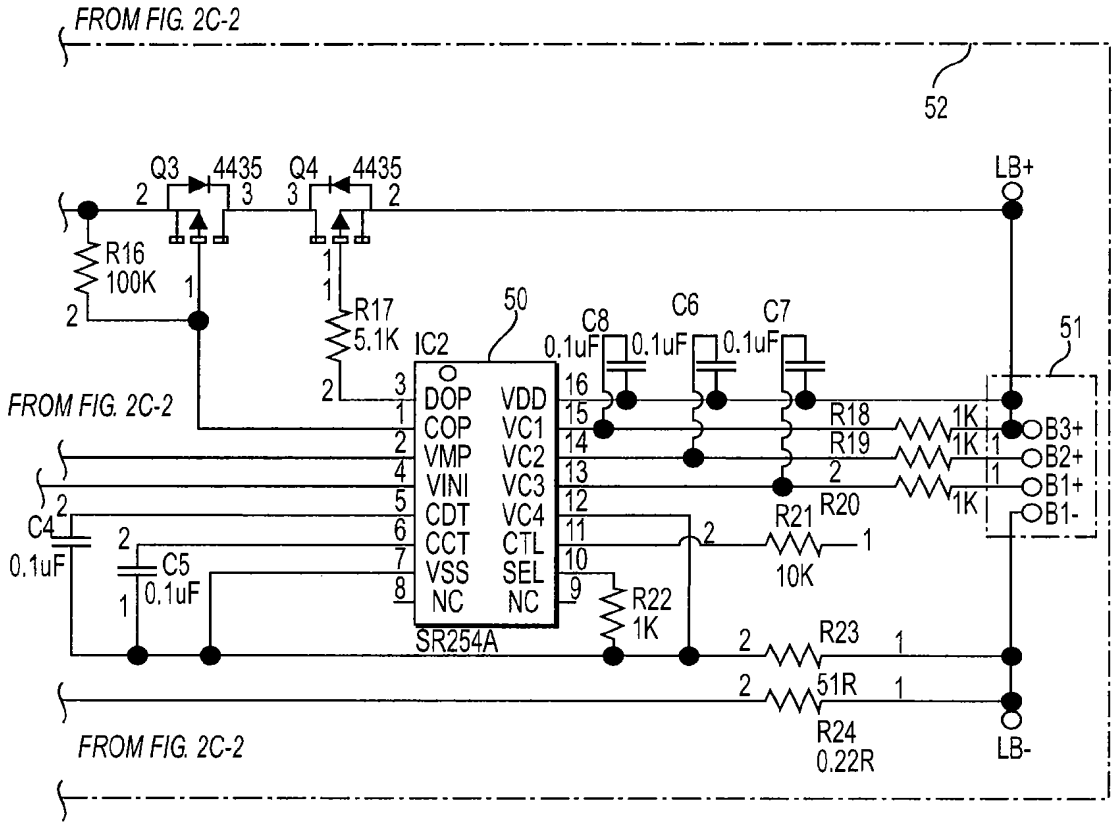


FIG. 2C-2

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12/13



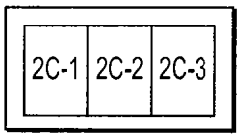


FIG. 2C-3

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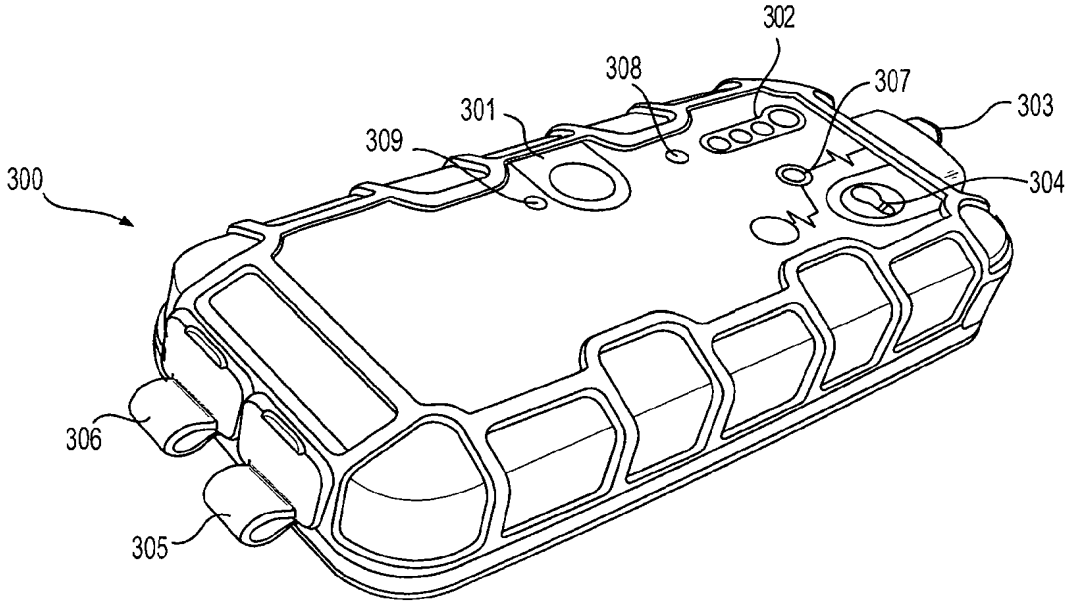


FIG. 3

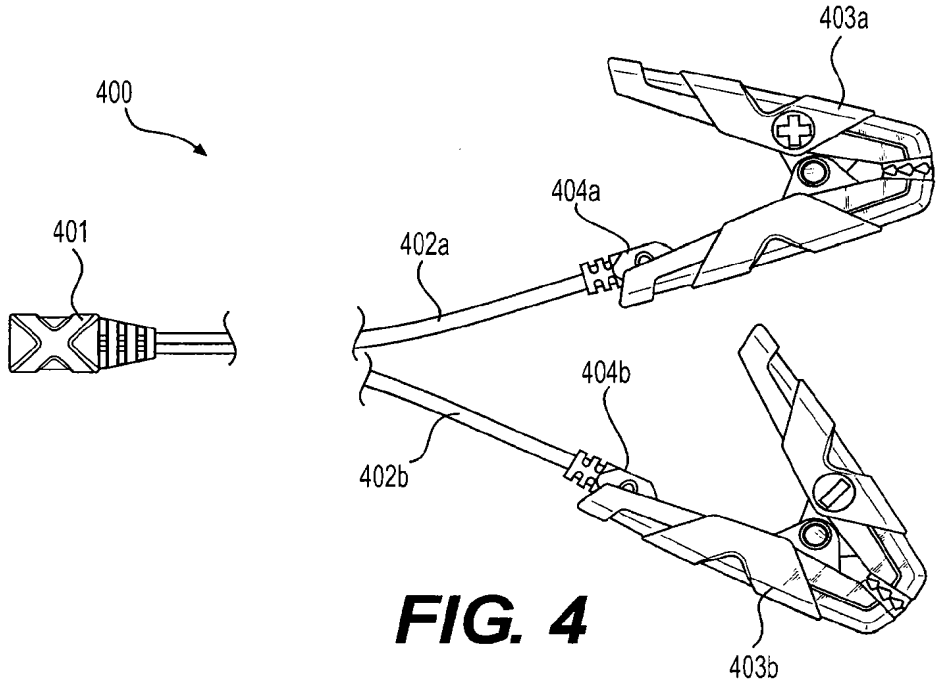


FIG. 4

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 616 409 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **94301838.2**

(22) Date of filing : **15.03.94**

(51) Int. Cl.[5] : **H02J 7/00**

(30) Priority : **17.03.93 GB 9305446**

(43) Date of publication of application :
21.09.94 Bulletin 94/38

(84) Designated Contracting States :
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

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(54) Portable electrical power supply.

(57) A portable power supply is shown generally at 10. The power supply comprises a sealed rechargeable lead acid battery 11 to which is connected a charging circuit 12 for charging the battery 11.

A switching unit 13 controls the switching of power from the battery 11 either to accessory sockets 14 or to power output leads represented by 15.

Between the switching unit 13 and the power output leads 15 are a reverse-polarity protection circuit 16, a vehicle-start test/timer unit 17 and a stand by/monitor circuit 18, the operation of all of which will be described below.

The power supply apparatus 10 is primarily for use in the supply of 12 V dc electrical power at locations remote from conventional electricity supplies. The battery 11, at the heart of the apparatus, can be recharged from either a domestic mains electricity supply, using an integral mains charger unit 19, or from a 12-18 V dc source, such as a vehicle cigar lighter socket, a photovoltaic solar cell array, a wind-driven generator etc. using an integral 12 V dc charger lead 20.

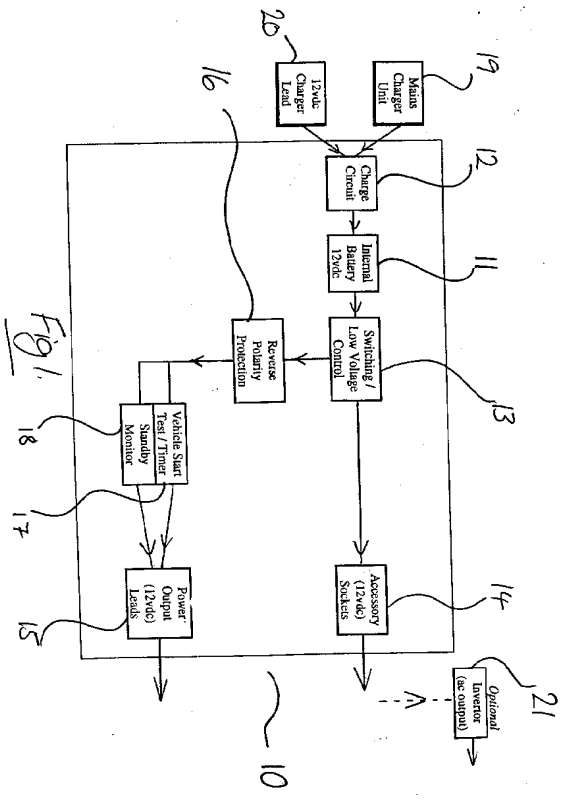


Fig 1.

EP 0 616 409 A2

ADC EX1002
IPR2025-00885

The present invention relates to a portable electrical power supply apparatus and to a method of supplying electrical power.

According to a first aspect of the present invention, there is provided portable apparatus for the supply of electrical power, the apparatus comprising rechargeable energy storage means arranged, in use, to store electrical energy, output means arranged, in use, to provide an output for electrical power from the storage means and charging means arranged, in use, to charge the storage means with electrical energy from an external source.

In a preferred arrangement the apparatus comprises a housing.

Preferably the storage means comprises at least one battery.

In a preferred arrangement, the charging means comprises an electrical charging circuit arranged, in use, to recharge the or each battery from an external source of electrical power.

The unit may be arranged to supply direct current electrical power. Alternatively or additionally, the apparatus may be arranged to supply alternating current electrical power.

The charging means may be arranged in use to recharge the or each battery from an external source of alternating current electrical power.

Preferably the charging means is arranged, in use, to recharge the or each battery from an external source of mains electrical power.

Alternatively or additionally, the charging means may be arranged in use to recharge the or each battery from an external source of direct current electrical power.

Preferably the charging means is arranged in use to recharge the or each battery from a direct current power source of a vehicle.

The apparatus preferably comprises a first monitor means arranged in use to monitor an external power supply. In a preferred arrangement, the apparatus is arranged in use to supply electrical power automatically to an external appliance according to the monitored condition of the external power supply.

The apparatus may be arranged in use to supply electrical power to an external appliance automatically, according to a condition of an external power supply to an external appliance, which condition is detected by the first monitor means.

The apparatus may comprise a second monitor means arranged, in use, to monitor a condition of an external appliance. Preferably, the apparatus is arranged in use to supply electrical power to an external appliance according to the monitored condition of the appliance, which condition is detected by the second monitoring means.

The first and second monitor means may comprise a common monitor means.

Preferably the apparatus comprises connection means for connection with an external battery. The connection means may comprise electrically conductive cables.

In a preferred arrangement, the apparatus comprises means to recharge a battery of a vehicle to which it is connected.

Alternatively or additionally, the apparatus may be arranged to supply electrical power to assist in the starting of a vehicle engine. Preferably, the apparatus is arranged in use to recharge to a predetermined extent a vehicle battery to which it is connected and to supply electrical power directly from its own battery for supplementing the vehicle battery during starting of the vehicle engine.

In a preferred arrangement the housing comprises a case. The case may comprise a closure member which is moveable between a first open position in which a user may gain access to one or more controls of the apparatus and a second closed position, in which the user may not so gain access.

The case may comprise a transparent window portion for enabling a user to see one or more controls of the apparatus.

In a preferred arrangement, the closure member comprises the transparent portion.

The case may be provided with at least one carrying handle.

Preferably the case comprises a bag.

According to a second aspect of the present invention, there is provided a method of starting an engine using a portable power supply apparatus, the method including electrically connecting the apparatus to terminals of a battery of the engine, supplying a charging current from a storage means of the apparatus to the battery of the engine to a predetermined extent, and subsequently switching on a starter motor of the engine whilst the apparatus is still electrically connected to the battery of the engine.

The method may comprise starting the engine using a portable power supply apparatus according to any statement herein.

According to a third aspect of the present invention, there is provided a method of supplying electrical power to an electrical appliance from portable supply apparatus, the method including supplying power from a rechargeable storage means to at least one output means, which output means is connected to the appliance.

Preferably the method includes recharging the storage means from either a mains electricity source or from a direct current power source.

The method may include supplying electrical power using apparatus according to any statement herein.

The invention may be carried into practice in various ways, but an embodiment will now be described by way of example with reference to the accompanying diagrammatic drawings in which:

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Figure 1 shows schematically a portable power supply apparatus according to one embodiment of the present invention, and

Figure 2 shows a carrying case for the apparatus of Figure 1.

Referring to Figure 1, a portable power supply is shown generally at 10. The power supply comprises a sealed rechargeable lead acid battery 11 to which is connected a charging circuit 12 for charging the battery 11.

A switching unit 13 controls the switching of power from the battery 11 either to accessory sockets 14 or to power output leads represented by 15.

Between the switching unit 13 and the power output leads 15 are a reverse-polarity protection circuit 16, a vehicle-start test/timer unit 17 and a stand by/monitor circuit 18, the operation of all of which will be described below.

The power supply apparatus 10 is primarily for use in the supply of 12 V dc electrical power at locations remote from conventional electricity supplies. The battery 11, at the heart of the apparatus, can be recharged from either a domestic mains electricity supply, using an integral mains charger unit 19, or from a 12-18 V dc source, such as a vehicle cigar lighter socket, a photovoltaic solar cell array, a wind-driven generator etc. using an integral 12 V dc charger lead 20.

For example, the mains charger unit 19 which is permanently attached to the apparatus on a short lead, permits full recharging of the battery 11 from a conventional mains electricity supply in around 15 hours. Alternatively, the 12 V dc lead permits recharging of the battery 11 from a vehicle's cigar lighter socket during a short journey.

The 12 V dc accessory sockets 14 comprise conventional vehicle cigar-lighter sockets which are protected by a 30 amp fuse (not shown). If it is required to operate a 12 V applicance in this way, the switch 13 is made to connect the sockets 14 to the battery 11 and the appliance is connected using a conventional cigar lighter plug, which fits into one of the sockets 14.

An optional inverter device 21 may be employed to provide a 240 V ac supply. This is achieved by connecting two cigar lighter plugs (not shown) of the device 21 into the two sockets 14.

In addition to supplying power to a range of 12 V appliances and a range of 240 V ac appliances the apparatus can also be used to assist the starting of a vehicle engine (not shown).

To do this, the switch unit 13 is made to connect the battery 11 to the leads 15. The leads 15 are then connected to terminals on the vehicle battery (not shown) and, for a predetermined time interval, the vehicle battery is charged from the internal battery 11 of the apparatus. Once the time interval has elapsed, the test/timer unit 17 provides a visual indication on the exterior of the apparatus to confirm this and the vehicle may be started. The leads 15 are left connected to the terminals of the vehicle battery so that the charge on the vehicle battery can be supplemented by the charge on the internal battery 11.

The reverse polarity protection circuit 16 is arranged to disconnect the internal battery 11 in the event that the leads 15 are connected to the wrong terminals on the battery, thereby avoiding damage to either the internal battery 11 or the vehicle battery (not shown).

The stand by/monitor 18 is used to monitor the charge on an external battery, for example, a caravan battery, which is being used to provide power for one or more appliances. In the event that the charge on the external battery falls below a predetermined level, the stand by/monitor unit detects this and begins to charge the external battery from the internal battery 11, thereby maintaining the operation of the appliances.

Additionally, the stand by/monitor unit can monitor a mains supply and, in the event of mains failure, can enable the internal battery 11 to provide a back up power supply for an appliance connected by the sockets 14.

In more detail, the switching unit 13 comprises a 3-way mechanical switch, the three positions of which correspond to: (1) output via the sockets 14, (2) off position, (3) output via the leads 15. In addition, the switching unit 13 comprises an energise switch, which electrically connects the sockets 14 to the internal battery 11 via a low voltage control circuit.

The accessory sockets are protected by a 30 amp fuse and are intended to deliver the 12 V output to a range of optional 12 V plug-in low current accessories. The low voltage control circuit operates via a small relay (not shown), which disconnects the output in order to prevent the output voltage from falling below a certain value, as power is drained by the accessory.

This prevents the internal battery 11 from going into deep-discharge from which it would be unlikely to recover.

The heavy duty power leads 15 are used in the engine's start facility and are capable of delivering up to around 200 amps. No fuse protection is provided for this output, but protection is obtained by use of a large relay (not shown), which disconnects the output leads 15 when the voltage falls to below a predetermined value (as it would if the leads 15 were accidentally shorted together).

When the apparatus is connected to an external 12 V battery (for example a caravan battery), the apparatus continuously monitors the voltage of that battery, and if it should fall below a predetermined level (for example 10.5 V), the apparatus automatically closes the contacts of a large relay so connecting the apparatus' internal battery 11 to the caravan battery.

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This results in the caravan battery being boosted for a short period of time until its voltage is recovered, at which time the apparatus disconnects the internal battery 11 from the load. This operation is repeated for as long as electrical charge remains in the apparatus' internal battery 11. The net result is that the caravan owner, for example, can arrange 12 V accessories in the caravan for longer than the caravan battery would permit.

The charge circuit 12 comprises a full-wave bridge rectifier (the input of which is 16.5 V ac from the mains charger unit 19), a smoothing and filtering circuit, a voltage regulator and an output protection diode (the output is 14.5 V dc) to charge the internal 12 V battery 11.

Referring to Figure 2, this shows a carrying case containing the apparatus of Figure 1. The case is in the form of a bag 22 having a zip-up flap 23 of transparent plastics material and a carrying strap 24 attached to each side of the bag 22 (only one attachment shown).

The transparent fold back flap 23 enables the user to see the controls without unzipping the flap 23. If, however, access to the controls is required, the flap 23 can be conveniently unzipped and folded back, for example to provide access to the accessory sockets 14 or to the three-position switch 25 of the switching unit 13 (see Figure 1).

The leads 15 (shown in Figure 1) are retained in internal compartments 26a and 26b, which are formed in cavities between an internal plastics box 28 in which the unit 10 is housed and the external canvas bag 22. Access to the leads 15 is obtained using a zipper 27, which extends around the side faces and bottom face of the bag 22.

The above-described invention provides a convenient fully portable and rechargeable power storage and supply unit. The canvas bag 22 is strong and weatherproof and is designed to be carried on the shoulder using the strap 24.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. Portable apparatus for the supply of electrical power characterised in that the apparatus comprises rechargeable energy storage means arranged, in use, to store electrical energy, output means arranged, in use, to provide an output for electrical power from the storage means and charging means arranged in use to charge the storage means with electrical energy from an external source.

2. Apparatus according to Claim 1, wherein the apparatus comprises a housing.

3. Apparatus according to Claim 1 or Claim 2, wherein the storage means comprises at least one battery.

4. Apparatus according to any of Claims 1 to 3, wherein the charging means comprises an electrical charging circuit arranged, in use, to recharge the or each battery from an external source of electrical power.

5. Apparatus according to any of Claims 1 to 4, wherein the unit is arranged to supply direct current electrical power.

6. Apparatus according to any of Claims 1 to 5, wherein the apparatus is arranged to supply alternating current electrical power.

7. Apparatus according to any of Claims 1 to 6, wherein the charging means is arranged in use to recharge the or each battery from an external source of alternating current electrical power.

8. Apparatus according to any of Claims 1 to 7, wherein the charging means is arranged, in use, to recharge the or each battery from an external source of mains electrical power.

9. Apparatus according to any of Claims 1 to 8, wherein the charging means is arranged in use to recharge the or each battery from an external

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source of direct current electrical power.

10. Apparatus according to any of Claims 1 to 9, wherein the charging means is arranged in use to recharge the or each battery from a direct current power source of a vehicle.

11. Apparatus according to any of Claims 1 to 10, wherein the apparatus comprises a first monitor means arranged in use to monitor an external power supply.

12. Apparatus according to Claim 11, wherein the apparatus is arranged in use to supply electrical power automatically to an external appliance according to the monitored condition of the external power supply.

13. Apparatus according to Claim 11 or Claim 12, wherein the apparatus is arranged in use to supply electrical power to an external appliance automatically, according to a condition of an external power supply to an external appliance, which condition is detected by the first monitor means.

14. Apparatus according to any of Claims 1 to 13, wherein the apparatus comprises a second monitor means arranged in use to monitor a condition of an external appliance.

15. Apparatus according to Claim 14, wherein the apparatus is arranged in use to supply electrical power to an external appliance according to the monitored condition of the appliance, which condition is detected by the second monitor means.

16. Apparatus according to Claim 11 and Claim 14, wherein the first and second monitor means comprise a common monitor means.

17. Apparatus according to Claim 2, wherein the housing comprises a case.

18. Apparatus according to Claim 17, wherein the case comprises a closure member which is moveable between a first open position in which a user may gain access to one or more controls of the apparatus and a second closed position in which the user may not so gain access.

19. Apparatus according to Claim 17 or 18 wherein the case comprises a transparent window portion for enabling a user to see one or more controls of the apparatus.

20. Apparatus according to Claim 19, wherein the closure member comprises the transparent portion.

21. Apparatus according to any of Claims 17 to 20, wherein the case comprises a bag.

22. A method of starting an engine using a portable power supply apparatus, the method including electrically connecting the apparatus to terminals of a battery of the engine, supplying a charging current from a storage means of the apparatus to the battery of the engine to a predetermined extent, and subsequently switching on a starter motor of the engine whilst the apparatus is still electrically connected to the battery of the engine.

23. A method of supplying electrical power to an electrical appliance from portable supply apparatus, the method including supplying power from a rechargable storage means to at least one output means, which output means is connected to the appliance.

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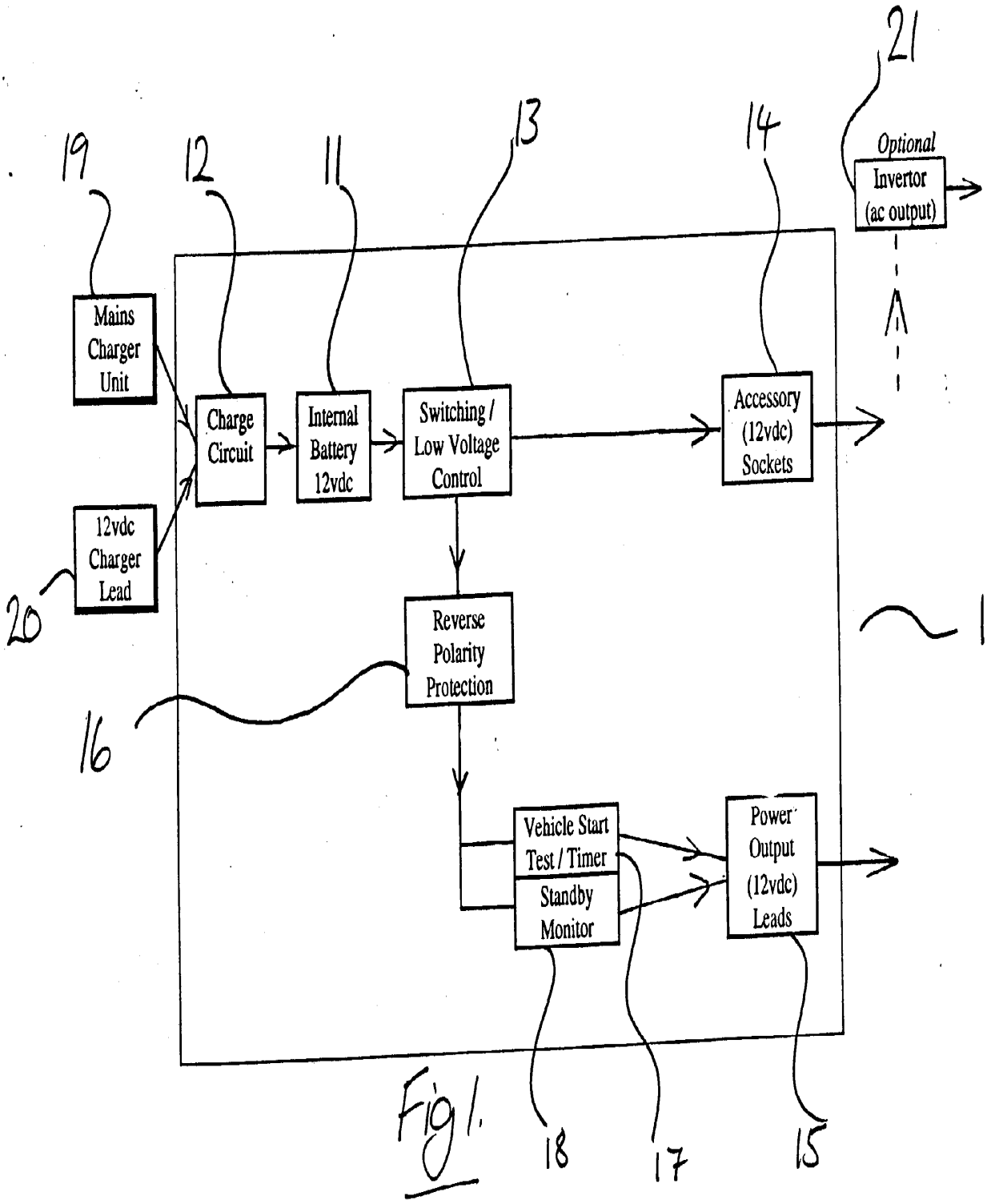


Fig 1.

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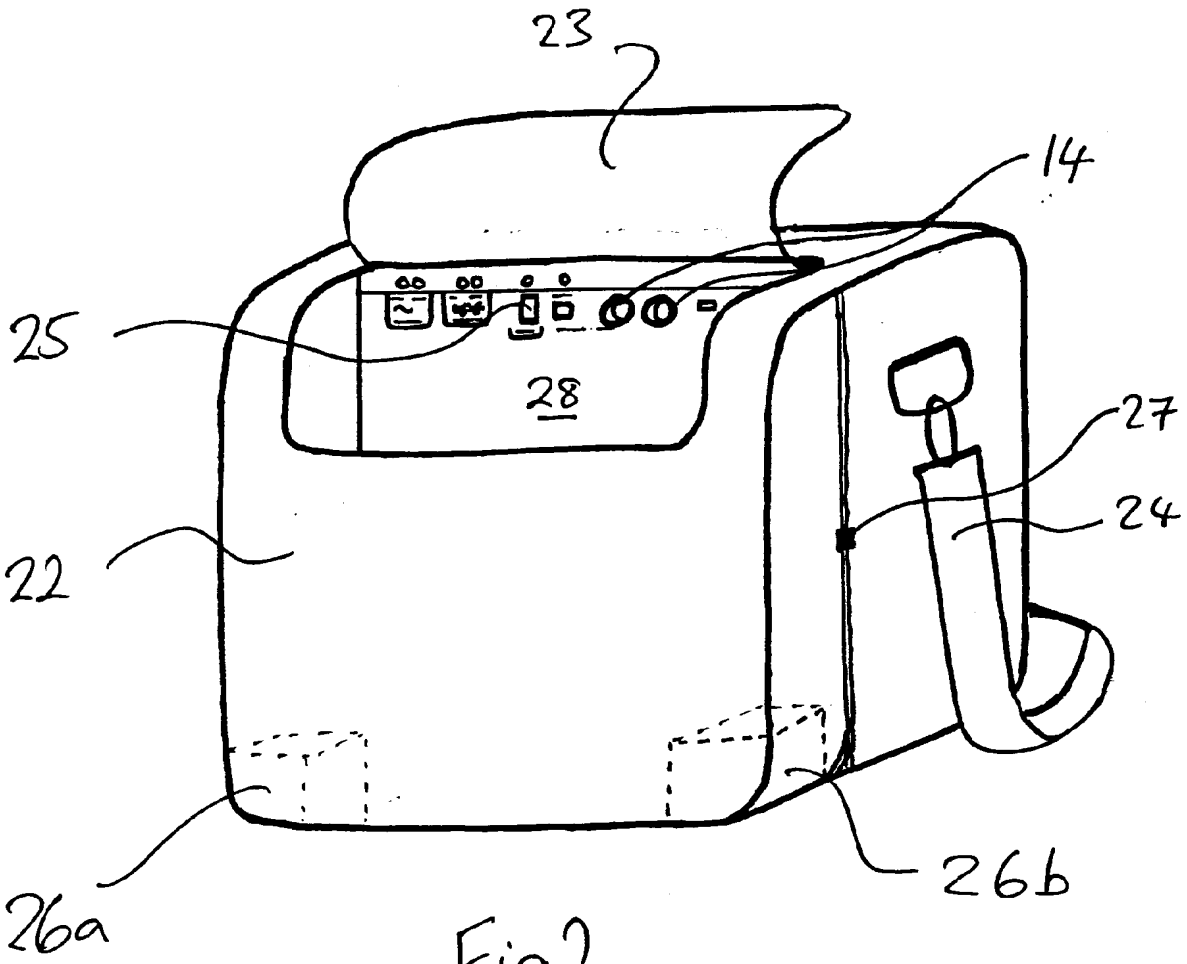


Fig2.

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(12) STANDARD PATENT APPLICATION (11) Application No. **AU 2019201081 A1**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Battery connector device for a battery jump starting device

(51) International Patent Classification(s)
F02N 11/12 (2006.01) ***H02J 7/00*** (2006.01)
F02N 11/14 (2006.01) ***H02J 7/32*** (2006.01)
F02N 19/00 (2010.01)

(21) Application No: **2019201081** (22) Date of Filing: **2019.02.15**

(43) Publication Date: **2019.03.07**
(43) Publication Journal Date: **2019.03.07**

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ABSTRACT

A battery device for use in a vehicle jump starter, the device comprising:

a battery comprising at least one battery cell having a positive terminal tab and a negative terminal tab;

a positive battery cable of the vehicle jump starter directly connected to the positive terminal tab of the at least one battery cell; and

a negative terminal conductor bar directly connected to the negative terminal tab of the at least one battery cell.

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TITLE

BATTERY CONNECTOR DEVICE FOR A BATTERY JUMP STARTING DEVICE

FIELD

A portable battery connector device, for example, a battery connector arrangement or assembly for a battery jump starting device, in particular a portable vehicle jump starting apparatus, configured for enhancing the conductivity between the battery of the jump starting apparatus and a battery being charged.

BACKGROUND

The exists a portable vehicle battery jump start apparatus as disclosed in U.S. Patent No. 9,007,015 to Nook et al. The apparatus utilizes a lithium ion battery pack. In this type of apparatus, there exists a need to maximize conductivity from the battery pack to the vehicle battery of the vehicle being jump started.

For successful car jump-starts, there are two main factors dictating the results. The first factor is the amount of power provided by the lithium ion battery pack, and the second factor is the maximum conductivity. You need both factors to have the best chance to jump-start big engines. One factor without the other factor is not enough.

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SUMMARY

The presently described subject matter is directed to a battery device, for example, a battery connector, battery connector arrangement, or battery conductor assembly for use in a device for jump starting a vehicle, and a device for jump starting a vehicle comprising the battery connector device.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having at least one battery conductor connected to a terminal of the battery.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having at least one battery conductor or cable connected to a battery tab of the battery.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive conductor and a negative conductor connected to the battery.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive conductor plate and/or a negative conductor plate connected to the battery.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive conductor plate and/or a negative conductor plate connected to the battery, and a positive cable connected to the positive conductor plate and/or a negative cable connected to the negative conductor plate.

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The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive battery conductor connected to a positive terminal of the battery and/or a negative battery conductor connected to a negative terminal of the battery.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive battery conductor connected to a positive terminal contact of the battery and/or a negative battery conductor connected to a negative terminal contact of the battery, the battery conductors being soldered to the respective terminals of the battery.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive battery conductor connected to a positive terminal of the battery and/or a negative battery conductor connected to a negative terminal contact of the battery, and a relay connected to one of the battery conductors of the battery.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive battery conductor connected to a positive terminal contact of the battery and/or a negative battery conductor connected to a negative terminal contact of the battery, and a relay connected to the negative battery conductor.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive battery conductor connected to a positive terminal contact of the battery and/or a negative battery conductor connected to

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a negative terminal contact of the battery, and a relay connected to the negative battery conductor.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive battery conductor connected to a positive terminal contact of the battery and/or a negative battery conductor connected to a negative terminal contact of the battery, and multiple relays connected to the negative battery conductor.

The presently described subject matter is directed to a battery connector device comprising or consisting of a battery having a positive battery conductor connected to a positive terminal contact of the battery and/or a negative battery conductor connected to a negative terminal contact of the battery, and a positive cable connected to the positive battery conductor.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a front view of the battery jump starting device with the clamps un-deployed.

FIG. 2 is a rear perspective view of the battery jump starting device shown in FIG. 1.

FIG. 3 is an end perspective view of the battery jump starting device shown in FIGS. 1 and 2.

FIG. 4 is a front perspective view of the battery jump starting device shown in FIG. 1, however, with the clamps deployed.

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FIG. 5 is a front perspective view of a battery connector device contained within the battery jump starting device shown in FIG. 1, however, with the negative cable not yet installed.

FIG. 6 is a top planer view of the battery connector device shown in FIG. 5.

FIG. 7 is a side elevational view of the battery connector device shown in FIG. 5.

FIG. 8 is an end elevational view of the battery connector device shown in FIG. 5.

FIG. 9 is a perspective view of the battery connector device shown in FIG. 5, however, with the negative cable connected to the battery connector device.

FIG. 10 is a view perspective view of the battery connector device shown in FIG. 5, however, with a diode connector installed on the positive cable.

FIG. 11 is a perspective view of the battery connector device connected to other components or parts of the battery jump starting device.

FIG. 12 is a perspective view of the battery assembly of the battery connector device shown in FIG. 5.

FIG. 13 is a front perspective view of another battery connector device for the battery jump starting device.

FIG. 14 is a detailed view of the positive cable connection with the relay printed circuit board prior to being soldered thereto.

FIG. 15 is a detailed view of the positive cable connection with the relay printed circuit board after being soldered thereto.

FIG. 16 is a front perspective view of the battery assembly of the battery connector device shown in FIG. 13.

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FIG. 17 is a partial top planar view of the battery assembly shown in FIG. 16, however, with the positive terminal conductor sheet in an unwound condition.

FIG. 18 is a partial top planer view of the positive terminal conductor of the battery assembly shown in FIG. 16.

FIG. 19 is an end perspective view of the positive terminal conductor partially wound around the end of the positive cable.

FIG. 20 is an end perspective view of the positive terminal conductor fully wound around the end of the positive cable.

FIG. 21 is a side perspective view of the positive terminal conductor fully wound around and soldered to the end of the positive cable.

FIG. 22 is an opposite end perspective view of the positive terminal conductor fully wound around and soldered to the end of the positive cable.

FIG. 23 is a perspective view of the diode connector between sections of the positive cable.

FIG. 24 is a perspective view of a Schottky Diode used in the diode connector.

FIG. 25 is a perspective view of the diode connector insulated with a shrink wrap sleeve.

FIG. 27 is a graphical illustration showing a load test of the battery connection shown in FIGS. 5-10.

FIG. 28 is a graphical illustration showing a load test of the battery connection shown in FIGS. 13-25.

FIG. 29 is a front view of a further battery connector device for the battery jump starting device.

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FIG. 30 is a front view of the battery connector device comprising a plurality of battery cells, separate tab, and conductors (e.g. plate conductors) prior to assembly.

FIG. 31 is a front view of the battery connector device comprising battery cells being prepared with separate tabs for lengthening the tabs.

FIG. 32 is a front view of the battery connector device comprising the plurality of battery cells, separate tab, and conductors shown in FIG. 30, after assembly.

FIG. 33 is a perspective view showing the battery connector device comprising the battery cell assembly shown in FIG. 32, after folding the battery cells.

FIG. 34 is an end perspective view of the battery connector device showing the separate tab being wrapped or wound around an exposed end of the positive cable, and soldered together.

FIG. 35 is an opposite end perspective view of the battery connector device showing a negative battery tab wrapped around the negative terminal conductor plate and welded and/or soldered together.

FIG. 36 is a perspective view of the battery connector device showing the flat separate tab connected to the battery and extending outwardly prior to connection to the positive cable.

FIG. 37 is a side view of the temperature sensor assembly with wires and connector.

FIG. 38 is a perspective view of the diode circuit board assembled connected inline or spliced into the positive cable.

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DETAILED DESCRIPTION

A battery jump starter device 10 is shown in FIGS. 1 and 2. The battery jump starting device 10 comprises a casing 12 having a display 14 provided with an arrangement of light emitting diodes (LEDs) 16.

The battery jump starting device 10 further comprises a positive cable 18 having a positive clamp 20 and a negative cable 22 having a negative clamp 24. The positive cable 18 and negative cable 22 pass through openings 12a, 12b, respectively, in the casing 12.

The clamps 20, 24 are stowed away or docked in an un-deployed mode by clamping each to a respective side posts 26 extending outwardly on opposite sides of the casing 12, as shown in FIG. 1. The side posts 26 are shown in FIG. 2. The clamps 20, 24 are docked when the battery jump starter device 10 is in non-use, and then unclamped from the side post 26 during use.

The battery jump starting device 10 is configured to jump start a vehicle battery. For example, the battery jump starting device 10 can be the PORTABLE VEHICLE JUMP START APPARATUS WITH SAFETY PROTECTION disclosed in U.S. Patent No. 9,007,015, which is fully incorporated herein by reference, or a device or apparatus similar thereto.

The battery jump starting device 10 comprises electrical components or parts located inside the casing 12. For example, the battery jump starting device 10 comprises a battery connector device 100 shown in FIGS. 3 - 9.

The battery connector device 100 comprises a battery assembly 110 having a battery 112. For example, the battery 112 is a lithium ion rechargeable type battery. The

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battery connector device 100 is configured to maximize conductivity from the battery 112 to the cables 18, 22 and clamps 20, 24 of the battery jump starter device 10. The battery 112 comprises a battery casing 112a, for example, a rectangular-shaped battery casing 112a.

The battery 112 comprises a positive tab at one end (e.g. width) of the battery 112, and a negative terminal tab at an opposite end (e.g. width) of the battery 112. For example, the battery 112 comprises one or more battery cells each having a positive and negative tab. For example, the positive tab from one battery cell is located at the one end of the battery 112 and the negative tab from one battery cell is located at the opposite end of the battery 112. A positive terminal conductor plate 114 is connected (e.g. soldered, welded, or sonically welded) at the one end of the battery 112 to the positive tab (i.e. contact) of the battery 112. The positive terminal conductor plate 114 extends along the one end (e.g. width) of the battery 112.

The positive cable 18 can be connected (e.g. directly connected by soldering) to the positive terminal conductor plate 114 and/or the positive tab of the battery 112. For example, the positive terminal conductor bar 114 can be provided with a conductive loop 116 wrapping around (e.g. entirely wrapping around) and connected (e.g. crimped and/or soldered) to an exposed end 18a of the positive cable 18. For example, the positive terminal conductor plate 114 is made from heavy gauge copper sheet (e.g. machined, cut, or stamped therefrom).

As shown in FIGS. 5 and 6, the positive terminal conductor sheet 114 can be configured (e.g. bent) to wrap around one of the square-shaped corners of the rectangular-shaped casing 112a of the battery 112 (e.g. L-shaped). The L-shaped

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positive terminal conductor sheet 114 can extend along an end of the battery 112 and along at least a portion of the side of the battery 112, as shown in FIG. 5.

The positive terminal conductor plate 114 can also be mechanically coupled and/or adhered to the outer surface of the battery casing 112a to provide additional support and stability thereof (e.g. assembled to survive mechanical shock when drop testing the battery jump starter device 10). For example, the positive terminal conductor bar 114 can be mechanically connected to the battery casing 112 by adhesive (e.g. silicon adhesive), double sided tape, double sided foam tape, insulated plastic or ceramic connector with snap fit connection and/or adhesive connection, and/or the battery casing 112 can be formed (e.g. molded) to mechanically connect (e.g. snap fit or interference connection) with the positive terminal conductor plate 114.

The positive cable 18 can be a single piece of wire or a cable (e.g. twisted or braided wires) extending from the battery 110 to the positive clamp 20. Specifically, one end of the positive cable 18 is connected to the positive terminal conductor plate 114 connected to the battery 18, and the opposite end of the positive cable 18 is connected to the positive clamp 20.

More specifically, the positive cable 18 can comprise a flexible or bent cable portion 118 for changing the direction of the positive cable 18 within the casing 12. The positive cable 18 can be fitted with a flexible outer sleeve portion 120 transitioning into a flexible inner sleeve portion 122 to flexibly accommodate the positive cable 18 passing through the casing 12. The flexible outer sleeve portion 120 is externally located relative to the casing 12 of the battery jump starter device 10, and the flexible inner sleeve

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portion 122 is internally located relative to the casing 12 of the battery jump starter device 10.

The flexible outer sleeve portion 120 is configured to reinforce the connection between the positive cable 18 and the casing 12 of the battery jump starter device while remaining flexible. For example, the flexible outer sleeve portion 120 is provided with one or more grooves 124 (e.g. three (3) shown in FIG. 5) exposing portions of the positive cable 18. The one or more grooves 124 act as hinges to ease bending of the positive cable 18 within the flexible outer sleeve portion 120.

The flexible sleeve 120 comprises an outer flange 124 spaced apart (e.g. a small distance equal to about a wall thickness of the casing 12 of the battery jump starter device 10) from an in inner flange 126. The flanges 124, 126 further anchor the positive cable 18 to the casing 12 of the battery jump starter device 10.

The flexible sleeve 120 comprises a sleeve portion 128 (FIG. 6) connecting together the outer flange 124 and inner flange 126. For example, the flexible outer sleeve portion 120 is molded or applied onto and around the positive cable 18 as a single unit (e.g. the flexible sleeve 120 is molded onto a portion of the positive cable 18 inserted within the mold during the molding process). Alternatively, the flexible sleeve 120 is made (e.g. molded) separately, and then installed or assembled onto a portion of the positive cable 18.

The positive cable 18 comprises an inner conductor 18b (e.g. single wire conductor, twisted wires, or braided wires) disposed within an outer insulating sheath 18c (e.g. extruded plastic sheath). The inner conductor 18b, for example, can be a solid wire conductor or a multi strand metal wire conductor comprising bundle of wires 18d.

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The inner wire can be made of copper or aluminum. The flexible sleeve 120 can be applied (e.g. molded or installed or assembled) onto and surrounding the outer insulating sheath 18c of the positive cable 18.

The battery connector device 100 further comprises a negative terminal conductor plate 130 connected (e.g. soldered, welded, or sonically welded) at an opposite end of the battery 112 to the negative tab (i.e. contact) of the battery 112. The negative terminal conductor plate 130 can extend along the opposite end of the battery 112.

The other end of the negative terminal conductor plate 130 is provided with a negative terminal conductor plate connector portion 132, as shown in FIGS. 5 and 6.

The negative terminal conductor plate 130 can be configured to wrap around one of the corners of the rectangular-shaped battery 112 (e.g. L-shaped). The L-shaped negative terminal conductor plate 130 can extend along an end of the battery 112 and along at least a portion of the side of the battery 112, as shown in FIGS. 5 and 6.

The negative terminal conductor bar 130 can also be mechanically coupled and/or adhered to the outer surface of the battery casing 112a to provide additional support and stability thereof (e.g. to survive mechanical shock when drop testing the battery jump starter device 10). For example, the negative terminal conductor bar 114 can be mechanically connected to the battery casing 112a by adhesive (e.g. silicon adhesive), double sided tape, double sided foam tape, insulating plastic or ceramic connector with snap fit connection and/or adhesive connection, and/or the battery casing 112 can be formed (e.g. molded) to mechanically connect (e.g. snap fit or interference connection) with the positive terminal conductor plate 114.

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The battery connector device 100 further comprises a smart switch battery interface 134. The smart switch battery interface 134 comprises a relay printed circuit board (PCB) 136 having a first circuit board conductor bar 138 spaced apart from a second circuit board conductor bar 140 located on one side of the circuit board 136, as shown in FIGS. 5 and 6.

A pair of relays 142 are mounted on an opposite side of the circuit board 136. The relays 142 include relay anchoring pins 142a located in through holes 136a in the relay printed circuit board 136 (FIGS. 5 and 7). The relays 142 further comprise relay connector pins 142b extending through the through holes 136b provided in the circuit board 136 and slots 138a provided in the first conductor bar 138. The relays 142 even further comprise relay connector pins 142c located in the through holes 136c provided in the circuit board 136 and through holes 140a provided in the second conductor bar 140. The relay anchoring pins 136a are soldered in place to mechanically connect the relays 142 to the circuit board 136. The relay connecting pins 142b and 142c are soldered in place to mechanically and electrically connect the relays 142, respectively, to the circuit board conductor plates 138, 140.

The through holes 136a in the circuit board 136 are rectangular-shaped (FIGS. 5 and 7) and accommodate the relay anchoring pins 142a. Specifically, a base portion of the relay anchoring pins 142a are rectangular-shaped with square-shaped ends. The square-shaped ends are dimensionally less wide verses the base portions creating transverse edges oriented flush with the outer surface of the circuit board 136. When solder is applied to the exposed ends of the relay anchoring pins 142a, the solder

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connects to the sides of the square-shaped ends and transverse edges to anchor and lock the relay anchoring pins to the circuit board 136.

The slots 132a provided in negative terminal conductor bar connector portion 132 are rectangular-shaped and the through holes138a in the first circuit board conductor bar 138 (FIG. 3) are T-shaped to accommodate the three (3) horizontally oriented relay connector pins 142b, as shown in FIG. 3. The ends of the relay connector pins 142b are shown flush with the outer surface of the negative terminal conductor bar connector portion 132. When solder is applied to the exposed ends of the relay connector pins 142b, the solder fills in the slots 132a in the negative terminal conductor bar connector portion 132 and the through holes 138a of the first circuit board conductor bar 138, and connects the sides of the connector pins 142b with inner edges of the slots 132a and through holes 138a to anchoring the relays 142 to the circuit board 136 and negative terminal conductor bar connector portion 132. This applied solder also electrically connects the negative terminal conductor bar connector portion 132 to the first circuit board conductor bar 138.

The through holes 140a provided in the second circuit board conductor bar 140 are T-shaped to accommodate the three (3) vertically oriented relay connecting pins 142c, as shown in FIG. 3. The relay connector prongs 140a extend outwardly from the outer surface of the circuit board 136 to connect with the exposed conductor end 144a of the negative cable 144, and shown in FIG. 7. When solder is applied to the exposed conductor end 144a and the ends of the relay connector prongs 140a, the solder fills in the T-shaped slot and electrically connects the relay connector prongs 140a, second

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circuit board conductor 140, and exposed conductor end 144a of the negative cable 144.

The negative terminal conductor bar connector portion 132 of the negative terminal conductor bar 130 is connected (e.g. by soldering) to the first circuit board conductor bar 138 of the circuit board 136. The exposed conductor end 22a (i.e. with the insulating sheath removed) of the negative cable 22 is connected (e.g. by soldering) to the second circuit board conductor bar 140, as shown in FIG. 9.

The battery connector device 100 can be modified by providing the positive cable 18 with a diode connection 150, as shown in FIG. 10. For example, a diode connection is installed (e.g. spliced) into the positive cable 18. The diode connection 150 comprises a diode printed circuit board (PCB) 152 provided with a set of back-charge diodes 154 (e.g. Schottky Diodes) located on one side thereof, and a conductor bar 156 provided on an opposite side of the circuit board 152.

ASSEMBLY

The battery jump starting device 10 comprises the casing 12 having an upper casing portion 12a and a lower casing portion 12b, as shown in FIG. 11. The upper casing portion 12a and the lower casing portion 12b are configured to be connected together when assembling the battery jump starting device 10.

The battery jump starting device 10 further comprises the battery connection device 100 and controller assembly 210 both disposed within the casing 12. The

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controller assembly 210 comprises a circuit board 212 located adjacent to another circuit board 214.

The positive terminal of the battery assembly 110 (FIG. 12) is connected to the circuit board 212 via a positive power wire 216. For example, the positive power wire 216 is soldered to the positive conductor bar 114 (FIG. 5). The negative terminal of the battery assembly 110 is connected to the circuit board 214 via a negative power wire 218.

The relay circuit board 136 is provided with a wire set 220 having a connector 222. The connector 222 is configured to connect with the relay board connector 224 located on the circuit board 212 of the controller assembly 210 during assembly of the battery jump starting device 10.

The battery assembly 110 further comprises a wire set 226 having a connector 228. The connector 228 is configured to connect with the battery cell charging/monitoring connector 230 located on the circuit board 212 of the controller assembly 220.

The battery assembly 110 also comprises a battery temperature sensor having a wire set 232 having a connector 234. The connector 234 is configured to connect with the temperature sensor connector 236 located on the circuit board 212 of the controller assembly 220.

The circuit board 212 is provided with in charge power resistors 240 and an out relay 242, as shown in FIG. 11. Further, the lower casing portion 12a is provided with a main user out connector 244 having a wire set 246 connected to the circuit board 214,

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and a main user in connector 248 having a wire set 250 connected to the circuit board 214.

The battery assembly 110 is connected to battery jump starting device 10, as shown in FIG. 11. The battery connector device 110 is installed within the casing 12 of the battery jump starting device 10 when assembled.

ENHANCED CONDUCTIVITY

An enhanced conductivity battery connector device 400 is shown in FIGS. 13 – 25. The enhanced conductivity battery connector device 400 provides a significantly increased conductivity compared to the battery connector device 100, as shown in FIGS. 5 – 10.

The amount of power to be conducted from the battery 412 to the clamps can be enhanced as follows:

1) Increase Wire Gauge

e.g. change 4AWG (American Wire Gage) positive cable 18 and negative cable 22 (FIG. 9) to a 2AWG positive cable 318 and negative cable 322 (FIGS. 13 and 15).

2) Increase Conductivity of Negative Cable Connection

e.g. negative cable end 322a (FIG. 15) connection to the relays will extend all the way across the connector pins 422c of the relays 422.

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3) Increase Conductivity of Positive Cable Connection

e.g. the positive battery tab 414 is lengthened so that the positive cable 318 can be rolled up (FIGS. 17-22) in the positive battery tab 414 and soldered together thoroughly;

4) Increase Conductivity of Diode Connection

e.g. replace the diode connection 150 (FIG. 5) with the diode connection 450 (FIG. 23).

5) Redesign Resistor/Diode Printed Circuit Board (PCB)

e.g. replace the diode printed circuit board (PCB) 152 (FIG. 10) with the diode printed circuit board (PCB) 452 (FIG. 23).

6) Reconnect Resistors

e.g. reconnect resistors R134A&B, R135A&B located on the diode printed circuit board (PCB) 152 (FIG. 10) to be connected again.

A detailed description of each of these enhanced conductivity features or arrangement is set forth below.

1) Increase Wire Gauge

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The gauge of the positive cable 18 and negative cable 22 (FIG. 9), for example, can be increased from 4AWG (American Wire Gage) cable to a 2AWG cable for positive cable 318 and negative cable 322 (FIGS. 13 and 15). The comparative specifications of the 4AWG cable and 2AWG cable are as follows:

	2AWG	4AWG
Diameter	0.2576 in	0.2294 in
	(6.544 mm)	(5.189 mm)
Turns of wire	3.88/in	4.89/in
	(1.53/cm)	(1.93/cm)
Area	66.4 kcmil	41.7 kcmil
	(33.6 mm^2)	(21.2 mm^2)
Resistance/length	0.5127 mΩ/m	0.8152 mΩ/m
	(0.1563 mΩ/ft)	(0.2485 mΩ/m)
Ampacity	95 (60° C)	70 (60° C)
	115 (75° C)	85 (75° C)
	130 (90° C)	95 (90° C)
Fusing current	1.3 kA (10 s)	946 A (10 s)
	10.2 kA (1s)	6.4 kA (1 s)
	57kA (32 ms)	36 kA (32 ms)

The 2AWG cable provides a significant increase of conductivity (i.e. ampacity) compared to the 4AWG cable (i.e. approximately 36%).

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2) Increase Conductivity of Negative Cable Connection

The negative cable 322 (FIG. 15) can be connected to the battery 412 (FIG. 13) in a manner to increase the conductivity (i.e. ampacity) between the battery 412 and negative cable 322. For example, the negative cable end 322a can be directly connected (e.g. soldered) to the connector prongs 442c (FIG. 15) of the relays 442. Specifically, the negative cable end 322a can extend across and directly connect to all relays 342 of the smart switch battery interface 434, as shown in FIGS. 14 and 15. Further, the negative cable end 322a can be connected to a conductor loop 441 of the circuit board conductor bar 440.

The negative cable 322, for example, can be stranded wire comprising an inner electrical wire conductor 322b composed of an untwisted or twisted bundle of wires 322d disposed within an outer electrical insulating sheath 322c. The electrical insulating sheath 322c of the negative cable 322 can be removed from the negative cable end 322a exposing the inner electrical conductor 322b at the negative cable end 322a.

The exposed bundle of wires 322d of the electrical conductor 322b can be forced over the ends of the exposed connector pins 442c of the relays 442 so that strands of wires 322d are captured between the adjacent connector pins 442c. The exposed bundles of wires 332d can be further forced into contact with the conductor bar 440 (e.g. made of copper). Solder 423 is applied to this assembly so that the solder flows between the exposed bundles of wires 422d to the connector pins 442c and the conductor bar 440 to complete the electrical connection between the negative cable 322 and the smart switch battery interface 434 connected to the battery 412.

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The length of the exposed bundle of wires 322d is selected so that exposed bundle of wires 322d directly connects with each set of connector pins 442c of each and every relay 442 to provide the maximum electrical conductivity (i.e. maximum ampacity) between the negative cable 322 and the battery 412.

3) Increase Conductivity of Positive Cable Connection

The positive cable 318 can be connected to the battery 412 in a manner to increase the conductivity (i.e. ampacity) between the battery 412 and positive cable 318. For example, the positive cable 318 can be rolled up in the positive battery tab 414 and soldered together thoroughly. The connection between the positive cable 318 and battery 412 is shown in FIGS. 16-22.

The positive cable 318, for example, can be stranded wire comprising an inner electrical wire conductor 318b composed of an untwisted or twisted bundle of wires 318d disposed within an outer electrical insulating sheath 318c. The electrical insulating sheath 318c of the positive cable 318 can be removed from the positive cable end 318a exposing the inner electrical conductor 318b at the positive cable end 318a.

The battery 412 is provided with a positive battery tab 414. The positive battery tab 414 is a metal sheet (e.g. copper sheet) connected to the positive terminal tab 414 of the battery 412.

The exposed bundle of wires 318d of the inner electrical conductor 318b can be soldered with tin, and then rolled up within the positive battery tab 312a. Solder 415 (FIG. 21) is applied to the exposed bundle of wires 318d and the positive battery tab 312a.

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The length of the exposed bundle of wires 318d is selected so that exposed bundle of wires 318d directly connects with the full width of the positive battery tab 414 to provide the maximum electrical conductivity (i.e. maximum ampacity) between the battery 312 and the positive cable 318.

4) Increase Conductivity of Diode Connection

The positive cable 318 can be provided with a diode connection 450 configured to increase the conductivity along the positive cable 318, as shown in FIGS. 23 – 25.

The diode connection 450 comprises a plurality of diodes 454 connected between positive cable sections 318e and 318f (FIG. 25). For example, the diode connection 450 comprises six (6) back-charge type diodes (e.g. Schottky barrier diodes).

The diodes 454 are soldered between the positive cable sections 318e and 318f. Specifically, the diode conductor tabs 454a are soldered to the positive cable section 318e and the diode conductor prongs 454b are soldered to the positive cable section 318f. More specifically, the diode conductor prongs 454b of the diodes 354 extend through the diode circuit board 452, extend into the bundle of wires 318b, and then are soldered in place completing assembly of the diode connection 450.

The diode connection 450 is then insulated, for example, using a shrink wrap insulator 455 (FIG. 25), which is applied around the diode connection 450, and then shrunk by applying heat (e.g. using heat gun).

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5) Redesign Resistor/Diode Printed Circuit Board (PCB)

e.g. redesign of resistor/diode PCB to eliminate the diodes extending therefrom;

6) Reconnect Resistors

e.g. reconnect resistors R134A&B, R135A&B that are on the Resistor/Diode PCB to be connected again.

TEST #1

The battery connection device 100 shown in FIG. 5 was subjected to a 1250A Load Test. The results are shown in FIG. 27, and as follows:

Pulse #1 Average Power of 4799.01W

Pulse #2 Average Power of 5528.99W

Pulse #3 Average Power of 6101.63W

TEST #2

The battery connection device 400 shown in FIG. 13 was subjected to a 1250A Load Test. The results are shown in FIG. 28, and as follows:

Pulse #1 Average Power of 6584.61W

Pulse #2 Average Power of 7149.60W

Pulse #3 Average Power of 7325.91W

This results in a significant increase of approximately twenty percent (20%) for peak power compared to the results of TEST #1.

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Another enhanced conductivity battery conductor device 500 is shown in FIGS. 29 - 37. The enhanced conductivity battery connector device 500 provides a significantly increased conductivity compared to the battery connector device 100, as shown in FIGS. 5 – 10.

The battery conductor device 500 comprises the battery assembly 410, including the battery 512 connected to the positive cable 518 and the negative terminal conductor plate 530. A positive wire 519 is connected directly or indirectly to the positive tab or positive cable 518 of the battery 530, and a negative wire 523 is connected directly or indirectly to the negative tab or negative terminal conductor plate 530. The battery conductor device 500 can further include a bundle of wires 570 connected to or associated with the operation of the battery 512 (e.g. battery temperature sensor, power supply, etc.).

The battery 512 can comprise a single battery cell 512c (FIG. 30), or multiple battery cells 512C connected end-to-end in series. Three (3) separate battery cells 512c are shown in FIG. 30.

The battery cells 512c each have positive and negative tabs 512d located at opposite ends of each battery cell 512c. The battery cells 512c are connected together in series by welding (e.g. sonically and/or thermally welding) and/or soldering respective positive and negative tabs 512d together. For example, the tabs 512d are positioned so as to overlap each other (e.g. edges overlapping opposite tab 512d, or edge-to-edge).

The tabs 512d are metal plates (e.g. relative thin metal foils) extending outwardly from the body and opposite edges of each battery cell 512c. As shown in FIG. 30, the tabs 512d extend along opposite edges at the width of each battery cell 512c. The tabs

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512d are each centered and extend most of the width of each opposite edge of each battery cell 512c.

As shown in FIGS. 30 and 31, a separate tab 512e is added or connected to the right side of the battery cell 512c to extend the length of the tab 512d. The separate tab 512e is shown as having the same width as the tab 512d; however, this width can be different. To assemble the separate tab 512e to the tab 512d, for example, the separate tab 512e is positioned to overlap over the tab 512d, and then welded (e.g. sonically and/or thermally welded) and/or soldered together. The exposed end of the positive cable 518 is then wound up inside the separate tab, as shown in FIGS. 32 and 34. For example, the initially flat separate tab 512e is wrapped around the exposed end of the positive cable 518, and then connected to the exposed end by welding (e.g. sonically and/or thermally welding) and/or soldering. For example, a layer of solder is applied to one or both sides of the separate tab 512e, and then after wrapping the separate tab 512e around the exposed end of the positive wire 518, the assembly is heated to melt the layered solder and solder the assembly together.

The three (3) battery cells 512c once connected together, as shown in FIG. 32, are then folded over each other into the layered battery cell arrangement shown in FIG. 33. The layered battery cell arrangement can be packaged (e.g. the three (3) battery cells can be taped or shrink wrapped together), or placed within a battery cover or casing, as shown in FIG. 34.

As shown in FIG. 35, the negative tab 512d can be attached to the negative terminal conductor plate 530. For example, the negative tab 512d can be wrapped partially or fully, as shown, around the negative terminal conductor plate 530. The

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negative tab 512d can be provided with a plurality of through holes 512f to facilitate welding and/or soldering the negative tab 512d to the negative terminal conductor plate 530. For example, the through holes 512f can be square-shaped through holes arranged into a matrix, as shown in FIG. 35. The negative wire 523 is shown connected (e.g. soldered) to the negative tab 512d.

A separate tab 512e (see FIG. 30) can be connected to the negative tab 512d to lengthen same, so that the lengthened negative tab can be wrapped or wound around the negative terminal conductor plate 530 more than one time (e.g. 2, 3, 4, or more times). In this manner, the electrical connection between the negative tab 512d and the negative terminal conductor plate 530 can be enhanced. The separate tab 512e can be provided with a layer of solder on one or both sides, so that after the separate tab 512e is wrapped or wound around the negative terminal conductor plate 530, this assembly can be heated up to solder the separate tab 512e onto the negative terminal conductor plate 530.

The completed assembly of the battery conductor device 500 with the connected separate positive tab 512d ready to be wrapped or wound an exposed end of the positive cable 518 (FIG. 29) can be seen in FIG. 36. The bundle of wires 570 shown in FIG. 36, includes wires 572 for a temperature sensor embedded within the battery 512 (e.g. temperature sensor located near battery tab or between battery cells. The temperature sensor 574 having two (2) wires 572a, 572b is shown in FIG. 37.

The battery conductor device 500 can comprise a diode connector 550 connected inline or splice into the positive cable 518, as shown in FIG. 38.

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The battery conductor device 500 comprises a diode circuit board 552 having a plurality of diodes 454 assembled thereon. The diodes 454 each have a diode conductor tab 454a connected (e.g. soldered) to an exposed end of the positive cable 518. The prongs of the diodes 454 extend through holes in the diode circuit board 552, and are soldered to both the conductive traces and exposed end of the positive cable 518 along with a resistor 576 to complete the assembly.

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CLAIMS

1. A battery connector device for a battery jump starting device having a smart switch, the device comprising:

a battery comprising a positive terminal tab and a negative terminal tab;

a positive terminal conductor sheet connected to the positive terminal tab of the battery;

a negative terminal conductor bar connected to the negative terminal tab of the battery;

a positive cable connected to the positive terminal conductor sheet of the battery;

a smart switch interface connectable to the smart switch of the jump starting device, the smart switch interface comprising a circuit board having a first circuit board conductor bar spaced apart from a second circuit board conductor bar, the first circuit board conductor bar electrically connected to the negative terminal conductor bar of the battery, the smart switch interface further comprising one or more relays connected between the first circuit board conductor bar and the second circuit board conductor bar for providing isolation between the negative terminal tab of the battery and a battery being jump started; and

a negative cable connected to the second circuit board conductor bar.

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2. A battery connector device for a battery jump starting device having a smart switch, the device comprising:

a rechargeable battery comprising a positive terminal tab and a negative terminal tab;

a positive terminal conductor sheet connected to the positive terminal tab of the battery;

a negative terminal conductor bar connected to the negative terminal tab of the battery;

a positive cable connected to the positive terminal conductor sheet of the battery;

a smart switch interface connectable to the smart switch of the jump starting device, the smart switch interface comprising a circuit board having a first circuit board conductor bar spaced apart from a second circuit board conductor bar, the first circuit board conductor bar electrically connected to the negative terminal conductor bar of the battery, the smart switch interface further comprising a plurality of relays each connected between the first circuit board conductor bar and the second circuit board conductor bar for providing isolation between the negative terminal tab of the battery and a battery being jump started; and

a negative cable connected to the second circuit board conductor bar, the negative cable directly electrically connecting to each of the plurality of relays.

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3. A battery connector device for a battery jump starting device having a smart switch, the device comprising:

a rechargeable battery comprising a positive terminal tab and a negative terminal tab;

a positive terminal conductor sheet connected to the positive terminal tab of the battery;

a negative terminal conductor bar connected to the negative terminal tab of the battery;

a positive cable connected to the positive terminal conductor sheet of the battery;

a smart switch interface connectable to the smart switch of the jump starting device, the smart switch interface comprising a circuit board having a first circuit board conductor bar spaced apart from a second circuit board conductor bar, the first circuit board conductor bar electrically connected to the negative terminal conductor bar of the battery, the smart switch interface further comprising multiple relays each connected between the first circuit board conductor bar and the second circuit board conductor bar for providing isolation between the negative terminal tab of the battery and a battery being jump started;

a negative cable connected to the second circuit board conductor bar, the negative cable directly electrically connecting to each of the plurality of relays; and

a diode connection provided between a first section of the positive cable and a second section of the positive cable.

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4. The device according to claim 1, wherein the one or more relays is multiple relays connected in parallel between the first circuit board conductor bar and the second circuit board conductor bar.

5. The device according to claim 1, wherein the negative terminal conductor bar is configured to mechanically and electrically connect the battery to the smart switch battery interface.

6. The device according to claim 5, wherein the negative terminal conductor bar is configured to position the smart switch battery above and adjacent to the battery.

7. The device according to claim 1, wherein the positive terminal conductor sheet wraps around one end of the positive cable to electrically connect the battery to the positive cable.

8. The device according to claim 1, wherein the positive terminal conductor bar is ultrasonically welded to the positive terminal tab of the battery and the negative terminal conductor bar is ultrasonically welded to the negative terminal tab of the battery.

9. The device according to claim 1, wherein the battery is rectangular-shaped and a width of the positive terminal conductor sheet of the battery is equal to the width of the battery, and the negative terminal conductor bar is L-shaped and configured to wrap around a respective corner of the battery.

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10. The device according to claim 9, wherein the battery tabs are mounted flush with a casing of the battery.

11. The device according to claim 1, wherein a diode connection is provided between a first section of the positive cable and a second section of the positive cable.

12. The device according to claim 11, wherein the diode connection comprises one or more diodes connected between the first section of the positive cable and the second section of the positive cable.

13. The device according to claim 12, wherein the diode connection comprises multiple diodes each connected between the first section of the positive cable and the second section of the positive cable.

14. The device according to claim 13, wherein conductor tabs of the multiple diodes are connected to the first section of the positive cable and the conductor prongs of the multiple diodes are connected to the second section of the positive cable.

15. The device according to claim 14, wherein the multiple diodes are connected to a printed circuit board.

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16. The device according to claim 15, wherein the conductor prongs of the multiple diodes extend through the printed circuit board and electrically connect with the second section of the conductor prongs.

17. The device according to claim 16, wherein the multiple diodes are arranged abutting each other along a single axis.

18. The device according to claim 13, wherein the diode connector is insulated with a heat shrink insulator.

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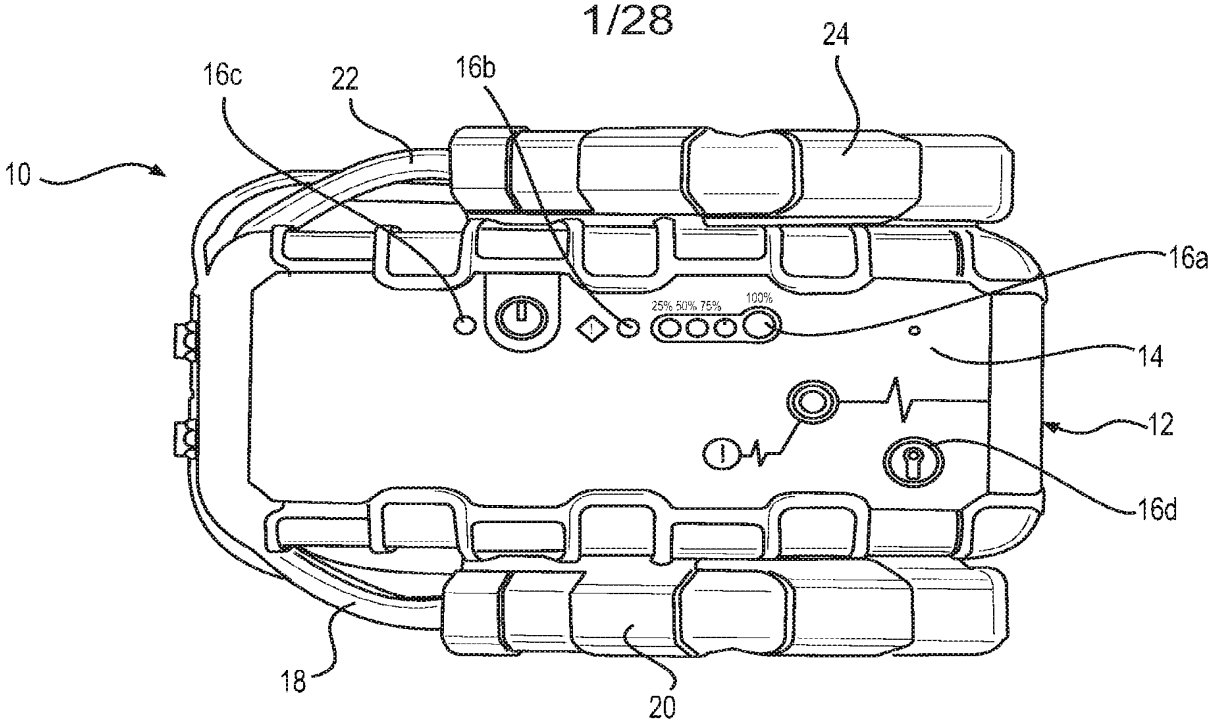


FIG. 1

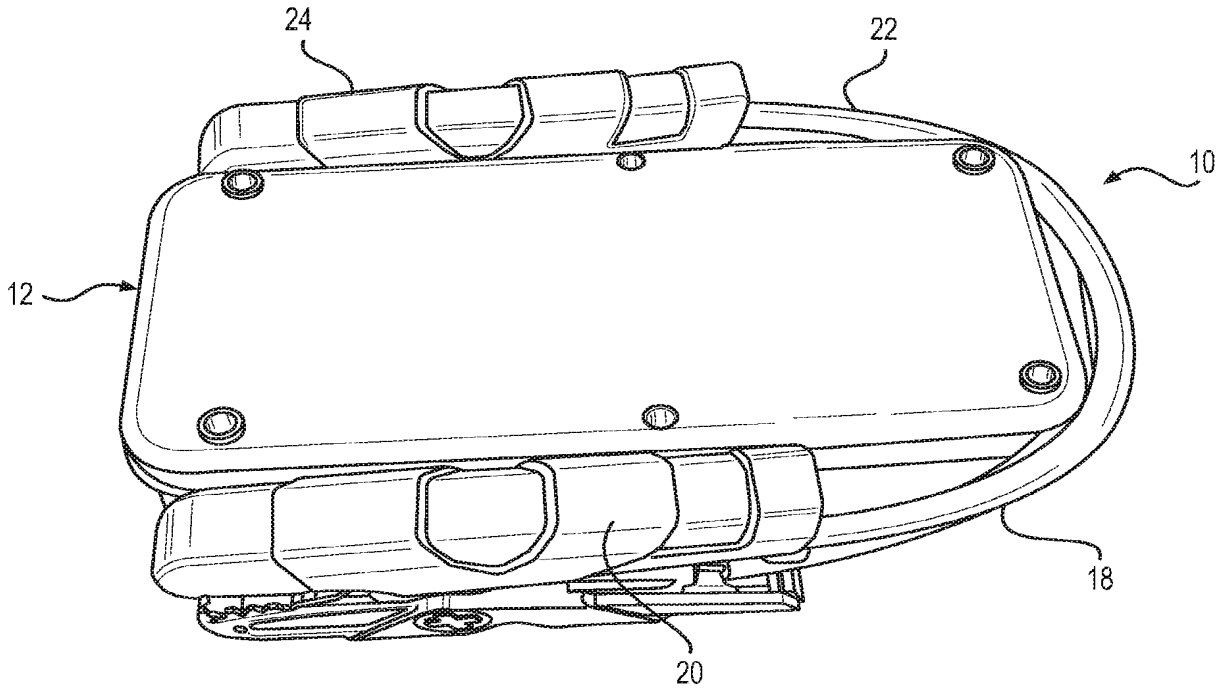


FIG. 2

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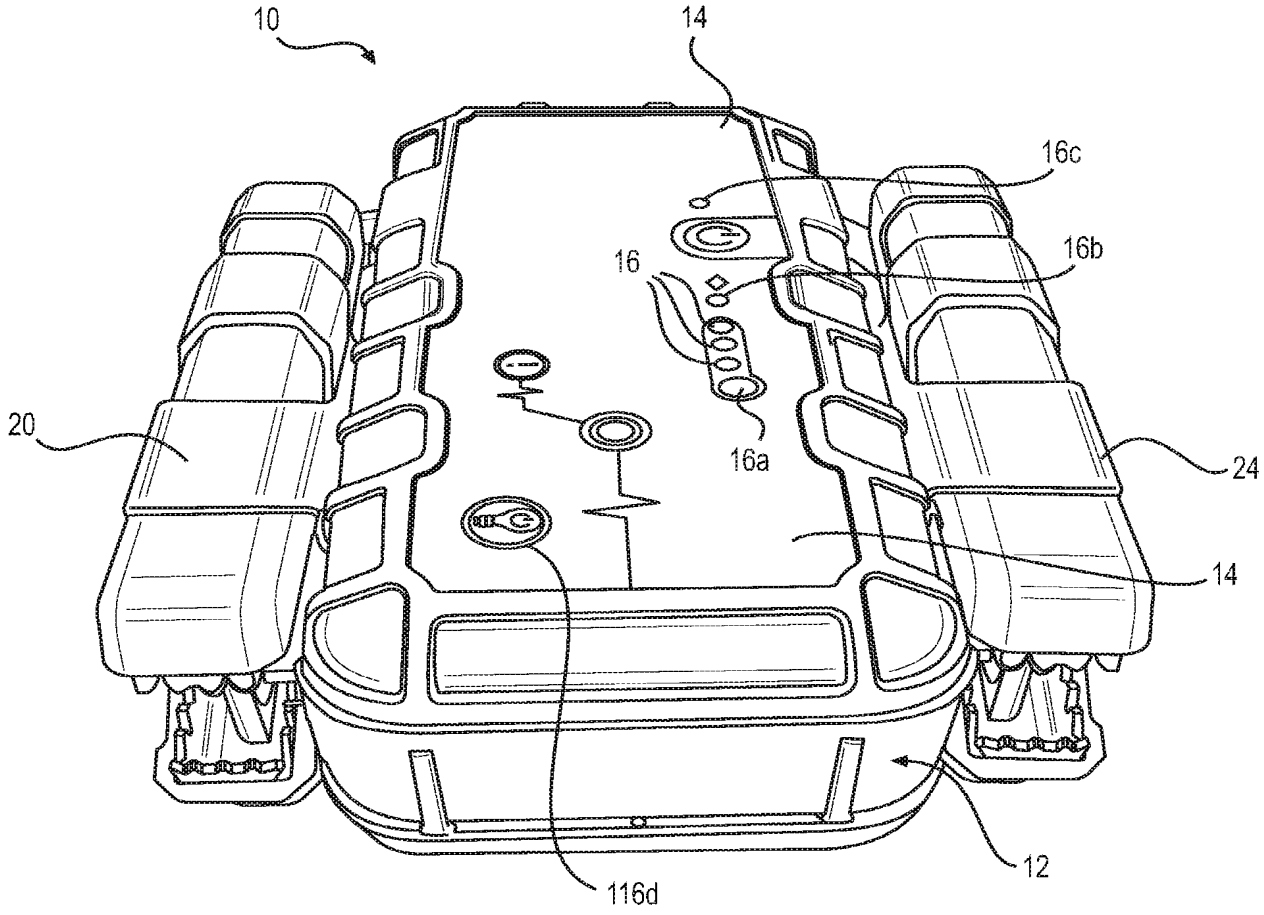


FIG. 3

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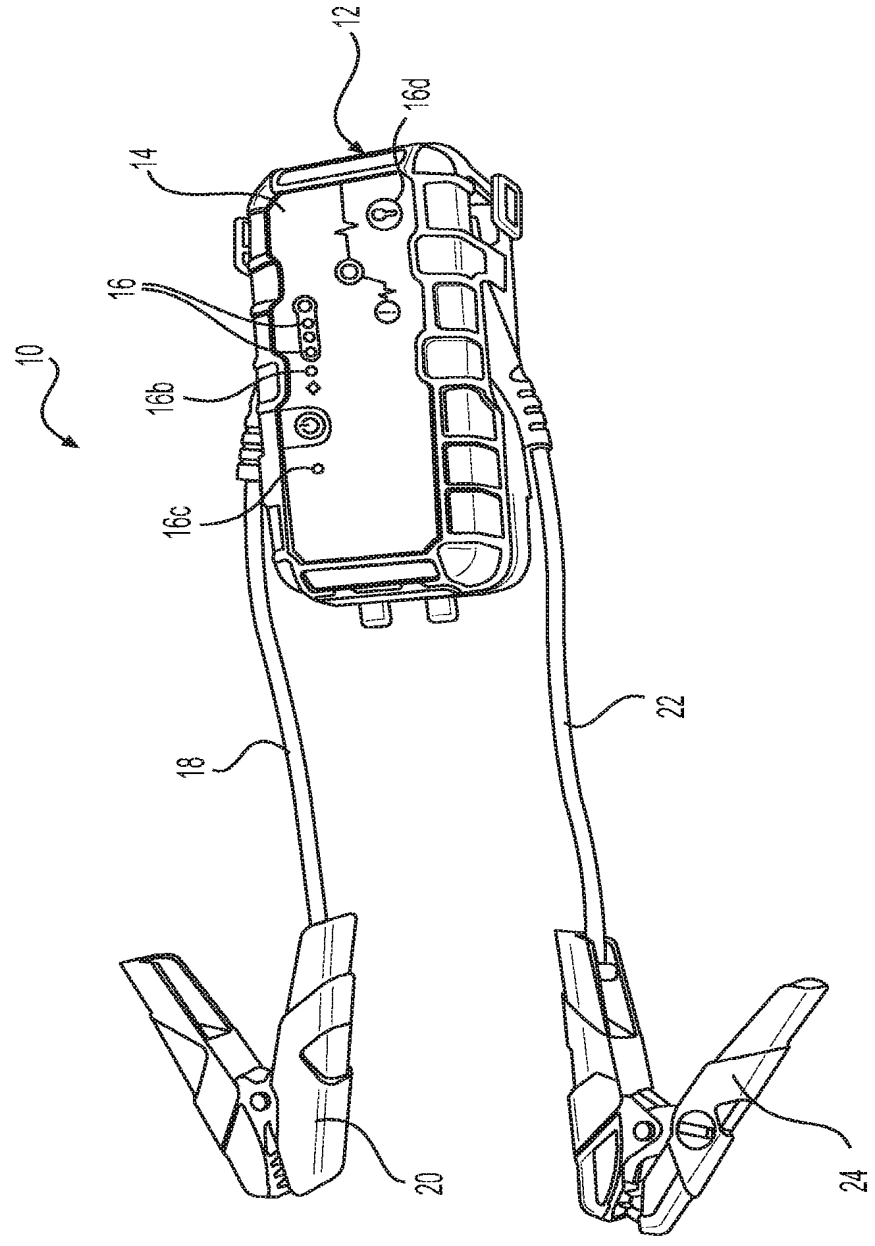


FIG. 4

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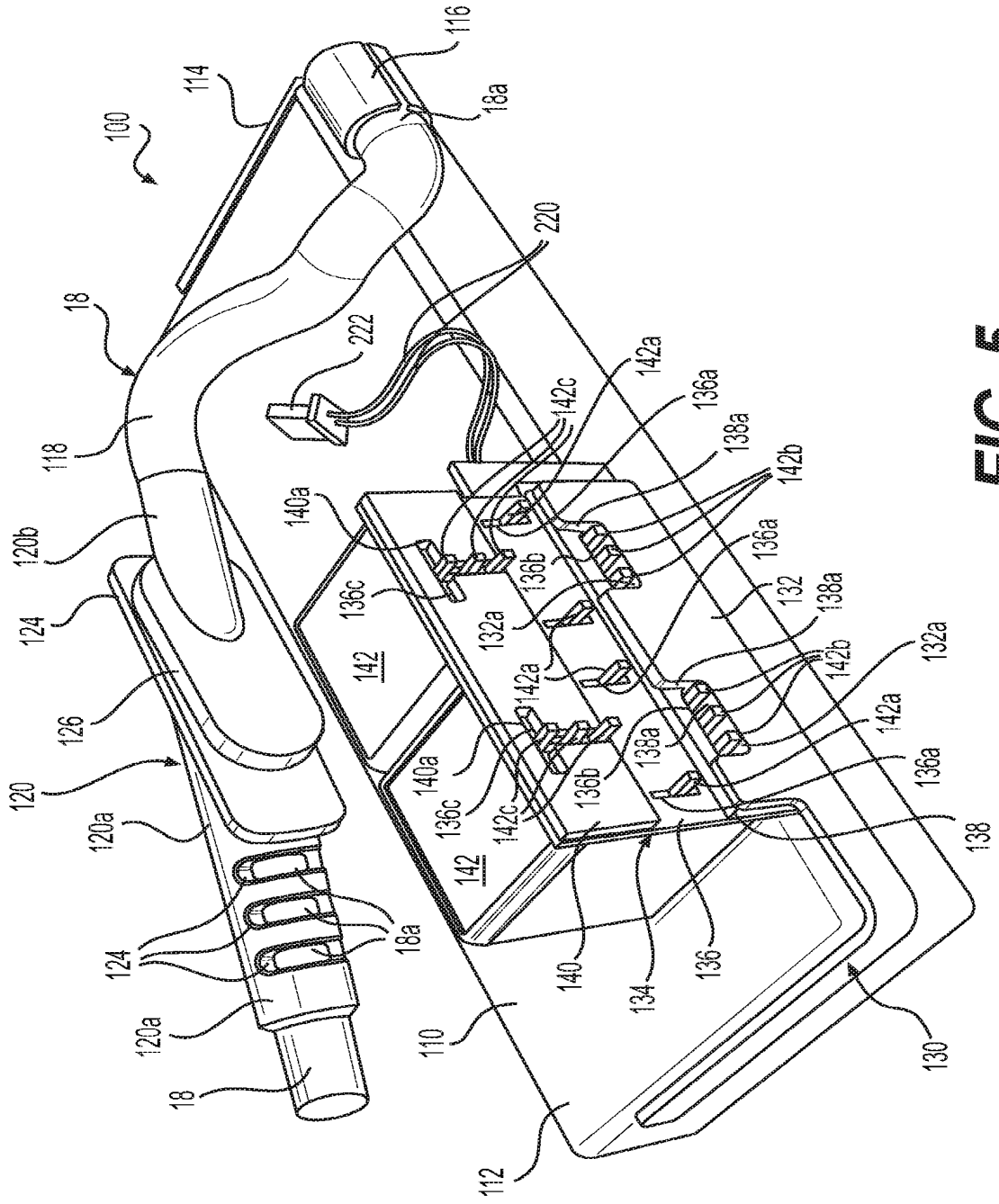


FIG. 5

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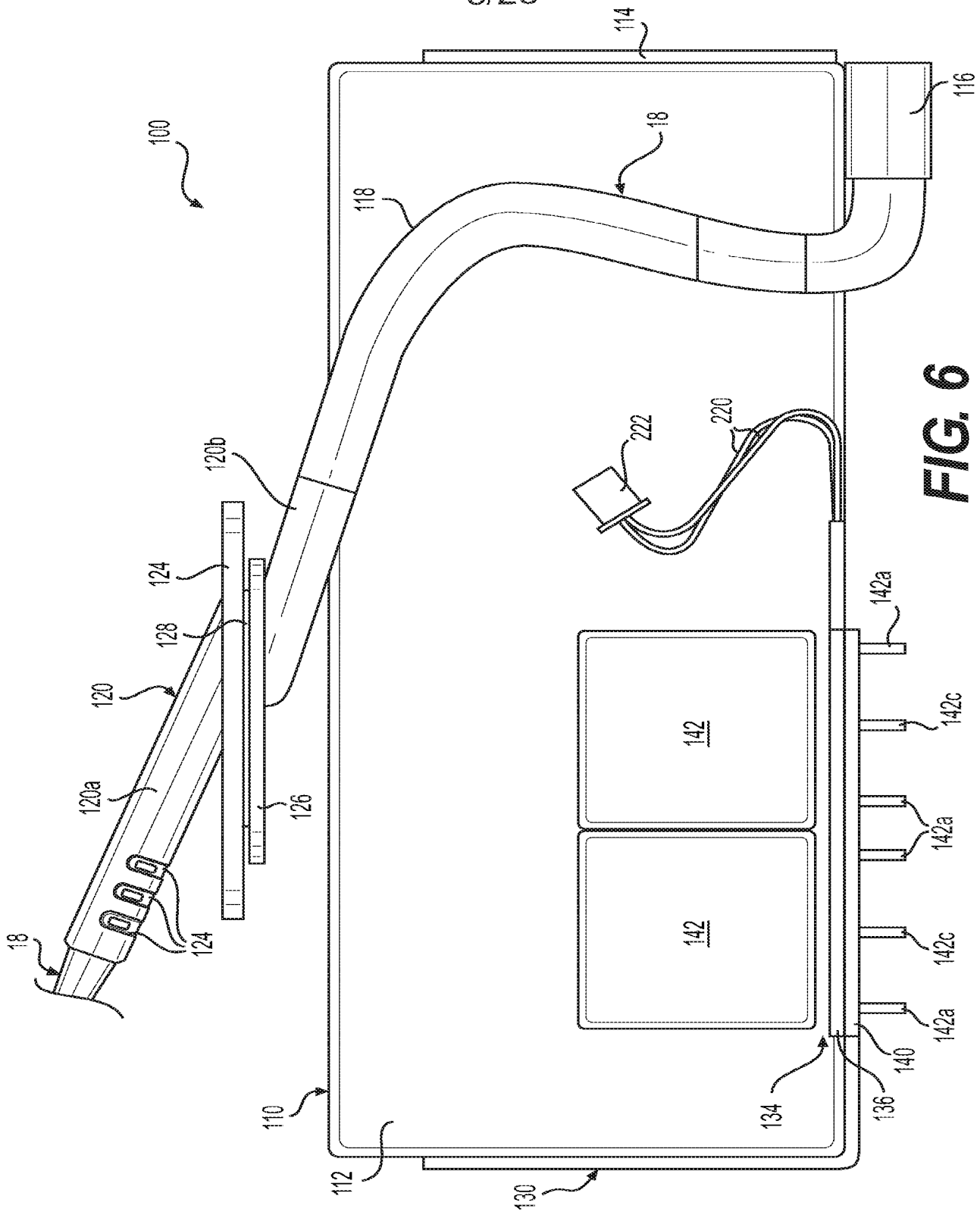


FIG. 6

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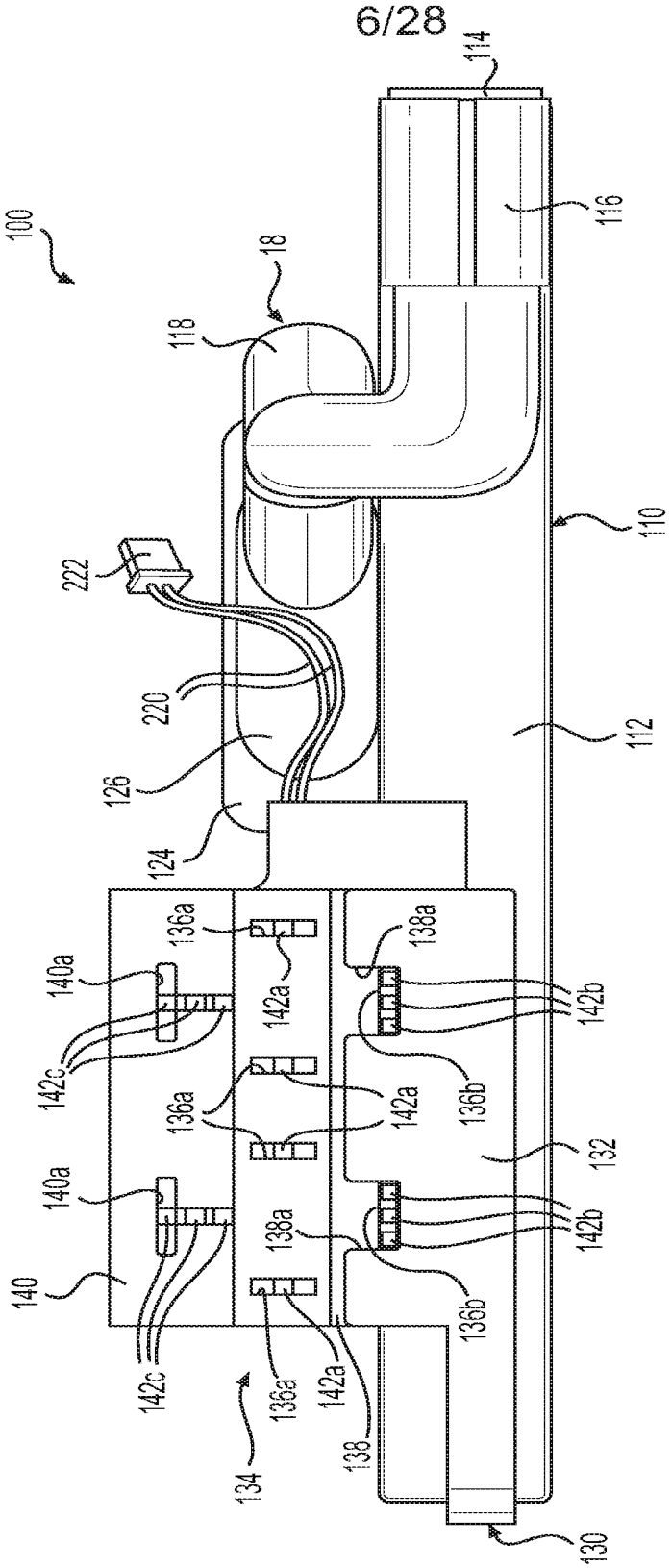


FIG. 7

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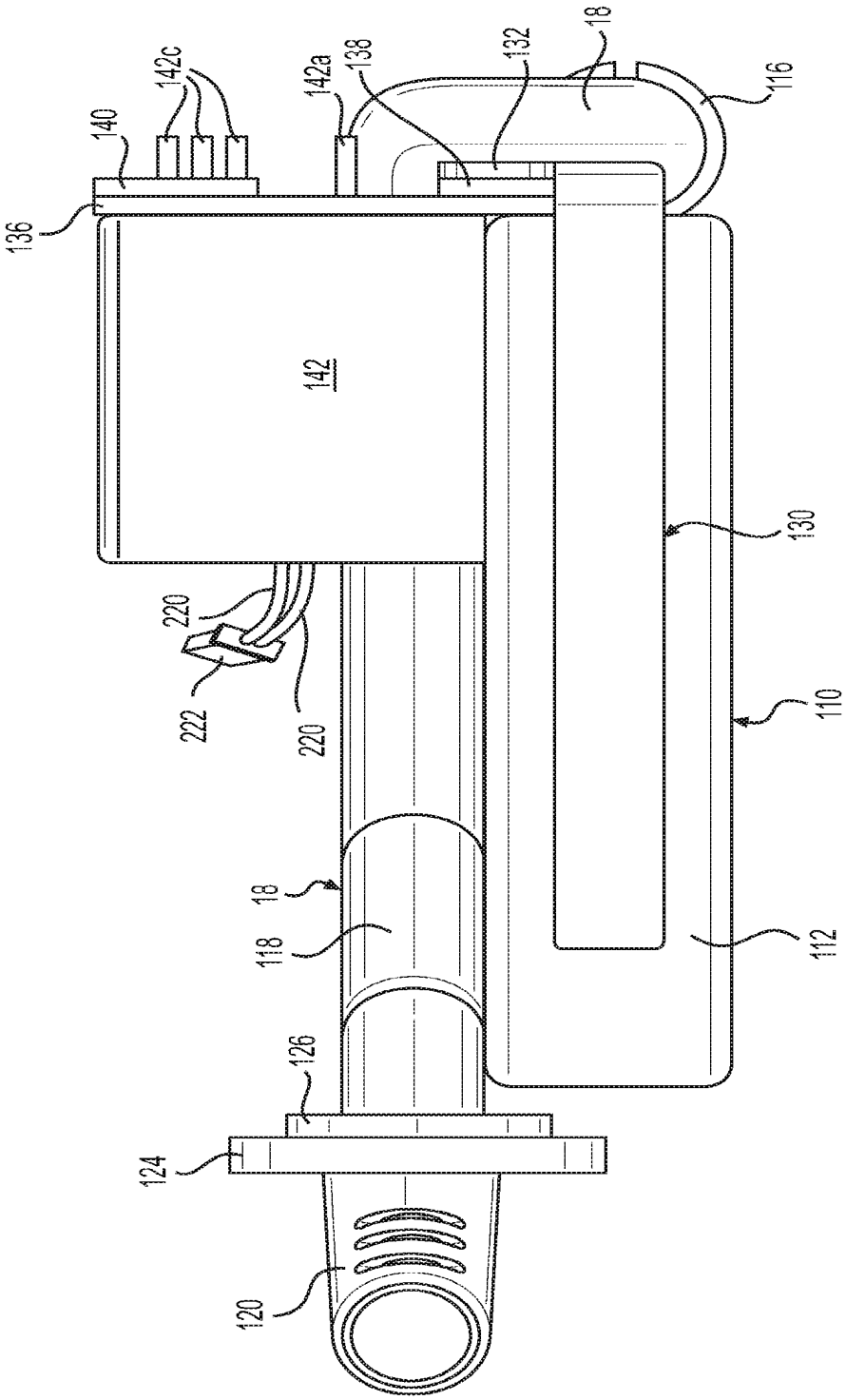


FIG. 8

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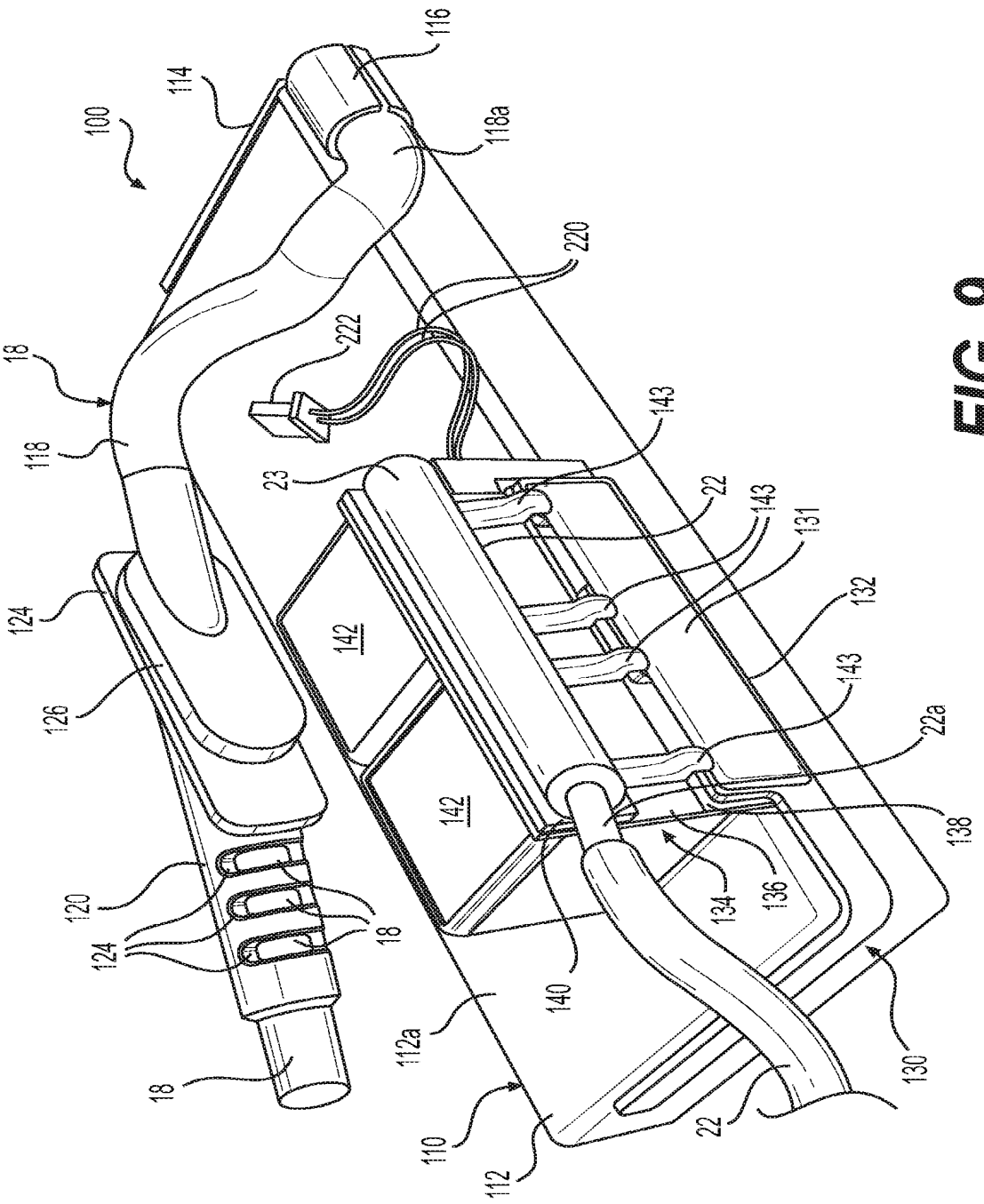


FIG. 9

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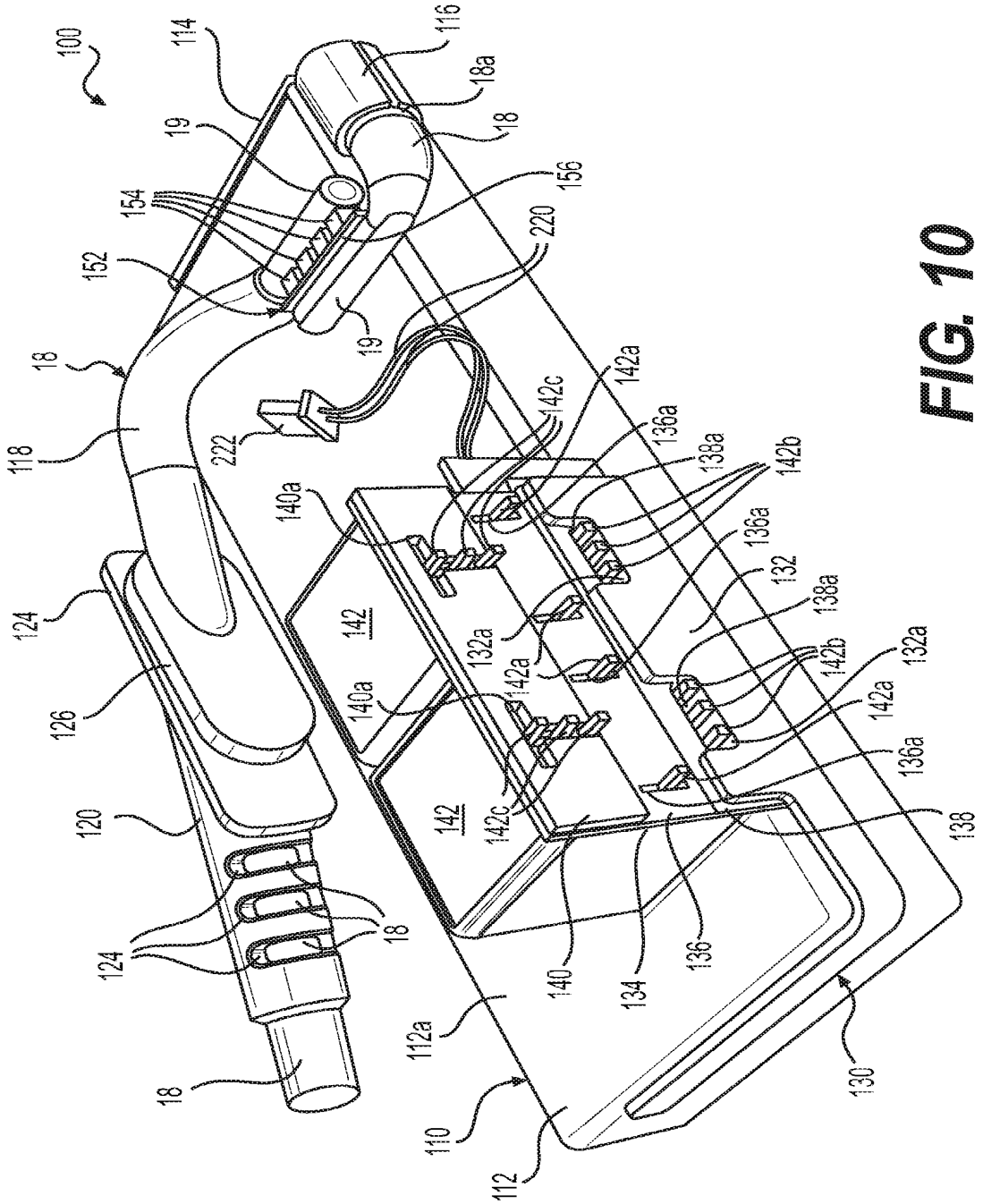


FIG. 10

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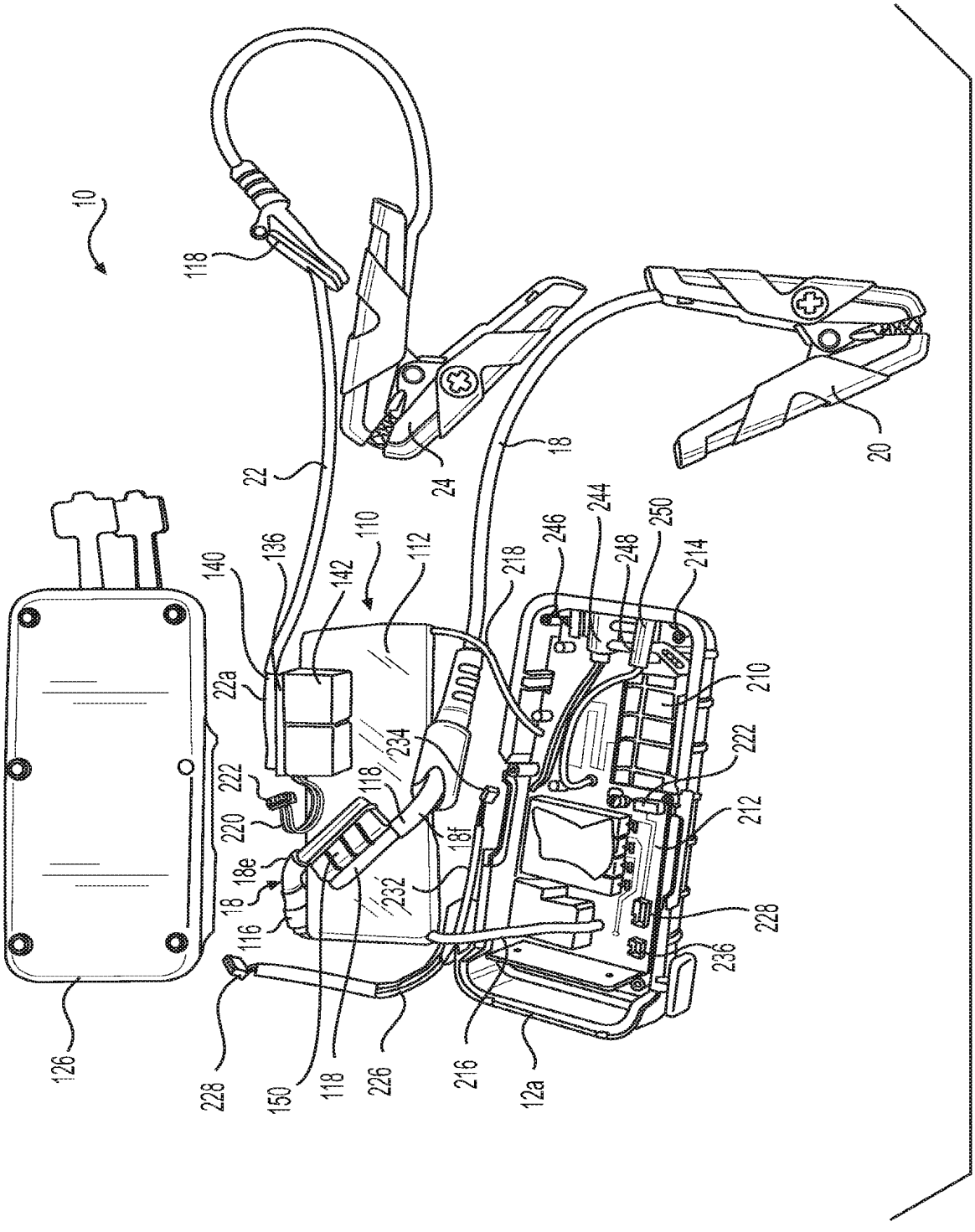


FIG. 11

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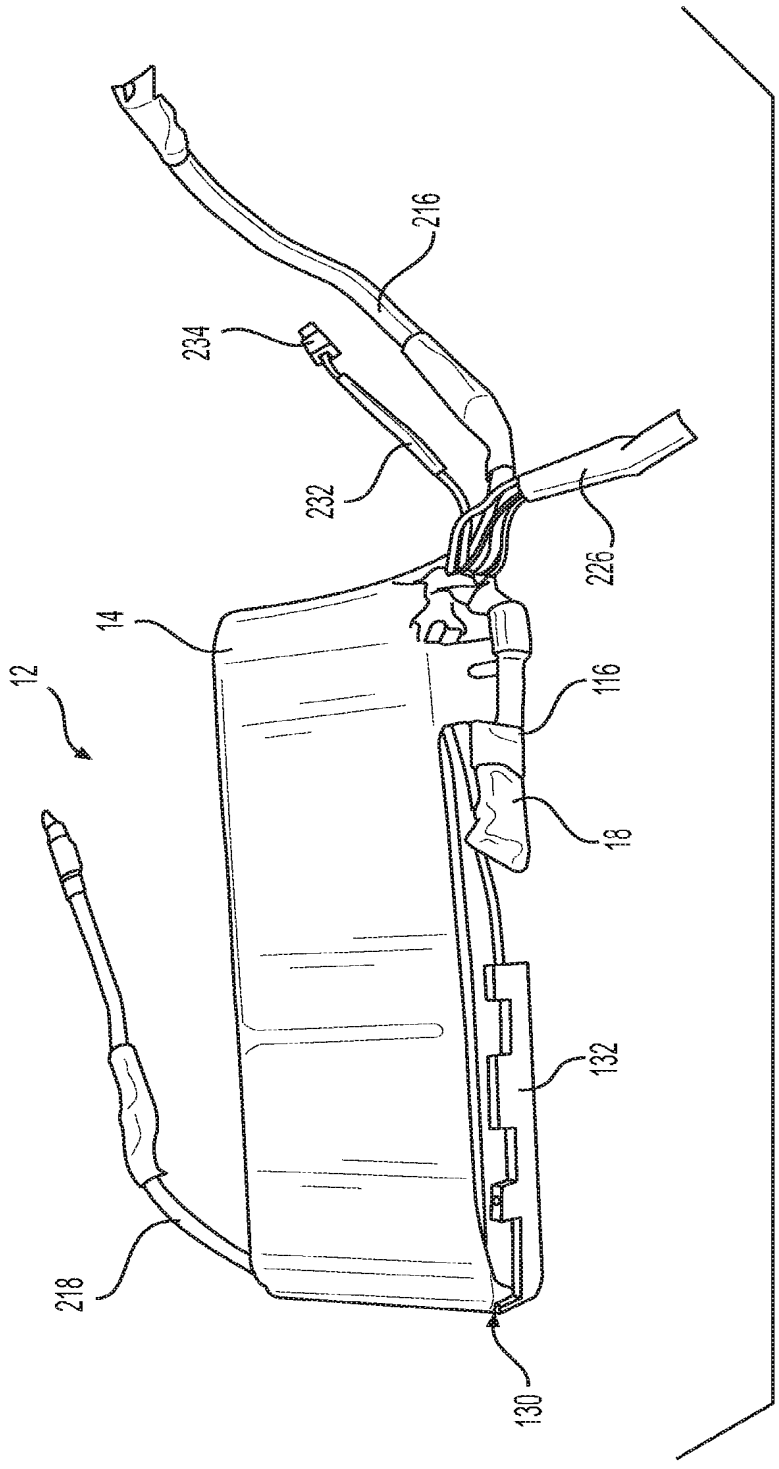


FIG. 12

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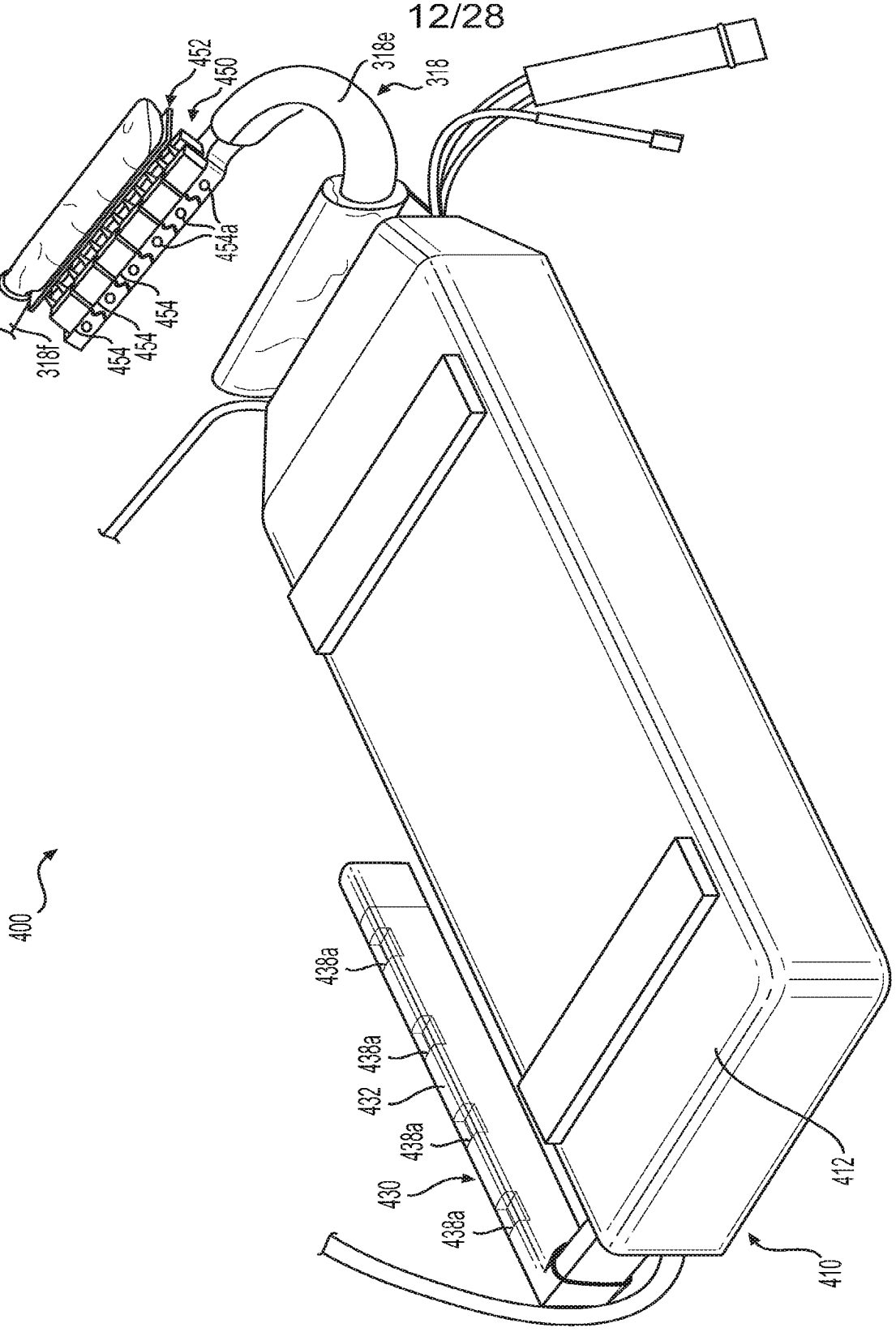


FIG. 13

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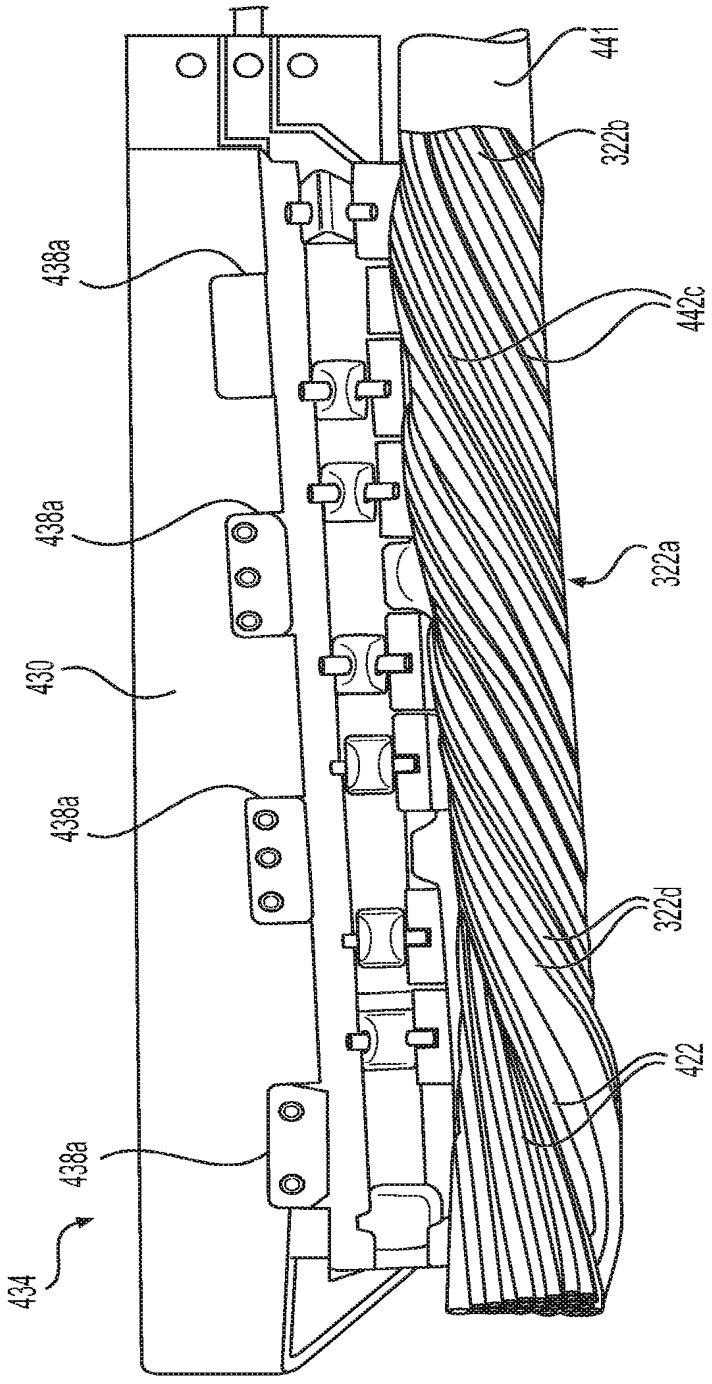


FIG. 14

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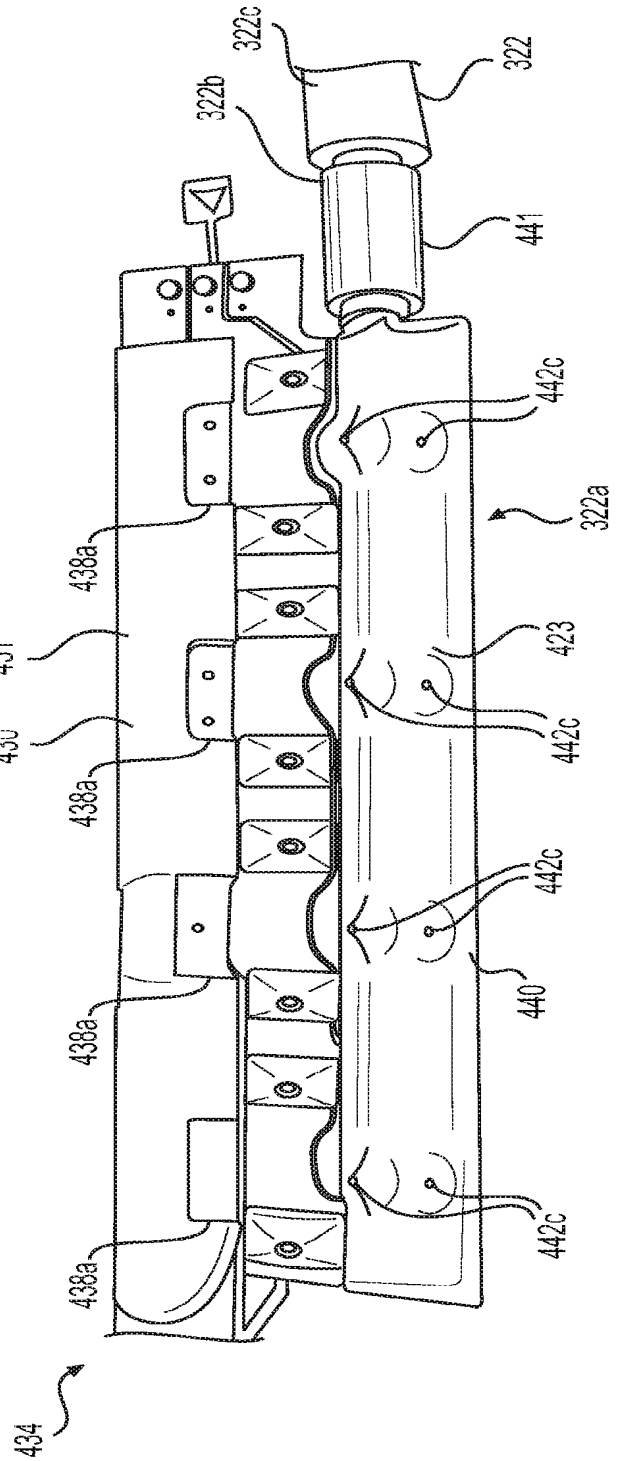


FIG. 15

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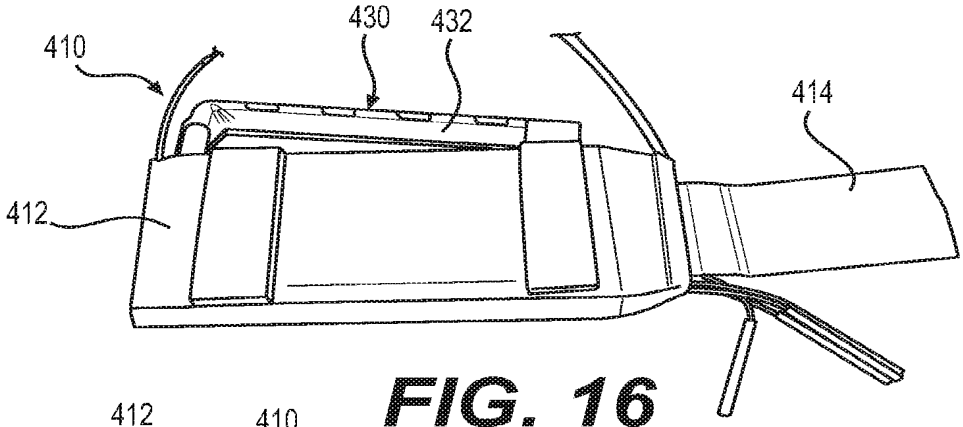


FIG. 16

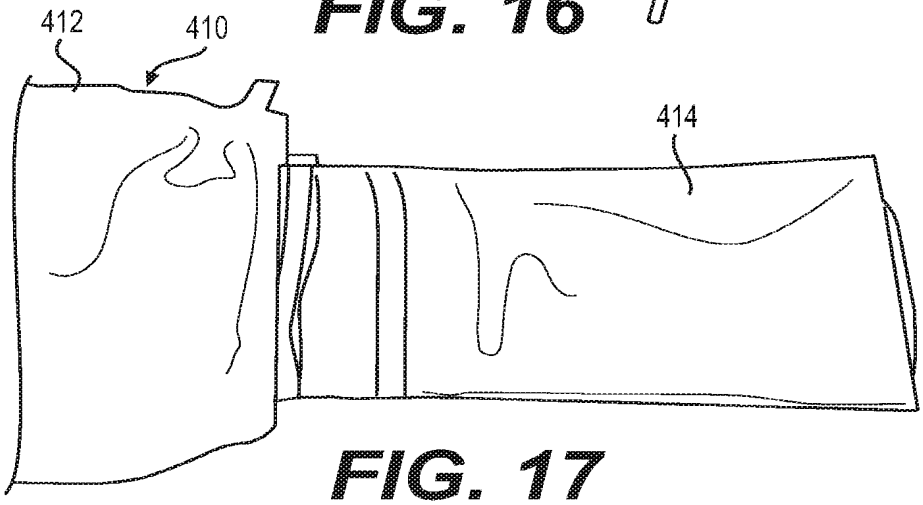


FIG. 17

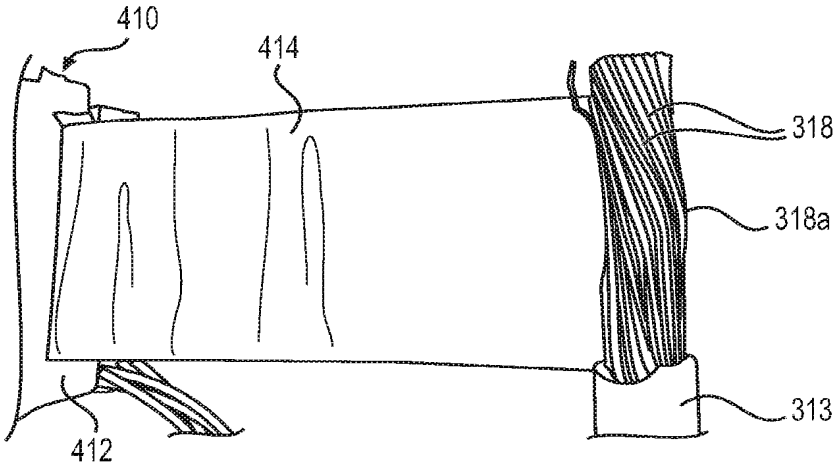


FIG. 18

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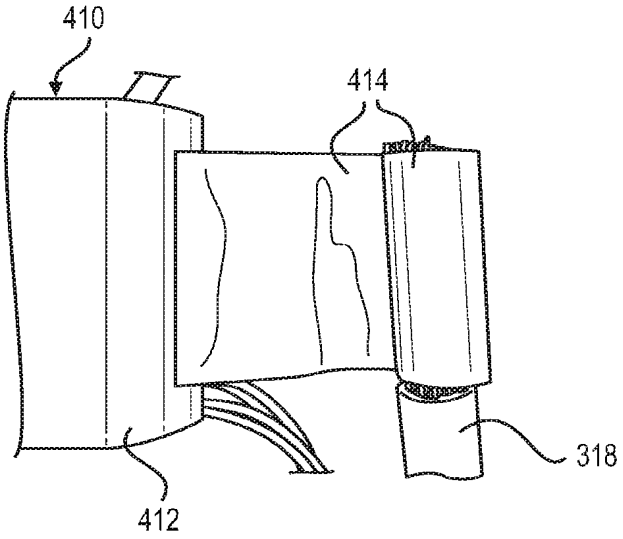


FIG. 19

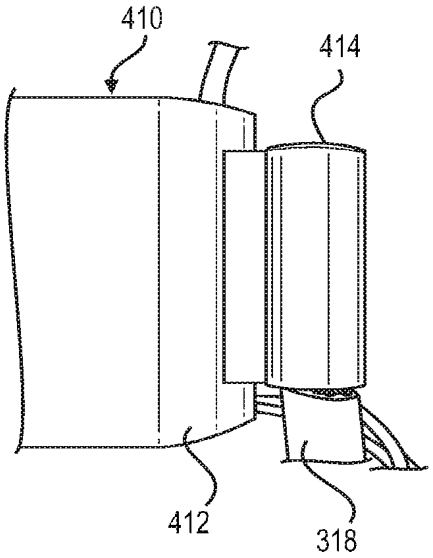


FIG. 20

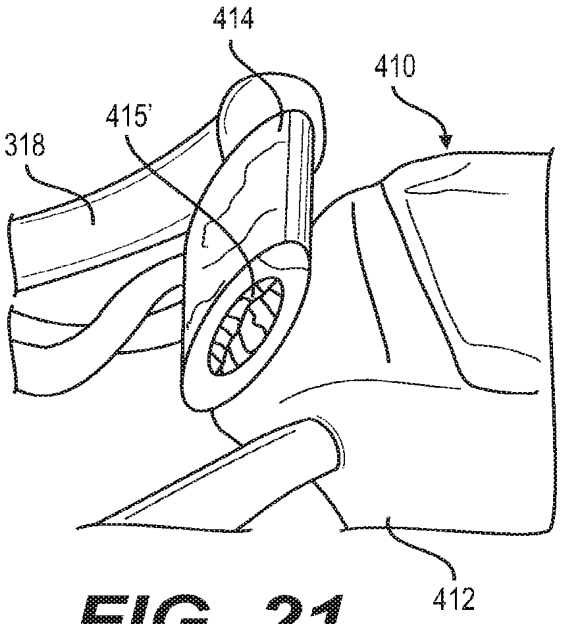


FIG. 21

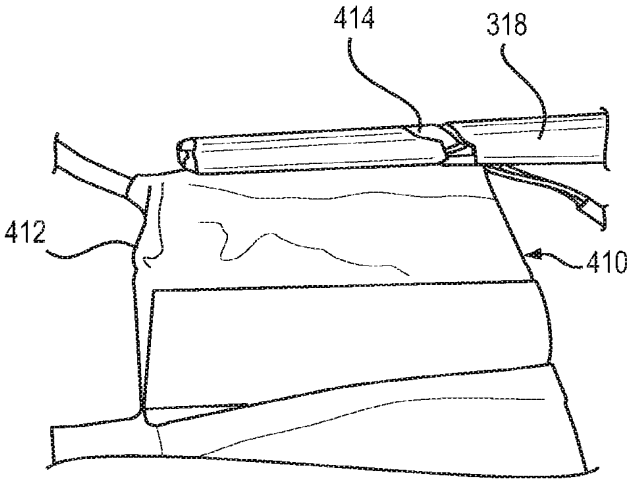


FIG. 22

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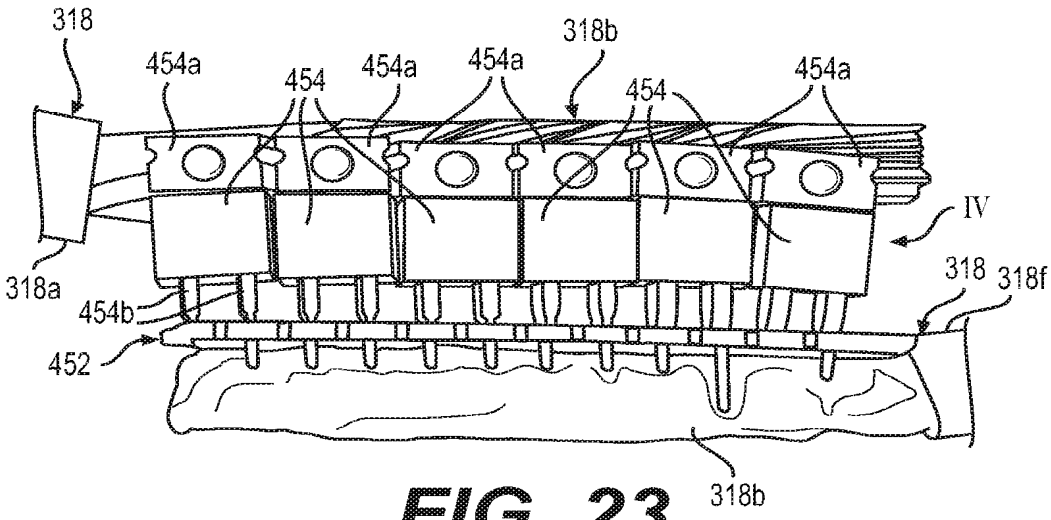


FIG. 23

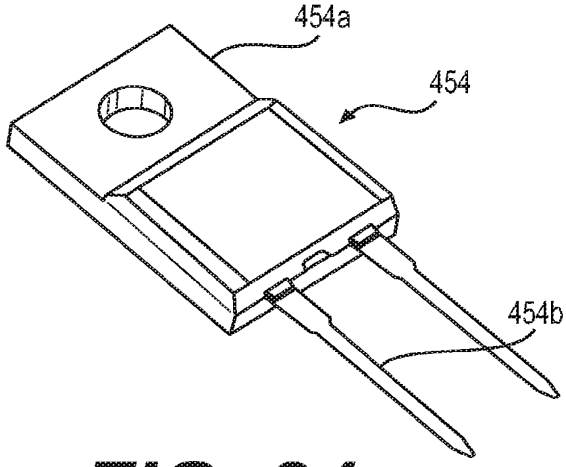


FIG. 24

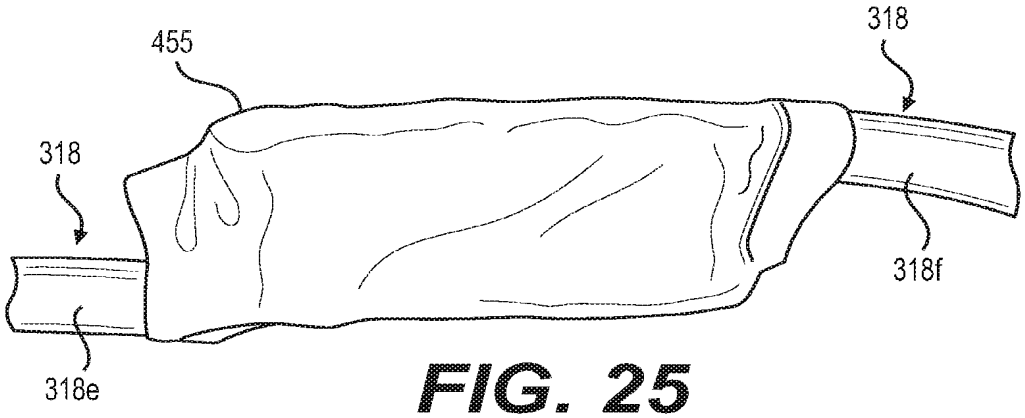
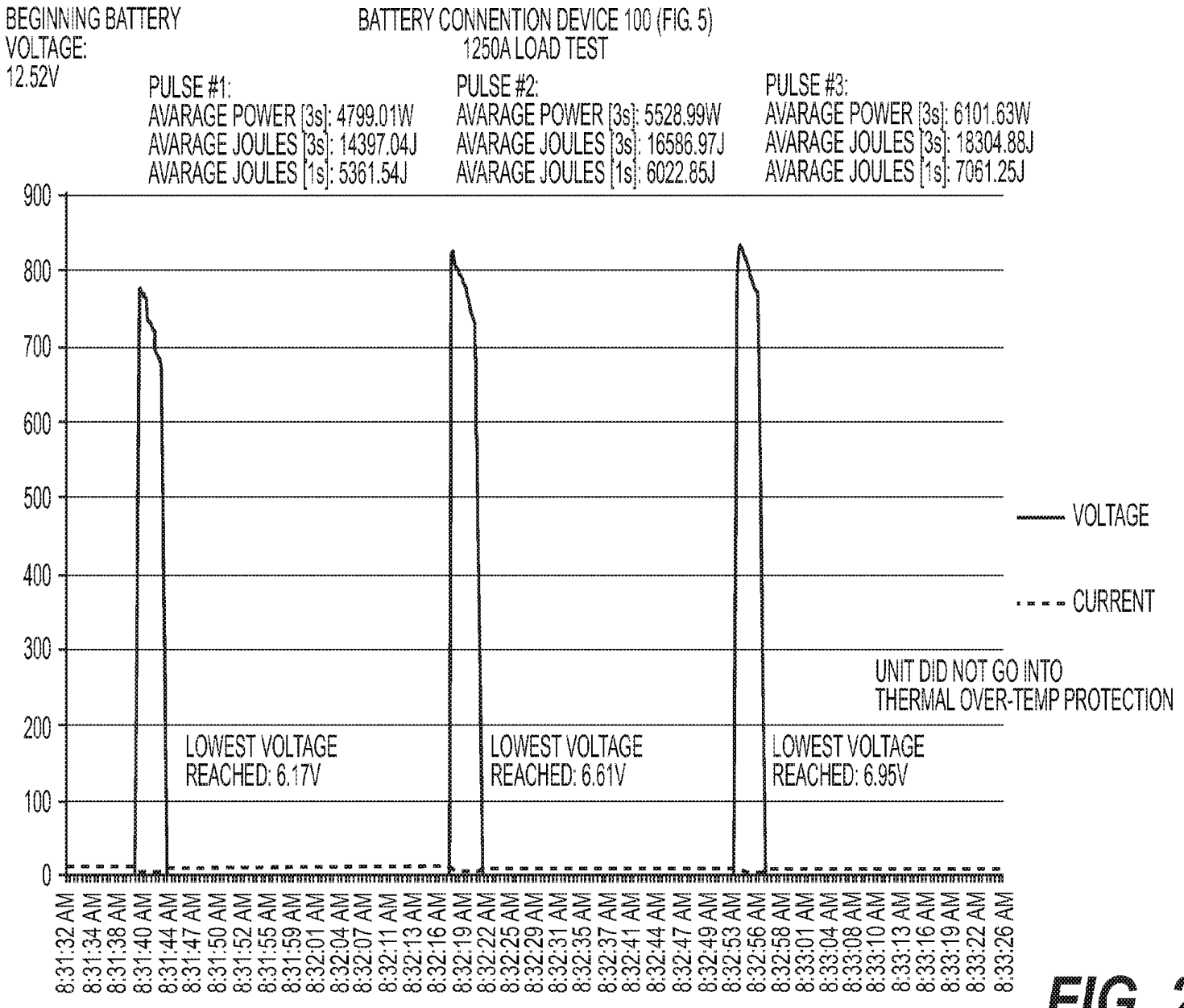


FIG. 25


BEGINNING BATTERY VOLTAGE:
12.52V
BATTERY CONNENTION DEVICE 100 (FIG. 5)
1250A LOAD TEST
PULSE #1:
AVARAGE POWER [3s]: 4799.01W
AVARAGE JOULES [3s]: 14397.04J
AVARAGE JOULES [1s]: 5361.54J
PULSE #2:
AVARAGE POWER [3s]: 5528.99W
AVARAGE JOULES [3s]: 16586.97J
AVARAGE JOULES [1s]: 6022.85J
PULSE #3:
AVARAGE POWER [3s]: 6101.63W
AVARAGE JOULES [3s]: 18304.88J
AVARAGE JOULES [1s]: 7061.25J
900
800
700
600
500
400
300
200
100
0
VOLTAGE
CURRENT
UNIT DID NOT GO INTO THERMAL OVER-TEMP PROTECTION
LOWEST VOLTAGE REACHED: 6.17V
LOWEST VOLTAGE REACHED: 6.61V
LOWEST VOLTAGE REACHED: 6.95V
8:31:32 AM
8:31:34 AM
8:31:38 AM
8:31:40 AM
8:31:44 AM
8:31:47 AM
8:31:50 AM
8:31:52 AM
8:31:55 AM
8:31:59 AM
8:32:01 AM
8:32:04 AM
8:32:07 AM
8:32:11 AM
8:32:13 AM
8:32:16 AM
8:32:19 AM
8:32:22 AM
8:32:25 AM
8:32:29 AM
8:32:31 AM
8:32:35 AM
8:32:37 AM
8:32:41 AM
8:32:44 AM
8:32:47 AM
8:32:49 AM
8:32:53 AM
8:32:56 AM
8:32:58 AM
8:33:01 AM
8:33:04 AM
8:33:08 AM
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8:33:16 AM
8:33:19 AM
8:33:22 AM
8:33:26 AM

18/28

FIG. 27

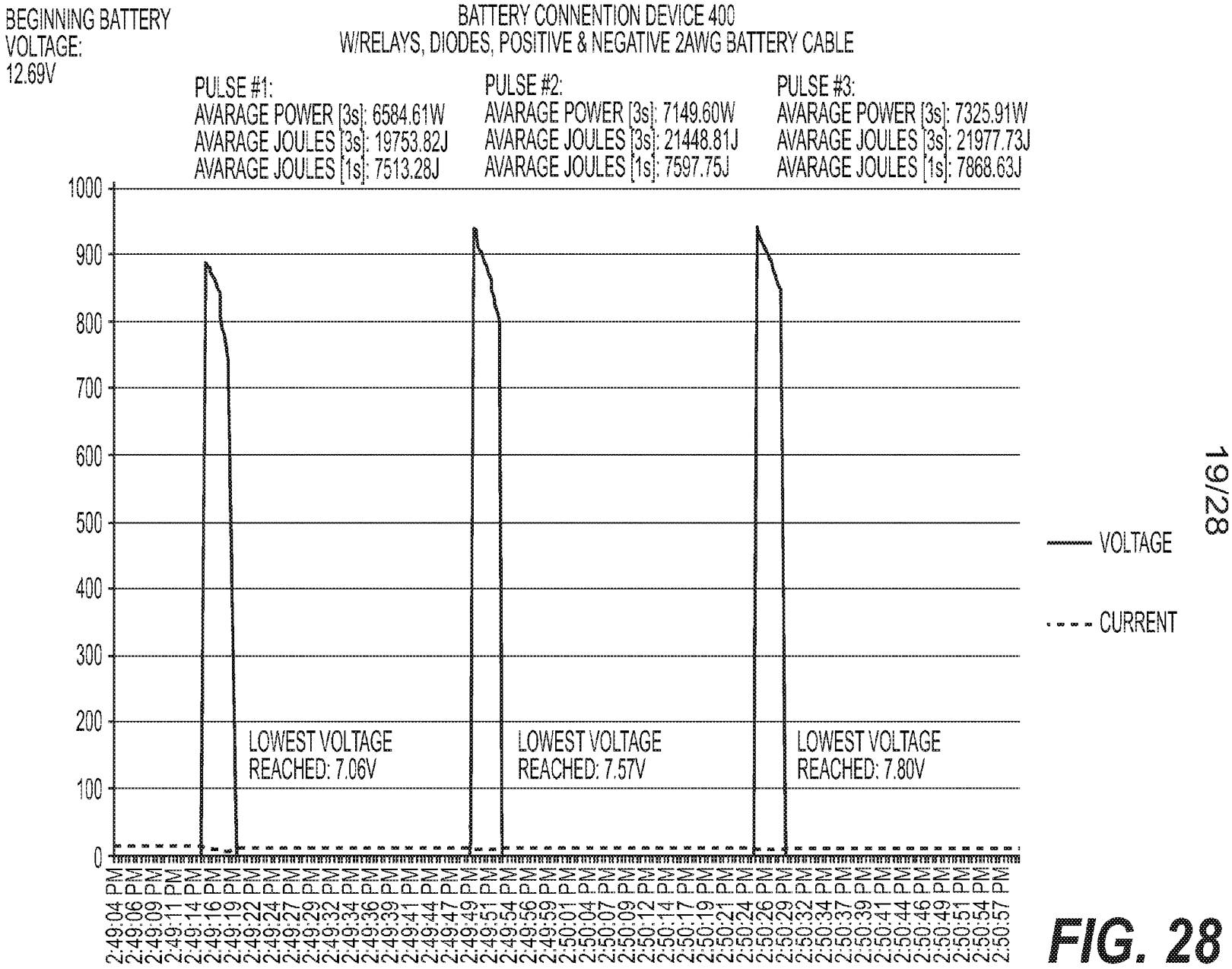


FIG. 28

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IPR2025-00885

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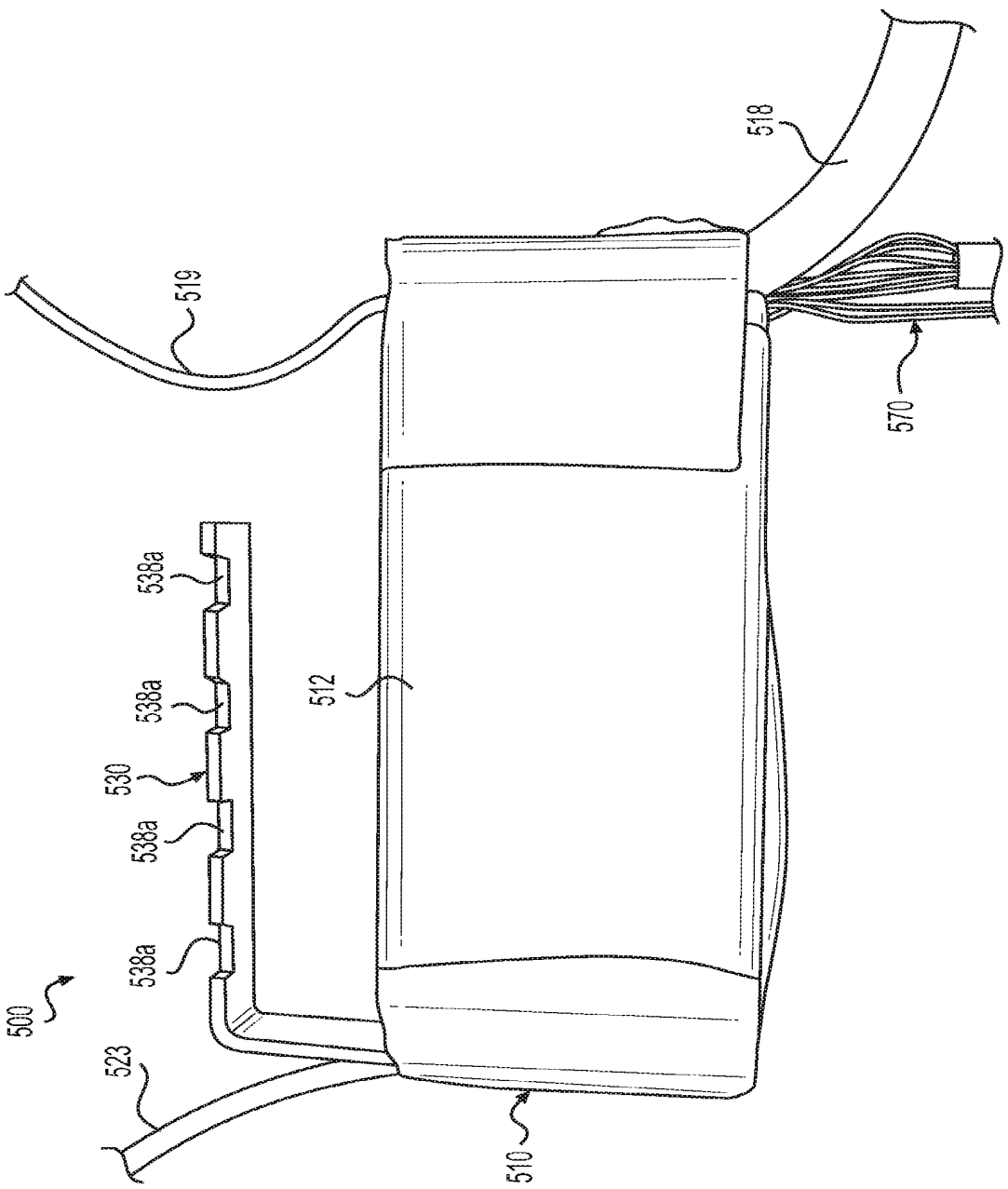


FIG. 29

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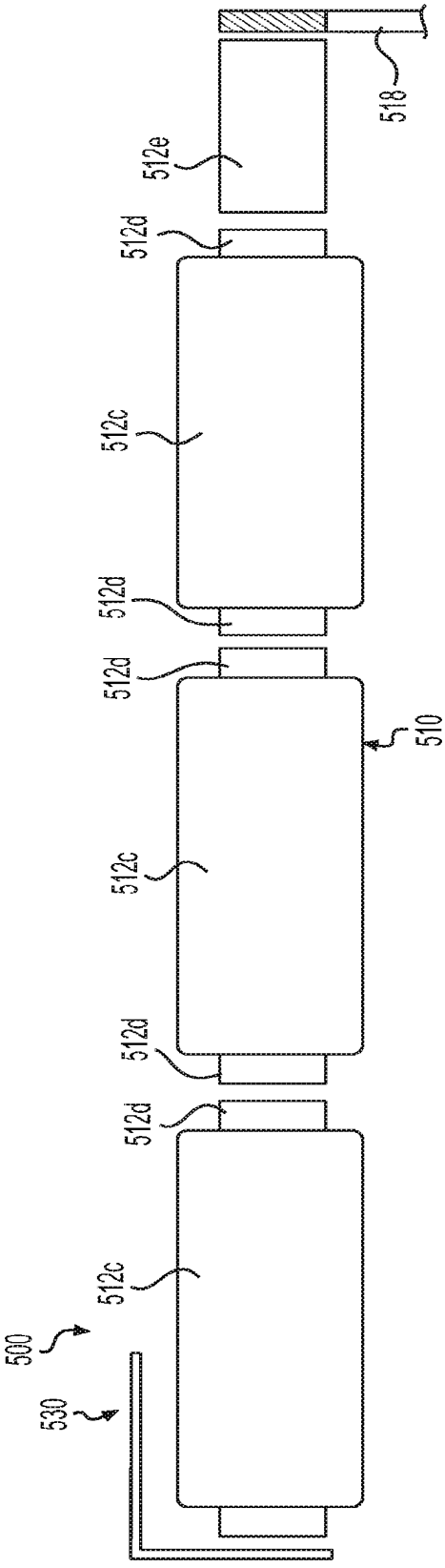


FIG. 30

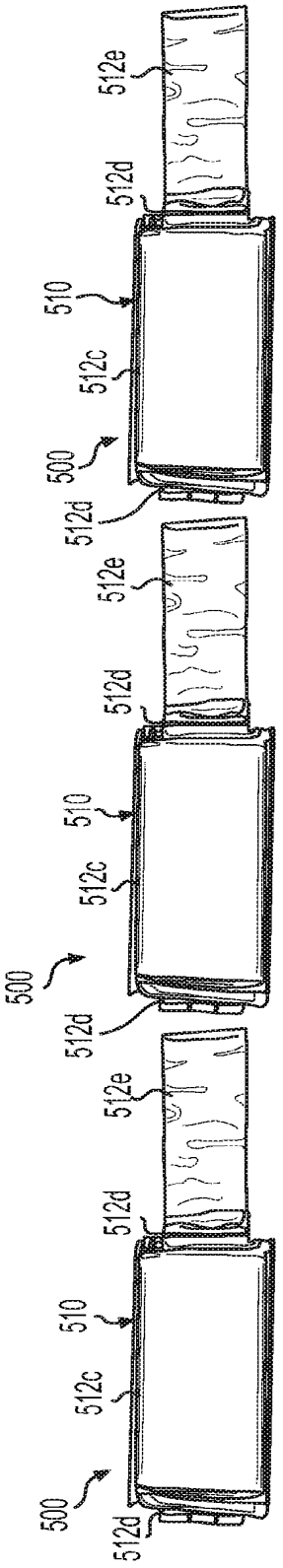


FIG. 31

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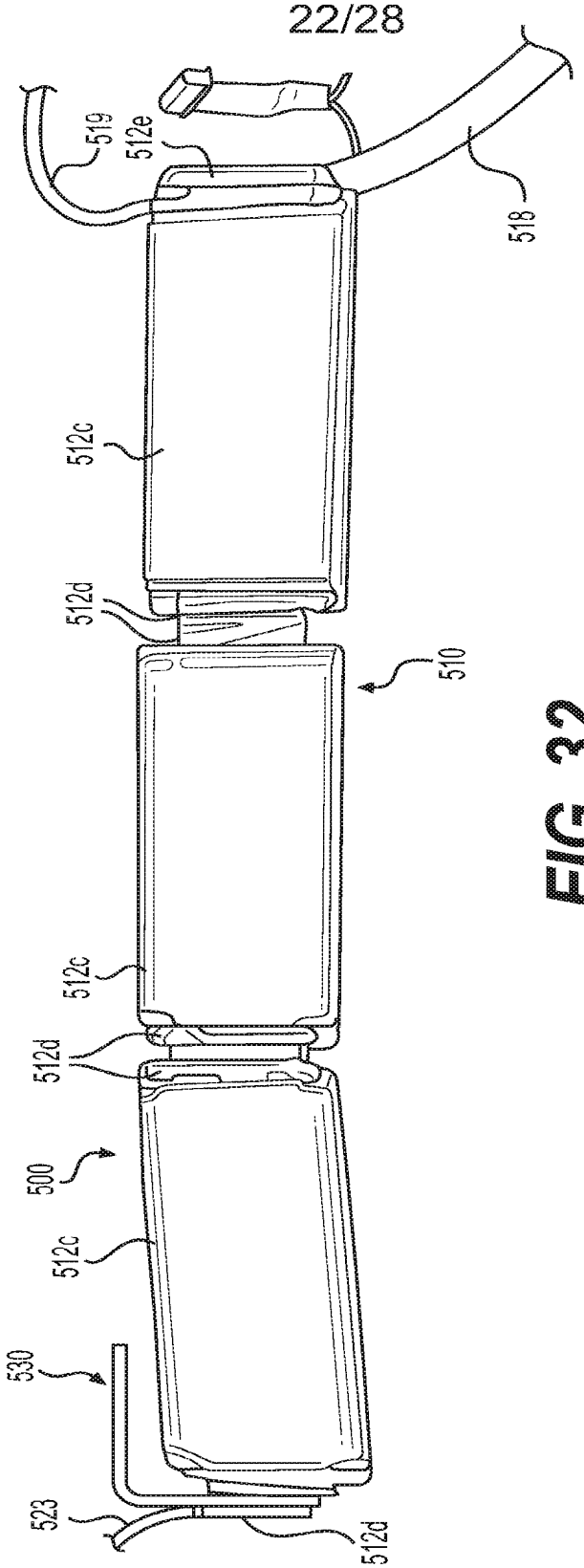


FIG. 32

2019201081 15 Feb 2019

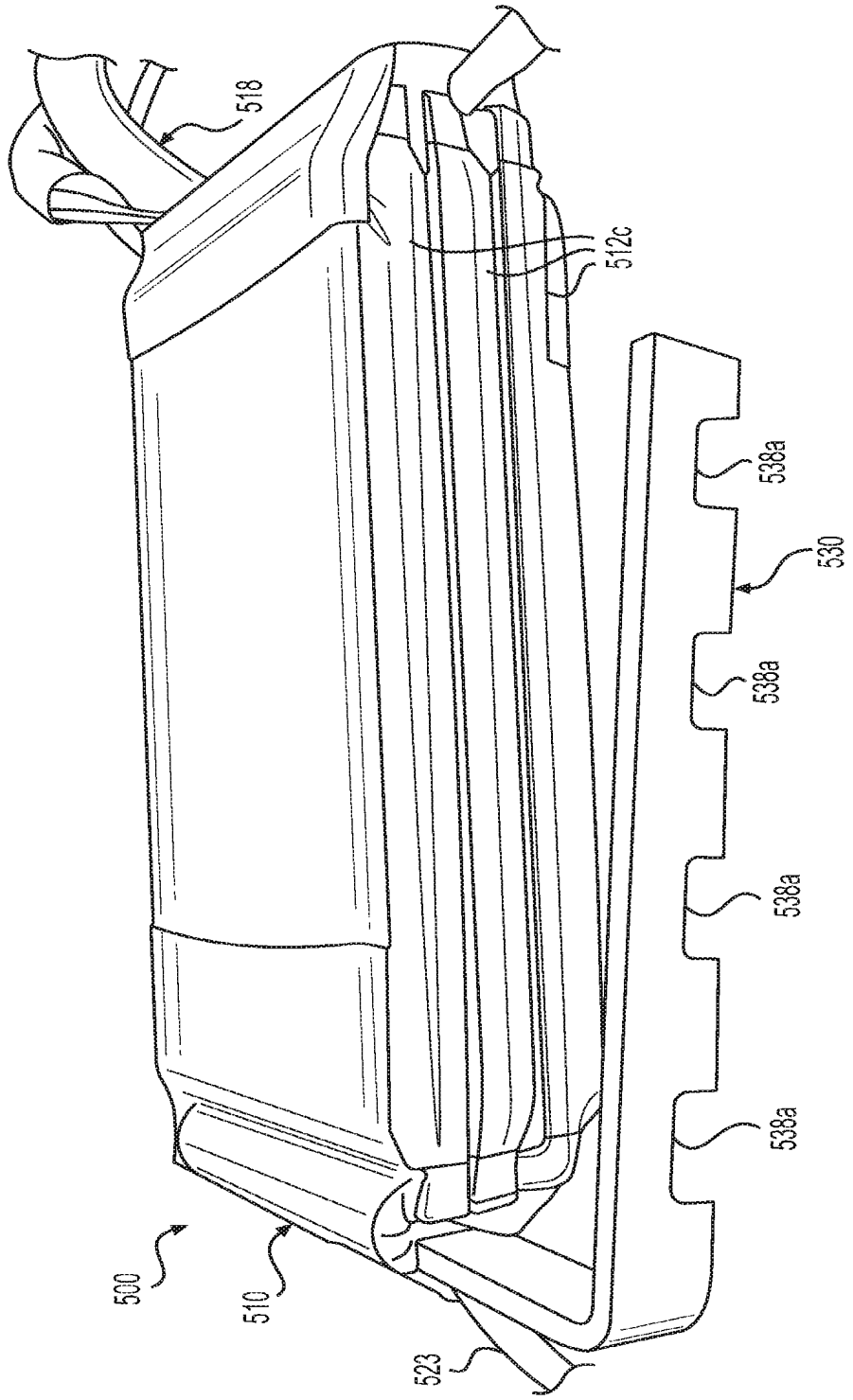


FIG. 33

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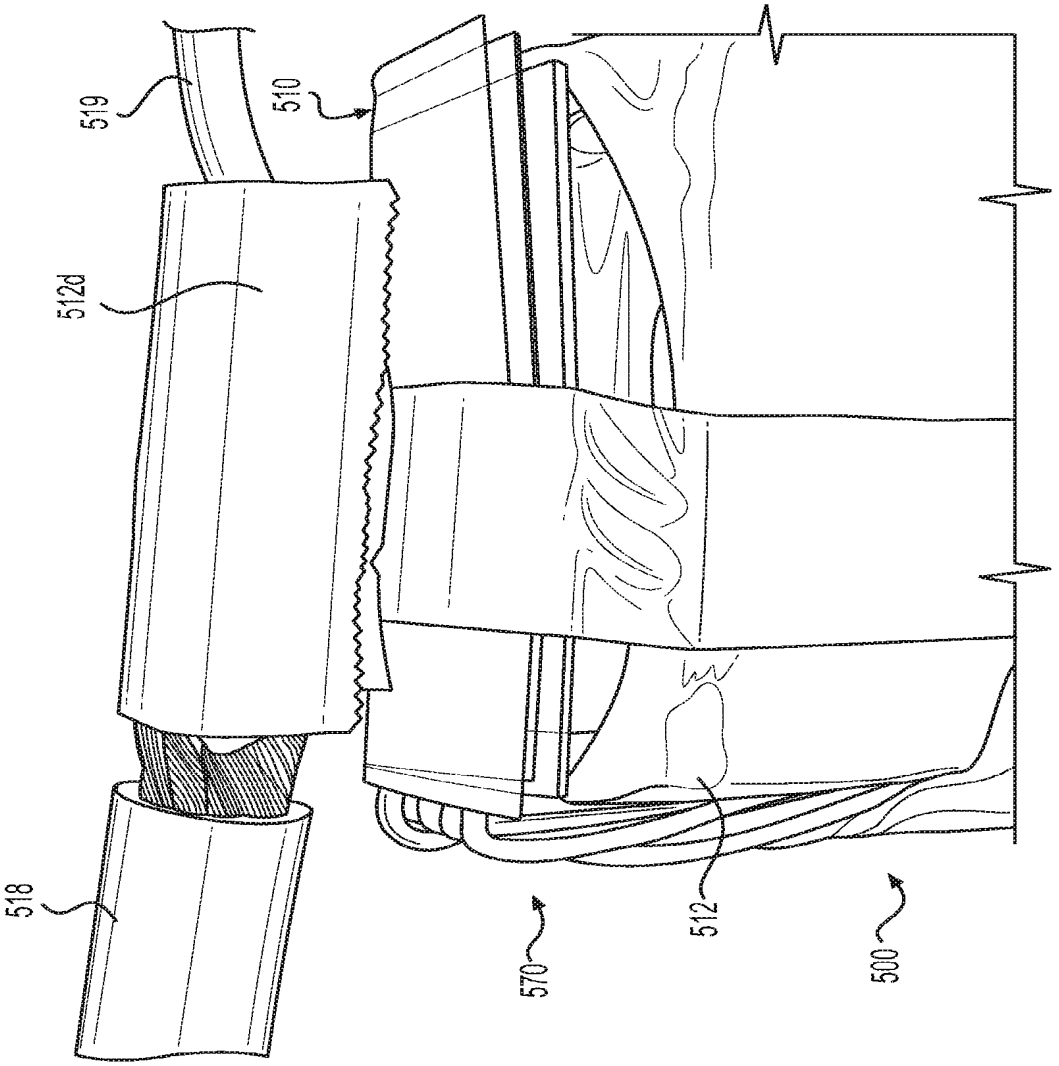


FIG. 34

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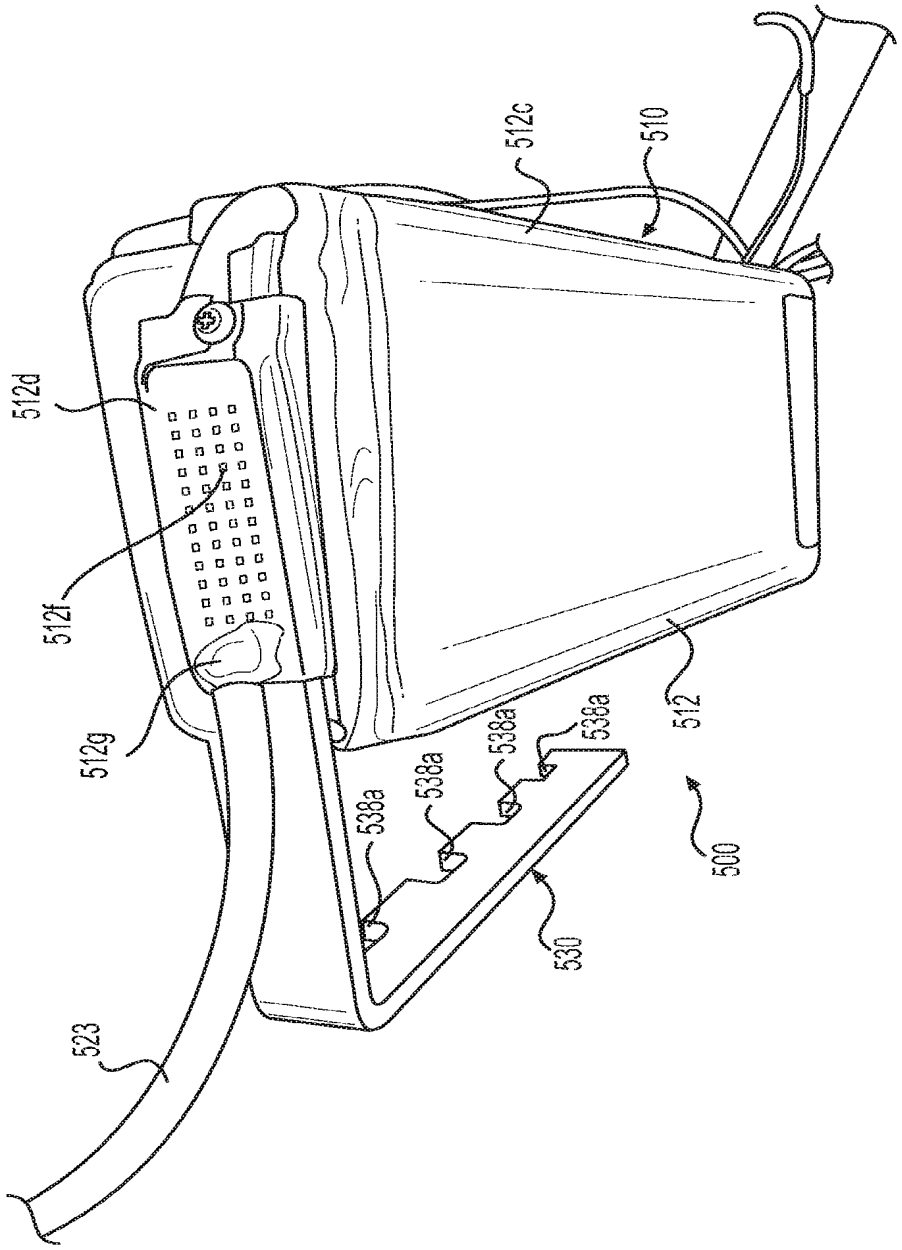


FIG. 35

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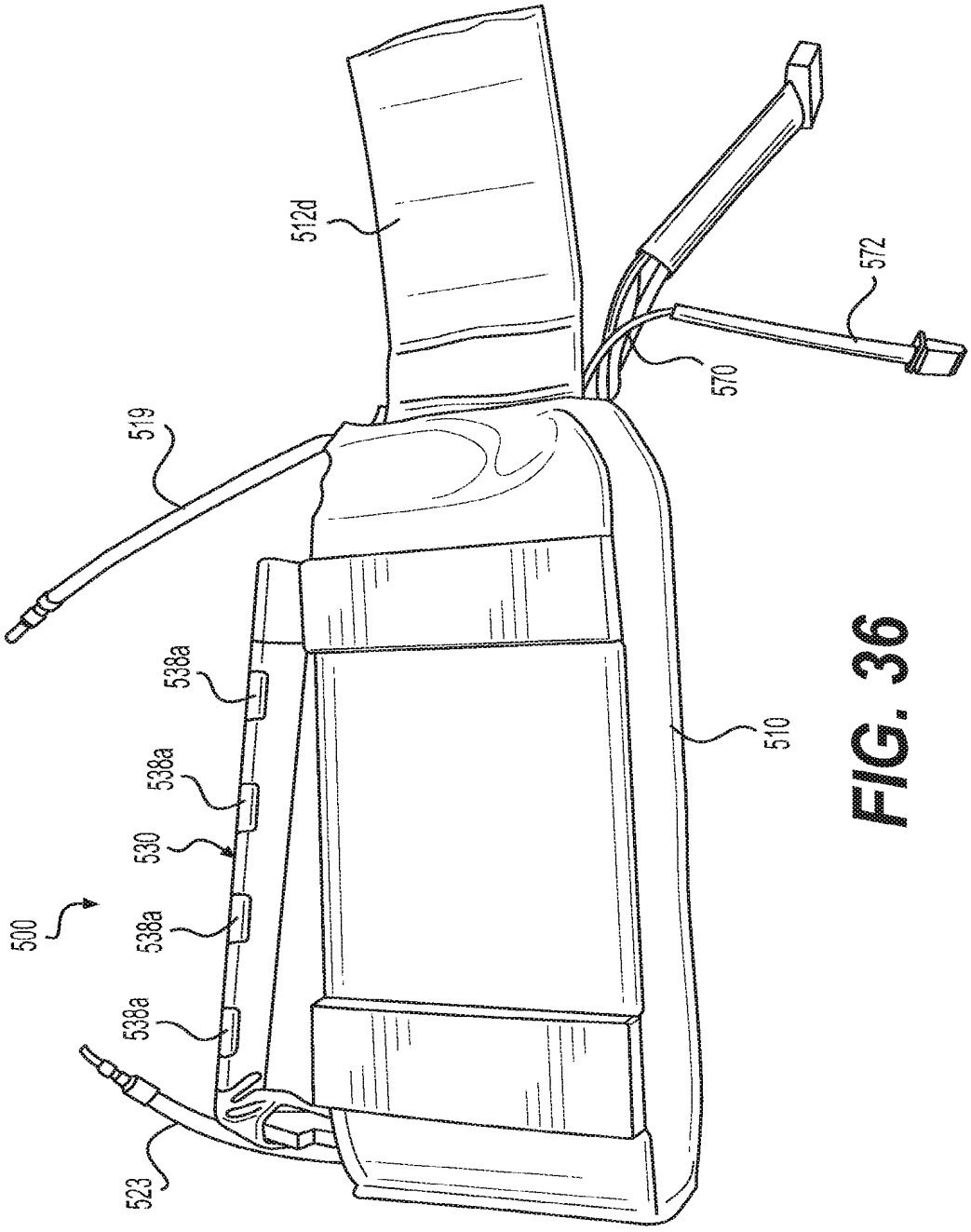


FIG. 36

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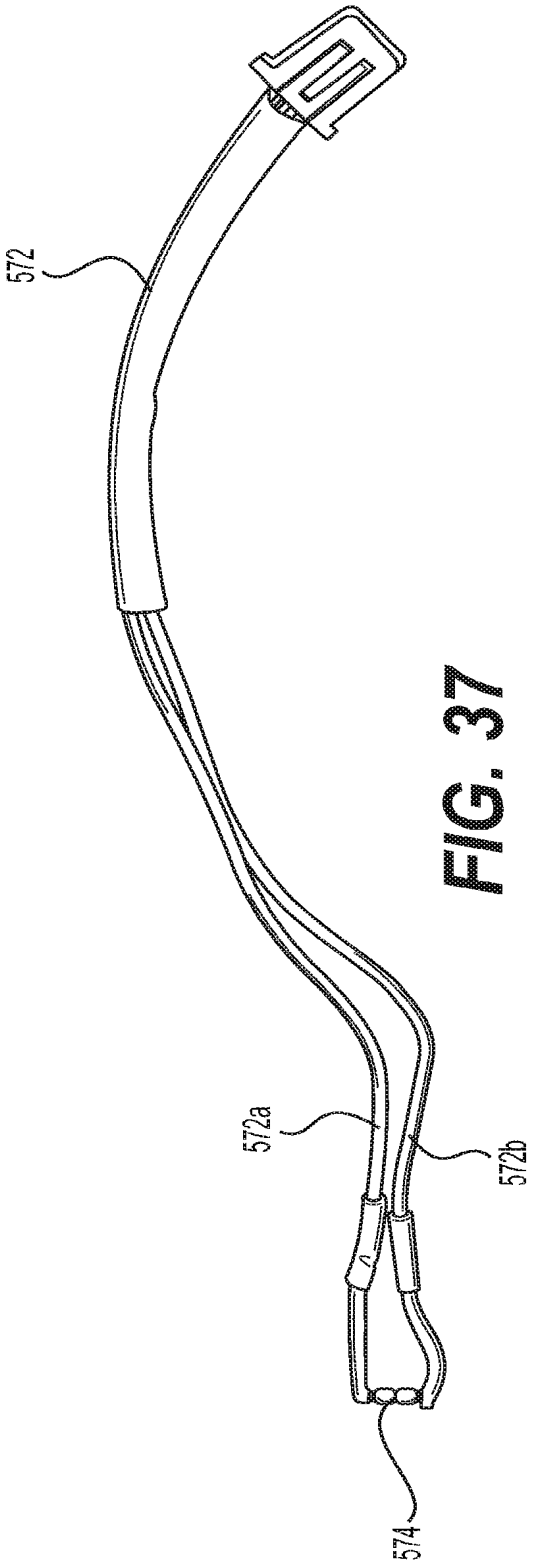


FIG. 37

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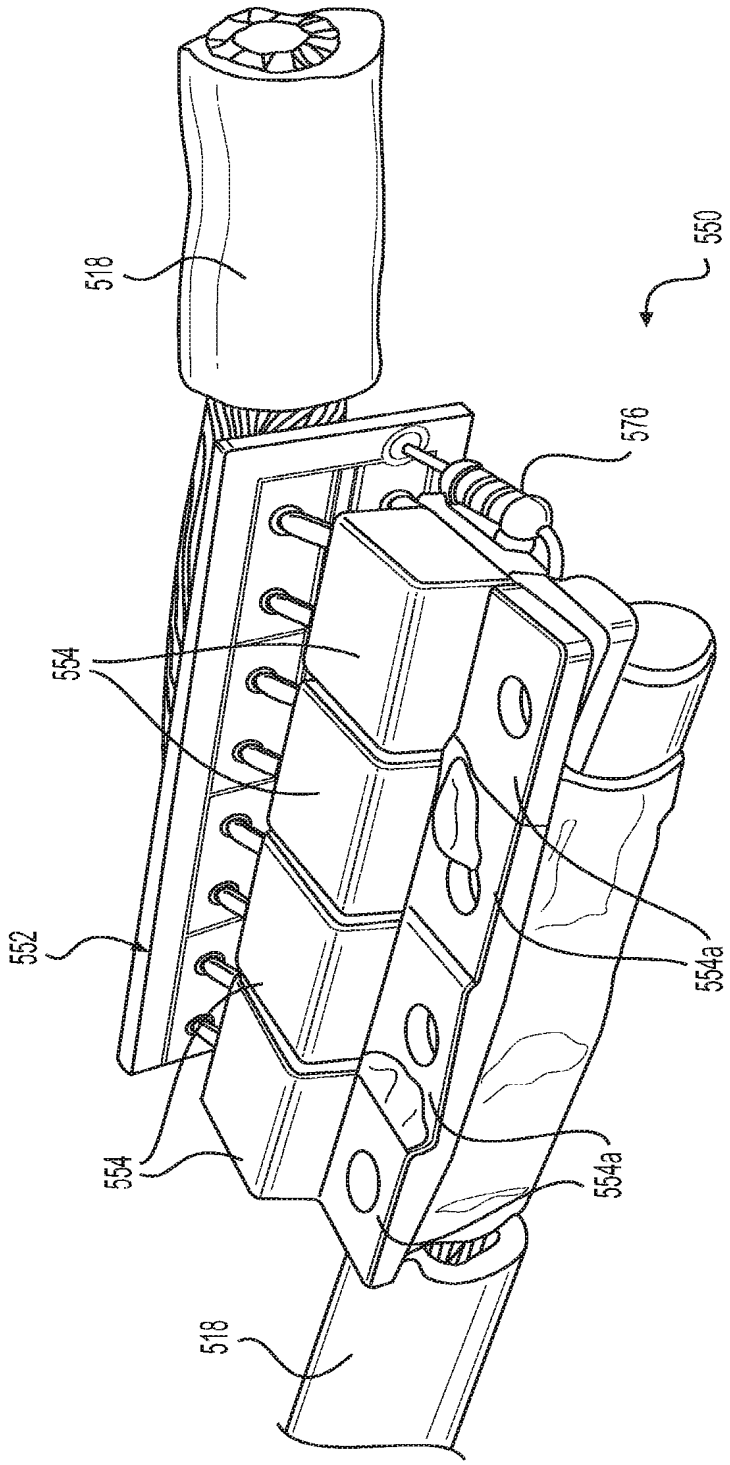


FIG. 38

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

	Jonathan NOOK et al.
Appl. No.:	16/819,831
Filing Date:	March 16, 2020
Exam:	M. Baye DIAO
Art Unit:	2859
Conf.:	1630
Title:	**PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION**

LETTER TO THE EXAMINER

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

The copies of the references cited with the Information Disclosure Statement filed herewith are not attached as allowed under CFR 1.98(d)(1)(2). **The earlier application is identified as US Patent Application No.: 15/691,884, filed on August 31, 2017, now granted as US Patent No.: 10,604,024, issued on March 11, 2020**.

The Examiner is invited to contact the undersigned attorney at the below-listed telephone number, with regard to any questions that may arise.

Respectfully submitted,
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EX 1010

USB Battery Charging 1.2 Compliance Plan

Revision 1.0

October 12, 2011

Revision History

Revision	Issue Date	Author	Comment
1.0	Oct 26, 2011	Pat Crowe	First release

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1 Introduction

1.1 General

This compliance plan enables test and certification of USB Portable Devices, Chargers and Charging Ports, Micro-ACAs, Standard-ACAs and ACA-Docks to USB 2.0 specification and to Battery Charging specification revision 1.2.

Charging Ports include Dedicated Charging Ports and Charging Downstream Ports as defined in the Battery Charging Specification revision 1.2. A USB Charger is a device with a Dedicated Charging Port, such as a wall adapter or car power adapter. Herein, USB Chargers are referred to as Dedicated Charging Ports as functionally they are identical.

Previously a USB Portable Device with a battery and charging capability simply took power from a USB port without any control. With BC 1.2, a Portable Device can get more power and the battery can be charged faster. It is important to verify that a Portable Device complies with the BC 1.2 specification while communicating with a Charging Downstream Port and identifying a Dedicated Charger, and ensuring that it continues to operate as a functional USB device.

Many existing dedicated chargers have offered a USB compliant physical connection but lacked a USB compliance program. This led to many chargers having characteristics incompatible with USB specifications.

As well, even though PC host ports go through an extensive certification process, future PCs that claim a USB compliant Charging Port in their feature list will be required to pass compliance checks described in this document. These checks are in addition to those required for a USB compliant Standard Downstream Port.

1.2 Objective of the Compliance Program

The overall objective of the USB Charger and Charging Port compliance program is to mirror the effectiveness of the USB-IF compliance program. The benefits of a compliance program have been proven by the USB initiative: the proliferation of knowledge, more stringent testing, and a higher standard of quality.

1.3 Scope of the Document

This document provides a compliance plan applicable to Portable Devices, USB Chargers and Charging Ports, Micro-ACAs, Standard-ACAs and ACA-Docks, as defined in the BC 1.2 specification.

1.4 Intended Audience

This plan is intended for compliance test labs and workshops. In addition, the document is intended for device manufacturers for pre-certification activities before applying for official compliance certification.

1.5 Reference Document(s)

- Battery Charging 1.2 Specification and Adopters Agreement
  http://www.usb.org/developers/devclass_docs/

- Universal Serial Bus Specification Revision 2.0 Specification
  http://www.usb.org/developers/docs/

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2 Acronyms and Terms

This chapter lists and defines terms and abbreviations used throughout this document.

ACA	Accessory Charger Adapter
BC 1.2	USB-IF Battery Charging Specification version 1.2
CDP	Charging Downstream Port
CMO	Common Mode Offset
CMV	Common Mode Voltage
DBP	Dead Battery Provision
DC	Direct Current
DCD	Data Contact Detect
DCP	Dedicated Charging Port
ETB	Electrical Test Board
FS	Full-speed
HS	High-speed
ID	Identification
LS	Low-speed
MRP	Multiple Role Port (CDP/DCP/SDP)
OTG	On-The-Go
PC	Personal Computer
PD	Portable Device
PET	Protocol and Electrical Tester
PHY	Physical Layer Interface for High Speed USB
PS2	Personal System 2
SDP	Standard Downstream Port
SIE	Serial Interface Engine
SRP	Session Request Protocol
TID	Test Identification Number
TPL	Targeted Peripheral List
USB	Universal Serial Bus
USBCV	USB Command Verifier
USB-IF	USB Implementers Forum
UUT	Unit Under Test
VBUS	Voltage line of the USB interface

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3 Scope of Tests

This document describes suites of tests for a number of product types. These tests only cover the additional requirements for these products, relating to the functionality of battery charging. Most of the product types will require further compliance testing to ensure their functionality in other areas, and it is beyond the scope of this document to define those tests.

For example, a Portable Device (PD) may be an OTG device and as such, require to be tested according to the appropriate OTG Supplement Compliance Plan.

The document is divided into suites of tests, each of which represents all or part of the Battery Charging test requirements for a particular product. A given product shall be tested against all the appropriate test suites. The following examples, which are not exhaustive, illustrate this principle.

PD

Test against both:

- 'PD, except Dead Battery Provision' tests and
- 'PD, Dead Battery Provision' tests.

Simple Charger

Test against:

- DCP tests

Charging Port on Host

Test against:

- CDP tests

Hub

Test against:

- CDP tests
- DCP tests
- SDP tests
- MRP tests

ACA or ACA-Dock

Test against the one appropriate category from:

- Micro-ACA, Separate Charger
- Micro-ACA, Combined Charger
- Standard-ACA, Separate Charger
- Standard-ACA, Combined Charger
- ACA-Dock

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4 PET – Protocol and Electrical Tester

The PET is a unit, designed to perform compliance testing or assist with development work leading towards compliance testing on On-the-Go, Battery Charging and other general USB applications. It is described in detail in the document:

- Protocol and Electrical Tester Specification

A brief breakdown of its functional blocks follows.

4.1 Serial Interface Engine (SIE)

A fully functional SIE, with both host and peripheral capabilities, connected via a PHY to the UUT micro-AB receptacle on the front panel. This is under the control of the Script Processor.

4.2 Electrical Test Board (ETB)

This contains circuitry to allow control and measurement of the electrical parameters for USB, OTG and BC specifications. It includes VBUS Generator, ID pin circuitry, data line test mode circuitry, VBUS current and voltage loads, and a variety of voltage and current measuring blocks. Extra connections are provided to enable the testing of Accessory Charger Adapters (ACAs). The ETB functionality required is shown in Figure 4-1.

4.3 Script Processor

Scripts are downloaded to this processor to control the sequence of operations required for a particular test. The processor controls the SIE and ETB as required by the operator. Scripts for all the OTG and BC compliance tests would be provided by the application accompanying the PET.

4.4 USB Analyzer

The PET could also provide full USB analyzer functionality. By designing the analyzer into the PET circuitry the analyzer could be designed to have zero impact on the data line transmission quality.

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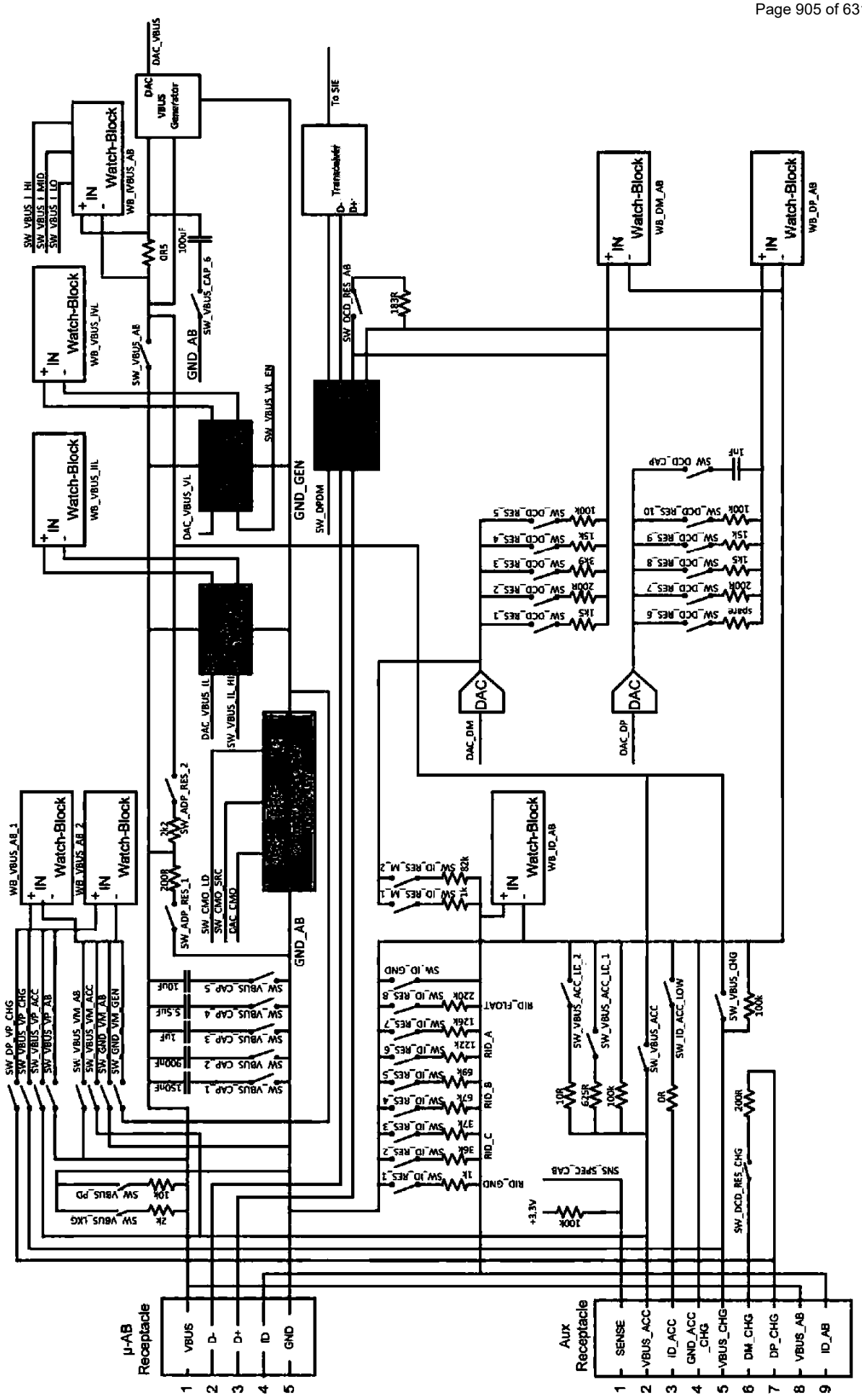


Figure 4-1 ETB Block Diagram

5 Test Cables Required

The cables required by the PET tester are described below.

Each cable should be labeled, and specify the lead loop resistance value, required to be entered into the test dialog, if the lead is replaced. The tester application contains a check box to specify whether the UUT has a captive lead, as in this case the captive test cable is deemed to be part of the unit under test.

5.1 Special Test Cable A

Table 5-1 Special Test Cable A

Micro-B plug to Micro-B plug		
Micro-B plug (PET)	Micro-B plug (UUT)	Purpose
1	1	VBUS
2	2	D-
3	3	D+
4	4	ID
5	5	GND

This cable has been specified to allow control of the ID pin of the unit-under-test. It is important to use this cable when the test specifies it. The particular resistance of the cable has also been allowed for in the test suite.

5.2 Special Test Cable B

Table 5-2 Special Test Cable B

Micro-B plug to Standard-A plug		
Micro-B plug (PET)	Standard-A plug (UUT)	Purpose
1	1	VBUS
2	2	D-
3	3	D+
nc		
5	4	GND

Although this is a standard cable configuration, it is important to use the specified cable, as its particular resistance has been allowed for in the test suite.

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5.3 Special Test Cable C

Table 5-3 Special Test Cable C

9-pin D-type Assembly			
D-type (PET)	Standard-A Receptacle (ACA Charger Port)	Micro-B Plug (ACA Accessory Port)	Purpose
1 (linked to 4)			Cable Sense
2		1	Accessory VBUS
3		4	Accessory ID
4	4	5	GND
5	1		Charger VBUS
6	2		Charger D-
7	3		Charger D+
8			OTG VBUS
9			OTG ID

This cable is used when testing a Micro-ACA. This is correct for a Micro-ACA with a captive charger port cable. For a Micro-ACA with a Micro-B receptacle as the charger port, connect Special Cable B to the Standard-A receptacle of Special cable C, and plug the other end into the charger port of the ACA.

5.4 Special Test Cable D

Table 5-4 Special Test Cable D

9-pin D-type Assembly			
D-type (PET)	Standard-A Receptacle (ACA Charger Port)	Standard-A Plug (ACA Accessory Port)	Purpose
1 (linked to 4)			Cable Sense
2		1	Accessory VBUS
3			Accessory ID
4	4	4	GND
5	1		Charger VBUS
6	2		Charger D-
7	3		Charger D+
8			OTG VBUS
9			OTG ID

This cable is used when testing a Standard-ACA. This is correct for a Standard-ACA with a captive charger port cable. For a Standard-ACA with a Micro-B receptacle as the charger port, connect Special Cable B to the Standard-A receptacle of Special cable C, and plug the other end into the charger port of the ACA.

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5.5 Special Test Cable E

Table 5-5 Special Test Cable E

Micro-A plug to Standard-A receptacle		
Micro-A plug (PET)	Standard-A receptacle (UUT)	Purpose
1	1	VBUS
2	2	D-
3	3	D+
4 - Connected to pin 5		
5	4	GND

This is a short adapter cable, which may be used to connect a PD with a standard-A plug to the PET.

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6 Test Setups

6.1 OTG Device as Unit-Under-Test (Setup no. 1)

When running a test-suite relating to an OTG device, the first test will prompt you to connect it to the PET using 'Special Cable A'. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reasons:

It has 5 cores, instead of the usual 4. This allows the PET to control the ID pin of the UUT.

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

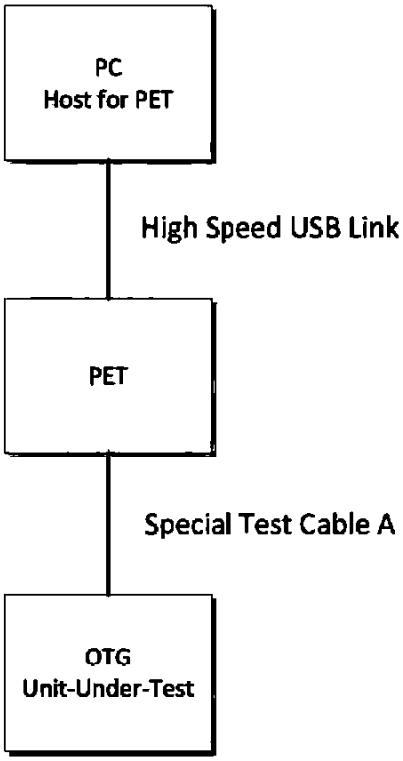


Figure 6-1 Setup No 1 – OTG Device

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6.2 Embedded Host as Unit-Under-Test (Setup no. 2)

When running a test-suite relating to an Embedded Host, the first test will prompt you to connect it to the PET using 'Special Cable B'. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

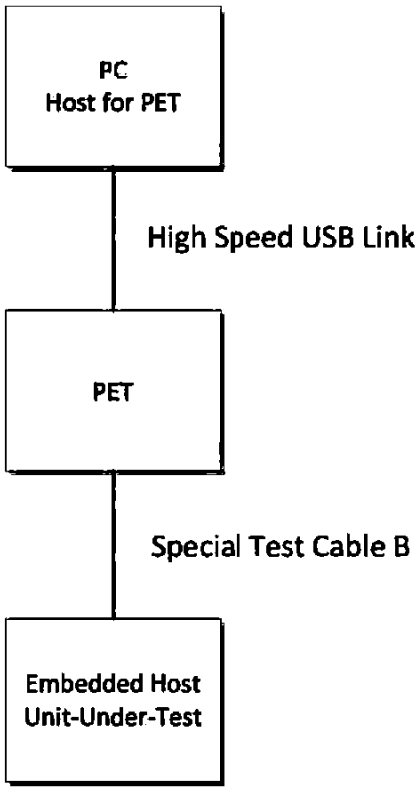


Figure 6-2 Setup No 2 – Embedded Host

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6.3 Peripheral Only as Unit-Under-Test (Setup no. 3)

When running a test-suite relating to a Peripheral-Only OTG device with a ***Micro-B receptacle***, the first test will prompt you to connect it to the PET using 'Special Cable A'. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

Another possibility is that the device has a captive cable with a ***Micro-A plug***. In this case use this, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

Finally, the device may have a captive cable with a ***Standard-A plug***. In this case, use 'Special Cable E' to connect the ***Standard-A plug*** to the ***Micro-AB receptacle*** of the PET, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

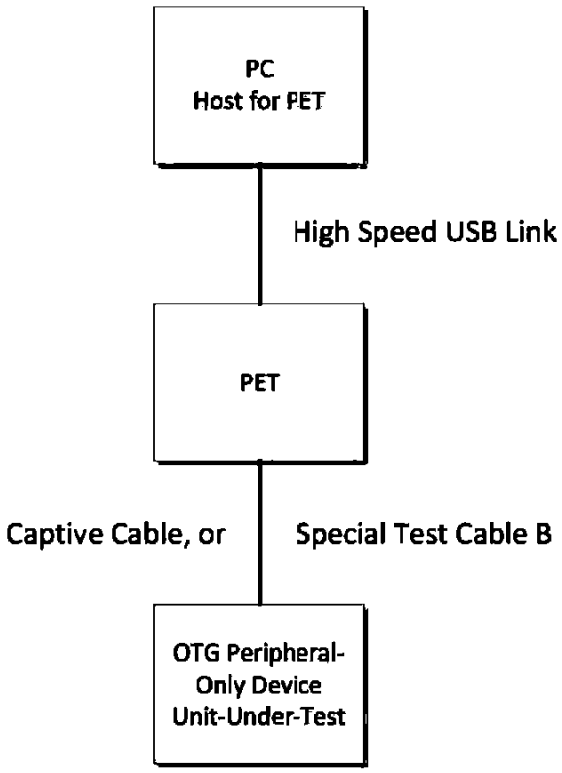


Figure 6-3 Setup No 3 – Peripheral Only

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6.4 PD as Unit-Under-Test (Setup no. 4)

A Portable Device (PD) is assumed to have a ***Micro-B receptacle*** or a ***Micro-AB receptacle***. A PD that mates with an ACA-Dock or ACA is required to have a ***Micro-AB receptacle***. The PD may alternatively have a captive cable.

When running a test-suite relating to a PD having a ***Micro-B receptacle*** or a ***Micro-AB receptacle***, the first test will prompt you to connect it to the PET using 'Special Cable A'. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

The other possibility is that the device has a captive cable with a ***micro-A plug***. In this case use this, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

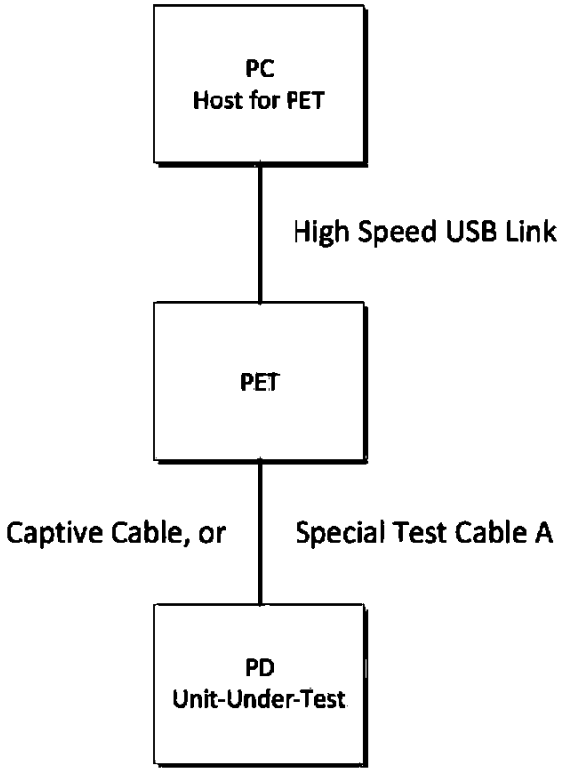


Figure 6-4 Setup No 4 – Portable Device

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6.5 CDP (or SDP) as Unit-Under-Test (Setup no. 5)

A Charging Downstream Port (CDP) must be equipped with a Standard-A receptacle.

When running a test-suite relating to a CDP, the first test will prompt you to connect it to the PET using 'Special Cable B'. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

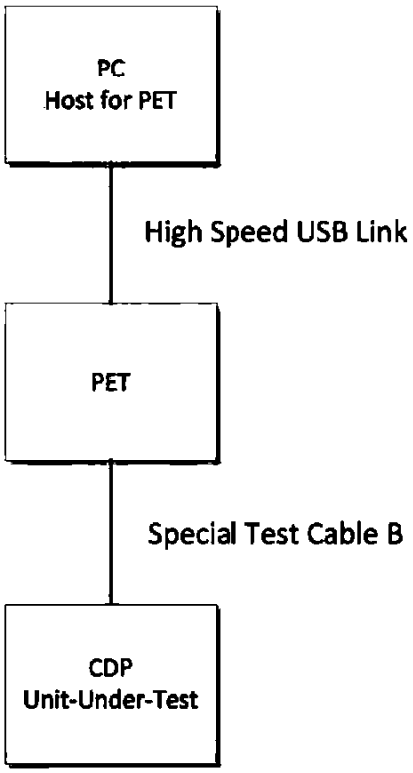


Figure 6-5 Setup No 5 – CDP

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6.6 DCP as Unit-Under-Test (Setup no. 6)

A Dedicated Charging Port (DCP) must be equipped with a ***Standard-A receptacle***, or a captive cable terminated with a ***Micro-B plug***.

When running a test-suite relating to a DCP with a ***Standard-A receptacle***, the first test will prompt you to connect it to the PET using 'Special Cable B'. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

The other possibility is that the device has a captive cable with a ***micro-B plug***. In this case use this, and check the 'Captive Cable' check box, in the 'USB-PET Test Suites' Dialog.

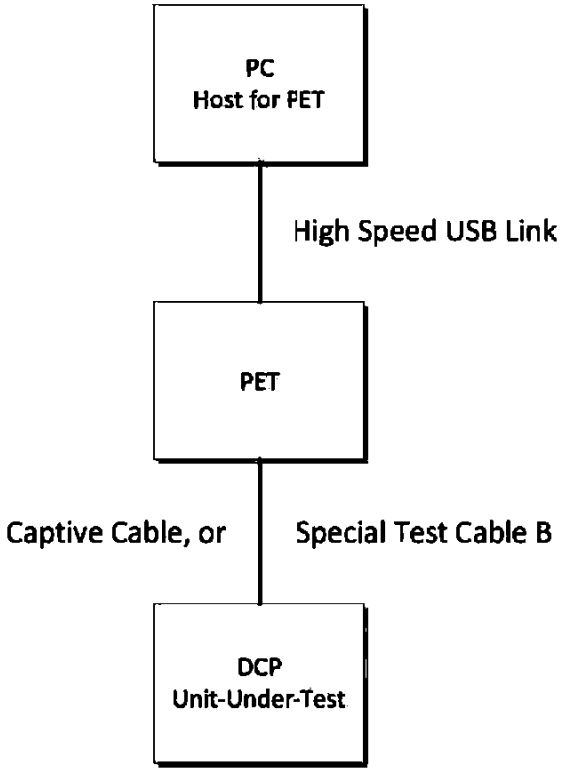


Figure 6-6 Setup No 6 – DCP

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6.7 Micro-ACA (Separate Charger) as Unit-Under-Test (Setup no. 7)

An Accessory Charger Adapter having a Micro-AB receptacle for its accessory port (Micro-ACA) must be equipped with:

- a captive cable terminated with a Micro-A plug for its OTG port
- a Micro-B receptacle, or a captive cable with Standard-A plug for its charger port, and of course
- a Micro-AB receptacle for its accessory port

When running a test-suite relating to a Micro-ACA, the first test will prompt you to connect it to the PET using 'Special Cable C'.

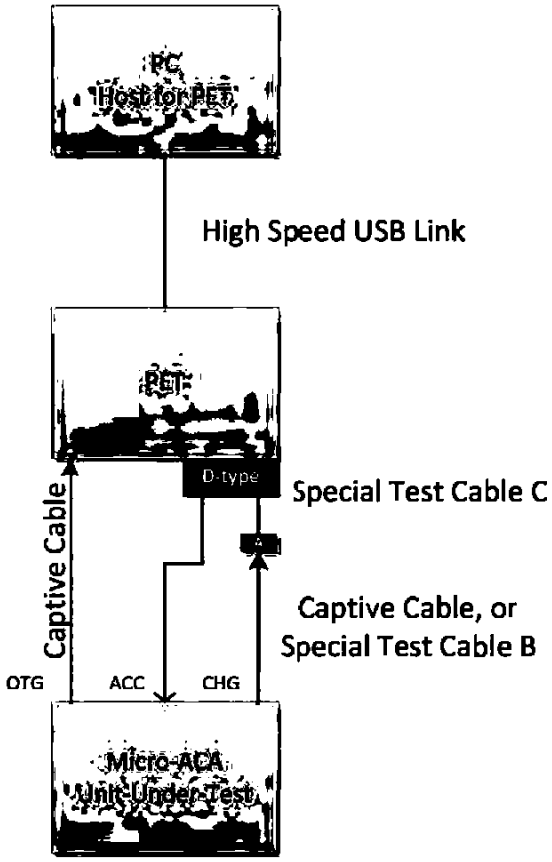


Figure 6-7 Setup No 7 – Micro-ACA

6.8 Micro-ACA (Combined Charger) as Unit-Under-Test (Setup no. 7b)

This is the same as Setup 7 except that there is no charger cable coming from the UUT.

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6.9 Standard-ACA (Separate Charger) as Unit-Under-Test (Setup no. 8)

An Accessory Charger Adapter having a Standard-A receptacle for its accessory port (Standard-ACA), must be equipped with:

- a captive cable terminated with a Micro-A plug for its OTG port
- a Micro-B receptacle, or a captive cable with Standard-A plug for its charger port, and of course
- a Standard-A receptacle for its accessory port

When running a test-suite relating to a Standard-ACA, the first test will prompt you to connect it to the PET using 'Special Cable D'.

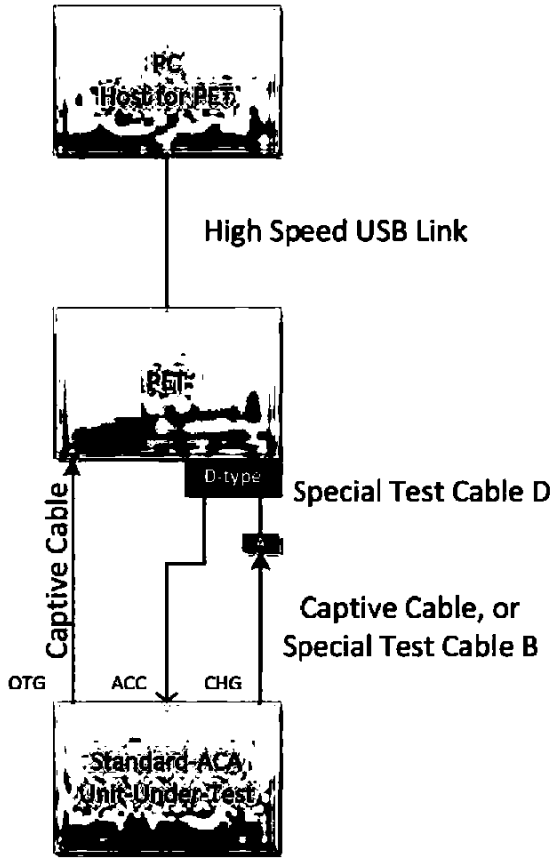


Figure 6-8 Setup No 8 – Standard-ACA

6.10 Standard-ACA (Combined Charger) as Unit-Under-Test (Setup no. 8b)

This is the same as Setup 8 except that there is no charger cable coming from the UUT.

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6.11 ACA-Dock as Unit-Under-Test (Setup no. 9)

An ACA-Dock must be equipped with a Micro-A plug, for connecting to the Micro-AB receptacle of a PD. It is represented here as a captive cable. In practice it may comprise part of a fixture, which may be difficult to connect to the PET front panel. In this case it is the responsibility of the vendor to provide a suitable means to connect the ACA-Dock to the Micro-AB receptacle of the PET.

When running a test-suite relating to an ACA-Dock, the first test will prompt you to connect it to the PET using its captive cable.

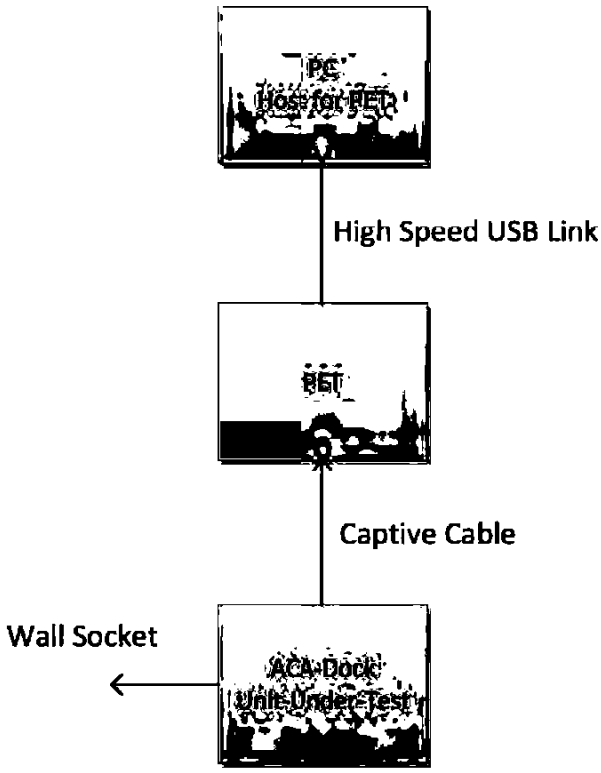


Figure 6-9 Setup No 9 – ACA-Dock

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7 Portable Device Compliance

7.1 Submission Materials

7.1.1 Device Specific Information and Materials

Table 7-1 Device Specific Information and Materials for PDs

Item	Function	Value/ Support
1	Captive Cable	Yes ☐ No ☐
2	Apply Dead Battery Provision	Yes ☐ No ☐
3	Weak Battery Threshold	V
4	Maximum Charging Current with Dedicated Charger	_____mA
5	Maximum Charging Current with Charging Downstream Port operating at LS or FS	_____mA
6	Maximum charging current with Charging Downstream Port operating at HS	_____mA
7	Typical and maximum times that UUT with a dead battery will take to connect after being attached to a Standard Downstream Port	Typ. ____m ____s Max. ____m ____s
8	Typical and maximum times that UUT with a dead battery will take to connect after being attached to a Charging Downstream Port	Typ. ____m ____s Max. ____m ____s
9	Maximum current that the UUT can draw from a CDP	_____mA
10	The USB-IF TID for the UUT USB receptacle or captive plug intended to connect the UUT to a host or OTG device.	
11	Supply 2 batteries in a dead state for the Dead Battery Provision test.	
12	Supply 2 batteries in a state just above the weak battery threshold.	
13	Supply 1 good battery.	

7.1.2 Checklist

Table 7-2 Checklist for PDs

ID - Question		Response	Test Number	BC 1.2 Reference
PD1	Can the PD detect when VBUS is greater than a threshold in the range VOTG_SESS_VLD ?	Yes ☐ No ☐	Vendor Declaration	3.2.2 3.3.1
PD2	Can the PD detect when D+ is greater than a threshold in the range VDAT_REF ?	Yes ☐ No ☐	Vendor Declaration	3.3.1
PD3	Can the PD detect when D- is greater than a threshold in the range VDAT_REF ?	Yes ☐ No ☐	Vendor Declaration	3.3.1

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PD4	Can the PD detect when D- is greater than a threshold in the range VLGC ?	Yes ☐ No ☐	Vendor Declaration	3.3.1
PD5	[Optional] Does PD use a current source IDP_SRC and pull-down resistor RDM_DWN to detect when the data pins have made contact during an attach event?	Yes ☐ No ☐	7.3	3.2.3.1 3.4.1 4.6.2
PD6	If yes, does PD commence Primary Detection within TDCD_TIMEOUT max after VBUS rises above VOTG_SESS_VLD, if pin contact has not been detected on D+ or ID pins?	Yes ☐ No ☐	7.3	3.2.3.1 3.3.2 4.6.2
PD7	If no, does PD wait a time of TDCD_TIMEOUT after the attach event before starting Primary Detection?	Yes ☐ No ☐	7.4	3.2.3.1 3.3.2 4.6.2
PD8	Does PD connect within TSVLD_CON_PWD of the attach event?	Yes ☐ No ☐	7.6, 7.7, 7.10, 7.11	3.2.3.1
PD9	Does PD wait for D+ to stay below VLGC_LOW for TDCD_DBNC min before disconnecting IDP_SRC and RDM_DWN?	Yes ☐ No ☐	7.3	3.3.2 3.4.1
PD10	Does PD turn on VDP_SRC and IDM_SINK and maintain them for TVDPSRC_ON during Primary Detection?	Yes ☐ No ☐	7.6, 7.7	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 3.4.2
PD11	Is the design of VDP_SRC such that an external device is able to pull D+ to 2.2V through RDP_UP?	Yes ☐ No ☐	7.8	3.2.4.4 5
PD12	Does PD compare D- with VDAT_REF during Primary Detection to distinguish between an SDP and a Charging Port?	Yes ☐ No ☐	7.7	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 4.6.2
PD13	[Optional] Does PD compare D- with VLGC during Primary Detection?	Yes ☐ No ☐	Vendor Declaration	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 4.6.2
PD14	[Optional] Does PD implement Secondary Detection?	Yes ☐ No ☐	7.5, 7.6	4.6.2
PD15	If the PD supports Secondary Detection, does the PD turn on VDM_SRC and IDP_SINK and maintain them for TVDMSRC_ON during Secondary Detection?	Yes ☐ No ☐ N/A ☐	7.5, 7.6	3.2.5.1 3.2.5.2 3.3.2 3.4.2
PD16	If the PD supports Secondary Detection, does the PD compare D+ with VDAT_REF during Secondary Detection to distinguish between a DCP and a CDP?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.5.1 3.2.5.2 3.3.2 3.4.2

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PD17	If the PD supports Secondary Detection, and during this detects that it is attached to a DCP, does it disable VDM_SRC and IDP_SINK, and either enable VDP_SRC or pull D+ up to VDP_UP through RDP_UP, within TSVLD_CON_PWD of attach, and maintain this for as long as it draws more than ISUSP? If the PD does not support Secondary Detection, and during Primary Detection has detected that it is connected to a DCP or to a CDP, does it pull D+ up to VDP_UP through RDP_UP, within TSVLD_CON_PWD of attach, and maintain this for as long as it draws more than ISUSP?	Yes ☐ No ☐	7.5	3.2.5.1 3.3.2
PD18	If the PD supports Secondary Detection, and during this detects that it is attached to a CDP, does it turn off VDP_SRC, VDM_SRC and IDP_SINK, and connect within TSVLD_CON_PWD of attach?	Yes ☐ No ☐ N/A ☐	7.6	3.2.5.2 3.3.2 3.4.2
PD19	[Optional] Does PD implement ACA Detection?	Yes ☐ No ☐	Vendor Declaration	3.2.6 4.6.2
PD20	If the PD supports ACA detection, does PD have a Micro-AB receptacle?	Yes ☐ No ☐ N/A ☐	Inspection	3.2.6 4.6.4
PD21	If the PD supports ACA detection, is it able to detect being attached to an ACA-Dock when it sees the following conditions: • VBUS > VOTG_SESS_VLD • ID at RID_A • D+ at VLGC_HI • VDAT_REF < D- < VLGC	Yes ☐ No ☐ N/A ☐	7.8	3.2.4.4 3.3.2 3.2.6
PD22	If the PD supports ACA detection, is it able to detect being attached to an ACA with a FS B-device on its accessory port and a charging port attached, when it sees the following conditions: • ID at RID_A • D- < VDAT_REF	Yes ☐ No ☐ N/A ☐	7.9	3.2.4.5 3.3.2 3.2.6
PD23	If the PD supports ACA detection, is it able to detect being attached to an ACA with a LS B-device on its accessory port and a charging port attached, when it sees the following conditions: • ID at RID_A • D- > VLGC	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.4.5 3.2.6

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PD24	If the PD supports ACA detection, is it able to detect being attached to an ACA having a charging port attached when it sees the following condition: • ID at RID_B	Yes ☐ No ☐ N/A ☐	7.10	3.2.4.5 3.2.6
PD25	If the PD supports ACA detection, is it able to detect being attached to an ACA with an A-device on its accessory port and a charging port attached, when it sees the following condition: • ID at RID_C	Yes ☐ No ☐ N/A ☐	7.11	3.2.4.5 3.2.6
PD26	If the PD supports ACA detection, is it able to detect being attached to an ACA with an B-device on its accessory port and no charging port attached, when it sees the following condition: • ID at RID_GND	Yes ☐ No ☐ N/A ☐	7.12	3.2.6
PD27	If the PD supports ACA detection, does it continue to monitor the ID line after doing Primary detection, and respond correctly to resistance changes?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.4.5 3.2.6 6.2.7
PD28	Does PD discharge VBUS to less than VBUS_LKG within TVLD_VLKG whenever VBUS is removed?	Yes ☐ No ☐	7.7	4.6.3
PD29	Does PD wait at least TCP_VDM_EN after disconnecting, before restarting the charger detection process?	Yes ☐ No ☐	Vendor Declaration	4.6.3
PD30	Does PD draw no more than IDEV_CHG max from a Charging Port? What is the value of IMAX_BC, the actual maximum current drawn? Note: IMAX_BC is the maximum current that the PD can draw from a CDP.	Yes ☐ No ☐ _____mA	7.5, 7.6, 7.8, 7.9, 7.10, 7.11	4.6.1
PD31	Does PD draw no more than ICFG_MAX from a SDP?	Yes ☐ No ☐	7.7	2.1
PD32	Does PD pull output voltage of a Charging Port no lower than VDCP_SHTDWN?	Yes ☐ No ☐	Vendor Declaration	4.6.1
PD33	Does the PD correctly support LS, FS, HS and chirp signaling when the local ground is (IMAX_BC **x 0.25Ω** + 5mV)* higher than the remote ground, where IMAX_BC is the maximum current that the PD can draw from a CDP? *maximum of 0.375V	Yes ☐ No ☐	7.13, 7.14	3.5

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DBP1	Does PD draw no more than IUNIT when PD is not able to connect?	Yes ☐ No ☐	7.15	2.2
DBP2	Does PD reduce current drawn to ISUSP within TSVLD_CON_WKB after attach if it is unable to connect and be enumerated?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP3	Does PD enable VDP_SRC within TDBP_ATT_VDPSRC of attach and maintain it if it is unable to connect?	Yes ☐ No ☐	7.15	2.2
DBP4	Does PD connect within TDBP_ VDPSRC_CON of disabling VDP_SRC?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP5	Does PD prevent the use of DBP current to perform tasks unrelated to battery charging?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP6	If the PD uses the DBP, can the device normally operate stand-alone from internal battery power?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	2.2
DBP7	Can the PD, with a dead battery, pass the inrush test?	Yes ☐ No ☐	Vendor Declaration	2.2

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7.2 B-UUT Initial Power-up Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a downstream port.
Purpose	To prepare the PD for the following tests.
Preconditions	To ensure that the PD has been powered up and is ready for the subsequent tests. All following PD tests assume that this test has been run first. In the case of an ADP capable device, this test also confirms functional startup sequence.
Parameters	TB_SRP_FAIL, TB_ADP_PRB, TPWRJP_RDY
Description	The test operator is then instructed to connect up the PD in preparation for the tests, and to perform any actions required to power it up.

7.2.1 Test Procedure

Part 1 – Common to All B-UUT Types

1. The user enters into the PET:
    - whether the UUT is capable of ADP

The test sequence followed depends on the UUT type

- PD capable of ADP
- PD not capable of ADP

Part 2 – For PD UUT capable of ADP

2. Operator: Ensure UUT connected using special cable A or, where the device does not have a micro-AB or micro-B receptacle, a suitable alternative.
3. UUT is either powered or is not powered. PET is not applying VBUS, and not applying capacitance between VBUS and ground, ID pin is not connected to ground.
4. Operator: Turn UUT off, if not already off.
5. Operator: Turn UUT on.
6. Check that UUT performs an ADP probe within TPWRUP_RDY (30 sec or as specified by vendor).
7. To check probe, check that VBUS goes below 0.3V and then rises above 0.5V within 10ms.
8. After the first probe check that either a further probe (or probes) is performed, or that D+ goes high. Wait here till D+ goes high or TPWRUP_RDY times out.
9. Check that D+ stays high for at least 5ms.
10. Check that D+ goes low within 10ms of start of pulse.

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11. Check ADP probe is not performed for TB_SRP_FAIL min (5 sec) after start of D+ (SRP) pulse.

12. Check that ADP probe is performed within TB_SRP_FAIL max plus TB_ADP_PRB max (6.0 + 2.6 = 8.6 sec) after start of D+ (SRP) pulse.

13. Now ready for any other B_UUT test.

Part 2 – For PD UUT not capable of ADP

2. Operator: Ensure UUT connected using special cable A or, where the device does not have a micro-AB or micro-B receptacle, a suitable alternative

3. UUT is either powered or is not powered. PET is not applying V_{BUS}, and not applying capacitance between V_{BUS} and ground, ID pin is not connected to ground.

4. Operator: Turn UUT on, if not already on.

5. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10kΩ) to V_{BUS} and turns on V_{BUS}.

6. Check that D+ goes high within T_{PWRUP_RDY} (30 sec).

7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

8. Wait 5 seconds to allow disconnection to be detected.

9. Now ready for any other B_UUT test.

Following Tests

From now on all test sequences must start and finish with the PET holding V_{BUS} off, and no capacitance or pull-down resistance connected to V_{BUS}. This allows the tests to be performed in any sequence. In between tests, the ID pin is not connected to ground.

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7.3 Data Contact Detect Test – With Current Source

Test Setup	Test Setup 4. UUT is a PD, PET simulates a downstream port.
Pre-conditions	Only required if UUT supports DCD using IDP_SRC. The charge state of the battery is not critical in this test, provided it is above the Weak Battery Threshold.
Purpose	To validate a correct data contact detection procedure when the UUT supports DCD using IDP_SRC.
Description	Check that IDP_SRC is maintained for TDCD_DBNC after D+ is pulled low and that TDCD_TIMEOUT is complied with.
Parameters	RDM_DWN or IDM_SINK, TDCD_DBNC, IDP_SRC
Checklist	PD5, PD6, PD9
Pass Criteria	Step 3: D+ to rises above 2V Step 6: D- does not exceed 0.498V Step 10: D+ is less than 0.375V.

7.3.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on.

DCD using IDP_SRC

1. PET applies CADP_VBUS max (6.5µF) and a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V.
2. Start timer when VBUS reaches 0.8V.
3. Wait for D+ to rise above 2V. (If it doesn't within 0.9 second – test fails.) This proves that IDP_SRC is sufficiently large to overcome the UUT's own leakage current. [PD5]
4. Measure and report time till it does.
5. After 1ms of D+ exceeding 2V, measure and report voltage on D+.
6. Connect 0.8V via 15kΩ to D-. Check voltage at D- is in correct range for a pull-down value meeting the specification (i.e. that voltage is not greater than 0.498V and not less than 0.390V). [PD5]

Note: For worst case max RDM_DWN of 24.8K we need a max voltage at D- of 0.498V. For worst case min RDM_DWN of 14.25K we need a min voltage at D- of 0.390V.

7. Disconnect components in previous step.
8. Connect 15kΩ from D+ to 0V.
9. Wait just less than TDCD_DBNC min (<10ms = 9.5ms). [PD9]
10. Check voltage on D+ is less than 0.375V. This proves that IDP_SRC and leakage, together, are low enough to provide a low logic level on D+, even after nearly

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T_{DCD_DBNC} min (10ms). (Voltage to be adjusted in actual test script to allow for small tester leakage.)

Note: Highest current sourced by UUT should be I_{DP_SRC} max (13µA) plus V_{DAT_LKG} max (3.6V) across R_{DAT_LKG} min (300K), equals 13 + 12 µA = 25µA. 25µA x 15K = 0.375V.

11. Disconnect everything from V_{BUS}, and switch V_{BUS} off.

12. Wait 2 seconds for disconnect to be detected.

DCD using Timeout

13. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.

14. Start timer when V_{BUS} reaches 0.8V.

15. Wait for D+ to rise above 2V. (If it doesn't within 0.9 second – test fails.).

16. Check that D+ goes down to voltage in the range V_{DP_SRC} (0.5 to 0.7V) within $T_{DCD\_TIMEOUT}$ (0.3 to 0.9 sec) of D+ going high and within 1 second of V_{BUS} reaching 0.8V. [PD6]

17. Turn off V_{BUS}.

18. Wait 8 seconds, ignoring SRP pulse, for disconnect to be detected.

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7.4 Data Contact Detect Test – No Current Source

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Only required if UUT does not support DCD using IDP_SRC. The charge state of the battery is not critical in this test, provided it is above the Weak Battery Threshold.
Purpose	To validate a correct data contact detection procedure when the UUT does not support DCD using IDP_SRC.
Description	Check that Primary Detection commences within TDCD_TIMEOUT max of VBUS turning on.
Parameters	RDM_DWN or IDM_SINK, TDCD_DBNC, IDP_SRC
Checklist	PD5, PD7
Pass Criteria	Step 3: Time for D+ to go to VDP_SRC is 0.3 to 0.9 sec.

7.4.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on.

DCD using Timeout

1. PET applies CADP_VBUS max (6.5µF) and a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V.
2. Start timer when VBUS reaches 0.8V.
3. Connect 15k resistors from 0V to D+, and from 0V to D-.
4. Check that D+ goes up to voltage in the range VDP_SRC (0.5 to 0.7V) within TDCD_TIMEOUT (0.3 to 0.9 sec) of VBUS going on. [PD7]
5. Disconnect 15k pull-down resistors from D+ and D-.
6. Disconnect capacitance and pull-down resistor from VBUS and switch VBUS off.
7. Wait 8 seconds, ignoring SRP pulse, for disconnect to be detected.

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7.5 DCP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a DCP.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a DCP.
Description	PET simulates a DCP and monitors activity on D+ and D-, and current drawn.
Parameters	VDP_SRC, VDM_SRC, TVDPSRC_ON, TVDMSRC_ON,
Checklist	PD14, PD15, PD17, PD30
Pass Criteria	See below

7.5.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on.

DCD

1. PET connects 200R between D+ and D-.
2. PET connects voltage source of 0V via 100k to D-, to prevent false detection of voltage on D+ etc.
3. PET applies CADP_VBUS max (6.5µF) and a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to VB_BUS nom (5V). ID pin is left floating.

Primary Detection

4. Wait for D+ to rise above 0.5V
5. Wait 1ms for D+ to settle.
6. Measure D+ and check voltage is VDP_SRC (0.5 to 0.7V).
7. Wait for slightly less than TVDPSRC_ON min (38ms).
8. Check that D+ voltage is still VDP_SRC (0.5 to 0.7V)
9. Wait for D+ to go below 0.5V, or above 0.8V, or for TSVLD_CON_PWD (1 sec) from VBUS going on to expire.

TSVLD_CON_PWD expires:

Implication is that change between driving VDP_SRC, then driving VDM_SRC and then driving VDP_SRC was not seen by the tester, as no gaps were inserted. We can only assume that this is not a failure. Skip to 'Checking Current Draw'.

D+ goes below 0.5V:

If secondary detection is declared not to be implemented, skip to 'Checking Current Draw'.

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If secondary detection is declared to be implemented, proceed with 'Secondary Detection'.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a 'device connect'.

If secondary detection is declared not to be implemented, this is a valid procedure, and the tester will report that this sequence has occurred, and skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, and less than 80ms has passed since D+ first rose above 0.5V, this constitutes a failure because the specified periods T_{VDPSRC_ON} plus T_{VDMSRC_ON} have not been completed. [PD14]

If secondary detection is declared to be implemented, and more than 80ms has passed since D+ first rose above 0.5V, this implies that the change between driving V_{DP_SRC} and then driving V_{DM_SRC} was not seen by the tester. The only possible conclusion here is to assume a pass at this stage, and to skip to 'Checking Current Draw'.

Secondary Detection

10. Wait for D- to rise above 0.5V, or above 0.8V, or for expiration of $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} going on.

$T_{SVLD\_CON\_PWD}$ expires:
This constitutes a failure because neither V_{DP_SRC} nor a pullup to V_{DP_UP} through R_{DP_UP} occurred.

D- goes above 0.5V:
First check if it goes between 0.7V and 0.8V within 1ms. If so this is an error.

Also check if it goes above 0.8V within 1ms. If so go to 'D- goes above 0.8V'.

If voltage stays within V_{DM_SRC} (0.5 to 0.7V), assume this is secondary detection and go to Step 11.

D- goes above 0.8V:
This will be regarded as a 'device connect'. (D+ and D- are connected via 200R.)

If less than 80ms has passed since D+ first rose above 0.5V, this constitutes a failure because the specified periods T_{VDPSRC_ON} plus T_{VDMSRC_ON} have not been completed. [PD14]

Otherwise, proceed to 'Checking Current Draw'.

(In practice we may have missed gap between V_{DP_SRC} and V_{DM_SRC}, and be seeing a gap between V_{DM_SRC} and connect. However this will not invalidate the next steps.)

11. Wait for slightly less than T_{VDMSRC_ON} min (38ms).

12. Check that D- voltage is still V_{DM_SRC} (0.5 to 0.7V). [PD14], [PD15]

13. Wait for D- to go below 0.5V, or above 0.8V, or for $T_{SVLD\_CON\_PWD}$ max (1 sec) from V_{BUS} going on to expire.

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Checking Current Draw

14. If secondary detection is declared to be implemented, display message to test operator 'PD under test should now have detected DCP'.
    If secondary detection is declared not to be implemented, display message to test operator 'PD under test should now have detected DCP or CDP'.
    (This is a development aid.)

15. Check current drawn does not exceed 1.5A from now on. [PD30]

16. Check D+ is held at or above V_{DP_SRC} min (0.5V) for the entire period, starting $T_{SVLD\_CON\_PWD}$ max (1 sec) after V_{BUS} was applied, that current drawn exceeds I_{SUSP} max (2.5mA). *Note that the voltage drop in the cable ground will raise the apparent voltage on D+.* [PD17]

17. Maintain session for 30 seconds from step 14.

18. Disconnect 200R resistor between D+ and D-.

19. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

20. Disconnect voltage source and 100k resistor from D-.

21. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.6 CDP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test must be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a CDP. Also to check correct renegotiation behavior.
Description	PET simulates a CDP and monitors activity on D+ and D- , and current drawn.
Parameters	VDP_SRC, TVDPSRC_ON, TSVLD_CON_PWD, IMAX_BC
Checklist	PD8, PD10, PD14, PD15, PD18, PD28, PD30
Pass Criteria	See below

7.6.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on.

DCD

1. Switch data lines to PET test circuit. PET applies a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V. ID pin is left floating.
2. Connect 0V via 15k resistor to D+. Connect 0V via15k resistor to D-.

Primary Detection

3. Wait for D+ to rise above 0.5V
4. Wait 1ms for D+ to settle.
5. Measure D+ and check voltage is VDP_SRC (0.5 to 0.7V). [PD10]
6. Check value of IDM_SINK, as follows: Change voltage on 15k resistor to D- to 0.6V. Wait 1ms, then check voltage at D- is in correct range for a worst case IDM_SINK of 25µA (i.e. that voltage is not greater than 0.225V). [PD10]
7. Change voltage on 15k resistor to D- to 0V.
8. Wait for 17ms (together with 2ms delay above, this is less than TVDMSRC_EN max).
9. Disconnect 15K resistor from D- and replace with 1K5 from 0.7V.
10. Wait 1ms for D- to settle.
11. Measure voltage on D-. This must be above 0.4V, to prove that IDM_SINK max (175µA) is not exceeded.
12. Wait 19ms (together with 20ms delay above, this is less than TVDPSRC_ON min).
13. Check that D+ voltage is still VDP_SRC (0.5 to 0.7V). [PD10]

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14. Wait for D+ to go below 0.5V, or above 0.8V, or for TSVLD_CON_PWD (1 sec) from VBUS going on to expire.

TSVLD_CON_PWD expires:

This is a failure, as the UUT failed to connect within TSVLD_CON_PWD (1 sec). [PD8]

D+ goes below 0.5V:

End of primary detection, proceed from step 15.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a 'device connect'. [PD8]

If secondary detection is declared not to be implemented, this is a valid procedure, and the tester will report that this sequence has occurred, perform steps 13 and 14, and then skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, this is a failure, secondary detection was not attempted. [PD14]

15. Disconnect 1K5 resistor from D- and replace with 15K from 0V.

16. Wait 100us (for D- to fall).

If secondary detection is declared not to be implemented, skip to Checking Current Draw.

Secondary Detection

17. Wait for D- to rise above 0.5V

18. Wait 1ms for D- to settle.

19. Measure D- and check voltage is VDM_SRC (0.5 to 0.7V). [PD15]

20. Check value of IDP_SINK, as follows: Change voltage on 15k resistor to D+ to 0.6V. Wait 20ms, then check voltage at D+ is in correct range for a worst case IDP_SINK of 25µA (i.e. that voltage is not greater than 0.225V). [PD15]

21. Change voltage on 15k resistor to D+ to 0V.

22. Wait for 18ms (together with 21ms delays above, this is less than TVDMSRC_ON min).

23. Check that D- voltage is still VDM_SRC (0.5 to 0.7V). [PD14] [PD15]

24. DO NOT Connect 0.6V to D+.

25. Wait for D- to go below 0.5V.

Checking Current Draw

26. If secondary detection is declared to be implemented, display message to test operator 'PD under test should now have detected CDP'.
    If secondary detection is declared not to be implemented, display message to test

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operator 'PD under test should now have detected DCP or CDP'.
(This is a development aid.)

27. Switch data lines to transceiver.

28. Check current drawn does not exceed I_{MAX_BC} from now on until end of step 31. [PD30]

29. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on. [PD8] [If secondary detection supported: PD18]

30. Enumerate UUT (at HS if possible), and Set Configuration 1.

31. Maintain session for 30 seconds from configuration.

Checking Renegotiation

32. Switch data lines to PET test circuit. Turn off V_{BUS} and disconnect pull-down resistance from VBUS.

33. Check that the PD discharges V_{BUS} to less than V_{BUS_LKG} max (0.7V) within T_{VLD_VLKG} max (500ms). [PD28]

34. Wait for T_{VBUS_REAPP} min (100ms).

35. Apply a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turn on V_{BUS} to 5V.

36. Connect 0V via 15k resistor to D+. Connect 0V via15k resistor to D-.

Note: We will emulate an SDP this time to demonstrate that renegotiation was successful.

Renegotiation - Primary Detection

37. Wait for D+ to rise above 0.5V.

38. Wait 1ms for D+ to settle.

39. Measure D+ and check voltage is V_{DP_SRC} (0.5 to 0.7V). [PD10]

Renegotiation - Checking Current Draw

40. Switch data lines to transceiver.

41. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on.

42. Display message to test operator 'PD under test should now have detected SDP'.

43. Wait for 150ms (D+ debounce time plus 50ms).

44. Check that current drawn from V_{BUS} does not exceed I_{UNIT} (100mA).

45. Turn off V_{BUS} and disconnect pull-down resistance from V_{BUS}.

46. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.7 SDP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a SDP.
Description	PET simulates a SDP and monitors activity on D+, and current drawn.
Parameters	VDP_SRC, TVDPSRC_ON, TSVLD_CON_PWD
Checklist	PD8, PD10, PD12, PD28, PD31
Pass Criteria	See below

7.7.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on.

DCD

1. PET applies a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V. ID pin is left floating.
2. Connect 0V via15k resistor to D+. Connect 0V via15k resistor to D-.

Primary Detection

3. Wait for D+ to rise above 0.5V
4. Wait 1ms for D+ to settle.
5. Measure D+ and check voltage is VDP_SRC (0.5 to 0.7V). [PD10]
6. Check value of IDM_SINK, as follows: Change voltage on 15k resistor to D- to 0.6V. Wait 20ms, then check voltage at D- is in correct range for a worst case IDM_SINK of 25µA (i.e. that voltage is not greater than 0.225V). [PD10]
7. Change voltage on 15k resistor to D- to 0V.
8. Wait for 18ms (together with 21ms delay above, this is less than TVDPSRC_ON min).
9. Check that D+ voltage is still VDP_SRC (0.5 to 0.7V) [PD10]
10. **Do not** connect 0.6V to D-.
11. Wait for D+ to go below 0.5V, or above 0.8V, or for TSVLD_CON_PWD (1 sec) from VBUS going on to expire.

TSVLD_CON_PWD expires:

This is a failure, as the UUT failed to connect within TSVLD_CON_PWD (1 sec). [PD8]

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D+ goes below 0.5V:

If secondary detection is declared not to be implemented, skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, proceed with 'Secondary Detection'.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a legitimate 'device connect'. Skip to 'Checking Current Draw'. [PD8]

Secondary Detection

12. Note: If the primary detection identifies an SDP, then Secondary Detection may not occur. In this case there is no purpose in looking for Secondary Detection, even if it does occur. So we will go straight to 'Checking Current Draw'.

Checking Current Draw

13. Display message to test operator 'PD under test should now have detected SDP. (This is a development aid.)

14. Check current drawn does not exceed I_{CFG_MAX} (500mA) from now on. [PD12], [PD31]

15. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on. [PD8]

16. Enumerate UUT (at HS if possible), and Set Configuration 1.

17. Maintain session for 30 seconds from configuration.

18. Turn off V_{BUS} and disconnect pull-down resistance from V_{BUS}.

19. Check that V_{BUS} falls below V_{BUS_LKG} max (0.7V) within T_{VLD_VLKG} max (500ms). [PD28]

20. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.8 ACA-Dock Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates ACA-Dock.
Pre-conditions	Only required if UUT supports ACA detection. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of RID_A, owing to the current flowing in the cable ground.
Purpose	Demonstrate that PD UUT responds to RID_A on ID pin. i.e. The PD is attached to an ACA-Dock that is driving VBUS.
Description	Connect RID_A to ID pin and check that PD behaves correctly.
Parameters	RID_A
Checklist	PD11, PD21, PD30
Pass Criteria	Step 9: UUT enumerates the PET.

7.8.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on.

1. Switch data lines to PET test circuit. Set up transceiver (now not connected) to peripheral mode with 1k5 pull-up to 3.3V on D+, and 15k pull-down on D-.

2. PET applies CADP_VBUS max (6.5µF) and a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V.

3. Wait 10ms.

4. Simultaneously

   - Connect ID pin to ground via RID_A min (122k).
   - Connect 0.6V via 200R to D-.
   - Connect 3.3V via 1K5 to D+.

5. Check that D+ remains above VLGC_HI min (2.0V) for TDCD_TIMEOUT min (0.3 sec). [PD11]

Note: DCD using current source is not available in this case.

6. Display message to test operator 'PD under test should now have detected ACA-Dock'. (This is a development aid, and may appear up to 0.4sec before actual detection.)

7. Check that SE0 occurs within TA_BCON_ARST max (30 sec).

8. On detecting SE0, switch data lines to transceiver. This has the effect of disconnecting the 0.6V from D-, and replaces the test circuit pull-up with the transceiver pull-up.

9. Check that UUT enumerates the PET within 30 seconds. PET responds as test device 0x1A0A/0x0200. [PD21]

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10. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]

11. Wait 10 seconds.

12. Simulate a detach as follows:

    - Switch off transceiver D+ pullup
    - Switch off transceiver pull-down from D-.
    - Disconnect R_{ID_A} from ID pin
    - Disconnect 0.6V via 200R from D-.
    - Disconnect data line test circuit 3.3V via 1K5 from D+
    - Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

13. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

14. Repeat steps 1-13 using R_{ID_A} max (126k).

End of Test

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7.9 ACA-A Detection Test

Test Setup	**Test Setup 4. UUT is a PD, PET simulates.**
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	Demonstrate that PD UUT responds to RID_A on ID pin (i.e. the PD is attached to an ACA that has a charger on its Charger Port, and a B-device on its Accessory Port). This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of RID_A, owing to the current flowing in the cable ground.
Description	Connect RID_A to ID pin and check that PD behaves correctly.
Parameters	RID_A
Checklist	PD22, PD30
Pass Criteria	Step 6: UUT enumerates the PET.

7.9.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on. ID pin not connected.

1. PET applies CADP_VBUS max (6.5µF) and a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V
2. Wait 10ms to simulate plug insertion.
3. Connect ID pin to ground via RID_A min (122k).
4. Display message to test operator 'PD under test should now have detected ACA-A'. (This is a development aid, and may appear slightly before actual detection.)
5. Connect using D+.
6. Check that UUT resets and enumerates the PET within 30 seconds. PET responds as test device 0x1A0A/0x0200. [PD22]
7. From now on check current drawn and report. Check that this current does not exceed IMAX_BC. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]
8. Wait 10 seconds.
9. Disconnect using D+.
10. Disconnect resistor from ID pin.
11. Turn off VBUS and disconnect capacitance and pull-down resistance from VBUS.
12. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.
13. Repeat steps 1-12 using RID_A max (126k).

End of Test

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7.10 ACA-B Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates ACA-B.
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	To validate a correct detection procedure when the UUT encounters an ACA-B (i.e. the PD is attached to an ACA that has a charger on its Charger Port, and does not have an accessory on its Accessory Port).
Description	PET simulates an ACA-B and monitors activity on D+, and current drawn.
Parameters	RID_B
Checklist	PD8, PD24, PD30
Pass Criteria	Step 97: UUT does not connect

7.10.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on. ID pin not connected.

DCD

1. Switch data lines to PET test circuit.
2. PET applies CADP_VBUS max (6.5µF) and a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V.
3. Wait 10ms to simulate plug insertion.
4. Connect ID pin to ground via RID_B min (67k).
5. Connect 0V via 15k resistor to D+. Connect 0V via 15k resistor to D-.
6. Start timer of TSVLD_CON_PWD (1 sec).
7. Wait for D+ to exceed VLGC min, or timer to expire.

Timer TSVLD_CON_PWD expires:

Proceed to ' Checking Current Draw'

D+ rises above 0.8V:

Check that D+ goes below 0.8V within no more than TB_DATA_PLS max (10ms). This represents a valid SRP pulse, which we will ignore. Proceed to ' Checking Current Draw'

Else UUT has attempted to connect – FAIL [PD8]

Primary Detection

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Primary detection is optional, and its parameters are measured elsewhere, so we will ignore it during this test.

Checking Current Draw

8. Display message to test operator 'PD under test should now have detected R_{ID_B}'. (This is a development aid.)

9. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]

10. Check D+ is held below V_{DAT_REF} min (0.25V) from now on. It is possible that SRP pulses are attempted, these should be ignored if they do not exceed $T_{B\_DATA\_PLS}$ max (10ms). [PD24]

11. Maintain session for 15 seconds from step 6.

12. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

13. Disconnect 15k pulldown resistor from D+ and D-.

14. Disconnect ID pin resistor.

15. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

16. Repeat steps 1-15 using R_{ID_B} max (69K).

17. Disconnect data lines from PET test circuit.

End of Test

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7.11 ACA-C Detection Test

Test Setup	**Test Setup 4. UUT is a PD, PET simulates ACA-C.**
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	To validate a correct detection procedure when the UUT encounters an ACA-C. i.e. The PD is attached to an ACA that has a charger on its Charger Port, and an A-device on its Accessory Port. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of RID_C, owing to the current flowing in the cable ground.
Description	PET simulates an ACA-C and monitors ectivity on D+, enumerates the PD UUT and monitors current drawn.
Parameters	RID_C
Checklist	PD8, PD25, PD30
Pass Criteria	**Step 8: UUT does connect**

7.11.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on. ID pin not connected.

DCD

1. **Switch data lines to PET test circuit.**
2. **PET applies CADP_VBUS max (6.5µF) and a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V**
3. **Wait 10ms to simulate plug insertion.**
4. **Connect ID pin to ground via RID_C min (36k).**
5. **Connect 0V via15k resistor to D+. Connect 0V via15k resistor to D-.**
6. **Start timer of TSVLD_CON_PWD (1 sec).**
7. **Wait for D+ to exceed VLGC min, or timer to expire.**

Timer TSVLD_CON_PWD expires:

UUT failed to connect – FAIL [PD8] [PD25]

D+ rises above 0.8V:

Check that D+ is high for more than 10ms. If not this is a failure (SRP not allowed). [PD25]

Else UUT has connected – proceed to ' Checking Current Draw'.

Primary Detection

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Primary detection is optional, and its parameters are measured elsewhere, so we will ignore it during this test.

Checking Current Draw

8. Switch data lines back to transceiver.
9. Display message to test operator 'PD under test should now have detected R_{ID_C}'. (This is a development aid.)
10. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]
11. Enumerate UUT and Set Configuration 1. [PD25]
12. Maintain session for 10 seconds from step 8.
13. Disconnect 15k pulldown resistor from D+ and D-.
14. Disconnect ID pin resistor.
15. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.
16. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.
17. Repeat steps 1-15 using R_{ID_C} max (37K)

End of Test

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7.12 ACA-GND Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Only required if UUT supports ACA detection. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of RID_GND, owing to the current flowing in the cable ground.
Purpose	Demonstrate that PD UUT responds to RID_GND max on ID pin. i.e. the PD is attached to a B-device, or to an ACA that has a B-device on its Accessory Port, but no charger.
Description	Connect RID_GND max to ID pin and check that PD behaves as A-device.
Parameters	RID_GND
Checklist	PD26
Pass Criteria	Step 6: VBUS turns on in response to SRP.

7.12.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on.

1. Connect 6.5µF from VBUS to ground.
2. Connect ID pin to ground via RID_GND max (1k).
3. Wait 3 seconds.
4. If VBUS is on, wait for it to go off, and stay off for 5 seconds.

This deals with ADP and any initial test for a peripheral.

5. Perform SRP for 7.5ms pulse.
6. Check that VBUS rises above VOTG_SESS_VLD within TA_SRP_RSPNS of rising edge of SRP pulse. [PD26]
7. Disconnect RID_GND, and capacitance and resistance from VBUS.
8. Wait for VBUS to go off, and stay off for 5 seconds.

End of Test

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7.13 Common Mode Test - Full Speed

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	This test should be performed with a good battery in order to minimize extra current flowing in the cable ground, as the PET provides the ground offset itself.
Purpose	This test verifies that a UUT is able to communicate with a charging downstream port at full-speed when cable ground is dropping I_{MAX_BC} x 0.25Ω + 5mV.
Description	This test will apply a maximum of 375mV offset to UUT ground, and then verify UUT will enumerate and work successfully. PET simulates an SDP to reduce the risk that the UUT itself draws a significant current.
Parameters	
Checklist	PD33
Pass Criteria	Step 5: UUT enumerates successfully Step 6: UUT functions as expected

7.13.1 Test procedure

Initial State. Special Test Cable A is connected to PD. V_{BUS} is off, capacitance of 6.5µF is connected to V_{BUS}, data lines switched to PET transceiver.

1. Apply a common mode offset of I_{MAX_BC} x 0.25 Ω + 5mV (a maximum of V_{GND_OFFSET} [0.375V] if I_{MAX_BC} is declared as 1500mA) with PET test socket higher than PET transceiver ground.
2. Turn V_{BUS} on to 5V.
3. Wait for UUT to connect
4. Wait 100ms.
5. Reset and enumerate at Full Speed. Check that enumeration was successful.
6. Continue for 10 seconds, without configuring, to perform a number of standard requests, (e.g. Get Device Descriptor) checking again for failure to respond to transactions. This is achieved by counting the number of failures to respond to transactions, and comparing this to an arbitrary ceiling. (A good device would never fail to respond in practice.) [PD33]
7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.
8. Remove common mode offset.
9. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.14 Common Mode Test - High Speed

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	This test should be performed with a good battery in order to minimize extra current flowing in the cable ground, as the PET provides the ground offset itself.
Purpose	This test verifies that a UUT is able to communicate with a charging downstream port at high-speed when cable ground is dropping I_{MAX_BC} x 0.25Ω + 5mV.
Description	This test will apply a maximum of 375mV offset to UUT ground, and then verify UUT will enumerate and work successfully. PET simulates an SDP to reduce the risk that the UUT itself draws a significant current.
Parameters	
Checklist	PD33
Pass Criteria	Step 5: UUT enumerates successfully Step 6: UUT functions as expected

7.14.1 Test procedure

Initial State. Special Test Cable A is connected to PD. V_{BUS} is off, capacitance of 6.5µF is connected to V_{BUS}, data lines switched to PET transceiver.

1. Apply a common mode offset of I_{MAX_BC} x 0.25 Ω + 5mV (a maximum of V_{GND_OFFSET} [0.375V] if I_{MAX_BC} is declared as 1500mA) with PET test socket higher than PET transceiver ground.
2. Turn V_{BUS} on to 5V.
3. Wait for UUT to connect
4. Wait 100ms.
5. Reset and enumerate at High Speed. Check that enumeration was successful.
6. Continue for 10 seconds, without configuring, to perform a number of standard requests, (e.g. Get Device Descriptor) checking again for failure to respond to transactions. This is achieved by counting the number of failures to respond to transactions, and comparing this to an arbitrary ceiling. (A good device would never fail to respond in practice.) [PD33
7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.
8. Remove common mode offset.
9. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.15 Dead Battery Provision Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates an SDP.
Pre-conditions	UUT has been fitted with a 'Dead Battery'. Assumption is that this remains dead for 30 second duration of test.
Purpose	To verify that the UUT complies with requirements of the 'Dead Battery Provision – Unconfigured Clause'
Description	This test is performed separately from the other PD tests, as it requires a dead battery to be fitted. VBUS is applied to the device, and the current drawn and D+ voltage are monitored.
Parameters	IUNIT, VDP_SRC
Checklist	DBP1, DBP3
Pass Criteria	Step 4: D+ is below VLGC min Step 9: D+ is at VDP_SRC Step 10: Watch-block has not been triggered.

7.15.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. Any mechanical switches on the PD required for it to be able to power up have been operated.

1. PET applies CADP_VBUS max (6.5µF) and a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V. ID pin is left floating.
2. Connect 0V via 15k resistor to D+. Connect 0V via 15k resistor to D-.
3. Wait TSVLD_CON_PWD max plus a margin (1 sec + .5 sec = 1.5 sec).
4. Set up a watch-block to monitor the current drawn from VBUS, and be triggered if this current exceeds IUNIT (100mA).
5. Check that D+ is below VLGC min (0.8v). If UUT connects at any time during the remainder of the test, skip to Step15. We must assume that the dead battery provision is no longer required by the UUT.
6. Display message to test operator 'PD under test should now have detected SDP'. (This is a development aid.)
7. For the next 30 seconds, follow the procedure in steps 8-10
8. Measure the average current drawn from VBUS, sampling every 1ms for a period of 1 second. Record whether this value exceeds ISUSP (2.5mA).
9. If the value does exceed ISUSP for two consecutive averages, then check that D+ is at VDP_SRC (0.5V-0.7V).
10. Check that the watch-block has not been triggered.
11. Turn off VBUS and disconnect capacitance and pull-down resistance from VBUS.

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12. Disconnect 15k pull-down resistors.

13. Wait 5 seconds for detachment to be recognized.

14. Skip to End of Test

Enumerating

15. Wait $T_{A\_BCON\_LDB}$ min (100ms) then issue a bus reset to the B-UUT.

16. Check that PET can enumerate UUT (at HS if possible), and Set Configuration 1.

17. For the next 30 seconds, check current drawn does not exceed bMaxPower.

18. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

19. Disconnect 15k pull-down resistors.

20. Wait 5 seconds for detachment to be recognized.

End of Test

Note: Parameters and behavior such as $T_{SVLD\_CON\_WKB}$, $T_{DBP\_VDPSRC\_CON}$ are verified by vendor declaration.

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8 Dedicated Charging Port (DCP) Compliance

8.1 Submission Materials

8.1.1 Device Specific Information

The following items are required to be submitted along with the UUT:

Table 8-1 Device Specific Information for DCPs

Item	Function	Value/ Support
1	Evidence the UUT contains on its nameplate and/or end-user documentation, the continuous current rating at which output voltage of 4.75V to 5.25V is provided	
2	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
3	The USB-IF TID for the UUT standard-A receptacle(s) or micro-B plug(s) (via captive cable)	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on VBUS to exceed V_{CHG_FAIL}?	
5	UUT Charging Port identification label drawing (If additional Charging or non Charging Ports are included in UUT)	
6	Description of UUT output or Charging Port operation and availability when multiple outputs or Charging Ports are present (if applicable)	
7	Description of UUT output or Charging Port operation and availability during Device power states (if applicable)	

8.1.2 Checklist

Table 8-2 Checklist for DCPs

Question		Response	Test Number	BC 1.2 Reference
DCP1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on or off?	Yes ☐ No ☐	8.2	4.1.1
DCP2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition?	Yes ☐ No ☐	Vendor Declaration	4.1.2
DCP3	If the UUT switches roles among SDP, CDP and DCP, does it allow VBUS to drop to less than V_{BUS_LKG} and wait for a time T_{VBUS_REAPP} before driving VBUS again?	Yes ☐ No ☐	Vendor Declaration	4.1.3
DCP4	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on VBUS will not exceed V_{CHG_FAIL}?	Yes ☐ No ☐	Vendor Declaration	4.1.5

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DCP5	As per provided UUT description: if the UUT provides multiple USB Charging Ports, the active UUT USB Charging Port does not affect operation of any other Charging Port.	Yes ☐ No ☐	Vendor Declaration	4.1.6
DCP6	Does the UUT output a voltage of VCHG (averaged over TVBUS_AVG) for all currents less than IDCP min?	Yes ☐ No ☐	8.5	4.4.1
DCP7	Does the UUT output a voltage less than VCHG max (averaged over TVBUS_AVG) for all currents between IDCP min and IDEV_CHG max?	Yes ☐ No ☐	8.5	4.4.1
DCP8	Is the output voltage of the UUT greater than VCHG_UNDSHT min for any step change in load current from IDCP_LOW to IDCP_MID?	Yes ☐ No ☐	8.2	4.4.2
DCP9	Is the output voltage of the UUT greater than VCHG_UNDSHT min for any step change in load current from IDCP_MID to IDCP_HI, including steps that occur TDCP_LD_STP after a transition from IDCP_LOW to IDCP_MID?	Yes ☐ No ☐	8.2	4.4.2
DCP10	Is the duration of any undershoot less than TDCP_UNDSHT ?	Yes ☐ No ☐	8.2	4.4.2
DCP11	Does the output voltage of the UUT drop below VCHG min for less than TDCP_UNDSHT, any step change in load current from IDCP_LOW to IDCP_HI provided the load current is less than IDCP min ?	Yes ☐ No ☐	8.2	4.4.2
DCP12	Does the UUT have a resistance between D+ and D- of RDCP_DAT ?	Yes ☐ No ☐	8.3	4.4.3
DCP13	Does the UUT have a leakage current from D+/D- less than or equal to RDAT_LKG tied to a voltage of VDAT_LKG ?	Yes ☐ No ☐	8.3	4.4.3
DCP14	Does the UUT have a capacitance from D+/D- of CDCP PWR ?	Yes ☐ No ☐	8.3	4.4.3
DCP15	Does the UUT have a Standard-A receptacle, or a captive cable terminated with a Micro-B plug?	**Standard-A ☐** **Captive ☐** **No ☐**	Inspection	4.4.4
DCP16	**Does the UUT provide VBUS discharge functionality?**	Yes ☐ No ☐	Vendor Declaration	4.1.3

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8.2 DCP Overshoot and Undershoot Voltage Test

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	This test must be run before any of the other DCP tests.
Purpose	**To verify the DCP meets overshoot and undershoot voltage specifications, for any specified step change in load.**
Description	This test changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels. Note: The DCP can have a Standard-A receptacle or a captive cable. In the case of a captive cable, the BC specification requires voltage measurements to be taken at the Micro-B plug of the captive cable.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT, TDCP_UNDSHT
Checklist	DCP1, DCP6, DCP8, DCP9, DCP10, DCP11, DCP12
Pass Criteria	Step 7 – Maximum voltage during overshoot is less than 6.0V. Step 19 – VBUS is in range 4.75V to 5.25V Step 20 – Minimum voltage during undershoot is above 4.1V. Step 20 – Maximum voltage during overshoot is less than 6.0V. Step 24 – VBUS is in range 4.75V to 5.25V Step 25 – Minimum voltage during undershoot is above 4.1V. Step 25 – Maximum voltage during overshoot is less than 6.0V. Step 28 – Minimum voltage during undershoot is above 4.1V. Step 28 – Maximum voltage during overshoot is less than 6.0V. Step 31 – VBUS is in range 4.75V to 5.25V Step 32 – VBUS is in range 4.75V to 5.25V

8.2.1 Test procedure

Initial State: No load applied. If captive cable equipped, check the 'Captive Cable' box in the test dialog.

1. **Ensure that UUT is connected via Special Test Cable B, or its captive cable, to the PET.**
2. **Ensure that DCP is in an unpowered state.**
3. **Wait for DCP voltage to fall below 0.5V, in case it has just been switched off. (Speed up fall using current load.)**
4. **Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on VBUS.**
5. **Instruct test operator to plug DCP into 'wall-socket', or to perform steps required to bring the DCP from an un-powered state to a powered one.**
6. **Wait for operator to click 'OK'.**

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7. Check watch-block overshoot detector latch was not triggered. [DCP1]

8. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on V_{BUS}.

9. With an applied current load of I_{DCP_LOW} min (0mA), check that V_{BUS} average is within appropriate range V_{CHG} (4.75V to 5.25V) over the next T_{VBUS_AVG} max (0.25 sec). [DCP6]

10. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1][DCP8]

11. Re-program watch-block to allow for voltage drop in cable.

Emulate attaching PD

12. Apply V_{DP_SRC} nom. (0.6V) to D+.

13. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)

14. Check D- > V_{DAT_REF} min (0.25V). [DCP12]

15. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).

16. Take D+ back to 0V.

Load Testing

17. Apply load of I_{DCP_MID} max (100mA) to V_{BUS}.

18. Wait T_{DCP_UNDSHT} max (10ms).

19. Check V_{BUS}, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable (spot check voltage). [DCP6][DCP10]

20. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1][DCP8]

21. Re-program watch-block to allow for voltage drop in cable.

22. Increase load on V_{BUS} to I_{DCP} min (500mA), 20ms after rise to I_{DCP} mid.

23. Wait T_{DCP_UNDSHT} max (10ms).

24. Check V_{BUS} average, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), over the next T_{VBUS_AVG} max (0.25 sec), making due allowance for voltage drop in cable. [DCP6]

25. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1] [DCP9]

26. Remove Current Load.

27. Wait 100ms

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28. Check watch-block overshoot and undershoot detector latches were not triggered.

29. Apply load of I_{DCP} min (500mA) to V_{BUS}.

30. Wait T_{DCP_UNDSHT} max (10ms).

31. Check V_{BUS}, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable (spot check voltage). [DCP1] [DCP9] [DCP11]

32. Check V_{BUS} average, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), over the next T_{VBUS_AVG} max (0.25 sec), making due allowance for voltage drop in cable. [DCP6]

33. Remove Current Load.

34. Wait 100ms

35. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1] [DCP9]

End of Test

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8.3 DCP Handshaking Test

Test Setup	**Test Setup 6. UUT is a DCP, PET simulates a PD.**
Pre-conditions	DCP Overshoot and Undershoot Voltage Test has been run, and DCP is now switched on.
Purpose	To verify the parameters of detection handshake. This test is particularly designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP, and may therefore have more complex circuitry on D+ and D- than a simple resistive connection.
Description	Test confirms correct handshake behavior.
Parameters	
Checklist	DCP6
Pass Criteria	Step 5 – Voltage is in range Step 10 - Voltage is in range

8.3.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on. Data lines switched to data measurement circuit.

1. **Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V). [DCP6]**
2. **Wait 200ms**

Primary Detection

3. **Connect voltage source (0.6V) via 200R resistor to D+.**
4. **Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).**
5. **Check D- voltage is in range V_{DM_SRC} (0.5V - 0.7V). [DCP12, DCP13]**
6. **Wait 20ms to complete T_{VDPSRC_ON}.**
7. **Disconnect voltage source via 200R resistor from D+.**

Secondary Detection

8. **Connect voltage source (0.6V) via 200R resistor to D-.**
9. **Wait 21ms.**
10. **Check D+ voltage is in range V_{DM_SRC} (0.5V - 0.7V). [DCP12, DCP13]**
11. **Wait 20ms to complete T_{VDMSRC_ON}.**
12. **Disconnect voltage source via 200R resistor from D-.**
13. **Wait 5 seconds for UUT to recover.**

End of Test

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8.4 DCP Resistance and Capacitance Tests

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	
Purpose	To verify that the resistance between D+/D- and data line resistance and capacitance to VBUS/GND is in valid range.
Description	This test measures the resistance of data lines (D+/D-) and then the resistance/capacitance from D+/D- to VBUS and to GND. Also, ID pin resistance is checked for sanity.
Parameters	RDCP_DAT, CDCP_PWR, RDAT_LKG
Checklist	DCP12, DCP13, DCP14
Pass Criteria	Step 6 - Resistance between D+ and D- is less than 200Ω. Step 12 - Resistances between D+/- and GND/VOH are greater than 150kΩ. (RDAT_LKG / 2). Step 15 - Capacitances between D+/- and GND are less than 1nF.

8.4.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on. Data lines switched to data measurement circuit.

Emulate attaching PD

1. Apply VDP_SRC nom. (0.6V) to D+.
2. Wait TVDMSRC_EN max + 1 ms (= 21ms)
3. Check D- > VDAT_REF min (0.25V).
4. Wait for 1ms more than the remainder of TVDPSRC_ON (40ms – 20ms = 20ms).
5. Take D+ back to 0V.

Checking Resistance between D+ and D-

6. Check that resistance from D+ to D- is less than RDCP_DAT max (200R). i.e. Connect 3.0V via 200R resistor to D+, connect 0V via 200R resistor to D-. Measure voltages at D+ and D-. The difference must be less than 1.05V. [DCP12]

Checking leakage from D+ or D-

7. Connect D+ via 100k to 0V
8. Wait 2 seconds to eliminate capacitive effects
9. Check that voltage at D+ is below 1.44V (Two RDAT_LKG (300k) in parallel, VDAT_LKG = 3.6V).
10. Connect D+ via 100K to 3.3V
11. Wait 2 seconds
12. Check that D+ is greater than 1.98V (Two RDAT_LKG (300k) in parallel, VDAT_LKG = 0V).

This shows that leakage resistance is greater than RDAT_LKG / 2. [DCP13]

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Checking Capacitance of D+ or D-

13. Discharge Standard 1nF capacitor and Capacitance under Test
    Connect 0V to D+ via 1nF test capacitor. Connect 0V to D- via 200R resistor. There is a tested, <200R, resistor between D- and D+. This will discharge the standard 1nF capacitor and the capacitance under test to 0V. Wait 10ms.

14. Isolate Capacitances
    Disconnect 0V from test capacitor to isolate it. Disconnect 0V from 200R resistor.

Note: We will now use the D+ voltage watch-block to determine whether, during the charge-sharing process, D+ rises above 1.65V. The watch-block amplifier has a limited band-width by design, so that the watch-block voltage set is lower than 1.65V. The actual value can be found in the test script.

15. Share Charge Between Capacitances
    Set D+ watch-block to be testing for voltage less than the value required. Connect 3.3V to D+ via 1nF test capacitor. Wait 1ms. This allows for charge sharing between standard 1nF capacitor and capacitance under test.

16. Read watch-block to see if voltage on D+ went above 1.65V. If it did, then the capacitance under test is less than 1nF and therefore in specification. [DCP14]

End of Test

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8.5 DCP Voltage and Current

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	
Purpose	To verify that the VBUS voltage / current load characteristic meets the specified requirements. These are steady-state tests, hence the 1 second delay in step 3. The test may result in shutdown of the DCP, so this test is placed last in the test sequence, as no recovery time is specified by the Battery Charging 1.2 Specification.
Description	This test measures the voltage at various current loads, in order to confirm correct behavior.
Parameters	VCHG, VDCP_SHTDWN
Checklist	DCP6, DCP7
Pass Criteria	Step 1 - VBUS voltage is in correct range. Step 9 - VBUS voltage is in correct range. Step 12 - VBUS voltage is in correct range.

8.5.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on.

1. IDCP is initially 0mA. Check that VBUS voltage, samples taken every 1 ms and averaged over TVBUS_AVG max (250ms), from DCP is within VCHG (4.75 – 5.25V). [DCP6]

Emulate attaching PD

2. Apply VDP_SRC nom. (0.6V) to D+.
3. Wait TVDMSRC_EN max + 1 ms (= 21ms)
4. Check D- > VDAT_REF min (0.25V).
5. Wait for 1ms more than the remainder of TVDPSRC_ON (40ms – 20ms = 20ms).
6. Take D+ back to 0V.
7. Apply load of IDCP min (500 mA) to VBUS.
8. Wait 1 sec to avoid possible transient period (overshoot and undershoot are measured separately).
9. Check that VBUS voltage from DCP, at DCP connector, with samples taken every 1 ms and averaged over TVBUS_AVG max (250ms), is within VCHG (4.75 – 5.25V), making due allowance for voltage drop in cable. [DCP6]
10. Increase load to IDEV_CHG max (1.5A).
11. Wait 1 sec to avoid possible overshoot.

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12. Check that V_{BUS} voltage from DCP, at DCP connector, with samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is below V_{CHG} max (5.25V), making due allowance for voltage drop in cable. The PET reports the voltage measured. [DCP7]

13. Disconnect the current load.

End of Test

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9 Charging Downstream Port (CDP) Compliance

9.1 Submission Materials

The following items are required to be submitted along with the UUT:

9.1.1 Device Specific Information

Table 9-1 Device Specific Information for CDPs

Item	Function	Value/ Support
1	Evidence the UUT contains on its nameplate and/or end-user documentation, the continuous current rating at which output voltage of 4.75V to 5.25V is provided	
2	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
3	The USB-IF TID for the UUT standard-A receptacle(s) or micro-B plug(s) (via captive cable)	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on VBUS to exceed VCHG_FAIL?	
5	UUT Charging Port identification label drawing (If additional Charging or non Charging Ports are included in UUT)	
6	Description of UUT output or Charging Port operation and availability when multiple outputs or Charging Ports are present (if applicable)	
7	Description of UUT output or Charging Port operation and availability during Device power states (if applicable)	

9.1.2 Checklist

Table 9-2 Checklist for CDPs

ID	Question	Response	Test Number	BC 1.2 Section Number
CDP1	Is the output voltage of the UUT less than VCHG_OVRSHT max for any step change in load current, and also when powering on or off?	Yes ☐ No ☐	9.2	4.1.1
CDP2	Is the output current of the UUT prevented from exceeding ICDP max under any condition?	Yes ☐ No ☐	Vendor Declaration	4.1.2
CDP3	If the UUT switches roles among SDP, CDP and DCP, does it allow VBUS to drop to less than VBUS_LKG and wait for a time TVBUS_REAPP before driving VBUS again?	Yes ☐ No ☐	Vendor Declaration	4.1.3
CDP4	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on VBUS will not exceed VCHG_FAIL?	Yes ☐ No ☐	Vendor Declaration	4.1.5

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CDP5	As per provided UUT description: if the UUT provides multiple USB Charging Ports, the active UUT USB Charging Port does not affect operation of any other Charging Port.	Yes ☐ No ☐	Vendor Declaration	4.1.6
CDP6	Does the UUT output a voltage of VCHG (averaged over TVBUS_AVG) for all currents less than ICDP min?	Yes ☐ No ☐	9.3	4.2.1
CDP7	Is the output voltage of the UUT greater than VCHG_UNDSHT min for any step change in load current where current is less than ICDP min?	Yes ☐ No ☐	9.2	4.2.3
CDP8	Does the CDP either: A.) Enable VDM_SRC within TCP_VDM_EN of a disconnect and disable VDM_SRC within TCP VDM DIS of a connect, or B.) Enable VDM_SRC, whenever D+ is greater than VDAT_REF and less than VLGC, and disable VDM_SRC, whenever D+ is less than VDAT_REF or greater than VLGC?	Yes ☐ (A ☐ B ☐) No ☐	9.4	3.4.2 4.2.4
CDP9	If the first option of CDP8 is implemented, is the design of VDM_SRC such that an external device is able to pull D- to 2.2V through RDM_UP ?	Yes ☐ No ☐ N/A ☐	9.4	5.
CDP10	If before connecting, a device applies VDM_SRC to D-, does the CDP maintain a voltage of less than VDAT_REF min on D+?	Yes ☐ No ☐	8.4	3.2.5.2
CDP11	If a PD draws more than ICFG_MAX from the CDP, does the CDP correctly support LS, FS, HS and chirp signaling when the local ground is VGND_OFFSET max lower than the remote ground.	Yes ☐ No ☐	9.5, 9.6	3.5
CDP12	Does the UUT have a Standard-A receptacle?	Yes ☐ No ☐	Inspection	4.2.5
CDP13	If the CDP goes into shutdown during a current overload condition, does it recover and output a voltage of VCHG within a time of TSHTDWN_REC when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

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CDP14 Does the UUT provide VBUS discharge functionality?	Yes ☐ No ☐	Vendor Declaration	4.1.3

9.2 CDP Overshoot and Undershoot Voltage Test

Test Setup	Test Setup 5. UUT is a CDP, PET simulates a PD.
Pre-conditions	This must be performed as the first test in the CDP suite.
Purpose	**To verify the CDP meets overshoot and undershoot voltage specifications, for any specified step change in load.**
Description	This test changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT
Checklist	CDP1, CDP7
Pass Criteria	Step 8 – Maximum voltage during overshoot is less than 6.0V. Step 10 – VBUS is in range 4.75V to 5.25V Step 18 – VBUS is in range 4.75V to 5.25V Step 19 – Minimum voltage during undershoot is above 4.1V. Step 19 – Maximum voltage during overshoot is less than 6.0V. Step 22 – Minimum voltage during undershoot is above 4.1V. Step 22 – Maximum voltage during overshoot is less than 6.0V.

9.2.1 Test procedure

Initial State: No load applied.

1. Ensure that UUT is connected via Special Test Cable B to the PET.
2. Ensure that CDP is in an un-powered state.
3. Wait for CDP voltage to fall below VBUS_LKG max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
4. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on VBUS.
5. Instruct test operator to perform steps required to bring the CDP from an un-powered state to a powered one.
6. Wait for operator to click 'OK'.
7. Wait for VBUS to rise above VCHG min (4.75V).
8. Check watch-block overshoot detector latch was not triggered. [CDP1]
9. Set up voltage watch-block ready to capture undershoot of VCHG_UNDSHT (4.1V), or overshoot of VCHG_OVRSHT (6.0V) on VBUS, allowing for voltage drop in cable.

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10. With no current load applied, check that V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [CDP6]

Emulate attaching PD

11. Apply V_{DP_SRC} nom. (0.6V) to D+.

12. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)

13. Check D- > V_{DAT_REF} min (0.25V).

14. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).

15. Take D+ back to 0V.

Load Testing

16. Apply load of I_{CDP} min (1.5A) to V_{BUS}.

17. Wait 10ms.

18. Check that V_{BUS} voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable.

19. Check watch-block overshoot and undershoot detector latches were not triggered. [CDP1] [CDP7]

20. Remove Current Load.

21. Wait 10ms

22. Check that V_{BUS} voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V).[CDP6]

23. Check watch-block overshoot and undershoot detector latches were not triggered. [CDP1] [CDP7]

End of Test

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9.3 CDP Voltage and Current Test

Test Setup	Test Setup 5. UUT is a CDP, PET simulates a PD.
Pre-conditions	CDP Overshoot and Undershoot Voltage Test has been run, and CDP is now switched on.
Purpose	To verify that the VBUS voltage / current load characteristic meets the specified requirements.
Description	This test measures the voltage at various current loads, in order to confirm correct behavior.
Parameters	VCHG
Checklist	CDP6
Pass Criteria	Step 1 - VBUS voltage is in correct range. Step 9 - VBUS voltage is in correct range.

9.3.1 Test procedure

Initial State: Special Cable B is connected to CDP. CDP is switched on.

1. Check that VBUS voltage, samples taken every 1 ms and averaged over TVBUS_AVG max (250ms), from CDP is within VCHG (4.75 – 5.25V). [CDP6]

Emulate attaching PD

2. Apply VDP_SRC nom. (0.6V) to D+.
3. Wait TVDMSRC_EN max + 1 ms (= 21ms)
4. Check D- > VDAT_REF min (0.25V).
5. Wait for 1ms more than the remainder of TVDPSRC_ON (40ms – 20ms = 20ms).
6. Take D+ back to 0V.

Load Testing

7. Apply load of ICDP min (1.5A) to VBUS.
8. Wait 1 sec to avoid possible transient period (overshoot and undershoot are measured separately).
9. Check that VBUS voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over TVBUS_AVG max (250ms), is within appropriate range VCHG (4.75V to 5.25V), making due allowance for voltage drop in cable. [CDP6]
10. Disconnect the current load.

Note: In order that the test should not damage the tester connectors, no recovery time test is performed. A special test configuration is detailed elsewhere to provide a means of performing this test safely, if required.

End of Test

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9.4 CDP Handshaking Test

Test Setup	**Test Setup 5. UUT is an CDP, PET simulates a PD.**
Pre-conditions	CDP Overshoot and Undershoot Voltage Test has been run, and CDP is now switched on.
Purpose	To verify the parameters of detection handshake.
Description	Test determines which of the two permissible behaviors is implemented, and confirms correct behavior.
Parameters	RDP_DWN, RDM_DWN, VDM_SRC, VDAT_REF, TVDMSRC_DIS, TVDMSRC_EN, TCP_VDM_DIS, TCP_VDM_EN, TVDMSRC_ON, RDAT_LKG, VDAT_LKG
Checklist	CDP8, CDP9, CDP10
Pass Criteria	Step 8: D- voltage is still in range VDM_SRC min (0.5V – 0.7V). Step 15: Voltage on D- is greater than 2V. Step 28: Voltage on D- is below VDAT_REF min (0.25V). or Step 35. D- voltage is still in range VDM_SRC min (0.5V – 0.7V). Step 43. Voltage on D- is below VDAT_REF min (0.25V).

9.4.1 Test procedure

Initial State: Special Cable B is connected to CDP. CDP is switched on.

1. Check VBUS is above VOTG_SESS_VLD max (4V). **[CDP6]**
2. Wait 200ms
3. Examine voltage on D-. If this is less than VDAT_REF min (0.25V), skip to step 31.

Behavior 1 – CDP maintains VDM_SRC while device not connected.

Primary Detection

4. Connect voltage source (0.6V) via 200R resistor to D+.
5. Wait slightly more than TVDMSRC_EN max (20ms +1 ms = 21ms).

Check VDM_SRC Gets Connected

6. Connect voltage source (0.5V) via 200R resistor to D-.
7. While voltage across 200R is less than 50mV, decrement the D- voltage source in steps of 2mV. Stop if D- voltage falls below VDM_SRC min (0.5V) - FAIL. Else we will now be drawing the required 250µA from VDM_SRC.
8. Check D- voltage is still in range VDM_SRC (0.5V – 0.7V). **[CDP8]**
9. Disconnect voltage source and 200R from D-.
10. Wait 20ms to complete TVDPSRC_ON

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11. Disconnect voltage source (0.6V) via 200R resistor from D+.
12. Wait 100ms.
13. Check if D- is still at V_{DM_SRC} (0.5V - 0.7V). If not – FAIL owing to inconsistent behavior.

D- Pull-up Test

14. Connect 3.3V via 1K5 to D-.
15. Check that D- is greater than 2.2V. [CDP9]
16. Disconnect 3.3V via 1K5 from D-.
17. Wait 5 seconds for UUT to recognize disconnect.

Primary Detection

18. Connect voltage source (0.6V) via 200R resistor to D+.
19. Wait T_{VDPSRC_ON} min (40ms)
20. Disconnect voltage source via 200R resistor from D+.

Secondary Detection

21. Connect voltage source (0.6V) via 200R resistor to D-.
22. Wait 21ms.
23. Check that D+ is below V_{DAT_REF} min (0.25V)
24. Wait 20ms to complete T_{VDMSRC_ON}.
25. Disconnect voltage source via 200R resistor from D-.

Check V_{DM_SRC} Gets Disconnected

26. Connect 3.3V via 1k5 resistor to D+.
27. Wait slightly more than T_{VDMSRC_DIS} max (20ms +1 ms = 21ms)
28. Check that D- voltage is below V_{DAT_REF} min (0.25V). [CDP8]
29. Disconnect 3.3V via 1k5 resistor from D+
30. Wait 5 seconds for UUT to recognize disconnect.

End of Test – Behavior 1

Behavior 2 – CDP only connects V_{DM_SRC} in response to Primary detection.

Primary Detection

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31. Connect voltage source (0.6V) via 200R resistor to D+.
32. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).

Check V_{DM_SRC} Gets Connected

33. Connect voltage source (0.5V) via 200R resistor to D-.
34. While voltage across 200R is less than 50mV, decrement the D- voltage source in steps of 2mV. Stop if D- voltage falls below V_{DM_SRC} min (0.5V) - FAIL. Else we will now be drawing the required 250µA from V_{DM_SRC}.
35. Check D- voltage is still in range V_{DM_SRC} (0.5V – 0.7V). [CDP8]
36. Disconnect voltage source and 200R from D-.
37. Wait 20ms to complete T_{VDPSRC_ON}
38. Disconnect voltage source (0.6V) via 200R resistor from D+.
39. Wait 100ms.
40. Check if D- is still at V_{DM_SRC} (0.5V - 0.7V). If so – FAIL owing to inconsistent behavior.

Secondary Detection

41. Connect voltage source (0.6V) via 200R resistor to D-.
42. Wait 21ms.
43. Check that D+ is below V_{DAT_REF} min (0.25V). [CDP10]
44. Wait 20ms to complete T_{VDMSRC_ON}.
45. Disconnect voltage source via 200R resistor from D-.
46. Wait 5 seconds for UUT to recover.

End of Test – Behavior 2

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9.5 CDP Ground Offset Test – Full Speed

Test Setup	Test Setup 5. UUT is an CDP, PET simulates a PD.
Pre-conditions	When running this test, ensure that an isolated computer is used for the tester host (e.g. Laptop).
Purpose	To verify that charging downstream port fulfills USB2.0 specification common mode voltage requirements at full speed.
Description	Insert specified command voltage offset and check UUT can enumerate reference device and operate well.
Parameters	
Checklist	CDP11
Pass Criteria	Step 9: Enumeration is successful.

9.5.1 Test procedure

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V).
2. Wait 200ms.

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check D- voltage is in range V_{DM_SRC} (0.5V-0.7V).
6. Switch data lines to transceiver.

CMO Test

7. Apply common mode offset of V_{GND_OFFSET} (0.375 V) with test socket lower than PET transceiver ground.
8. Connect using D+.
9. Allow PET to be reset and enumerated, responding as a Full Speed device. Check that communication is reliable. [CDP11] This is achieved as follows:
    - If we do not receive a Get Device Descriptor request within 30 seconds communication is deemed to have failed.
    - After the Get Device Descriptor setup transaction we NAK the IN transactions for 250 frames duration (mid-frame to mid-frame).
    - During this period we count the successfully received SOF packets; less than 100% success is considered a failure.
    - Assuming success, we now allow enumeration to continue, in whatever form the CDP chooses (we have no way to control the CDP).

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Note: we are now confident that we can receive IN packets, and need to check whether the CDP reliably receives packets we send to it.

- We monitor whether any IN transactions timeout when expecting ACK. This would indicate a failure of the CDP to have received our Data0/1 packet. Continue this monitoring until we get suspended, or for a chosen maximum period. A 'pass' requires 100% success in receiving ACKs to IN transactions.

10. Disconnect using D+

11. Remove common mode offset.

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9.6 CDP Ground Offset Test – High Speed

Test Setup	Test Setup 5. UUT is an CDP, PET simulates a PD.
Pre-conditions	When running this test, ensure that an isolated computer is used for the tester host (e.g. Laptop).
Purpose	To verify that charging downstream port fulfills USB2.0 specification common mode voltage requirements at high speed.
Description	Insert specified command voltage offset and check UUT can enumerate reference device and operate well.
Parameters	
Checklist	CDP11
Pass Criteria	Step 9: Enumeration is successful.

9.6.1 Test procedure

1. Check VBUS is above VOTG_SESS_VLD max (4V).
2. Wait 200ms.

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than TVDMSRC_EN max (20ms +1 ms = 21ms).
5. Check D- voltage is in range VDM_SRC (0.5V-0.7V).
6. Switch data lines to transceiver.

CMO Test

7. Apply common mode offset of VGND_OFFSET (0.375 V) with test socket lower than PET transceiver ground.
8. Connect using D+.
9. Allow PET to be reset and enumerated, responding as a High Speed device. Check that communication is reliable. [CDP11] This is achieved as follows:
    - If we do not receive a Get Device Descriptor request within 30 seconds communication is deemed to have failed.
    - After the Get Device Descriptor setup transaction we NAK the IN transactions for 250 frames duration (mid-frame to mid-frame).
    - During this period we count the successfully received SOF packets; less than 100% success is considered a failure.
    - Assuming success, we now allow enumeration to continue, in whatever form the CDP chooses (we have no way to control the CDP).

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Note: we are now confident that we can receive IN packets, and need to check whether the CDP reliably receives packets we send to it.

- We monitor whether any IN transactions timeout when expecting ACK. This would indicate a failure of the CDP to have received our Data0/1 packet. Continue this monitoring until we get suspended, or for a chosen maximum period. A 'pass' requires 100% success in receiving ACKs to IN transactions.

10. Disconnect using D+

11. Remove common mode offset.

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10 Standard Downstream Port (SDP) Compliance

This section is included in order to allow the testing of a Multiple Role Port, which may behave as a CDP, a DCP or an SDP, depending on circumstances. Its purpose is to check the additional BC requirement placed on an MRP acting as an SDP, namely to take part in detection handshaking correctly.

10.1 Submission Materials

10.1.1 Device Specific Information

The following items are required to be submitted along with the UUT:

Table 10-1 Device Specific Information for SDPs

Item	Function	Value/ Support
1	The USB-IF TID for the UUT standard-A receptacle(s).	

10.1.2 Checklist

Table 10-2 Checklist for DCPs

Question		Response	Test Number	BC 1.2 Reference
SDP1	If before connecting, a device applies V_{DP_SRC} to D+, does the SDP maintain a voltage of less than V_{DAT_REF} min on D-?	Yes ☐ No ☐	10.2	3.2.4.3
SDP2	If before connecting, a device applies V_{DM_SRC} to D-, does the SDP maintain a voltage of less than V_{DAT_REF} min on D+?	Yes ☐ No ☐	10.2	3.2.4.3
SDP3	Does the UUT provide VBUS discharge functionality?	Yes ☐ No ☐	Vendor Declaration	4.1.3

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10.2 SDP Handshaking Test

Test Setup	Test Setup 5. UUT is a SDP, PET simulates a PD.
Pre-conditions	SDP is switched on.
Purpose	To verify the parameters of detection handshake. This test is particularly designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP, and may therefore have more complex circuitry on D+ and D- than a standard downstream port.
Description	Test confirms correct handshake behavior.
Parameters	-
Checklist	SDP1. SDP2
Pass Criteria	Step 5. D- is below 0.25V. Step 10. D+ is below 0.25V.

10.2.1 Test procedure

Initial State: UUT is connected via Special Test Cable B to the PET. No load applied. SDP is switched on. Data lines switched to data measurement circuit.

1. Check VBUS is above VOTG_SESS_VLD max (4V).
2. Wait 200ms

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than TVDMSRC_EN max (20ms +1 ms = 21ms).
5. Check that D- is below VDAT_REF min (0.25V). [SDP1]
6. Wait 20ms to complete TVDPSRC_ON.
7. Disconnect voltage source via 200R resistor from D+.

Secondary Detection

8. Connect voltage source (0.6V) via 200R resistor to D-.
9. Wait 21ms.
10. Check that D+ is below VDAT_REF min (0.25V). [SDP2]
11. Wait 20ms to complete TVDMSRC_ON.
12. Disconnect voltage source via 200R resistor from D-.
13. Wait 5 seconds for UUT to recover.

End of Test

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11 Multiple Role Port (MRP) Compliance

This section is included in order to allow the testing of a Multiple Role Port, which may behave as a CDP, a DCP or an SDP, depending on circumstances. Its purpose is to check that the MRP port behaves correctly when switching between its roles.

11.1 Submission Materials

11.1.1 Device Specific Information

Table 11-1 Device Specific Information for SDPs

Item	Function	Value/ Support
1	Description of how to bring the UUT from an un-powered state to a state where it is acting as a CDP.	
2	Description of how to bring the UUT from a state where it is acting as a CDP, to a state where it is acting as an SDP, if applicable.	
3	Description of how to bring the UUT from a state where it is acting as an SDP, to a state where it is acting as a CDP, if applicable.	
4	Description of how to bring the UUT from a state where it is acting as a CDP, to a state where it is acting as a DCP, if applicable.	
5	Description of how to bring the UUT from a state where it is acting as a DCP, to a state where it is acting as a CDP, if applicable.	

11.1.2 Checklists

Table 11-2 Checklist for MRPs

Question		Response	BC1.2 Section Number
Information			
MRPI1	Can the MRP act as a CDP? *	Yes ☐ No ☐	4.1.3
MRPI2	Can the MRP act as a SDP?	Yes ☐ No ☐	4.1.3
MRPI3	Can the MRP act as a DCP?	Yes ☐ No ☐	4.1.3
MRPI4	Does the MRP force detection renegotiation when changing from a CDP to an SDP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI5	Does the MRP force detection renegotiation when changing from an SDP to a CDP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI6	Does the MRP force detection renegotiation when changing from a CDP to a DCP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI7	Does the MRP force detection renegotiation when changing from a DCP to a CDP role?	Yes ☐ No ☐ N/A ☐	4.1.3

* The Multiple Role Port compliance test assumes that the MRP can act as a CDP.

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Question		Response	Test Number	BC 1.2 Section Number
Requirements				
MRP1	If the MRP forces detection renegotiation when changing from an CDP to a SDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP2	If the MRP forces detection renegotiation when changing from an SDP to a CDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP3	If the MRP forces detection renegotiation when changing from an CDP to a DCP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP4	If the MRP forces detection renegotiation when changing from an DCP to a CDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3

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11.2 MRP Functional Test

Test Setup	Test Setup 5. UUT is an MRP, PET simulates a PD.
Pre-conditions	MRP is switched on.
Purpose	To verify the parameters of detection renegotiation. This test is designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP.
Description	Test confirms correct detection renegotiation behavior, where implemented.
Parameters	VBUS_LKG, TVBUS_REAPP
Checklist	MRP1, MRP2, MRP3, MRP4
Pass Criteria	Step 19. If implemented, VBUS goes below 0.7V for at least 100ms. Step 22. If implemented, VBUS goes below 0.7V for at least 100ms. Step 25. If implemented, VBUS goes below 0.7V for at least 100ms. Step 27. If implemented, VBUS goes below 0.7V for at least 100ms.

11.2.1 Test procedure

Initial State: No load applied.

1. Ensure that UUT is connected via Special Test Cable B to the PET.
2. Ensure that UUT is in an un-powered state.
3. Wait for UUT voltage to fall below VBUS_LKG max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
4. Ask the test operator whether the MRP can act as a CDP. Record the answer. [MRPI1] If answer is 'No', then abandon test.
5. Ask the test operator whether the MRP can act as a SDP. Record the answer. [MRPI2]
6. Ask the test operator whether the MRP can act as a DCP. Record the answer. [MRPI3]
7. If neither MRPI2 nor MRPI3 were answered 'Yes', then abandon test.
8. If MRPI2 was answered 'No', skip to step 11.
9. Ask the test operator whether the MRP forces detection renegotiation when changing from a CDP to an SDP role. Record the answer. [MRPI4]
10. Ask the test operator whether the MRP forces detection renegotiation when changing from an SDP to a CDP role. Record the answer. [MRPI5]
11. If MRPI3 was answered 'No', skip to step 14.
12. Ask the test operator whether the MRP forces detection renegotiation when changing from a CDP to a DCP role. Record the answer. [MRPI6]
13. Ask the test operator whether the MRP forces detection renegotiation when changing from a DCP to a CDP role. Record the answer. [MRPI7]

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14. If none of MRPI4, MRPI5, MRPI6, MRPI7 were answered 'Yes', then abandon test.

15. Instruct test operator to perform steps required to bring the UUT from an un-powered state to a powered one, such that it will be acting in a CDP role, and then to indicate that this has occurred.

16. Wait for operator to click 'OK'.

17. Wait for V_{BUS} to rise above V_{CHG} min (4.75V).

18. If the answer to MRPI2 is 'No', skip to Step 24.

19. Instruct test operator to perform steps required to change the role of the UUT from a CDP to an SDP, and then to click 'OK' to indicate that this has been done.

20. If the answer to MRPI4 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked 'OK' in the previous step. [MRP1]

21. Instruct test operator to perform steps required to change the role of the UUT from an SDP to an CDP, and then to click 'OK' to indicate that this has been done.

22. If the answer to MRPI5 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked 'OK' in the previous step.. [MRP2]

23. If the answer to MRPI3 is 'No', skip to 'End of Test'.

24. Instruct test operator to perform steps required to change the role of the UUT from a CDP to a DCP, and then to click 'OK' to indicate that this has been done.

25. If the answer to MRPI6 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked 'OK' in the previous step. [MRP3]

26. Instruct test operator to perform steps required to change the role of the UUT from an DCP to an CDP, and then to click 'OK' to indicate that this has been done.

27. If the answer to MRPI7 was 'No' skip to 'End of Test'; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked 'OK' in the previous step. [MRP4]

End of Test

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12 Micro-ACA Compliance, Separate Charger

Note: There are some discrepancies in the BC 1.2 Specification with regard to the Micro-ACA. Essentially, these relate to the requirement in Table 6-2 of that document that the Accessory switch be closed, in rows 1-3 (i.e. have a resistance of less than 200mΩ) at a time when there is no power available to the Micro-ACA. The presence and/or required value of C_{MACA_VBUS} capacitor(s) is also related to this. As some further work will be required to resolve this issue, it was decided to release this Compliance Plan with the appropriate parts of the Micro-ACA tests left out, with the intention of adding them as soon as a resolution is found.

This situation has no effect on the Standard-ACA tests.

12.1 Submission Materials

12.1.1 Device Specific Information

Table 12-1 Device Specific Information for Micro-ACAs with Separate Charger

Item	Function	Value/ Support
1	The USB-IF TID for the UUT micro-AB receptacle used for the accessory port	
2	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
3	The USB-IF TID for the UUT standard-A plug or micro-B receptacle used for the charger port	

12.1.2 Checklists

Table 12-2 Checklist for Micro-ACAs

Question		Response	Test Number	BC 1.2 Section Number
Questions relating to all Micro-ACAs				
MACA1	Does the UUT have a capacitance from VBUS to ground of C_{MACA_VBUS} on its OTG port?	Yes ☐ No ☐	12.12	6.2.6
MACA2	Does the UUT have a capacitance from VBUS to ground of C_{MACA_VBUS} on its accessory port?	Yes ☐ No ☐	12.12	6.2.6
MACA3	Does the ACA have an indicator showing when the charger port is able to supply power to the other ports?	Yes ☐ No ☐	12.3 - 012.11	6.1
MACA4	Is the Charger Port on the UUT clearly labeled 'Charger Only'? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	Inspection	6.1

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MACA5	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_GND when nothing is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_GND when the unit is not connected to a power source and a B-device is connected to its accessory port?	Yes ☐ No ☐	012.11	4.5.3
MACA6	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_GND when an SDP is connected to its charger port, and a B-device is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.5	4.5.3
MACA7	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_A when a DCP or a CDP is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_A when the unit is connected to a power source, and a B-device is connected to its accessory port?	Yes ☐ No ☐	12.8	4.5.3
MACA8	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_B when a DCP or a CDP is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_B when the unit is connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.6	4.5.3

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MACA9	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_B when a DCP or a CDP is connected to its charger port, and an A-device not providing VBUS is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_B when the unit is connected to a power source, and an A-device not providing VBUS is connected to its accessory port?	Yes ☐ No ☐	12.7	4.5.3
MACA10	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_C when a DCP or a CDP is connected to its charger port, and an A-device providing VBUS is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_C when the unit is connected to a power source, and an A-device providing VBUS is connected to its accessory port?	Yes ☐ No ☐	12.7	4.5.3
MACA11	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_FLOAT when nothing is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_FLOAT when the unit is not connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.9	4.5.3
MACA12	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_ FLOAT when an SDP is connected to its charger port, and nothing is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3	4.5.3

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MACA13	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_FLOAT when nothing is connected to its charger port, and an A-device not supplying VBUS is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_FLOAT when the unit is not connected to a power source, and an A-device not supplying VBUS is connected to its accessory port?	Yes ☐ No ☐	12.10	4.5.3
MACA14	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_ FLOAT when an SDP is connected to its charger port, and an A-device not supplying VBUS is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.4	4.5.3
MACA15	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_FLOAT when nothing is connected to its charger port, and an A-device supplying VBUS is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_FLOAT when the unit is not connected to a power source, and an A-device supplying VBUS is connected to its accessory port?	Yes ☐ No ☐	12.10	4.5.3
MACA16	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_ FLOAT when an SDP is connected to its charger port, and an A-device supplying VBUS is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.4	4.5.3
MACA17	Does the UUT directly connect the data pins of the OTG port directly to the data pins of the accessory port?	Yes ☐ No ☐	Vendor Declaration	4.5.3
MACA18	Does the UUT have a captive cable terminated with a Micro-A plug on its OTG port?	Yes ☐ No ☐	Inspection	4.5.4
MACA19	Does the Micro-A plug have a valid TID?	Yes ☐ No ☐	Vendor Declaration	

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MACA20	Does the UUT have a Micro-AB receptacle on its OTG port?	Yes ☐ No ☐	Inspection	6.1
MACA21	Does the Micro-AB receptacle have a valid TID?		Vendor Declaration	
MACA22	Does the UUT Charger Port have a Micro-B receptacle, a captive cable terminated with a Standard-A plug, or a captive cable terminated with a Charger?	Micro-B ☐ Standard-A ☐ Charger ☐ No ☐	Inspection	6.2.1
MACA23	If the Charger Port has a Micro-B receptacle or a Standard-A plug, does this have a valid TID?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	
MACA24	Does the UUT charger port draw less than ISUSP when anything other than a charging port is attached to it? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3, 12.4, 12.5	6.2.6
MACA25	Does the UUT charger port draw less than ISUSP when a charging port is attached to it, and nothing is attached to the OTG port or accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.6	6.2.6
MACA26	Is the resistance between the VBUS_CHG and VBUS_OTG pins of the UUT, RACA_CHG_OTG when the charger switch is closed, and the voltage on VBUS_CHG is VACA_OPR? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.6	6.2.6
MACA27	Is the resistance between the VBUS_CHG and VBUS_ACC pins of the UUT, RACA_CHG_ACC when the accessory switch is closed, and the voltage on VBUS_CHG is VACA_OPR? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
MACA28	Is the resistance between the VBUS_OTG and VBUS_ACC pins of the UUT, RACA_OTG_ACC when the accessory switch is closed, and the voltage on VBUS_OTG is VACA_OPR?	Yes ☐ No ☐	12.8	6.2.6
MACA29	Is the resistance between the internal ground of the UUT and the ground pin of the Micro-AB receptacle attached to the OTG port of the UUT, ROTG_ACA_GND?	Yes ☐ No ☐	Vendor Declaration	6.2.6

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MACA30	Does the UUT output VDP_SRC on DP_CHG when it detects VBUS_CHG? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
MACA31	Does the UUT close its charger switch when it detects DN_CHG greater than VDAT_REF and VBUS_CHG remains above VOTG_SESS_VLD? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
Questions specific to Micro-ACAs with Combined Charger				
MACC1	Is the output voltage of the UUT less than VCHG_OVRSHT max for any step change in load current, and also when powering on or off? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.1.1
MACC2	Is the output current of the UUT prevented from exceeding ICDP max under any condition? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	4.1.2
MACC3	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on VBUS will not exceed VCHG_FAIL? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	4.1.5
MACC4	Is the output voltage of the UUT OTG port greater than VCHG_UNDSHT min for any step change in load current where current is less than ICDP min? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.5.2
MACC5	Is the output voltage of the UUT Accessory port greater than VCHG_UNDSHT min for any step change in load current where current is less than ICFG_MAX? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.5.2

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MACC6	Does the UUT output a voltage of VCHG (averaged over TVBUS_AVG) for all currents less than ICDP min on its OTG port? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4
MACC7	Does the UUT output a voltage of VCHG (averaged over TVBUS_AVG) allowing for a drop across RACA_OTG_ACC for all currents less than 500mA on its ACC port? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4
MACC8	If the UUT goes into shutdown during a current overload condition, does it recover and output a voltage of VCHG within a time of TSHTDWN_REC when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

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12.2 PET Cable Calibration

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	This is the first procedure in the Micro-ACA Test Suite.
Purpose	To calibrate the Test Cables, and to prepare the Micro-ACA for the following tests.
Description	The test operator is instructed to connect the test cables in turn, and these are calibrated. The test operator is then instructed to connect up the Micro-ACA in preparation for the tests.

12.2.1 Test procedure

1. Instruct test operator to plug Special Cable C into PET D-type connector, and the Micro-B plug of the Special Cable C into the PET Micro-AB receptacle, and then click on 'OK'.

2. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

3. Instruct test operator to unplug the Micro-B plug of the Special Cable C from the PET Micro-AB receptacle, and then click on 'OK'.

4. If 'Captive Cable' checkbox is checked, skip to step 8.

5. Instruct test operator to plug Special Cable B into the Standard-A receptacle of Special Cable C, and the Micro-B plug of the Special Cable B into the PET Micro-AB receptacle, and then click on 'OK'.

6. PET passes a current of 1500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

7. PET passes a current of 2000mA through the VBUS conductor of the cable, and measures and records the voltage drop.

8. Instruct test operator to unplug the Micro-B plug of the Special Cable B from the PET Micro-AB receptacle, and then click on 'OK'.

9. Instruct test operator to plug the Micro-B plug of Special Cable C into the Accessory Port of the Micro-ACA under test, and then click on 'OK'.

10. Instruct test operator to plug the Micro-B plug of the captive OTG cable of the Micro-ACA under test into the PET Micro-AB receptacle, and then click on 'OK'.

11. **With Captive Charger Cable**
    Instruct test operator to plug the Standard-A plug of the captive Charger cable of the Micro-ACA under test into the Standard-A receptacle of Special Cable C, and then click on 'OK'.

    With No Captive Charger Cable
    Instruct test operator to plug the Micro-B plug of Special Cable B into the Charger port of the Micro-ACA under test, and then click on 'OK'.

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Check that cables are connected:

12. Connect 10kΩ pull-down resistor to OTG port VBUS.
13. Apply 5V to VBUS on charger port.
14. Connect together D+ and D- on charger port via 200R.
15. Apply ground to ID pin on accessory port.
16. Check that we can sense 5V on VBUS on OTG port.
17. Check that we can sense 5V on VBUS on accessory port.
18. Remove 5V from VBUS on charger port.
19. Disconnect D+ from D- on charger port.
20. Disconnect 10kΩ pull-down resistor from OTG port VBUS.
21. Remove ground from ID pin on accessory port.
22. If test fails report 'Either cables not correctly connected or accessory port ID pin not functioning'.

End of Test

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12.3 SDP attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and Nothing attached to accessory port
Description	**The PET simulates an SDP being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check whether VBUS comes from the OTG port or the Accessory Port. Check the resistance to ground of ID pin on OTG port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.**
Parameters	RID_FLOAT, ISUSP
Checklist	MACA3, MACA12, MACA24
Pass Criteria	Step 3. VBUS is not coming from the Accessory port. Step 4. VBUS is not coming from the OTG port. Step 5. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 7. Indicator is off. Step 8. UUT is drawing less than ISUSP from the charger port

12.3.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. **Connect 10kΩ pull-down resistor to OTG port VBUS.**
2. **Apply 5V to VBUS on charger port.**
3. **Check that VBUS is not coming from the Accessory port. i.e. Check that Accessory port VBUS is less than VOTG_VBUS_LKG (0.7V)**
4. **Check that VBUS is not coming from the OTG port. i.e. Check that OTG port VBUS is less than VOTG_VBUS_LKG (0.7V)**

Check RID_FLOAT

5. **Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220 kΩ). [MACA12]**

Check Indicator

6. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**
7. **Wait for response, if 'Yes', test fails. If 'No' it passes. [MACA3]**

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Check Current Drawn by UUT Charger Port

8. Check that the UUT is drawing less than I_{SUSP} (2.5mA) from the charger port. [MACA24]

9. Remove 5V from V_{BUS} on charger port.

10. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

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12.4 SDP attached to Charger Port, A-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and A-device attached to accessory port
Description	The PET simulates an SDP being attached to the Charger Port of the UUT, and an A-device to the Accessory Port of the UUT. Check whether VBUS comes from the OTG. Check the resistance to ground of ID pin on OTG port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.
Parameters	RID_FLOAT, ISUSP
Checklist	MACA3, MACA9, MACA10, MACA24
Pass Criteria	Step 5. VBUS is coming from the OTG port. Step 8. Indicator is off. Step 9. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 12. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 14. Voltage is less than 100mV Step 19. UUT is drawing less than ISUSP from the charger port

12.4.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Connect 5V to VBUS on charger port.
3. Connect 0V to VBUS on accessory port.
4. Check that voltage on VBUS from OTG is less than VOTG_VBUS_LKG (0.7V)
5. Connect 5V to VBUS on accessory port.
6. Check that voltage on VBUS from OTG port is >= 4.75V.

Check Indicator

7. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
8. Wait for response, if 'Yes', test fails. If 'No' it passes. [MACA3]

Check RID_FLOAT

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9. Connect 0V to VBUS on accessory port.

10. Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220 kΩ). [MACA9]

11. Connect 5V to VBUS on accessory port.

12. Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220 kΩ). [MACA10]

For now skip to step 16 (See note at start of Section 12)

Check RACA_OTG_ACC

13. Set OTG Port VBUS current load to 500mA.

14. Check that voltage on Accessory Port VBUS minus OTG VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms RACA_OTG_ACC (200mΩ).

15. Set OTG Port VBUS current load to 0mA.

Check Current Drawn by UUT Charger Port

16. Set OTG Port VBUS current load to 10mA.

17. Measure current drawn from VBUS generator.

18. Disconnect VBUS from Charger Port.

19. Check that current drops by less than ISUSP (2.5mA) [MACA24]

20. Remove 5V from VBUS on OTG port.

21. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

22. Set OTG Port VBUS current load to 0mA.

End of Test

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12.5 SDP attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and B-device attached to accessory port
Description	**The PET simulates an SDP being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT.** **Check whether VBUS comes from the OTG port or the Accessory Port. Check the resistance to ground of the ID pin on OTG port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.**
Parameters	RID_GND, RACA_OTG_ACC, ISUSP
Checklist	MACA3, MACA6, MACA24, MACA28
Pass Criteria	Step 4. VBUS is not coming from the Accessory port. Step 5. VBUS is not coming from the OTG port. Step 6. Resistance to ground of ID pin on OTG port is RID_GND. Step 8. Indicator is off. Step 11. Voltage is less than 100mV Step 16. UUT is drawing less than ISUSP from the charger port

12.5.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Apply 5V to VBUS on charger port.
3. Apply ground to ID pin on accessory port.
4. Check that VBUS is not coming from the Accessory port. i.e. Check that Accessory port VBUS is less than VOTG_VBUS_LKG (0.7V).
5. Check that VBUS is not coming from the OTG port. i.e. Check that OTG port VBUS is less than VOTG_VBUS_LKG (0.7V)

Check RID_GND

6. Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [MACA6]

Check Indicator

7. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
8. Wait for response, if 'Yes', test fails. If 'No' it passes. [MACA3]

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For now skip to step 13 (See note at start of Section 12)

Check $R_{CA\_OTG\_ACC}$

9. Apply V_{BUS} to OTG port
10. Connect 10Ω load to Accessory Port V_{BUS} line
11. Check that voltage on OTG V_{BUS} minus Accessory Port V_{BUS} is less than 100mV, allowing for the voltage drop in the test cables. This confirms $R_{CA\_OTG\_ACC}$ (200mΩ). [MACA28]
12. Remove 10Ω load from accessory port V_{BUS} line

Check Current Drawn by UUT Charger Port

13. Connect 625Ω load to Accessory Port V_{BUS} line.
14. Measure current drawn from V_{BUS} generator.
15. Disconnect V_{BUS} from Charger Port.
16. Check that current drops by less than I_{SUSP} (2.5mA) [MACA24]
17. Remove 5V from V_{BUS} on OTG port.
18. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.
19. Disconnect 625Ω load from Accessory Port V_{BUS} line.
20. Disconnect ground from ID pin on accessory port.

End of Test

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12.6 DCP or CDP attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Charger attached to the Charger Port and Nothing attached to accessory port
Description	The PET simulates a DCP or CDP being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check whether VBUS comes from the OTG Port or the Accessory Port. Check the resistance to ground of the ID pin on OTG Port. Check the resistance between VBUS on the Charger Port, and on the OTG Port. Check correct functioning of the Indicator. Check UUT outputs VDP_SRC on Charger Port D+.
Parameters	RID_B, RACA_CHG_OTG, VDP_SRC
Checklist	MACA3, MACA8, MACA24, MACA25
Pass Criteria	Step 4. VBUS is not coming from the Accessory port. Step 5. VBUS is coming from the OTG port. Step 6. Less than 2.5mA is being drawn by the charger port. Step 8. Voltage is less than 300mV Step 10. Resistance to ground of ID pin on OTG port is RID_B. Step 12. Indicator is on. Step 13. Voltage is 0.5V-0.7V.

12.6.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Apply 5V to VBUS on charger port.
3. Connect together D+ and D- on charger port via 200R.
4. Check that VBUS is not coming from the Accessory port. i.e. Check that Accessory port VBUS is less than VOTG_VBUS_LKG (0.7V)
5. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.
6. Check that less than ISUSP max (2.5mA) is being drawn by charger port. [MACA24]

Check RACA_CHG_OTG

7. Set OTG Port VBUS current load to 1500mA.

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8. Check that voltage on Charger V_{BUS} minus OTG Port V_{BUS} is less than 300mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_CHG\_OTG}$ (200mΩ). [MACA26]

9. Set OTG Port V_{BUS} current load to 0mA.

Check R_{ID_B}

10. Check that resistance to ground of ID pin on OTG port is R_{ID_B} (67-69 kΩ). [MACA8]

Check Indicator

11. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

12. Wait for response, if 'Yes', test passes. If 'No' it fails. [MACA3]

Check V_{DP_SRC}

13. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V).

14. Remove 5V from V_{BUS} on charger port.

15. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

16. Disconnect D+ from D- on charger port.

End of Test

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12.7 DCP or CDP attached to Charger Port, A-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with DCP or CDP attached to the Charger Port and A-device attached to accessory port
Description	**The PET simulates a DCP or CDP being attached to the Charger Port of the UUT, and an A-device to the Accessory Port of the UUT.** **Check whether VBUS comes from the OTG. Check the resistance to ground of ID pin on OTG Port. Check correct functioning of the Indicator. Check UUT outputs V_{DP_SRC} on Charger Port D+.**
Parameters	R_{ID_C}, I_{SUSP}, V_{DP_SRC}
Checklist	MACA3, MACA9, MACA10
Pass Criteria	Step 5. VBUS is coming from the OTG port. Step 6. Resistance to ground of ID pin on OTG port is R_{ID_B}. Step 8. Resistance to ground of ID pin on OTG port is R_{ID_C}. Step 10. Indicator is on. Step 15. Current is < 2.5mA Step 17. Voltage is 0.5V-0.7V.

12.7.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No V_{BUS} voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port V_{BUS}.
2. Apply 0V to V_{BUS} on Accessory Port.
3. Apply 5V to V_{BUS} on Charger Port.
4. Connect together D+ and D- on charger port via 200Ω.
5. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 4.75V.

Check R_{ID_B} and R_{ID_C}

6. Check that resistance to ground of ID pin on OTG port is R_{ID_B} (67-69 kΩ). [MACA9]
7. Apply 5V to V_{BUS} on Accessory Port.
8. Check that resistance to ground of ID pin on OTG port is R_{ID_C} (36-37 kΩ). [MACA10]

Check Indicator

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9. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

10. Wait for response, if 'Yes', test passes. If 'No' it fails. [MACA3]

Check Current From Accessory Port

11. Set OTG Port V_{BUS} current load to 10 mA.

12. Measure current from V_{BUS} generator.

13. Disconnect V_{BUS} from Accessory Port.

14. Measure current from V_{BUS} generator and subtract from previous measurement.

15. Check that difference is less than I_{SUSP} (2.5mA).

16. Set OTG Port V_{BUS} current load to zero.

Check V_{DP_SRC}

17. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V).

18. Remove 5V from V_{BUS} on Charger Port.

19. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

20. Disconnect D+ from D- on charger port.

End of Test

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12.8 DCP or CDP attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with DCP or CDP attached to the Charger Port and B-device attached to accessory port
Description	**The PET simulates a DCP or CDP being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT.** **Check whether VBUS comes from the OTG Port or the Accessory Port. Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the Charger Port, and on the OTG Port. Check the resistance between VBUS on the Charger Port, and on the Accessory Port. Check correct functioning of the Indicator. Check UUT outputs VDP_SRC on Charger Port D+.**
Parameters	RID_A, VACA_OPR, VACA_DIS, RACA_CHG_ACC, RACA_CHG_OTG, VDP_SRC
Checklist	MACA3, MACA7, MACA26, MACA27, MACA30
Pass Criteria	Step 6. VBUS is coming from the Accessory port. Step 7. VBUS is coming from the OTG port. Step 8. Resistance to ground of ID pin on OTG port is RID_A. Step 10. VBUS is coming from the Accessory port. Step 11. VBUS is coming from the OTG port. Step 15. Voltage is less than 500mV Step 17. Voltage is less than 300mV Step 20. Indicator is on. Step 21. Voltage is 0.5V-0.7V.

12.8.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Connect Accessory Port ID pin to ground.
3. Apply 5V to VBUS on charger port.
4. Connect together D+ and D- on charger port via 200R.
5. Connect 625Ω load on Accessory Port VBUS
6. Check that VBUS is coming from the Accessory port. i.e. Check that Accessory port VBUS is greater than 4.75V.

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7. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.

Check RID_A

8. Check that resistance to ground of ID pin on OTG port is RID_A (122-126 kΩ). [MACA7]

Check VACA_OPR

9. Change VBUS generator voltage to VACA_OPR min (4.1V).

10. Check that VBUS is coming from the Accessory port. i.e. Check that Accessory port VBUS is greater than 3.85V.

11. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 3.85V. [MACA27]

Check RACA_CHG_ACC

12. Disconnect 625Ω load from Accessory Port VBUS

13. Set OTG Port VBUS current load to 1500mA.

14. Connect 10Ω load to Accessory Port VBUS line.

15. Check that voltage on Charger VBUS minus Accessory Port VBUS is less than 500mV, allowing for the voltage drop in the test cables. This confirms RACA_CHG_ACC (400mΩ). [MACA27]

Note: The 500mV comprises 400mV across the Charger Switch (2A x 200mΩ), plus 100mV across the Accessory Switch (0.5A x 200mΩ).

Check RACA_CHG_OTG

16. Disconnect 10Ω load from Accessory Port VBUS line.

17. Check that voltage on Charger VBUS minus OTG Port VBUS is less than 300mV, allowing for the voltage drop in the test cables. This confirms RACA_CHG_OTG (200mΩ). [MACA26]

18. Set OTG Port VBUS current load to 0mA.

Check Indicator

19. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

20. Wait for response, if 'Yes', test passes. If 'No' it fails. [MACA3]

Check VDP_SRC

21. Check that voltage on D+ of charger port is VDP_SRC (0.5V-0.7V). [MACA30]

22. Remove 5V from VBUS on charger port.

23. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

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24. Disconnect Accessory Port ID pin from ground.

25. Disconnect D+ from D- on charger port.

End of Test

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12.9 Nothing attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and an A-device attached to accessory port
Description	**The PET simulates nothing being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT.** **Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.**
Parameters	RID_FLOAT
Checklist	MACA3, MACA11
Pass Criteria	Step 3. Voltage is less than 20mV. (Not mandatory) Step 6. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 8. Indicator is off.

12.9.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

For now skip to step 4 (See note at start of Section 12)

Check RACA_OTG_ACC

1. **Apply 0.75V to VBUS on OTG Port.**

Note: Accessory port has 100kΩ to ground on VBUS.

2. **Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 20mV. This confirms ability to transmit ADP probes.**

NOTE: Transmission of ADP probes is a desirable feature but it is not the intention of the BC Specification that this be mandatory.

3. **Disconnect VBUS from OTG port.**

Check RID_FLOAT

4. **Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220 kΩ). [MACA11]**

Check Indicator

5. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**

6. **Wait for response, if 'No', test passes. If 'Yes' it fails. [MACA3]**

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End of Test

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12.10 Nothing attached to Charger Port, A-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and A-device attached to accessory port
Description	**The PET simulates nothing being attached to the Charger Port of the UUT, and an A-device to the Accessory Port of the UUT.** **Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.**
Parameters	RID_FLOAT, RACA_OTG_ACC
Checklist	MACA3, MACA14, MACA15
Pass Criteria	Step 2. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 5. Voltage is less than 100mV. Step 8. Indicator is not on.

12.10.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check RID_FLOAT

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220kΩ). [MACA14]
3. Connect 5V VBUS to Accessory port.
4. Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220kΩ). [MACA15]

For now skip to step 8 (See note at start of Section 12)

Check RACA_OTG_ACC

5. Set OTG Port current load to 500mA.
6. Check that voltage on Accessory VBUS minus OTG Port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms RACA_OTG_ACC (200mΩ)
7. Set OTG Port current load to 0mA.

Check Indicator

8. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

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9. Wait for response, if 'No', test passes. If 'Yes' it fails. [MACA3]

10. Disconnect VBUS from Accessory port.

11. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

End of Test

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12.11 Nothing attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and a B-device attached to accessory port
Description	**The PET simulates nothing being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT.** **Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.**
Parameters	RID_GND, RACA_OTG_ACC
Checklist	MACA3, MACA5
Pass Criteria	Step 2. Resistance to ground of ID pin on OTG port is RID_GND. Step 5. Voltage is less than 100mV Step 8. Indicator is off.

12.11.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check RID_GND

1. Apply ground to ID pin on accessory port.
2. Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [MACA5]

For now skip to step 7 (See note at start of Section 12)

Check RACA_OTG_ACC

3. Connect 5V VBUS to OTG port.
4. Connect Accessory Port 10Ω load.
5. Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms RACA_OTG_ACC (200mΩ)
6. Disconnect Accessory Port 10Ω load.

Check Indicator

7. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
8. Wait for response, if 'No', test passes. If 'Yes' it fails. [MACA3]
9. Disconnect VBUS from OTG port.
10. Disconnect ground from ID pin on accessory port.

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End of Test

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12.12 Bypass Capacitance

Test Setup	UUT is a Micro-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check presence and values of bypass capacitors CMACA_VBUS. Note: If the ACA is capable of passing ADP probes from the OTG port to the accessory port when not powered, the capacitance at the OTG port will be seen as a combined capacitance. Therefore the range of capacitance at the OTG port is valid if it lies between 1 µF and 4 µF (2 x CMACA_VBUS max).
Description	**The PET simulates necessary conditions for measuring the bypass capacitors on the OTG port and the Accessory port.**
Parameters	CMACA_VBUS
Checklist	MACA1, MACA2
Pass Criteria	Step 6. Capacitance is 1-2 µF Step 10. Capacitance is 1-4 µF

12.12.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

For now skip this test (See note at start of Section 12)

Check Accessory Port Bypass Capacitance:

1. Apply 5V to VBUS on charger port.
2. Connect together D+ and D- on charger port via 200Ω.
3. Check that Accessory port VBUS is less than 0.25V
4. Connect 625R resistor from Accessory port VBUS to ground.
5. Connect 5V to VBUS on Accessory port.
6. Disconnect it and measure fall time as it discharges through the 625R pull-down resistor.
7. Evaluate capacitance from fall time and check it lies within CMACA_VBUS (1 – 2 µF). [MACA2]
8. Disconnect 5V from VBUS on charger port.
9. Disconnect 625R resistor from Accessory port VBUS to ground.
10. Disconnect D+ from D- on charger port.

Check OTG Port Bypass Capacitance:

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11. Use ADP circuit components in PET to evaluate OTG port capacitance.

12. Check that this capacitance lies within C_{MACA_VBUS} min and 2 x C_{MACA_VBUS} max (1 – 4 µF). [MACA1]

End of Test

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13 Micro-ACA Compliance, Combined Charger

Note: There are some discrepancies in the BC 1.2 Specification with regard to the Micro-ACA. Essentially, these relate to the requirement in Table 6-2 of that document that the Accessory switch be closed, in rows 1-3 (i.e. have a resistance of less than 200mΩ) at a time when there is no power available to the Micro-ACA. The presence and/or required value of C_{MACA_VBUS} capacitor(s) is also related to this. As some further work will be required to resolve this issue, it was decided to release this Compliance Plan with the appropriate parts of the Micro-ACA tests left out, with the intention of adding them as soon as a resolution is found.

This situation has no effect on the Standard-ACA tests.

13.1 Submission Materials

13.1.1 Device Specific Information

Table 13-1 Device Specific Information for Micro-ACAs with Combined Charger

Item	Function	Value/ Support
1	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
2	The USB-IF TID for the UUT micro-AB receptacle used for the accessory port	
3	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on V_{BUS} to exceed V_{CHG_FAIL}?	

13.1.2 Checklists

See previous section for Checklist

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13.2 PET Cable Calibration

Test Setup	Test Setup 7b. UUT is a Micro-ACA, with combined charger, PET simulates devices on the two ports.
Pre-conditions	This is the first procedure in the Micro-ACA, Combined Charger Test Suite.
Purpose	To calibrate the Test Cables, and to prepare the Micro-ACA for the following tests.
Description	The test operator is instructed to connect the test cables in turn, and these are calibrated. The test operator is then instructed to connect up the Micro-ACA in preparation for the tests.

13.2.1 Test procedure

1. Instruct test operator to plug Special Cable C into PET D-type connector, and the Micro-B plug of the Special Cable C into the PET Micro-AB receptacle, and then click on 'OK'.

2. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

3. Instruct test operator to unplug the Micro-B plug of the Special Cable C from the PET Micro-AB receptacle, and then click on 'OK'.

4. Instruct test operator to plug the Micro-B plug of Special Cable C into the Accessory Port of the Micro-ACA under test, and then click on 'OK'.

5. Instruct test operator to plug the Micro-B plug of the captive OTG cable of the Micro-ACA under test into the PET Micro-AB receptacle, and then click on 'OK'.

Check that cables are connected:

6. Connect 10kΩ pull-down resistor to OTG port VBUS.

7. Instruct test operator to power up the Micro-ACA under test, and then click on 'OK'.

8. Apply ground to ID pin on accessory port.

9. Check that we can sense 5V on VBUS on OTG port.

10. Check that we can sense 5V on VBUS on accessory port.

11. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

12. Remove ground from ID pin on accessory port.

13. If test fails report 'Either cables not correctly connected or UUT is not functioning'.

14. Instruct test operator to perform steps required to bring the Micro-ACA from a powered state to an un-powered one.

15. Wait for operator to click 'OK'.

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End of Test

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13.3 Micro-ACA Voltage, Current and Transient Test

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	PET Cable Calibration test has been run.
Purpose	**To verify the Micro-ACA meets voltage, current, voltage overshoot and undershoot specifications, for any specified step change in load.**
Description	This test measures the VBUS voltage at extremes of load current. It also changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT, VCHG
Checklist	MACC1, MACC4, MACC5, MACC6, MACC7
Pass Criteria	Step 8 – Latch not triggered Step 10 – Voltage in range Step 14 – Latches not triggered Step 17 – Voltage in range Step 18 – Latches not triggered Step 26 – Latch not triggered Step 28 – Voltage in range Step 32 – Latches not triggered Step 35 – Voltage in range Step 36 – Latches not triggered

13.3.1 Test procedure

Initial State: No load applied.

OTG Port

1. Ensure that Micro-ACA is in an un-powered state.
2. Wait for Micro-ACA OTG port VBUS to fall below VBUS_LKG max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
3. Connect accessory port ID pin to ground.
4. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on OTG port VBUS.
5. Instruct test operator to perform steps required to bring the Micro-ACA from an un-powered state to a powered one.
6. Wait for operator to click 'OK'.
7. Wait for Micro-ACA OTG port VBUS to rise above VCHG min (4.75V).
8. Check watch-block overshoot detector latch was not triggered. [MACC1]

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9. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on Micro-ACA OTG port V_{BUS}.

10. With no current load applied, check that Micro-ACA OTG port V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [MACC6]

Load Testing OTG port

11. Apply load of I_{CDP} min (1.5A) to Micro-ACA OTG port V_{BUS}.

12. Wait 10ms.

13. Check that Micro-ACA OTG port V_{BUS}, at Micro-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V).

14. Check watch-block overshoot and undershoot detector latches were not triggered. [MACC1] [MACC4]

15. Remove Current Load.

16. Wait 10ms

17. Check that V_{BUS} voltage from Micro-ACA accessory port V_{BUS}, at Micro-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V). [MACC6]

18. Check watch-block overshoot and undershoot detector latches were not triggered. [MACC1] [MACC4]

19. Instruct test operator to perform steps required to bring the Micro-ACA from a powered state to an un-powered one.

20. Wait for operator to click 'OK'.

Accessory Port

21. Wait for Micro-ACA accessory port V_{BUS} to fall below V_{BUS_LKG} max (0.7V). (Speed up fall using 10R resistive load.)

22. Set up voltage watch-block ready to capture overshoot of V_{CHG_OVRSHT} (6.0V) on accessory port V_{BUS}.

23. Instruct test operator to perform steps required to bring the Micro-ACA from an un-powered state to a powered one.

24. Wait for operator to click 'OK'.

25. Wait for Micro-ACA OTG port V_{BUS} to rise above V_{CHG} min (4.75V).

26. Check watch-block overshoot detector latch was not triggered. [MACC1]

27. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on Micro-ACA accessory port V_{BUS}, allowing for voltage drop in cable.

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28. With no current load applied, check that Micro-ACA accessory port V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [MACC7]

Load Testing Accessory port

29. Apply load of I_{CFG_MAX} (500mA) to Micro-ACA accessory port V_{BUS}.

30. Wait 10ms.

31. Check that Micro-ACA accessory port V_{BUS}, at Micro-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable.

32. Check watch-block overshoot and undershoot detector latches were not triggered. [MACC1] [MACC5]

33. Remove Current Load.

34. Wait 10ms

35. Check that V_{BUS} voltage from Micro-ACA accessory port V_{BUS}, at Micro-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range $V_{CHG} - R_{ACA\_OTG\_ACC} \times I_{CFG\_MAX}$ (4.65V to 5.25V). [MACC7]

36. Check watch-block overshoot and undershoot detector latches were not triggered. [MACC1] [MACC5]

37. Instruct test operator to perform steps required to bring the Micro-ACA from a powered state to an un-powered one.

38. Wait for operator to click 'OK'.

End of Test

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13.4 Micro-ACA Not Powered, Nothing attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA not powered and nothing attached to accessory port
Description	**The PET simulates nothing being attached to the Accessory Port of the UUT.** **Checks the resistance to ground of ID pin on OTG Port. Checks the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.**
Parameters	RID_FLOAT
Checklist	MACA3, MACA11
Pass Criteria	Step 3. Voltage is less than 20mV. (Not mandatory) Step 6. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 8. Indicator is off.

13.4.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is not powered. Accessory port ID pin is floating.

1. **Ensure that Micro-ACA is in an un-powered state.**

For now skip to step 5 (See note at start of Section 13)

Check RACA_OTG_ACC

2. **Apply 0.75V to VBUS on OTG Port.**

Note: **Accessory port has 100kΩ to ground on VBUS.**

3. **Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 20mV. This confirms ability to transmit ADP probes.**

NOTE: Transmission of ADP probes is a desirable feature but it is not the intention of the BC Specification that this be mandatory.

4. **Disconnect VBUS from OTG port.**

Check RID_FLOAT

5. **Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220 kΩ). [MACA11]**

Check Indicator

6. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**

7. **Wait for response, if 'No', test passes. If 'Yes' it fails. [MACA3]**

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End of Test

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13.5 Micro-ACA Not Powered, A-device attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA not powered and A-device attached to accessory port
Description	**The PET simulates an A-device being attached to the Accessory Port of the UUT.** **Checks the resistance to ground of ID pin on OTG Port. Checks the resistance between VBUS on the OTG Port, and on the Accessory Port. Checks correct functioning of the Indicator.**
Parameters	RID_FLOAT, RACA_OTG_ACC
Checklist	MACA3, MACA13, MACA14
Pass Criteria	Step 3. Resistance to ground of ID pin on OTG port is RID_FLOAT. Step 7. Voltage is less than 100mV. Step 10. Indicator is not on.

13.5.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is not powered. Accessory port ID pin is floating.

1. **Ensure that Micro-ACA is in an un-powered state.**

Check RID_FLOAT

2. **Connect 10kΩ pull-down resistor to OTG port VBUS.**
3. **Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220kΩ). [MACA13]**
4. **Connect 5V VBUS to Accessory port.**
5. **Check that resistance to ground of ID pin on OTG port is RID_FLOAT (> 220kΩ). [MACA14]**

For now skip to step 9 (See note at start of Section 13)

Check RACA_OTG_ACC

6. **Set OTG Port current load to 500mA.**
7. **Check that voltage on Accessory VBUS minus OTG Port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms RACA_OTG_ACC (200mΩ)**
8. **Set OTG Port current load to 0mA.**

Check Indicator

9. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**

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10. Wait for response, if 'No', test passes. If 'Yes' it fails. [MACA3]

11. Disconnect VBUS from Accessory port.

12. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

End of Test

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13.6 Micro-ACA Not Powered, B-device attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA not powered and a B-device attached to accessory port
Description	The PET simulates a B-device being attached to the Accessory Port of the UUT. Checks the resistance to ground of ID pin on OTG Port. Checks the resistance between VBUS on the OTG Port, and on the Accessory Port. Checks correct functioning of the Indicator.
Parameters	RID_GND, RACA_OTG_ACC
Checklist	MACA3, MACA5, MACA28
Pass Criteria	Step 2. Resistance to ground of ID pin on OTG port is RID_GND. Step 5. Voltage is less than 100mV Step 8. Indicator is off.

13.6.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is not powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in an un-powered state.

Check RID_GND

2. Apply ground to ID pin on accessory port.
3. Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [MACA5]

For now skip to step 8 (See note at start of Section 13)

Check RACA_OTG_ACC

4. Connect 5V VBUS to OTG port.
5. Connect Accessory Port 10Ω load.
6. Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms RACA_OTG_ACC (200mΩ). [MACA28]
7. Disconnect Accessory Port 10Ω load.

Check Indicator

8. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
9. Wait for response, if 'No', test passes. If 'Yes' it fails. [MACA3]

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10. Disconnect VBUS from OTG port.

11. Disconnect ground from ID pin on accessory port.

End of Test

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13.7 Micro-ACA Powered Up, Nothing attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA powered and Nothing attached to accessory port
Description	**The PET simulates nothing being attached to the Accessory Port of the UUT.** **Checks whether VBUS comes from the OTG Port or the Accessory Port. Checks the resistance to ground of ID pin on OTG Port. Checks correct functioning of the Indicator.**
Parameters	RID_B, RACA_CHG_OTG
Checklist	MACA3, MACA8
Pass Criteria	Step. VBUS is not coming from the Accessory port. Step. VBUS is coming from the OTG port. Step. Less than 2.5mA is being drawn by the charger port. Step. Voltage is less than 300mV Step. Resistance to ground of ID pin on OTG port is RID_B. Step. Indicator is on. Step. Voltage is 0.5V-0.7V.

13.7.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is not powered. Accessory port ID pin is floating.

1. **Instruct test operator to perform steps required to bring the Micro-ACA from an un-powered state to a powered one.**
2. **Wait for operator to click 'OK'.**
3. **Ensure that Micro-ACA is in a powered state.**

Check Switching Functionality:

4. **Connect 10kΩ pull-down resistor to OTG port VBUS.**
5. **Check that VBUS is not coming from the accessory port. i.e. Check that accessory port VBUS is less than VOTG_VBUS_LKG (0.7V)**
6. **Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.**

Check RID_B

7. **Check that resistance to ground of ID pin on OTG port is RID_B (67-69 kΩ). [MACA8]**

Check Indicator

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8. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

9. Wait for response, if 'Yes', test passes. If 'No' it fails. [MACA3]

10. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

End of Test

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13.8 Micro-ACA Powered Up, A-device attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA powered and A-device attached to accessory port
Description	**The PET simulates an A-device being attached to the Accessory Port of the UUT.** **Checks whether VBUS comes from the OTG port. Checks the resistance to ground of ID pin on OTG Port. Checks correct functioning of the Indicator.**
Parameters	RID_C, ISUSP
Checklist	MACA3, MACA9, MACA10
Pass Criteria	Step. VBUS is coming from the OTG port. Step. Resistance to ground of ID pin on OTG port is RID_B. Step. Resistance to ground of ID pin on OTG port is RID_C. Step. Indicator is on. Step. Current is < 2.5mA Step. Voltage is 0.5V-0.7V.

13.8.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in a powered state.

Check Switching Functionality:

2. Connect 10kΩ pull-down resistor to OTG port VBUS.
3. Apply 0V to VBUS on Accessory Port.
4. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.

Check RID_B and RID_C

5. Check that resistance to ground of ID pin on OTG port is RID_B (67-69 kΩ). [MACA9]
6. Apply 5V to VBUS on Accessory Port.
7. Check that resistance to ground of ID pin on OTG port is RID_C (36-37 kΩ). [MACA10]

Check Indicator

8. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
9. Wait for response, if 'Yes', test passes. If 'No' it fails. [MACA3]

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Check Current From Accessory Port

10. Set OTG Port V_{BUS} current load to 10 mA.
11. Measure current from V_{BUS} generator.
12. Disconnect V_{BUS} from Accessory Port.
13. Measure current from V_{BUS} generator and subtract from previous measurement.
14. Check that difference is less than I_{SUSP} (2.5mA).
15. Set OTG Port V_{BUS} current load to zero.
16. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

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13.9 Micro-ACA Powered Up, B-device attached to Accessory Port

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA powered and B-device attached to accessory port
Description	**The PET simulates a B-device being attached to the Accessory Port of the UUT.** **Checks whether VBUS comes from the OTG Port or the Accessory Port. Checks the resistance to ground of ID pin on OTG Port. Checks correct functioning of the Indicator.**
Parameters	RID_A, VACA_OPR, VACA_DIS, RACA_CHG_ACC, RACA_CHG_OTG
Checklist	MACA3, MACA7
Pass Criteria	Step 5. VBUS is coming from the Accessory port. Step 6. VBUS is coming from the OTG port. Step 7. Resistance to ground of ID pin on OTG port is RID_A. Step 9. Indicator is on.

13.9.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is powered. Accessory port ID pin is floating.

1. **Ensure that Micro-ACA is in a powered state.**

Check Switching Functionality:

2. **Connect 10kΩ pull-down resistor to OTG port VBUS.**
3. **Connect Accessory Port ID pin to ground.**
4. **Connect 625Ω load on Accessory Port VBUS**
5. **Check that VBUS is coming from the Accessory port. i.e. Check that Accessory port VBUS is greater than 4.75V.**
6. **Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.**

Check RID_A

7. **Check that resistance to ground of ID pin on OTG port is RID_A (122-126 kΩ). [MACA7]**

Check Indicator

8. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**
9. **Wait for response, if 'Yes', test passes. If 'No' it fails. [MACA3]**
10. **Disconnect 10kΩ pull-down resistor from OTG port VBUS.**

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11. Disconnect Accessory Port ID pin from ground.

End of Test

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13.10 Bypass Capacitance

Test Setup	Test Setup 7b. UUT is a Micro-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Checks presence and values of bypass capacitors CMACA_VBUS. Note: If the ACA is capable of passing ADP probes from the OTG port to the accessory port when not powered, the capacitance at the OTG port will be seen as a combined capacitance. Therefore the range of capacitance at the OTG port is valid if it lies between 1 µF and 4 µF (2 x CMACA_VBUS max).
Description	**The PET simulates necessary conditions for measuring the bypass capacitors on the OTG port and the Accessory port.**
Parameters	CMACA_VBUS
Checklist	MACA1, MACA2
Pass Criteria	Step 6. Capacitance is 1-2 µF Step 10. Capacitance is 1-4 µF

13.10.1 Test procedure

For now skip this test (See note at start of Section 13)

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to any port. ACA is powered. Accessory port ID pin is floating.

1. Ensure that Micro-ACA is in a powered state.

Check Accessory Port Bypass Capacitance:

2. Check that Accessory port VBUS is less than 0.25V
3. Connect 625R resistor from Accessory port VBUS to ground.
4. Connect 5V to VBUS on Accessory port.
5. Disconnect it and measure fall time as it discharges through the 625R pull-down resistor.
6. Evaluate capacitance from fall time and check it lies within CMACA_VBUS (1 – 2 µF). [MACA2]
7. Disconnect 625R resistor from Accessory port VBUS to ground.

Check OTG Port Bypass Capacitance:

8. Instruct test operator to perform steps required to bring the Micro-ACA from a powered state to an un-powered one.
9. Wait for operator to click 'OK'.

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10. Use ADP circuit components in PET to evaluate OTG port capacitance.

11. Check that this capacitance lies within C_{MACA_VBUS} min and 2 x C_{MACA_VBUS} max (1 – 4 µF). [MACA1]

End of Test

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14 Standard-ACA Compliance, Separate Charger

14.1 Submission Materials

14.1.1 Device Specific Information

Table 14-1 Device Specific Information for Standard-ACAs with Separate Charger

Item	Function	Value/ Support
1	The USB-IF TID for the UUT standard-A receptacle used for the accessory port	
2	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
3	The USB-IF TID for the UUT standard-A plug or micro-B receptacle used for the charger port	

14.1.2 Checklists

Table 14-2 Checklist for Standard-ACAs

Question		Response	Test Number	BC1.2 Section Number
Questions relating to all Standard-ACAs				
SACA1	Does the UUT have a capacitance from VBUS to ground of CMACA_VBUS on its OTG or accessory port?	Yes ☐ No ☐	12.12	6.2.6
SACA2	Does the ACA have an indicator showing when the charger port is able to supply power to the other ports?	Yes ☐ No ☐	12.3 - 012.11	6.1
SACA3	Is the Charger Port on the UUT clearly labeled 'Charger Only'? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	Inspection	6.1
SACA4	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_GND when nothing is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_GND when the unit is not connected to a power source and a B-device is connected to its accessory port?	Yes ☐ No ☐	012.11	4.5.3

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SACA5	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_GND when an SDP is connected to its charger port, and a B-device is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.5	4.5.3
SACA6	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_A when a DCP or a CDP is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_A when the unit is connected to a power source, and a B-device is connected to its accessory port?	Yes ☐ No ☐	12.8	4.5.3
SACA7	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_A when a DCP or a CDP is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_A when the unit is connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.6	4.5.3
SACA8	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through RID_GND when nothing is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through RID_GND when the unit is not connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.9	4.5.3

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SACA9	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when an SDP is connected to its charger port, and nothing is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3	4.5.3
SACA10	Does the UUT directly connect the data pins of the OTG port directly to the data pins of the accessory port?	Yes ☐ No ☐	Vendor Declaration	4.5.3
SACA11	Does the UUT directly connect V_{BUS} of the OTG port directly to V_{BUS} of the accessory port?	Yes ☐ No ☐	Vendor Declaration	6.3.3
SACA12	Does the UUT have a captive cable terminated with a Micro-A plug on its OTG port?	Yes ☐ No ☐	Inspection	4.5.4
SACA13	Does the Micro-A plug have a valid TID?	Yes ☐ No ☐	Vendor Declaration	
SACA14	Does the UUT have a Standard-A receptacle on its accessory port?	Yes ☐ No ☐	Inspection	6.1
SACA15	Does the Standard-A receptacle have a valid TID?		Vendor Declaration	
SACA16	Does the UUT Charger Port have a Micro-B receptacle, a captive cable terminated with a Standard-A plug, or a captive cable terminated with a Charger (or combined Charger)?	Micro-B ☐ Standard-A ☐ Charger ☐ No ☐	Inspection	6.2.1
SACA17	If the Charger Port has a Micro-B receptacle or a Standard-A plug, does this have a valid TID? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	
SACA18	Does the UUT charger port draw less than I_{SUSP} when anything other than a charging port is attached to it? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3, 12.4, 12.5	6.2.6

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SACA19	Does the UUT charger port draw less than I_{SUSP} when a charging port is attached to it, and nothing is attached to the OTG port or accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.6	6.2.6
SACA20	Is the resistance between VBUS_CHG and either VBUS_OTG pins or VBUS_ACC of the UUT, $R_{ACA\_CHG\_OTG}$ when the charger switch is closed, and the voltage on V_{BUS_CHG} is V_{ACA_OPR} ? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.6	6.2.6
SACA21	Is the resistance between the internal ground of the UUT and the ground pin of the Micro-AB receptacle attached to the OTG port of the UUT, $R_{OTG\_ACA\_GND}$?	Yes ☐ No ☐	Vendor Declaration	6.2.6
SACA22	Does the UUT output V_{DP_SRC} on DP_CHG when it detects VBUS_CHG? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
SACA23	Does the UUT close its charger switch when it detects DN_CHG greater than V_{DAT_REF} and VBUS_CHG remains above $V_{OTG\_SESS\_VLD}$? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.8	6.2.6
Questions specific to Standard-ACAs with Combined Charger				
SACC1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on or off? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.1.1
SACC2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	4.1.2

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SACC3	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on VBUS will not exceed VCHG_FAIL? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐	Vendor Declaration	4.1.5
SACC4	Is the output voltage of the UUT OTG port greater than VCHG_UNDSHT min for any step change in load current where current is less than ICDP min? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.5.2
SACC5	Is the output voltage of the UUT Accessory port greater than VCHG_UNDSHT min for any step change in load current where current is less than ICFG_MAX? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4.5.2
SACC6	Does the UUT output a voltage of VCHG (averaged over TVBUS_AVG) for all currents less than ICDP min on its OTG port? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4
SACC7	Does the UUT output a voltage of VCHG (averaged over TVBUS_AVG) allowing for a drop across RACA_OTG_ACC for all currents less than 500mA on its ACC port? This does not apply to a UUT with a separate charger.	Yes ☐ No ☐ N/A ☐		4
SACC8	If the UUT goes into shutdown during a current overload condition, does it recover and output a voltage of VCHG within a time of TSHTDWN_REC when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

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14.2 PET Cable Calibration

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	This is the first procedure in the Standard-ACA Test Suite.
Purpose	To calibrate the Test Cables, and to prepare the Standard-ACA for the following tests.
Description	The test operator is instructed to connect the test cables in turn, and these are calibrated. The test operator is then instructed to connect up the Standard-ACA in preparation for the tests.

14.2.1 Test procedure

1. Instruct test operator to plug Special Cable D into PET D-type connector, and the Standard-A plug of the Special Cable D into the Standard-A receptacle of the Special Cable D, and then click on 'OK'.

2. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

3. Instruct test operator to unplug Standard-A plug of the Special Cable D from the Standard-A receptacle of the Special Cable D, and then click on 'OK'.

4. If 'Captive Cable' checkbox is checked, skip to step 9.

5. Instruct test operator to plug Special Cable B into the Standard-A receptacle of Special Cable D, and the Micro-B plug of the Special Cable B into the PET Micro-AB receptacle, and then click on 'OK'.

6. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

7. PET passes a current of 1500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

8. Instruct test operator to unplug the Micro-B plug of the Special Cable B from the PET Micro-AB receptacle, and then click on 'OK'.

9. Instruct test operator to plug the Standard-A plug of Special Cable D into the Accessory Port of the Standard-ACA under test, and then click on 'OK'.

10. Instruct test operator to plug the Micro-B plug of the captive OTG cable of the Standard-ACA under test into the PET Micro-AB receptacle, and then click on 'OK'.

11. **With Captive Charger Cable**
    Instruct test operator to plug the Standard-A plug of the captive Charger cable of the Standard-ACA under test into the Standard-A receptacle of Special Cable D, and then click on 'OK'.

    With No Captive Charger Cable
    Instruct test operator to plug the Micro-B plug of Special Cable B into the Charger port of the Standard-ACA under test, and then click on 'OK'.

Check that cables are connected:

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12. Connect 10kΩ pull-down resistor to OTG port VBUS.
13. Apply 5V to VBUS on charger port.
14. Connect together D+ and D- on charger port via 200R.
15. Check that we can sense 5V on VBUS on OTG port.
16. Check that we can sense 5V on VBUS on accessory port.
17. Remove 5V from VBUS on charger port.
18. Disconnect D+ from D- on charger port.
19. Disconnect 10kΩ pull-down resistor from OTG port VBUS.
20. If test fails report 'Either cables not correctly connected or accessory port ID pin not functioning'.

End of Test

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14.3 SDP attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and Nothing attached to accessory port
Description	**The PET simulates an SDP being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT. Check whether VBUS comes from the OTG port or the Accessory Port. Check the resistance to ground of ID pin on OTG port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.**
Parameters	RID_GND, ISUSP
Checklist	SACA2, SACA9, SACA18
Pass Criteria	Step 3. VBUS is not coming from the Accessory port. Step 4. VBUS is not coming from the OTG port. Step 5. Resistance to ground of ID pin on OTG port is RID_GND. Step 7. Indicator is off. Step 8. UUT is drawing less than ISUSP from the charger port

14.3.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. **Connect 10kΩ pull-down resistor to OTG port VBUS.**
2. **Apply 5V to VBUS on charger port.**
3. **Check that VBUS is not coming from the Accessory port. i.e. Check that Accessory port VBUS is less than VOTG_VBUS_LKG (0.7V)**
4. **Check that VBUS is not coming from the OTG port. i.e. Check that OTG port VBUS is less than VOTG_VBUS_LKG (0.7V)**

Check RID_GND

5. **Check that resistance to ground of ID pin on OTG port is RID_GND (< 1 kΩ). [SACA9]**

Check Indicator

6. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**
7. **Wait for response, if 'Yes', test fails. If 'No' it passes. [SACA2]**

Check Current Drawn by UUT Charger Port

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8. Check that the UUT is drawing less than I_{SUSP} (2.5mA) from the charger port. [SACA18]

9. Remove 5V from V_{BUS} on charger port.

10. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

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14.4 SDP attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with SDP attached to the Charger Port and B-device attached to accessory port
Description	**The PET simulates an SDP being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT.** **Check whether VBUS comes from the OTG port or the Accessory Port. Check the resistance to ground of ID pin on OTG port. Check the current drawn by the Charger Port. Check correct functioning of the Indicator.**
Parameters	RID_GND, ISUSP
Checklist	SACA2, SACA5
Pass Criteria	Step 4. VBUS is not coming from the Accessory port. Step 5. VBUS is not coming from the OTG port. Step 6. Resistance to ground of ID pin on OTG port is RID_GND. Step 8. Indicator is off. Step 11. Voltage is less than 100mV Step 16. UUT is drawing less than ISUSP from the charger port

14.4.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. **Connect 10kΩ pull-down resistor to OTG port VBUS.**
2. **Apply 5V to VBUS on charger port.**
3. **Check that VBUS is not coming from the Accessory port. i.e. Check that Accessory port VBUS is less than VOTG_VBUS_LKG (0.7V).**
4. **Check that VBUS is not coming from the OTG port. i.e. Check that OTG port VBUS is less than VOTG_VBUS_LKG (0.7V)**

Check RID_GND

5. **Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [SACA5]**

Check Indicator

6. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**
7. **Wait for response, if 'Yes', test fails. If 'No' it passes. [SACA2]**

Check RACA_OTG_ACC

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8. Apply 5V VBUS to OTG port

9. Connect 10Ω load to Accessory port VBUS line

10. Check that voltage on OTG VBUS minus Accessory port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms that a VBUS path exists from OTG port to Accessory port.

11. Remove 10Ω load from accessory port VBUS line.

Check Current Drawn by UUT Charger Port

12. Connect 625Ω load to Accessory Port VBUS line.

13. Measure current drawn from VBUS generator.

14. Disconnect VBUS from Charger Port.

15. Check that current drops by less than ISUSP (2.5mA)

16. Remove 5V from VBUS on OTG port.

17. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

18. Disconnect 625Ω load from Accessory Port VBUS line.

End of Test

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14.5 DCP or CDP attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Charger attached to the Charger Port and Nothing attached to accessory port
Description	**The PET simulates a Charger being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT.** **Check whether VBUS comes from the OTG Port or the Accessory Port. Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the Charger Port, and on the OTG Port. Check correct functioning of the Indicator. Check UUT outputs VDP_SRC on Charger Port D+.**
Parameters	RID_A, RACA_CHG_OTG, VDP_SRC
Checklist	SACA2, SACA7, SACA19, SACA20, SACA22, SACA23
Pass Criteria	Step 4. VBUS is coming from the Accessory port. Step 5. VBUS is coming from the OTG port. Step 6. Less than 2.5mA is being drawn by the charger port. Step 8. Voltage is less than 300mV Step 10. Resistance to ground of ID pin on OTG port is RID_A. Step 12. Indicator is on. Step 13. Voltage is 0.5V-0.7V.

14.5.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. **Connect 10kΩ pull-down resistor to OTG port VBUS.**
2. **Apply 5V to VBUS on charger port.**
3. **Connect together D+ and D- on charger port via 200R.**
4. **Check that VBUS is coming from the Accessory port. i.e. Check that Accessory port VBUS is greater than 4.75V.**
5. **Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V. [SACA23]**
6. **Check that less than ISUSP max (2.5mA) is being drawn by charger port. [SACA19]**

Check RACA_CHG_OTG

7. **Set OTG Port VBUS current load to 1500mA.**

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8. Check that voltage on Charger V_{BUS} minus OTG Port V_{BUS} is less than 300mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_CHG\_OTG}$ (200mΩ). [SACA20]

9. Set OTG Port V_{BUS} current load to 0mA.

Check R_{ID_A}

10. Check that resistance to ground of ID pin on OTG port is R_{ID_A} (122-126 kΩ). [SACA7]

Check Indicator

11. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

12. Wait for response, if 'Yes', test passes. If 'No' it fails. [SACA2]

Check V_{DP_SRC}

13. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V). [SACA22]

14. Remove 5V from V_{BUS} on charger port.

15. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

16. Disconnect D+ from D- on charger port.

End of Test

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14.6 DCP or CDP attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Charger attached to the Charger Port and B-device attached to accessory port
Description	**The PET simulates a Charger being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT.** **Check whether VBUS comes from the OTG Port or the Accessory Port. Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the Charger Port, and on the OTG Port. Check the resistance between VBUS on the Charger Port, and on the Accessory Port. Check correct functioning of the Indicator. Check UUT outputs VDP_SRC on Charger Port D+.**
Parameters	RID_A, VACA_OPR, VACA_DIS, RACA_CHG_ACC, RACA_CHG_OTG, VDP_SRC
Checklist	SACA2, SACA6
Pass Criteria	Step 5. VBUS is coming from the Accessory port. Step 6. VBUS is coming from the OTG port. Step 7. Resistance to ground of ID pin on OTG port is RID_A. Step 9. VBUS is coming from the Accessory port. Step 10. VBUS is coming from the OTG port. Step 13. Voltage is less than 100mV Step 16. Indicator is on. Step 17. Voltage is > 0.5V-0.7V.

14.6.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check Switching Functionality:

1. Connect 10kΩ pull-down resistor to OTG port VBUS.
2. Apply 5V to VBUS on charger port.
3. Connect together D+ and D- on charger port via 200R.
4. Connect 625Ω load on Accessory Port VBUS
5. Check that VBUS is coming from the Accessory port. i.e. Check that Accessory port VBUS is greater than 4.75V.
6. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.

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Check R_{ID_A}

7. Check that resistance to ground of ID pin on OTG port is R_{ID_A} (122-126 kΩ). [SACA6]

Check V_{ACA_OPR}

8. Change V_{BUS} generator voltage to V_{ACA_OPR} min (4.1V).

9. Check that V_{BUS} is coming from the Accessory port. i.e. Check that Accessory port V_{BUS} is greater than 3.85V.

10. Check that V_{BUS} is coming from the OTG port. i.e. Check that OTG port V_{BUS} is greater than 3.85V.

Check $R_{ACA\_CHG\_ACC}$

11. Disconnect 625Ω load from Accessory Port V_{BUS}

12. Connect 10Ω load to Accessory Port V_{BUS} line.

13. Check that voltage on Charger V_{BUS} minus Accessory Port V_{BUS} is less than 100mV, allowing for the voltage drop in the test cables. This confirms $R_{ACA\_CHG\_ACC}$ (200mΩ).

14. Disconnect 10Ω load from Accessory Port V_{BUS} line.

Check Indicator

15. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated. [SACA2]

16. Wait for response, if 'Yes', test passes. If 'No' it fails.

Check V_{DP_SRC}

17. Check that voltage on D+ of charger port is V_{DP_SRC} (0.5V-0.7V).

18. Remove 5V from V_{BUS} on charger port.

19. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

20. Disconnect D+ from D- on charger port.

End of Test

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14.7 Nothing attached to Charger Port, Nothing attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and an nothing attached to accessory port
Description	**The PET simulates nothing being attached to the Charger Port of the UUT, and nothing to the Accessory Port of the UUT.** **Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.**
Parameters	RID_GND
Checklist	SACA2, SACA8
Pass Criteria	Step 2. Voltage is less than 20mV. Step 4. Resistance to ground of ID pin on OTG port is RID_GND. Step 6. Indicator is off.

14.7.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check RACA_OTG_ACC

1. **Apply 0.75V to VBUS on OTG Port.**

Note: Accessory port has 100kΩ to ground on VBUS.

2. **Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 20mV. This confirms ability to transmit ADP probes.**

3. **Disconnect VBUS from OTG port.**

Check RID_GND

4. **Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [SACA8]**

Check Indicator

5. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**

6. **Wait for response, if 'No', test passes. If 'Yes' it fails. [SACA2]**

End of Test

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14.8 Nothing attached to Charger Port, B-device attached to Accessory Port

Test Setup	UUT is a Standard-ACA, PET simulates devices on the three ports
Pre-conditions	
Purpose	Check ACA behavior with Nothing attached to the Charger Port and a B-device attached to accessory port
Description	**The PET simulates nothing being attached to the Charger Port of the UUT, and a B-device to the Accessory Port of the UUT.** **Check the resistance to ground of ID pin on OTG Port. Check the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.**
Parameters	RID_GND
Checklist	SACA2, SACA4
Pass Criteria	Step 1. Resistance to ground of ID pin on OTG port is RID_GND. Step 4. Voltage is less than 100mV Step 7. Indicator is off.

14.8.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check RID_GND

1. **Check that resistance to ground of ID pin on OTG port is RID_GND (< 1kΩ). [SACA4]**

Check RACA_OTG_ACC

2. **Connect 5V VBUS to OTG port.**
3. **Connect Accessory Port 10Ω load.**
4. **Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 100mV, allowing for the voltage drop in the test cables. This confirms that a VBUS path exists from OTG port to Accessory port.**
5. **Disconnect Accessory Port 10Ω load.**

Check Indicator

6. **Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.**
7. **Wait for response, if 'No', test passes. If 'Yes' it fails. [SACA2]**
8. **Disconnect VBUS from OTG port.**

End of Test

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14.9 Bypass Capacitance

Test Setup	UUT is a Standard-ACA. PET simulates devices on the three ports
Pre-conditions	
Purpose	Check presence and values of bypass capacitor CSACA_VBUS.
Description	**The PET simulates necessary conditions for measuring the bypass capacitor on the OTG / Accessory port.**
Parameters	CSACA_VBUS
Checklist	SACA1
Pass Criteria	Step 4. Capacitance is 10-100nF

14.9.1 Test procedure

Initial State: The PET is connected to all three ports of ACA. No VBUS voltage applied to any port. Switch between D+ and D- to charger port is open.

Check OTG Port Bypass Capacitance:

1. Use ADP circuit components in PET to evaluate capacitance on OTG port VBUS.
2. Check that this capacitance lies within CSACA_VBUS min and CSACA_VBUS max (10 – 100 nF). [SACA1]

End of Test

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15 Standard-ACA Compliance, Combined Charger

15.1 Submission Materials

15.1.1 Device Specific Information

Table 15-1 Device Specific Information for Standard-ACAs with Combined Charger

Item	Function	Value/ Support
1	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
2	The USB-IF TID for the UUT standard-A receptacle used for the accessory port	
3	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on V_{BUS} to exceed V_{CHG_FAIL}?	

15.1.2 Checklists

See previous section for submission Materials.

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15.2 PET Cable Calibration

Test Setup	Test Setup 8b. UUT is a Standard-ACA, with combined charger, PET simulates devices on the two ports.
Pre-conditions	This is the first procedure in the Standard-ACA, Combined Charger Test Suite.
Purpose	To calibrate the Test Cables, and to prepare the Standard-ACA for the following tests.
Description	The test operator is instructed to connect the test cables in turn, and these are calibrated. The test operator is then instructed to connect up the Standard-ACA in preparation for the tests.

15.2.1 Test procedure

1. Instruct test operator to plug Special Cable D into PET D-type connector, and the Standard-A plug of the Special Cable D into the Standard-A receptacle of the Special Cable D, and then click on 'OK'.

2. PET passes a current of 500mA through the VBUS conductor of the cable, and measures and records the voltage drop.

3. Instruct test operator to unplug Standard-A plug of the Special Cable D from the Standard-A receptacle of the Special Cable D, and then click on 'OK'.

4. Instruct test operator to plug the Standard-A plug of Special Cable D into the Accessory Port of the Standard-ACA under test, and then click on 'OK'.

5. Instruct test operator to plug the Micro-B plug of the captive OTG cable of the Standard-ACA under test into the PET Micro-AB receptacle, and then click on 'OK'.

Check that cables are connected:

6. Connect 10kΩ pull-down resistor to OTG port VBUS.

7. Instruct test operator to power up the Standard-ACA under test, and then click on 'OK'.

8. Check that we can sense 5V on VBUS on OTG port.

9. Check that we can sense 5V on VBUS on accessory port.

10. Disconnect 10kΩ pull-down resistor from OTG port VBUS.

11. If test fails report 'Either cables not correctly connected or UUT is not functioning'.

12. Instruct test operator to perform steps required to bring the Standard-ACA from a powered state to an un-powered one.

13. Wait for operator to click 'OK'.

End of Test

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15.3 Standard-ACA Voltage, Current and Transient Test

Test Setup	Test Setup 8b. UUT is a Standard-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	PET Cable Calibration test has been run.
Purpose	**To verify the Standard-ACA meets voltage, current, voltage overshoot and undershoot specifications, for any specified step change in load.**
Description	This test measures the VBUS voltage at extremes of load current. It also changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT, VCHG
Checklist	SACC1, SACC4, SACC5, SACC6, SACC7
Pass Criteria	Step 7 – Latch not triggered Step 9 – Voltage in range Step 13 – Latches not triggered Step 16 – Voltage in range Step 17 – Latches not triggered Step 25 – Latch not triggered Step 27 – Voltage in range Step 31 – Latches not triggered Step 35 – Latches not triggered

15.3.1 Test procedure

Initial State: No load applied.

OTG Port

1. Ensure that Standard-ACA is in an un-powered state.
2. Wait for Standard-ACA OTG port VBUS to fall below VBUS_LKG max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
3. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on OTG port VBUS.
4. Instruct test operator to perform steps required to bring the Standard-ACA from an un-powered state to a powered one.
5. Wait for operator to click 'OK'.
6. Wait for Standard-ACA OTG port VBUS to rise above VCHG min (4.75V).
7. Check watch-block overshoot detector latch was not triggered. [SACC1]
8. Set up voltage watch-block ready to capture undershoot of VCHG_UNDSHT (4.1V), or overshoot of VCHG_OVRSHT (6.0V) on Standard-ACA OTG port VBUS.

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9. With no current load applied, check that Standard-ACA OTG port VBUS is within appropriate range VCHG (4.75V to 5.25V). [SACC6]

Load Testing OTG port

10. Apply load of ICDP min (1.5A) to Standard-ACA OTG port VBUS.

11. Wait 10ms.

12. Check that Standard-ACA OTG port VBUS, at Standard-ACA connector, samples taken every 1 ms and averaged over TVBUS_AVG max (250ms), is within appropriate range VCHG (4.75V to 5.25V).

13. Check watch-block overshoot and undershoot detector latches were not triggered. [SACC1] [SACC4]

14. Remove Current Load.

15. Wait 10ms

16. Check that VBUS voltage from Standard-ACA OTG port VBUS, at Standard-ACA connector, samples taken every 1 ms and averaged over TVBUS_AVG max (250ms), is within appropriate range VCHG (4.75V to 5.25V). [SACC6]

17. Check watch-block overshoot and undershoot detector latches were not triggered. [SACC1] [SACC4]

18. Instruct test operator to perform steps required to bring the Standard-ACA from a powered state to an un-powered one.

19. Wait for operator to click 'OK'.

Accessory Port

20. Wait for Standard-ACA accessory port VBUS to fall below VBUS_LKG max (0.7V). (Speed up fall using 10R resistive load.)

21. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on accessory port VBUS.

22. Instruct test operator to perform steps required to bring the Standard-ACA from an un-powered state to a powered one.

23. Wait for operator to click 'OK'.

24. Wait for Standard-ACA accessory port VBUS to rise above VCHG min (4.75V).

25. Check watch-block overshoot detector latch was not triggered. [SACC1]

26. Set up voltage watch-block ready to capture undershoot of VCHG_UNDSHT (4.1V), or overshoot of VCHG_OVRSHT (6.0V) on Standard-ACA accessory port VBUS, allowing for voltage drop in cable.

27. With no current load applied, check that Standard-ACA accessory port VBUS is within appropriate range VCHG (4.75V to 5.25V). [SACC7]

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Load Testing Accessory port

28. Apply load of I_{CFG_MAX} (500mA) to Standard-ACA accessory port V_{BUS}.

29. Wait 10ms.

30. Check that Standard-ACA accessory port V_{BUS}, at Standard-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable.

31. Check watch-block overshoot and undershoot detector latches were not triggered. [SACC1] [SACC5]

32. Remove Current Load.

33. Wait 10ms

34. Check that V_{BUS} voltage from Standard-ACA accessory port V_{BUS}, at Standard-ACA connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range $V_{CHG} - R_{ACA\_OTG\_ACC} \times I_{CFG\_MAX}$ (4.65V to 5.25V). [SACC7]

35. Check watch-block overshoot and undershoot detector latches were not triggered. [SACC1] [SACC5]

36. Instruct test operator to perform steps required to bring the Standard-ACA from a powered state to an un-powered one.

37. Wait for operator to click 'OK'.

End of Test

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15.4 Standard-ACA Not Powered, Nothing or B-device attached to Accessory Port

Test Setup	Test Setup 8b. UUT is a Standard-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA not powered and nothing or a B-device attached to accessory port
Description	The PET simulates nothing being attached to the Accessory Port of the UUT. Checks the resistance to ground of ID pin on OTG Port. Checks the resistance between VBUS on the OTG Port, and on the Accessory Port. Check correct functioning of the Indicator.
Parameters	RID_FLOAT
Checklist	SACA2, SACA4, SACA8
Pass Criteria	Step 4. Voltage is less than 125mV. Step 7. Resistance to ground of ID pin on OTG port is RID_GND. Step 9. Indicator is off.

15.4.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to either port. ACA is not powered. Accessory port ID pin is floating.

1. Ensure that Standard-ACA is in an un-powered state.

Check VBUS Continuity

2. Apply 5V to VBUS on OTG Port.
3. Connect 10R load on accessory port VBUS.
4. Check that voltage on OTG VBUS minus Accessory Port VBUS is less than 125mV. (This value matches the drop allowed by OTG 2.0 in a detachable cable).
5. Disconnect 10R load from accessory port VBUS.
6. Disconnect VBUS from OTG port.

Check RID_GND

7. Check that resistance to ground of ID pin on OTG port is RID_GND (< 1 kΩ). [SACA4] [SACA8]

Check Indicator

8. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
9. Wait for response, if 'No', test passes. If 'Yes' it fails. [SACA2]

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End of Test

15.5 Standard-ACA Powered Up, Nothing or B-device attached to Accessory Port

Test Setup	Test Setup 8b. UUT is a Standard-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check ACA behavior with ACA powered and Nothing or a B-device attached to accessory port
Description	The PET simulates nothing being attached to the Accessory Port of the UUT. Checks whether VBUS comes from the OTG Port or the Accessory Port. Checks the resistance to ground of ID pin on OTG Port. Checks correct functioning of the Indicator.
Parameters	RID_A
Checklist	SACA2. SACA6. SACA7
Pass Criteria	Step 5. VBUS is coming from the Accessory port. Step 6. VBUS is coming from the OTG port. Step 7. Resistance to ground of ID pin on OTG port is RID_A. Step 9. Indicator is on.

15.5.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to either port. ACA is not powered. Accessory port ID pin is floating.

1. Instruct test operator to perform steps required to bring the Standard-ACA from an un-powered state to a powered one.
2. Wait for operator to click 'OK'.
3. Ensure that Standard-ACA is in a powered state.

Check Switching Functionality:

4. Connect 10kΩ pull-down resistor to OTG port VBUS.
5. Check that VBUS is coming from the accessory port. i.e. Check that accessory port VBUS is greater than 4.75V.
6. Check that VBUS is coming from the OTG port. i.e. Check that OTG port VBUS is greater than 4.75V.

Check RID_A

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7. Check that resistance to ground of ID pin on OTG port is R_{ID_A} (122-126 kΩ). [SACA6] [SACA7]

Check Indicator

8. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

9. Wait for response, if 'Yes', test passes. If 'No' it fails. [SACA2]

10. Disconnect 10kΩ pull-down resistor from OTG port V_{BUS}.

End of Test

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15.6 Bypass Capacitance

Test Setup	Test Setup 8b. UUT is a Standard-ACA with combined charger, PET simulates devices on the two ports.
Pre-conditions	
Purpose	Check presence and values of bypass capacitor CSACA_VBUS.
Description	**The PET simulates necessary conditions for measuring the bypass capacitor on the OTG / Accessory port.**
Parameters	CSACA_VBUS
Checklist	SACA1
Pass Criteria	Step 4. Capacitance is 10-100nF

15.6.1 Test procedure

Initial State: The PET is connected to both ports of ACA. No VBUS voltage applied to either port.

Check OTG Port Bypass Capacitance:

1. **Ensure that Standard-ACA is in an un-powered state.**
2. **Use ADP circuit components in PET to evaluate capacitance on OTG port VBUS.**
3. **Check that this capacitance lies within CSACA_VBUS min and CSACA_VBUS max (10 – 100 nF). [SACA1]**

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16 ACA-Dock Compliance

Note: USB2.0 tests are to be run separately, using appropriate equipment.

16.1 Submission Materials

16.1.1 Device Specific Information

Table 16-1 Device Specific Information for ACA-Docks

Item	Function	Value/ Support
1	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
2	The USB-IF TID for the UUT micro-A plug used for connecting the PD	
3	Schematics or other proof that a single UUT failure will not cause the output voltage on VBUS to exceed VCHG_FAIL?	
4	If it is not possible to plug the ACA-Dock into the PET Micr0-AB receptacle, a means of achieving this	

16.1.2 Checklists

Table 16-2 Checklist for ACA-Docks

ID and Question		Response	Test Number	BC 1.2 Section Number
ACAD1	Is the output voltage of the UUT less than VCHG_OVRSHT max for any step change in load current, and also when powering on or off?	Yes ☐ No ☐	16.2	4.1.1
ACAD2	Is the output current of the UUT prevented from exceeding ICDP max under any condition?	Yes ☐ No ☐	Vendor Declaration	4.1.2
ACAD3	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on VBUS will not exceed VCHG_FAIL?	Yes ☐ No ☐	Vendor Declaration	4.1.5
ACAD4	As per provided UUT description: if the UUT provides multiple USB Charging Ports, the active UUT USB Charging Port does not affect operation of any other Charging Port.	Yes ☐ No ☐	Vendor Declaration	4.1.6
ACAD5	Does the UUT output a voltage of VCHG (averaged over TVBUS_AVG) for all currents less than ICDP min?	Yes ☐ No ☐	16.3	4.3.1

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ACAD6	Is the output voltage of the UUT greater than VCHG_UNDSHT min for any step change in load current where current is less than ICDP min?	Yes ☐ No ☐	16.2	4.3.2
ACAD7	Does the UUT enable VDM_SRC within TCP_VDM_EN if D+/- are at idle, and disable VDM_SRC within TCP_VDM_DIS of any USB activity on D+/-?	Yes ☐ No ☐	16.3	4.3.3
ACAD8	Does the UUT pull the ID pin to ground through a resistance of RID_A, whenever the connected PD is allowed to act as host and to draw current, and through RID_FLOAT at all other times?	Yes ☐ No ☐	16.3	4.3.3
ACAD9	Does the UUT have a captive cable with a Micro-A plug?	Yes ☐ No ☐	Inspection	4.3.4
ACAD10	Does the Micro-A plug have a valid TID?	Yes ☐ No ☐	Vendor Declaration	
ACAD11	Does the UUT have a captive (non-removable) USB hub?	Yes ☐ No ☐	Vendor Declaration	
ACAD12	If the hub has exposed downstream-facing ports, are they exposed via Standard-A receptacle(s) with valid TID(s)?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	
ACAD13	Does the hub silicon have a valid TID?	Yes ☐ No ☐	Vendor Declaration	
ACAD14	Does the UUT have an indicator showing when it is able to supply power to the OTG port?	Yes ☐ No ☐	16.3, 16.4	
ACAD15	If the UUT goes into shutdown during a current overload condition, does it recover and output a voltage of VCHG within a time of TSHTDWN_REC when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

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16.2 ACA-Dock Overshoot and Undershoot Voltage Test

Test Setup	Test Setup 9. UUT is an ACA-Dock, PET simulates a PD.
Pre-conditions	This must be performed as the first test in the ACA-Dock suite.
Purpose	To verify the ACA-Dock meets overshoot and undershoot voltage specifications, for any specified step change in load.
Description	This test changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT
Checklist	ACAD1, ACAD6
Pass Criteria	Step 4 – Maximum voltage during overshoot is less than 6.0V. Step 6 – VBUS is in range 4.75V to 5.25V Step 9 – VBUS is in range 4.75V to 5.25V Step 10 – Minimum voltage during undershoot is above 4.1V. Step 10 – Maximum voltage during overshoot is less than 6.0V. Step 13 – VBUS is in range 4.75V to 5.25V Step 14 – Minimum voltage during undershoot is above 4.1V. Step 14 – Maximum voltage during overshoot is less than 6.0V.

16.2.1 Test procedure

Initial State: No VBUS voltage applied. ACA-Dock is not powered.

1. Instruct test operator to plug captive cable of the ACA-Dock into the Micro-AB receptacle of the PET, and then click on 'OK'.

Note: If this is not physically possible, then make use of the alternative arrangement provided by the vendor.

2. Ask test operator to ensure that power is disconnected from the ACA-Dock, and then click on 'OK'. Check that VBUS is off.

3. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on VBUS.

4. Instruct test operator to perform steps required to bring the ACA-Dock from an un-powered state to a powered one.

5. Wait for operator to click 'OK'.

6. Wait for ACA-Dock OTG port VBUS to rise above VCHG min (4.75V).

7. Check watch-block overshoot detector latch was not triggered. [ACAD1]

8. Set up voltage watch-block ready to capture undershoot of VCHG_UNDSHT (4.1V), or overshoot of VCHG_OVRSHT (6.0V) on VBUS, allowing for voltage drop in cable.

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9. With an applied current load of 0mA, check that V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V).

10. Apply load of I_{CDP} min (1.5A) to V_{BUS}.

11. Wait 10ms.

12. Check that V_{BUS} voltage from ACA-Dock, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V).

13. Check watch-block overshoot and undershoot detector latches were not triggered. [ACAD1] [ACAD6]

14. Remove Current Load.

15. Wait 10ms

16. Check that V_{BUS} voltage from ACA-Dock, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V). [ACAD1] [ACAD6]

17. Check watch-block overshoot and undershoot detector latches were not triggered.

End of Test

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16.3 ACA-Dock Voltage, Current, and RID_A Test

Test Setup	Test Setup 9. UUT is an ACA-Dock, PET simulates a PD.
Pre-conditions	ACA-Dock Overshoot and Undershoot Voltage Test has been run, and ACA-Dock is now switched on.
Purpose	To verify that the VBUS voltage / current load characteristic meets the specified requirements.
Description	This test measures the voltage at various current loads, in order to confirm correct behavior.
Parameters	VCHG, RID_A, VDM_SRC
Checklist	ACAD5, ACAD7, ACAD8, ACAD14
Pass Criteria	Step1 - VBUS voltage is in correct range Step 4 - VBUS voltage is in correct range. Step 7 - Voltage on ID pin is in correct range. Step 9 – Response was 'Yes'. Step 10 - VDM_SRC is in correct range.

16.3.1 Test procedure

Initial State: The captive cable of the ACA-Dock is connected to the Micro-AB receptacle of the PET. No VBUS voltage applied. ACA-Dock is powered.

Check Voltage under load

1. Confirm that power has been connected to ACA-Dock, asking test operator to connect it, if not.
2. Check that VBUS voltage, samples taken every 1 ms and averaged over TVBUS_AVG max (250ms), from ACA-Dock is within VCHG (4.75 – 5.25V). [ACAD5]
3. Apply load of ICDP min (1.5A) to VBUS.
4. Wait 1 sec to avoid possible overshoot period (overshoot and undershoot are measured separately).
5. Check that VBUS voltage from ACA-Dock, samples taken every 1 ms and averaged over TVBUS_AVG max (250ms), is within VCHG (4.75 – 5.25V). [ACAD5]
6. Disconnect the current load.

Check ID pin

7. Connect voltage source (3.3V) via 82k resistor to ID pin.
8. Check voltage on ID pin is in the range 1.970V – 2.002V. [ACAD8]

Note: This shows that the RID_A value from the ACA-Dock lies in the range 122k – 126k.

Check Indicator

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9. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.

10. Wait for response, if 'Yes', test passes. If 'No' it fails. [ACAD14]

Check V_{DM_SRC}

11. Check that voltage on D- is in range V_{DM_SRC} (0.5 to 0.7V). [ACAD7]

End of Test

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16.4 ACA-Dock not Powered

Test Setup	Test Setup 9. UUT is an ACA-Dock, PET simulates a PD.
Pre-conditions	ACA-Dock Overshoot and Undershoot Voltage Test has been run, and ACA-Dock is now switched on.
Purpose	To verify that the ID pin and the indicator meets the specified requirements under no power conditions.
Description	This test measures the ID pin, and checks the indicator, after the power has been removed.
Parameters	RID_FLOAT
Checklist	ACAD8, ACAD14
Pass Criteria	Step 3 - Voltage on ID pin is 2.40V or above. Step 5 – Response was 'No'.

16.4.1 Test procedure

Initial State: ACA-Dock Micro-A plug is connected to Micro-AB receptacle on PET. No VBUS voltage applied. ACA-Dock is powered.

Check ID pin

1. Ask test operator to disconnect power from ACA-Dock, and then to confirm that this has been done.
2. Connect voltage source (3.3V) via 82k resistor to ID pin.
3. Check voltage on ID pin is 2.40V or above. [ACAD8]

Note: This shows that the RID_FLOAT value from the ACA-Dock lies above 220k.

Check Indicator

4. Ask test operator to confirm 'Yes' or 'No' whether indicator lamp on UUT is illuminated.
5. Wait for response, if 'No', test passes. If 'Yes' it fails. [ACAD14]

End of Test

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/819,831	03/16/2020	Jonathan Lewis NOOK	054985-000055-US-02-01

CONFIRMATION NO. 1630

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OC000000120510298

Title:PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

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PLUS Search Results for S/N 16819831, Searched Thu Dec 31 08:21:03 EST 2020

The Patent Linguistics Utility System (PLUS) is a USPTO automated search system for U.S. Patents from 1971 to the present PLUS is a query-by-example search system which produces a list of patents that are most closely related linguistically to the application searched. This search was prepared by the staff of the Scientific and Technical Information Center, SIRA.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/819,831	03/16/2020	Jonathan Lewis NOOK	054985-000055-US-02-01	1630

20230 7590 08/23/2021

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EXAMINER	
DIAO, M BAYE	

ART UNIT	PAPER NUMBER
2859	

NOTIFICATION DATE	DELIVERY MODE
08/23/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patlaw@vorys.com

ADC EX1002
IPR2025-00885

Office Action Summary	Application No. 16/819,831	Applicant(s) NOOK et al.	
	Examiner M'BAYE DIAO	Art Unit 2859	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 03/16/2020.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 24-74 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 24-74 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 03/16/2020 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 07/23/2020.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

ADC EX1002
IPR2025-00885

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Amendment

2. Acknowledgement is made of preliminary amendment filed on 07/16/2020 in which claims 1-23 have been canceled while claims 24-74 have been newly added. By this amendment, claims 24-74 are now pending in the application for prosecution in a first action on the merits.

Claim Objections

3. Claim 54 is objected to because of the following informalities: Claim 54 is missing a period at its end and thus is in an improper format. Additionally, the limitations of, "and the polarity circuit further comprises second diode connected between the second optically coupled phototransistor and the depleted or discharged battery" should read -- and the polarity circuit further comprises a second diode connected between the second optically coupled phototransistor and the depleted or discharged battery.--

4. Appropriate correction is required.

Information Disclosure Statement

5. The information disclosure statements (IDS) submitted on 07/23/2020 are in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statements are being considered by the examiner and placed of record. Initialed copies are attached herewith.

Claim Rejections - 35 USC § 102

6. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the

statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention.
>
> (a)(2) the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.

8. **Claim(s) 24-52,60,62-66 are rejected under 35 U.S.C. 102(a)(1)|(a)(2) as being anticipated by Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387)**.

9. Regarding claims 24,25,26, and 27: Richardson discloses a jump starter apparatus**(10)** for boosting or charging**(abstract; ¶[0001])** a depleted or discharged battery**(battery of vehicle 28; see ¶[0006], Fig. 2C)** having a positive battery terminal**(Red clamp; Fig. 2C)** and a negative battery terminal**(Black clamp; Fig. 2C)**, the apparatus comprising: a power supply**(22)(note- jump starter batteries 22 provide power to the battery of the vehicle (28) to be jump started; see ¶[0006], Fig. 2C)**; a positive battery terminal connector**(jumper cables 60 has a positive battery terminal connector; see Fig. 2C)** for connecting the jump starter apparatus**(10)** to the positive battery terminal**(Red clamp; see Fig. 2C)** of the depleted or discharged battery**(battery of vehicle 28)**; a negative battery terminal connector**(jumper cables 60 has a negative battery terminal connector; see Fig. 2C)** for connecting the jump starter apparatus**(10)** to the negative battery terminal**(Black clamp; Fig. 2C)** of the depleted or discharged battery**(battery of vehicle 28)**; a power switch**(contact relay 34)** configured to

electrically connect the power supply**(22)** to the depleted or discharged battery**(battery of vehicle 28)** when boosting or charging the depleted or discharged battery; and a control system or circuit**(12)** connected to and controlling**(via output signal 58 in response to signals output by vehicle voltage sensor 30 as I and input at pin 34 at ADC3, see Figs. 2B & 2D and as H at pin 32 at ADC5 see Figs. 2B & 2D from sensors (30 and 24) indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs)** the power switch**(34)**, the control system or circuit**(12)** configured to detect presence of the depleted or discharged battery**(battery of vehicle 28)** when connected between the positive and negative battery terminal connectors and to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit**(12)** switching on power from the power supply**(22)** to the depleted or discharged battery**(battery of vehicle 28)** when the following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are connected to the depleted or discharge battery; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity**(note- Richardson discloses that "a programmable microprocessor 12 which receives inputs 14 and produces information outputs 16 and control outputs 18" (¶[0011]). It uses the term microprocessor and microcontroller interchangeably throughout the specification. (¶[0015] and Fig. 1) As shown in Fig. 1, inputs 14 include input signals from reverse voltage sensor 24 and vehicle voltage sensor 30, and outputs 18 and 58 which is directed to contact relay 34. (see Fig. 1, ¶[0014]) ("A reverse LED 48 is illuminated when the microprocessor 12 determines that a reverse voltage jumper cable voltage is detected by reverse polarity sensor 24 . . . A fault LED 56 is**

turned on any time the microprocessor 12 detects any operational, sensor or internal fault . . . A contact relay control output 58 operates the contact relay 34. When the jump starter operation has been successfully initiated, the contact relay 34 is closed"(turn on the switch, as per claims 19-20)). Furthermore, as discussed above, Fig. 2C clearly shows line H which carries a signal from reverse voltage sensor 24 and line I which carries a signal from vehicle voltage sensor 30. (see also Fig. 2C). Figure 2D shows an image of the microcontroller which includes inputs H and I. (Fig. 2D). Richardson further discloses (see ¶[0015]) that the microcontroller receives signals from the vehicle voltage sensor 30 and the reverse voltage sensor 24 and that it generates a control signal 58(activated output signal, as per claim 11) which controls the contact relay 34 to connect the jump starter batteries 22 to the vehicle to be started 28. Richardson also makes clear that the microcontroller only closes relay 34(activate switch or turn on switch) if the reverse polarity sensor 24 and vehicle voltage sensor 30 indicate the presence of a vehicle battery connected with proper polarity. For example, Richardson states that "when the jump starter 10 is initially powered on 200, the microprocessor initializes the hardware . . . . then performs a self-test operation 208 where . . . all sensors 20, 24, 30, 32, 38, 40 . . . are tested". Richardson further discloses the process of measuring the vehicle battery voltage necessarily entails detecting the presence of a vehicle battery connected to the positive and negative output ports since reading a sufficiently low voltage would indicate either the absence of a vehicle battery or a battery with a voltage below a required threshold for detection. Only after the reverse polarity and battery presence tests have been conducted at steps 214 and 252 does the process proceed to step 268 where microprocessor 12 sends a signal to close contact relay

34(turn on the power switch; as per claims 19-20). (See also Fig. 3, Fig. 6, see also ¶[0014] and [0027])

10. Accordingly claims 24-27 are clearly anticipated.

11. Regarding claim 28, Richardson discloses all the claimed invention as set forth and discussed above in claim 24. Richardson further discloses, wherein the control system or circuit**(12)** automatically switches**(via automatic pushbutton 42)** on power from the power supply**(22)** to the depleted or discharged battery**(battery of vehicle 28)** when the following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are connected to the depleted or discharged battery**(as detected by presence sensor detector 30)** ; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity**(as detected by reverse voltage sensor 24; see¶[0020])(Note-via output signal 58 in response to signals output by vehicle voltage sensor 30 as I and input at pin 34 at ADC3, see Figs. 2B & 2D and as H at pin 32 at ADC5 see Figs. 2B & 2D from sensors (30 and 24; see ¶[0012]) indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs)**.

12. Regarding claim 29, Richardson discloses all the claimed invention as set forth and discussed above in claim 24. Richardson discloses, further comprising a manual switch**(44)(see ¶[0013])** to allow a user to manually switch on power from the power supply to the depleted or discharged battery**(battery of vehicle 28)**.

13. Regarding claim 30, Richardson discloses all the claimed invention as set forth and discussed above in claim 28. Richardson discloses, further comprising a manual switch**(44)(see**

¶[0013]) to allow a user to manually switch on power from the power supply to the depleted or discharged battery(**battery of vehicle 28**).

14. Regarding claim 31, Richardson discloses all the claimed invention as set forth and discussed above in claim 28. Richardson discloses, further comprising a manual switch(**push button switch 44**) to allow a user to override the automatic switching and manually switch on power from the power supply(**22**) to the deplete or discharged battery(**battery of vehicle 28**)(**see ¶[0013]**).

15. Regarding claim 32, Richardson discloses all the claimed invention as set forth and discussed above in claim 31. Richardson discloses, wherein the manual switch comprises a manual override button(**44**)(**see ¶[0013]**).

16. Regarding claim 33, Richardson discloses all the claimed invention as set forth and discussed above in claim 32. Richardson discloses, wherein the manual switch(**44**) is configured so that a user presses and holds down the manual override button for a predetermined period of time to prevent inadvertent actuation of a manual mode(**¶[0039]**).

17. Regarding claim 34, Richardson discloses all the claimed invention as set forth and discussed above in claim 24. Richardson discloses, further comprising a manual switch(**44**) for manually switching on power from the power supply(**22**) to the deplete or discharged battery(**battery of vehicle 28**) in the event the control system or circuit(**12**) is unable to automatically switch on power from the power supply(**22**) to the depleted or discharged battery(**battery of vehicle 28**)(**see ¶[0013]-[0014]**).

18. Regarding claim 35, Richardson discloses all the claimed invention as set forth and discussed above in claim 29. Richardson discloses, wherein the manual switch(**44**) is configured

to prevent manual override if the depleted or discharged battery is connected in reverse to the positive and negative battery terminal connectors(**¶[0014]-[0015]**).

19. Regarding claim 36, Richardson discloses all the claimed invention as set forth and discussed above in claim 29. Richardson discloses, wherein the manual switch(**44**) is configured to allow a user to jump start a vehicle having either a missing battery, or the depleted or discharged battery of the vehicle(**28**) having a battery voltage so low that automatic detection of the battery voltage and switching by the control system or circuit(**12**) is not possible(**see ¶[0014],[0026]**).

20. Regarding claim 37, Richardson discloses all the claimed invention as set forth and discussed above in claim 24. Richardson discloses, wherein the control system or circuit(**12**) comprises a presence circuit(**construed as vehicle voltage sensor 30 which consists of two resistors and a capacitor as shown in Fig. 2B below. Furthermore, these two resistors are connected to vehicle battery 28 via the line designated as Q which as shown in Fig. 2A connects directly to line A shown in Fig.2C and which provides an output signal via line I. These resistors are connected to vehicle battery 28 via the line designated as Q which as shown in Fig. 2A connects directly to line A shown in Fig. 2C and which provides an output signal via line I**) configured to detect presence of the depleted or discharged battery(**battery of vehicle 28**) when connected between the positive and negative battery terminal connectors(**note- Richardson discloses that voltage sensor 30 detects whether or not the jumper cables are connected to the vehicle battery. For example, Richardson states that "[i]f the system detects an increase in the difference between the measured jump starter battery voltage 20 and the voltage measured 30 across the contact relay 34 indicating that one of the jumper cables has been disconnected 302 from the vehicle's battery system or starter system 28**

then a jumper cable unplugged error count is incremented 304" ¶[0033]) and a polarity circuit**(24)("a reverse voltage sensor 24 monitors the polarity of the jumper cables on line 26"-Note: Reverse voltage sensor 24 is shown on Fig. 2B and consists of 5 resistors connected in sequence, a capacitor, and further connected to component operational amplifier LMC6484, which is connected to line Q and which provides an output signal on line H. Reverse voltage sensor 24 monitors the polarity of the jumper cables on line 26 which are connected to the vehicle's electrical system 28, ¶[0012]; see also ¶[0020] ("once jumper cables 60 have been connected to the vehicle to be started 28, the voltage is measured by reverse voltage sensor 24 to determine if the cables have been properly connected to the vehicle 214")** configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors**(black and Red clamps of cable 60; see Fig. 2C) (note- Richardson discloses that the jumper cables have a positive and negative polarity, see ¶[0012]**).

21. Regarding claim 38, Richardson discloses all the claimed invention as set forth and discussed above in claim 26. Richardson discloses, wherein the presence circuit**(30)** comprises a presence sensor and the polarity circuit**(24)** comprises a polarity sensor**(see ¶[0012],[0015] ,[0020], and [0028]**).

22. Regarding claim 39, Richardson discloses all the claimed invention as set forth and discussed above in claim 26. Richardson discloses, wherein the presence circuit is a presence sensor**(30)** and the polarity circuit is a polarity sensor**(24) (see ¶[0012],[0015] ,[0020], and [0028]**).

23. Regarding claim 40, Richardson discloses all the claimed invention as set forth and discussed above in claim 27. Richardson discloses, wherein the presence circuit comprises a

presence sensor(**30**) and the polarity circuit comprises a polarity sensor(**24**) **(see ¶[0012],[0015] ,[0020], and [0028]**).

24. Regarding claim 41, Richardson discloses all the claimed invention as set forth and discussed above in claim 27. Richardson discloses, wherein the presence circuit is a presence sensor(**30**) and the polarity circuit is a polarity sensor(**24**) **(see ¶[0012],[0015] ,[0020], and [0028]**).

25. Regarding claim 42, Richardson discloses all the claimed invention as set forth and discussed above in claim 24. Richardson discloses, wherein the control system or circuit comprises a microcontroller(**12**) **(note- Richardson discloses that "a programmable microprocessor 12 which receives inputs 14 and produces information outputs 16 and control outputs 18." (¶[0011]). It uses the term microprocessor and microcontroller interchangeably throughout the specification. (¶[0015] and Fig. 1) As shown in Fig. 1, inputs 14 include input signals from reverse voltage sensor 24 and vehicle voltage sensor 30, and outputs 18 and 58 which is directed to contact relay 34. (see Fig. 1, ¶[0014]) ("A reverse LED 48 is illuminated when the microprocessor 12 determines that a reverse voltage jumper cable voltage is detected by reverse polarity sensor 24 . . . A fault LED 56 is turned on any time the microprocessor 12 detects any operational, sensor or internal fault . . . A contact relay control output 58 operates the contact relay 34. When the jump starter operation has been successfully initiated, the contact relay 34 is closed"(turn on the switch, as per claims 19-20)). Furthermore, as discussed above, Fig. 2C clearly shows line H which carries a signal from reverse voltage sensor 24 and line I which carries a signal from vehicle voltage sensor 30. (see also Fig. 2C). Figure 2D shows an image of the microcontroller which includes inputs H and I. (Fig. 2D). Richardson further discloses (see**

¶[0015]) that the microcontroller receives signals from the vehicle voltage sensor 30 and the reverse voltage sensor 24 and that it generates a control signal 58(activated output signal, as per claim 11) which controls the contact relay 34 to connect the jump starter batteries 22 to the vehicle to be started 28. Richardson also makes clear that the microcontroller only closes relay 34(activate switch or turn on switch) if the reverse polarity sensor 24 and vehicle voltage sensor 30 indicate the presence of a vehicle battery connected with proper polarity. For example, Richardson states that "when the jump starter 10 is initially powered on 200, the microprocessor initializes the hardware . . . . then performs a self-test operation 208 where . . . all sensors 20, 24, 30, 32, 38, 40 . . . are tested". Richardson further discloses the process of measuring the vehicle battery voltage necessarily entails detecting the presence of a vehicle battery connected to the positive and negative output ports since reading a sufficiently low voltage would indicate either the absence of a vehicle battery or a battery with a voltage below a required threshold for detection. Only after the reverse polarity and battery presence tests have been conducted at steps 214 and 252 does the process proceed to step 268 where microprocessor 12 sends a signal to close contact relay 34(turn on the power switch; as per claims 19-20). (See also Fig. 3, Fig. 6, see also ¶[0014] and [0027])

26. Regarding claim 43, Richardson discloses all the claimed invention as set forth and discussed above in claim 25. Richardson discloses, wherein the control system or circuit comprises a microcontroller**(12) (note- Richardson discloses that "a programmable microprocessor 12 which receives inputs 14 and produces information outputs 16 and control outputs 18." (¶[0011]). It uses the term microprocessor and microcontroller interchangeably throughout the specification. (¶[0015] and Fig. 1)**.

27. Regarding claim 44, Richardson discloses all the claimed invention as set forth and discussed above in claim 26. Richardson discloses, wherein the control system or circuit(12) comprises a microcontroller electrically connected to and receiving inputs from the presence circuit(30) and the polarity circuit(24) **(note- Richardson discloses that "a programmable microprocessor 12 which receives inputs 14 and produces information outputs 16 and control outputs 18." (¶[0011]). It uses the term microprocessor and microcontroller interchangeably throughout the specification. (¶[0015] and Fig. 1) As shown in Fig. 1, inputs 14 include input signals from reverse voltage sensor 24 and vehicle voltage sensor 30, and outputs 18 and 58 which is directed to contact relay 34. (see Fig. 1, ¶[0014]) ("A reverse LED 48 is illuminated when the microprocessor 12 determines that a reverse voltage jumper cable voltage is detected by reverse polarity sensor 24 . . . A fault LED 56 is turned on any time the microprocessor 12 detects any operational, sensor or internal fault . . . A contact relay control output 58 operates the contact relay 34. When the jump starter operation has been successfully initiated, the contact relay 34 is closed"(turn on the switch, as per claims 19-20)). Furthermore, as discussed above, Fig. 2C clearly shows line H which carries a signal from reverse voltage sensor 24 and line I which carries a signal from vehicle voltage sensor 30. (see also Fig. 2C). Figure 2D shows an image of the microcontroller which includes inputs H and I. (Fig. 2D). Richardson further discloses (see ¶[0015]) that the microcontroller receives signals from the vehicle voltage sensor 30 and the reverse voltage sensor 24 and that it generates a control signal 58(activated output signal, as per claim 11) which controls the contact relay 34 to connect the jump starter batteries 22 to the vehicle to be started 28. Richardson also makes clear that the microcontroller only closes relay 34(activate switch or turn on switch) if the reverse polarity sensor 24 and**

vehicle voltage sensor 30 indicate the presence of a vehicle battery connected with proper polarity. For example, Richardson states that "when the jump starter 10 is initially powered on 200, the microprocessor initializes the hardware . . . . then performs a self-test operation 208 where . . . all sensors 20, 24, 30, 32, 38, 40 . . . are tested". Richardson further discloses the process of measuring the vehicle battery voltage necessarily entails detecting the presence of a vehicle battery connected to the positive and negative output ports since reading a sufficiently low voltage would indicate either the absence of a vehicle battery or a battery with a voltage below a required threshold for detection. Only after the reverse polarity and battery presence tests have been conducted at steps 214 and 252 does the process proceed to step 268 where microprocessor 12 sends a signal to close contact relay 34(turn on the power switch; as per claims 19-20). (See also Fig. 3, Fig. 6, see also ¶[0014] and [0027]).

28. Regarding claim 45, Richardson discloses all the claimed invention as set forth and discussed above in claim 27. Richardson discloses, wherein the control system or circuit(12) comprises a microcontroller electrically connected to and receiving inputs from the presence circuit(30) and the polarity circuit(24) **(note- Richardson discloses that "a programmable microprocessor 12 which receives inputs 14 and produces information outputs 16 and control outputs 18." (¶[0011]). It uses the term microprocessor and microcontroller interchangeably throughout the specification. (¶[0015] and Fig. 1) As shown in Fig. 1, inputs 14 include input signals from reverse voltage sensor 24 and vehicle voltage sensor 30, and outputs 18 and 58 which is directed to contact relay 34. (see Fig. 1, ¶[0014]) ("A reverse LED 48 is illuminated when the microprocessor 12 determines that a reverse voltage jumper cable voltage is detected by reverse polarity sensor 24 . . . A fault LED 56 is**

turned on any time the microprocessor 12 detects any operational, sensor or internal fault . . . A contact relay control output 58 operates the contact relay 34. When the jump starter operation has been successfully initiated, the contact relay 34 is closed"(turn on the switch, as per claims 19-20)). Furthermore, as discussed above, Fig. 2C clearly shows line H which carries a signal from reverse voltage sensor 24 and line I which carries a signal from vehicle voltage sensor 30. (see also Fig. 2C). Figure 2D shows an image of the microcontroller which includes inputs H and I. (Fig. 2D).

29. Regarding claim 46, Richardson discloses all the claimed invention as set forth and discussed above in claim 24. Richardson discloses, wherein the control system or circuit comprising a presence circuit or sensor**(30)** configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors**(Red and Black clamps of cable 60)**, a polarity circuit or sensor**(24)** configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, and a microcontroller**(12)** electrically connected to the presence circuit or sensor**(30)** and the polarity circuit sensor**(24)** and receiving signals from the presence circuit or sensor and the polarity circuit or sensor**(see ¶[0011],[0014]-[0015]).**

30. Regarding claim 47, Richardson discloses all the claimed invention as set forth and discussed above in claim 42. Richardson discloses, wherein the control system or circuit is configured so that microcontroller**(12)** determines when it is safe to turn on the power switch**(34)(Richardson states that "when the jump starter 10 is initially powered on 200, the microprocessor initializes the hardware . . . . then performs a self-test operation 208 where . . . all sensors 20, 24, 30, 32, 38, 40 . . . are tested". Richardson further discloses the process of measuring the vehicle battery voltage necessarily entails detecting the presence**

of a vehicle battery connected to the positive and negative output ports since reading a sufficiently low voltage would indicate either the absence of a vehicle battery or a battery with a voltage below a required threshold for detection. Only after the reverse polarity and battery presence tests have been conducted at steps 214 and 252 does the process proceed to step 268 where microprocessor 12 sends a signal to close contact relay 34(turn on the power switch; as per claims 19-20). (See also Fig. 3, Fig. 6, see also ¶[0014] and [0027])

31. Regarding claim 48, Richardson discloses all the claimed invention as set forth and discussed above in claim 47. Richardson discloses, wherein the control system or circuit is configured so that microcontroller software of the microcontroller**(12)** determines when it is safe to turn on the power switch**(See also Fig. 3, Fig. 6, see also ¶[0014] and [0027])**.

32. Regarding claim 49, Richardson discloses all the claimed invention as set forth and discussed above in claim 42. Richardson discloses, wherein the microcontroller is a programmable microcontroller**(12)** configured to allow updates in functionality and system parameters**(see ¶[0011])**.

33. Regarding claim 50, Richardson discloses all the claimed invention as set forth and discussed above in claim 42. Richardson discloses, wherein the microcontroller is a programmable microcontroller configured to allow updates in functionality and system parameters, without requiring any change in hardware**(see ¶[0011])**.

34. Regarding claim 51, Richardson discloses all the claimed invention as set forth and discussed above in claim 42. Richardson discloses, wherein the microcontroller**(12)** comprises flash memory, and wherein the microcontroller with flash memory is used to control the control system or circuit**(see ¶[0011])**.

35. Regarding claim 52, Richardson discloses all the claimed invention as set forth and discussed above in claim 42. Richardson discloses, wherein the control system or circuit further comprises a voltage regulator providing regulation of internal operating voltage for the microcontroller(**12**) and sensors(**20,30,24, 32, 38, 40 . . .**)(**Fig. 2A; regulator LM7805 is a 5V regulator although not labeled**).

36. Regarding claim 60, Richardson discloses, wherein the positive battery connector terminal (**Red clamp of cable 60**) is a positive battery clamp releasably connectable to the positive terminal of the depleted or discharged battery(**battery of vehicle 28; see Figs. 1 and 2C**), and wherein the negative battery terminal connector(**black clamp of cable 60**) is a negative battery clamp releasably connectable to the negative terminal of the depleted or discharged battery(**battery of vehicle 28**).

37. Regarding claim 62, Richardson discloses, further comprising a temperature sensor(**38**)(**see ¶[0013] and Fig. 1**) configured to detect temperature of the power supply(**22**) and to provide a temperature signal to a microcontroller(**12**).

38. Regarding claim 63, Richardson discloses, further comprising a voltage measurement circuit(**20**) configured to measure output voltage of the power supply(**22**) and to provide a voltage measurement signal to the microcontroller(**12**)(**see ¶[0012] and Fig. 1**).

39. Regarding claim 64, Richardson discloses, further comprising a voltage regulator(**Fig. 2A; regulator LM7805 is a 5V regulator although not labeled**) configured to convert output voltage of the power supply(**22**) to a voltage level appropriate to provide operating power to internal components of the jump starting apparatus(**10**).

40. Regarding claim 65, Richardson discloses, wherein the polarity circuit(**24**) is a reverse polarity circuit(**see ¶[0013]-[0014], [0020]**).

41. Regarding claim 66, Richardson discloses, wherein the polarity **circuit(24)** comprises a reverse polarity sensor(**note the 102K resistor and voltage divider formed by the 10.2K and 3.16K constitute a reverse polarity sensor provided to output H; see Fig. 2B**).

Claim Rejections - 35 USC § 103

42. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

43. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

44. The factual inquiries for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

45. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and

effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

46. **Claim 53,58-59 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Krieger et al., (Krieger) US 2004/0130298(Exhibit 1009 on IPR2020-00944).**

47. Regarding claim 53, Richardson does not expressly teach the limitations of: "wherein the presence circuit comprises a first optically coupled isolator phototransistor and the polarity circuit comprises a second optically coupled isolator phototransistor".

48. Krieger teaches factual evidence of, wherein the presence circuit(**16**)comprises a first optically coupled isolator phototransistor(**22**) and the polarity circuit(**also performed by 16**) comprises a second optically coupled isolator phototransistor(**22**)(**[0033]**)(**note- the opto-isolator (16) only turns on when it is properly biased "as a result of a correct polarity connection being made between the boosting battery (2) and the depleted battery (11). By detecting the correct connection of the depleted battery (11), Krieger also necessarily and implicitly detects that the depleted battery (11) is present; See [0033]-[0034],[0038],[0048]).**

49. However Krieger does not expressly teach "a second optically coupled isolator phototransistor". Richardson and Krieger are battery jump starter apparatus analogous art.

50. It would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to incorporate the teaching of Krieger into the jump starter apparatus of Richardson, wherein the presence circuit comprises a first optically coupled isolator phototransistor and the polarity circuit comprises a second optically coupled isolator phototransistor, as recited, so as to prevent the battery assembly from providing a discharge

output to the external load, as recited, for the advantages of providing a safe delivery of power to the depleted battery of the vehicle that need to be jump started while preventing a potentially dangerous situation that could result when an improper polarity connection is made between the boosting battery and the depleted battery, as per the teachings of Krieger (**¶[0034]**). It would have further been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention was made to include in the jump starter apparatus of Richardson, wherein the presence circuit that comprises a first optically coupled isolator phototransistor and the polarity circuit comprises a second optically coupled isolator phototransistor since it has been held that mere duplication of the essential working parts of a device involves only routine skill in the art. St. Regis Paper Co. v. Bemis Co., 193 USPQ 8.

51. Accordingly claim 53 would have been obvious.

52. Regarding claim 58, Richardson does not expressly teach that the power switch is a FET switch. Instead, Richardson discloses that power switch **(34)** is a relay.

53. Krieger discloses factual evidence of, "wherein the power switch is a FET switch **(12).**

54. It would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have substituted the relay of Richardson by a FET switch as disclosed by Krieger for the advantages of the fast switching speed, their low loss and their low on-resistance type that FET present over relay switches.

55. Accordingly claim 58 would have been obvious.

56. Regarding claim 59, Richardson in view of Krieger discloses all the claimed invention as set forth and discussed above in claim 58. Krieger further discloses, wherein the FET switch **(12)** comprises a plurality of FETs in parallel**(12a,12b,12c,12d).**

57. **Claims 55-57 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Butler et al., (Butler) WO 2016/025869.**

58. Regarding claim 55, Richardson teaches that the power supply **(22)** is a rechargeable **battery(see ¶[0014])** but stay silent regarding the type of battery.

59. Butler discloses factual evidence of, wherein the power supply is a rechargeable lithium ion battery **(150)(see ¶[0039]).**

60. Richardson and Butler are battery jump starter apparatus analogous art. Therefore it would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have incorporated the teachings of Butler into the apparatus of Richardson by selecting a rechargeable lithium ion battery for the internal power supply since it is known in the art that lithium ion batteries have a sufficient and highly rated boost jump start energy. Lithium ion batteries present numerous advantages and characteristics such as high energy density, excellent cycle characteristics, safety under various operating environments, and long-term reliability.

61. Accordingly claims 55-57 would have been obvious.

62. **Claim 61 is rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Wanzong et al., (Wanzong) USPAT 5,319,298(Exhibit 1010 on IPR2021-00309).**

63. Regarding claim 61, Richardson does not expressly teach: "further comprising a plurality of power diodes coupled between an output of the jump starting apparatus to the depleted or discharged battery and the power supply to prevent back-charging of the power supply from an electrical system connected to the output".

64. Wanzong is an analogous art and discloses factual evidence of a battery maintainer and charger apparatus for battery vehicles**(col. 2, lines 59-67).** Wanzong discloses an **"isolation diode 160",** which acts as the power diodes to prevent back-charging of said internal power supply from an electrical system connected to said output port. As shown in **Fig. 1** of the reference**(see Fig. 1 of Wanzong)**, the isolation sensor **160** is between the output port **(output terminals 170 and 180)** of the charger apparatus and the internal power supply **(transformer 20/ full wave bridge rectifier 30/main capacitor 40)**. While Wanzong discloses a single power diode**(160)**, it would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have included a plurality of power diodes like the single power diode disclosed by Wanzong into the apparatus of Richardson in order to prevent back-charging and damage to the charging circuit during or after charging process.

65. Accordingly claim 61 would have been obvious.

66. **Claims 67-68 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Xinfang USPAT 9,506,446 Exhibit 1008 on IPR2020-01387).**

67. Regarding claim 67, Richardson discloses all the claimed invention as set forth and discussed above in claim 24. Richardson further discloses, wherein the positive battery connector and negative battery connector together form a jumper cable device**(Red and Black clamps of cable 60; see Fig. 2C).** However, Richardson fails to expressly disclose the jumper cable device comprising a plug connected to one of the cables and configured to plug into an output port of the battery jump starting apparatus.

68. Xinfang discloses factual evidence of, a jumper cable with a plug at one end and a pair of cables at the other end configured to be connected to terminals of a battery**(Xinfang; col. 2, lines 40-43).**

69. Richardson and Xinfang are jump starter apparatus analogous art**(Xinfang; col. 9, lines 1-8).**

70. Therefore it would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have incorporate the teachings of Xinfang into the apparatus of Richardson by having the positive battery connector and negative battery connector together form a jumper cable device comprising a plug connected to one of the cables and configured to plug into an output port of the battery jump starting apparatus, as recited, so as to provide additional convenience to users of using another commonly used power input for charging the jump starter device.

71. Accordingly claim 67 would have been obvious.

72. Regarding claim 68, Richardson in view of Xinfang discloses all the claimed invention as set forth and discussed above in claim 67. Xinfang further discloses, wherein an output port**(46)** and the plug are dimensioned so that the plug fits into the output port only in one specific orientation**(Xinfang; Fig. 2)**.

73. **Claims 69-71, and 74 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Epower-20 Brochure (IPR2020-00944 Exhibit 1012)**

74. Regarding claim 69, Richardson discloses all the claimed invention as set forth and discussed above in claim 24. However Richardson does not teach, further comprising a USB

charging port configured to provide charging power from an external power source to the power supply.

75. The Epower-20 Brochure is an analogous art and discloses factual evidence of jump starters with USB output ports to charge other devices. The Epower-20 brochure shows below a "14V 1A" "Input" port for charging the jump starter with a "Home charger" ("Input: AC/100V-240V, Output: DC/14V1A"). It would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have incorporate the USB charging port providing charging power from an external power source to an internal power supply into the apparatus of Richardson as modified by Krieger so as to provide additional convenience to users of using another commonly used power input for charging the jump starter device.

66. Regarding claim 70, Richardson in view of Epower-20 discloses all the claimed invention as set forth and discussed above in claim 69. The Epower-20 Brochure discloses, further comprising a USB charging circuit connecting the USB charging port to the power supply**(see Exhibit 1012 at 1 where two USB ports are shown in front of the flashlight). Furthermore the "Specification/data sheet" of the Epower-20 brochure states the "Output" includes "5V/2A, 5V/1A-mobile phone, tablet PC, other digital devices".** One of ordinary kill in the art would recognize and understand that the 5V/2A and 5V/1A outputs described and shown are USB outputs for charging mobile phones and other devices.

76. Regarding claim 71, Richardson in view of Epower-20 discloses all the claimed invention as set forth and discussed above in claim 70. Epower-20 further discloses, wherein the USB charging circuit comprises a DC-DC converter**(car charger with cigarette lighter input takes a DC input from vehicle battery and provide a DC 15V 10A output).**

77. Regarding claim 74, modified Richardson in view of Epower-20 discloses all the claimed invention as set forth and discussed in claim 70. However, the combination of Richardson and Epower-20 does not expressly teach, wherein the DC-DC converter is configured to be turned on and off via a circuit by an output from a microcontroller, one of ordinary skill in the art would have been motivated to configure the microcontroller taught by Richardson in view of Epower-20 to be turned on and off via a circuit by an output from a microcontroller so as to provide an efficient and automatic power control to increase the efficiency of the jump starter device.

78. Accordingly claims 69-71, and 74 would have been obvious.

79. **Claims 72-73 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Epower-20 Brochure (IPR2020-00944 Exhibit 1012) and in further view of Tinaphong US 2011/0175461**

80. Regarding claim 72, Richardson in view of Epower-20 discloses all the claimed invention as set forth and discussed above in claim 71. However, the combination of Richardson and Epower-20 does not expressly teach, wherein the DC-DC converter increases the voltage from a USB charger to charge the power supply.

81. Tinaphong discloses at least a USB input charge circuit **(input of first stage DC-DC converter circuit 20)** connected to the power supply **(18)**, the USB input charge circuit **(input of first stage DC-DC-converter circuit 20)** configured for converting**(via element 20 which is a first DC-DC converter)** power from a USB charger **(24)** to charge voltage and current for charging the power supply **(18)(See Figs. 2-3 and paragraph [0041]).** Richardson, Epower-20, and Tinaphong are jump start devices analogous art. Therefore it would have been obvious to one having ordinary skill in the art before the effective filing date of the

claimed invention to modify the apparatus of Richardson in view of Epower-20 by having the DC-DC converter increases the voltage from a USB charger to charge the power supply so as provide a continuous power supply.

82. Regarding claim 73, Richardson in view of Epower-20 and Tinaphong discloses all the claimed invention as set forth and discussed above in claim 72. However the above references do not expressly teach, wherein the DC-DC converter is configured to convert 5V potential provided from a USB charger to 12.4VDC. Instead, Tinaphong teaches converting and providing both a 5V DC signal on the USB charger connector from an external source to a 3.7V DC signal provided on the output of the second DC-DC converter(**¶[0040]**). It would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have configured the DC-DC converter of the apparatus of Richardson as modified by Epower-20 and Tinaphong to convert 5V potential provided from a USB charger to 12.4VDC, as recited, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980). Furthermore, combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results and when a device or technology is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or in a different one, so that if a person of ordinary skill can implement a predictable variation, the variation is likely obvious. Converting 5V potential provided from a USB charger to 12.4VDC would be obvious to try since such configuration is left to the discretion of the customer need and power requirements.

Double Patenting

83. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or

PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

84. **Claims 2-74 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-10,12-15,19-21,23, and 29-30,32-44,48-51 of copending Application No. 16/450,422 (reference application)**. Although the claims at issue are not identical, they are not patentably distinct from each other because they two applications are directed to the same inventive concept. Rewriting or rearranging the terms in a claim would not make the two applications patentably distinct.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Allowable Subject Matter

85. Claim 54 is objected to as being dependent upon a rejected base claim, but would be provisionally allowed if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

86. Regarding claim 54, the prior art of record fails to teach or reasonably suggest, in the claimed combination, wherein the presence circuit further comprises a first diode connected between the first optically coupled phototransistor and the depleted or discharged battery, and the polarity circuit further comprises a second diode connected between the second optically coupled phototransistor and the depleted or discharged battery.

Conclusion

87. Any inquiry concerning this communication or earlier communications from the examiner should be directed to M'BAYE DIAO whose telephone number is (571)272-6127. The examiner can normally be reached on M-F; 9:00AM-6:30PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DREW A DUNN can be reached on 571-272-2312. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

M'BAYE DIAO
Primary Examiner
Art Unit 2859

/M BAYE DIAO/
Primary Examiner, Art Unit 2859
August 18, 2021

Notice of References Cited	Application/Control No. 16/819,831	Applicant(s)/Patent Under Reexamination NOOK et al.	
	Examiner M'BAYE DIAO	Art Unit 2859	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-5319298-A	06-1994	Wanzong; Vern	H02J7/02	320/158
*	B	US-20110175461-A1	07-2011	Tinaphong; Prapan Paul	H02J50/402	307/149
*	C	US-20090039712-A1	02-2009	Czarnyszka; Thierry	H02J7/0034	307/127
*	D	US-7656118-B2	02-2010	Krieger; Michael	H02J7/0034	320/105
	E					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N	WO-2016025869-A1	02-2016	WO	CHEN XIAO	H02J7/0021
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

ADC EX1002
IPR2025-00885

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/819,831	NOOK et al.
	Examiner	Art Unit
	M'BAYE DIAO	2859

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	08/17/2021								
	1	-								
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	42	✓								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/819,831	NOOK et al.
	Examiner	**Art Unit**
	M'BAYE DIAO	2859

CLAIM		DATE								
Final	Original	08/17/2021								
	43	✓								
	44	✓								
	45	✓								
	46	✓								
	47	✓								
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	71	✓								
	72	✓								
	73	✓								
	74	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/819,831	NOOK et al.
	Examiner	Art Unit
	M'BAYE DIAO	2859

CPC - Searched*		
Symbol	Date	Examiner
B60L53/14 H02J7/342 H02J7/0047 H02J7/0034 H02J7/0029 H02J1/122 H02J7/00 H02J7/0048 H02J7/00302 H02J7/00309 H02J7/00306 Y02T90/14 Y02T10/7072 Y02T10/70 H02J2310/46	08/18/2021	MD

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
320	105	08/18/2021	MD

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

/M BAYE DIAO/ Primary Examiner, Art Unit 2859	

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/819,831	NOOK et al.
	Examiner	Art Unit
	M'BAYE DIAO	2859

Search Notes		
Search Notes	**Date**	**Examiner**
SEARCH(Search Notes attached).	08/18/2021	MD
Inventor Name and Assignee search (SEARCH).	08/18/2021	MD
PLUS Search conducted..	09/25/2020	MD
IP.COM search conducted.	08/18/2021	MD
Parent Applications noted.	08/18/2021	MD
IPR2018-00503 Reviewed Petition for Inter Partes Review of U.S. Patent No. 9,007,015.	08/18/2021	MD
IPR2020-00944 Reviewed Petition for Inter Partes Review of U.S. Patent No. 9,007,015.	08/18/2021	MD
IPR2020-01387 Reviewed Petition for Inter Partes Review of U.S. Patent No. 9,007,015.	08/18/2021	MD
IPR2021-00309 Reviewed Petition for Inter Partes Review of U.S. Patent No. 9,007,015.	08/18/2021	MD

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

/M BAYE DIAO/ Primary Examiner, Art Unit 2859	

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IPR2025-00885

Bibliographic Data

Application No: 16/819,831

Foreign Priority claimed: ◉ Yes ○ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /M BAYE DIAO/ Examiner's Signature | Initials

Title: PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
03/16/2020	320	2859	054985-000055-US-02-01
RULE			

APPLICANTS

THE NOCO COMPANY, Glenwillow, OH,

INVENTORS

Jonathan Lewis NOOK, Gates Mills, OH, UNITED STATES

William Knight NOOK, Shaker Heights, OH, UNITED STATES

James Richard STANFIELD, Glendale, AZ, UNITED STATES

Derek Michael UNDERHILL, Tempe, AZ, UNITED STATES

CONTINUING DATA

This application is a CON of 15691884 08/31/2017 PAT 10604024

15691884 is a CON of 14619655 02/11/2015 PAT 9770992

14619655 is a DIV of 14325938 07/08/2014 PAT 9007015

14325938 is a CON of PCT/US14/45434 07/03/2014

FOREIGN APPLICATIONS

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03/27/2020

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Vorys, Sater, Seymour and Pease LLP

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9th Floor

Washington, DC 20006-1152

UNITED STATES

FILING FEE RECEIVED

$1,115

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16819831
Filing Date	2020-03-16
First Named Inventor	Jonathan Lewis NOOK
Art Unit	2859
Examiner Name	M. Baye DIAO
Attorney Docket Number	054985-000055-US-02-01

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
/M.D/	1	3590357		1971-06-29	REID	
	2	3638108		1972-01-25	CHANNING	
	3	5194799		1993-03-16	TOMANTSCHGER	
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	5	5319298		1994-06-07	WANZONG	
	6	5820407		1998-10-13	MORSE et al.	
	7	6344733		2002-07-30	CRASS	
	8	6424158		2002-07-23	KLANG	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Jonathan Lewis NOOK
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	Attorney Docket Number	054985-000055-US-02-01

/M.D/	9	6650086		2003-11-18	CHANG	
	10	6679212		2004-01-20	KELLING	
	11	6759833		2004-07-06	CHEN	
	12	7345450		2008-03-18	KRIEGER et al.	
	13	7893657		2011-02-22	CHAVAKULA	
	14	8362745		2013-01-29	TINAPHONG	
	15	9153978		2015-10-06	READE	
	16	9243601		2016-01-26	REICHOW	
	17	9525297		2016-12-20	WANG	
	18	9809183		2014-03-27	WEFLEN	
	19	9954391		2018-04-24	LEI	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.D/

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Attorney Docket Number	054985-000055-US-02-01

/M.D/	20	10328808		2019-06-25	NOOK ET AL.	
	21	10604024		2020-03-31	NOOK ET AL.	
	22	D597029		2009-07-28	LI	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20010025618	A1	2001-10-04	KELLING	
	2	20040066168	A1	2004-04-08	GEORGE	
	3	20040130298	A1	2004-07-08	KRIEGER	
	4	20030141845	A1	2003-07-31	KRIEGER	
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	6	20040239290	A1	2004-12-02	KRIEGER	

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.D/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16819831
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	First Named Inventor	Jonathan Lewis NOOK
	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

/M.D/	7	20050116688	A1	2005-06-02	YIN	
	8	20060176011	A1	2006-08-10	LUI	
	9	20060220610	A1	2006-10-05	SOLBERG	
	10	20060244412	A1	2006-11-02	BONZER	
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	13	20120025766	A1	2012-02-02	READE	
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	15	20140084844	A1	2014-03-27	WEFLEN	
	16	20140210399	A1	2014-07-31	URSCHEL	
	17	20140368155	A1	2013-12-18	CHEN	

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First Named Inventor	Jonathan Lewis NOOK
Art Unit	2859
Examiner Name	M. Baye DIAO
Attorney Docket Number	054985-000055-US-02-01

/M.D/	18	20150054336	A1	2015-02-26	LIU	
	19	20150340907	A1	2015-11-26	LEI	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2011/113734	WO		2011-09-22	REICHOW		
	2	2012/036556	WO		2012-03-22	EIDSVIG		
	3	2012/080996	WO		2012-06-21	TRACY		
	4	2014/106407	WO		2014-10-07	LEI		
	5	0616409	EP		2014-09-07	HERBERT		
	6	103066662	CN		2013-04-24	LEI	English abstract attached	X

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number	16819831
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	First Named Inventor	Jonathan Lewis NOOK
	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
/M.D/	1	Copy of Exhibit 1008, www.xcar360.com	
	2	Copy of Exhibit 1009, www.electronicshub.org	
	3	Copy of Exhibit 1010, USB Battery Charging 1.2 Compliance Plan	
	4	Copy of the Petition for Inter Partes Review of U.S. Patent No. 9,007,015; IPR 2020-00944, filed May 14, 2020, 99 pages	
	5	Copy of Exhibit 1012, Model: Epower-20B brochure, 1 page	
	6	Copy of Exhibit 1013, Model: Epower-21 brochure, 1 page	
	7	Copy of Exhibit 1015, Fairchild Semiconductor brochure, MC78XX/LM78XX/MC78XXA, 28 pages	
	8	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. Shenzhen Valuelink E-Commerce Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division,1 page.	
	9	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. Shenzhen ChangXin Yang Technology Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page.	
	10	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. SZ Jingxinghui Electronics Technology Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page	

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	First Named Inventor	Jonathan Lewis NOOK
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	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

/M.D/	11	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. Shenzhen Anband Technology Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page.	
	12	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/30/17, The NOCO Company, Inc. v. Shenzhen Dika Na'er E-Commerce Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page.	
	13	Copy of PTAB notice regarding petition filed in Patent Number 9007015, Application Number 14/325938, filed on 01/15/2018, IPR2018-00503, 1 page	
	14	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 09/13/18, The NOCO Company, Inc. v. Halo2 Cloud, LLC, QVC, Inc., U.S. District Court Delaware, 1 page.	
	15	Copy of Notice of Filing Date Accorded to Petition and Time for Filing Patent Owner Preliminary Response, mailed May 21, 2020, Shenzhen Carku Technology Co., Ltd. v. The NOCO Company, IPR2020-00944, Patent 9,007,015, 4 pages.	
	16	International Search Report in corresponding PCT/US2014/045434, November 3, 2014.	
	17	Australian Patent Opposition #1, Australian Patent Application No. 2016269555, Statement of Grounds of Particulars, Brown & Watson International Pty Ltd., June 6, 2019, 6 pages; particular (e), the offering for sale and sale by Asia Bright Industrial (Hong Kong) Co, Ltd. of products identified as the JPS Jump Starter and the JPR Jump Starter prior to July 2014.	
	18	Australian Patent Opposition #1, Australian Patent Application No. 2016269555, Evidence in Support, filed September 6, 2019, 24 pages.	
	19	Australian Patent Opposition #1, Australian Patent Application No. 2016269555, Evidence in Support – Exhibits, filed September 6, 2019,166 pages; Annexure MD-1, early specification sheets for "the BW Jumpstarter", 4 pages; Annexure MD-2, product manual for "the BW Jumpstarter", PROJECTA; "2x22 Amp Hour High Performance Jumpstarter"; 2013; 20 pages.	
	20	Australian Patent Opposition #2, Australian Patent Application No. 2019201559, Statement of Grounds and Particulars, filed May 21, 2020, 8 pages.	
	21	THE NOCO COMPANY v. DELTONA TRANSFORMER CORPORATION and DELTRAN USA, LLC, Defendant Deltran USA, LLC's Invalidity Contentions, In the United States District Court for the Middle District of Florida, Orlando Division, USB Implementers Forum, Inc.,Battery Charging Specification, Revision 1.1, 04-15-2009 on page 8, Prior Art Offered for Sale or Publicly Used or Known on pages 8-10, MICRO-START/PPS, E-Power, Battery Tender Power Pack, PowerAll, and Electromate 400 on page 10; 141 pages.	

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IPR2025-00885

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.D/

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Application Number	16819831
Filing Date	2020-03-16
First Named Inventor	Jonathan Lewis NOOK
Art Unit	2859
Examiner Name	M. Baye DIAO
Attorney Docket Number	054985-000055-US-02-01

/M.D/	22	THE NOCO CO., INC. v. SMARTECH PRODUCTS, INC., et al., Smartech, Inc.'s Invalidity and Unenforceability Contents, Bestek 2400A Peak Current Portable Car Jump Starter Power Bank with 1000mAh Capacity (SMARTECH 00062-00069)("Bestek") on page 2; HALO 7800 mAh Portable Charger for Cell Phones & Tablets (SMARTECH 00070-00071)("HALO") on page 2; Schumacher Lithium Iron Jump Starter – SL1 Red Fuel (SMARTECH 00072-00073)("Schumacher") on page 2, filed June 19, 2019, 8 pages.
	23	THE NOCO COMPANY v. SHENZHEN DIKA NA'ER E-COMMERCE (Lead Case No. 1:17-cv-02282), THE NOCO COMPANY v. SHENZHEN CHANGXINYANG TECHNOLOGY CO., LTD (Case No. 1:117-cv-02209). THE NOCO COMPANY v. SHENZHEN VALUELINK E-COMMERCES CO., LTD (Case No. 1:17-cv-02210), Defendants' Amended Final Invalidity and Unenforceability Contents, The Powerall PBJS12000RD Jump Starter ("Powerall Jump Starter"), offered for sale by Gryphon Mobile Electronics at least as early as November 5, 2013, on page 2, The Lightning 12V

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/M BAYE DIAO/	Date Considered	08/18/2021

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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IPR2025-00885

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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	156178	(automobile vehicle car locomotive motorcycle motorbike EV (electric$2 NEAR vehicle) HEV (hybrid NEAR electric$2 NEAR vehicle)) NEAR charg$2	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:25 PM
L2	628	(jump boost) NEAR start$3 NEAR (apparatus device)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:26 PM
L3	1227683	output NEAR port	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:26 PM
L4	84	battery NEAR isolat$3 NEAR sens$2	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:27 PM
L5	1070	reverse NEAR polarity NEAR (sens$2 detect$2)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:27 PM
L6	101	battery NEAR isolat$3 NEAR (sens$2 detect$2)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:28 PM
L7	1427283	power NEAR switch	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:28 PM
L8	24049223	(microcontroller microprocessor controller processor)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:29 PM
L9	8	L1 L2 L3 L5 L6 L7 L8	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/06/17 01:29 PM
L10	3904	320/109,105.ccls.	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO);	OR	ON	ON	2021/06/17 01:36 PM

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IPR2025-00885

			FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L11	97030	(B60L53/00 B60L53/53 H02J7/0034 H02J7/0068 H02J2207/20 H02J7/0029 H02J9/005).cpc.	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:37 PM
L12	8	L1 L2 L3 L4 (L5 OR L6)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/06/17 01:38 PM
L13	10	L1 L2 L6 L7	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/06/17 01:39 PM
L14	2	"10875410".pn.	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:50 PM
L15	19	Richardson.inv. AND (jump ADJ start$3)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 03:15 PM
L16	94	("0000001" OR "0000002" OR "0000008" OR "0000075" OR "0000359" OR "0000926" OR "0006344" OR "10046653" OR "10328806" OR "17236260" OR "17236279" OR "17236339" OR "20010038276" OR "20020075003" OR "20030096158" OR "20040066168" OR "20040130298" OR "20050110467" OR "20050162124" OR "20050258797" OR "20090008374" OR "20090174362" OR "20100013302" OR "20100055546" OR "20100173182" OR "20100181959" OR "20100244766" OR "20100301800" OR	(US-PGPUB; USPAT)	OR	ON	ON	2021/06/17 09:50 PM

		"20110127947" OR "20110279089" OR "20120013189" OR "20120025763" OR "20120068662" OR "20120139498" OR "20130015814" OR "20130154543" OR "20130241488" OR "20140159509" OR "20150012174" OR "20150032312" OR "20150212135" OR "20150340907" OR "20210107365" OR "3267452" OR "3343057" OR "3950668" OR "3950688" OR "4871957" OR "5319298" OR "5487002" OR "5793185" OR "5831350" OR "6057667" OR "6130519" OR "6144110" OR "6160381" OR "6212054" OR "6249106" OR "6262492" OR "6271605" OR "6351102" OR "6362599" OR "6424158" OR "6426606" OR "6632103" OR "6774607" OR "6803743" OR "6919704" OR "7199555" OR "7339347" OR "7345450" OR "7579811" OR "7656118" OR "7675261" OR "8072900" OR "8125181" OR "8172603" OR "8183821" OR "8447543" OR "8565930" OR "8692513" OR "8723477" OR "8994327" OR "9007015" OR "9007023" OR "9248746" OR					

		"9263907" OR "9287725" OR "9333865" OR "9352652" OR "9412994" OR "9496728" OR "9506446" OR "9525297" OR "9871392" OR "9874611" OR "9954391").pn.					
L17	136	((("PILOT") near3 ("INC"))).AS,AANM.	(USPAT)	OR	ON	ON	2021/06/17 10:14 PM
L18	237	((("WANG") near3 ("Calvin")) OR (("WANG") near3 ("Chung-Hsin"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/06/17 10:14 PM
L19	17	L1 L2 L5 L8	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/06/17 10:15 PM
L20	2	"20090174362".pn.	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/17 07:27 PM
L21	35973	polarity NEAR detect$3	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 10:39 AM
L22	1	(battery NEAR presence NEAR (detect$3 sens$3)) WITH ((polarity (reverse NEAR polarity)) NEAR (detect$3 sens$3))	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 10:45 AM
L23	0	(jump-start$3 boost$3) NEAR (device apparatus) SAME (battery NEAR (presence (connect$3 NEAR status)) NEAR (detect$3 sens$3)) SAME ((polarity (reverse NEAR polarity)) NEAR (detect$3 sens$3))	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 10:49 AM
L24	4	((jump-start$3 boost$3) NEAR (device apparatus)) AND (battery NEAR (presence (connect$3 NEAR status)) NEAR	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 10:52 AM

		(detect$3 sens$3)) AND ((polarity (reverse NEAR polarity)) NEAR (detect$3 sens$3))					
L25	1	(presence NEAR circuit$2) WITH (optically NEAR coupled NEAR isolator NEAR phototransistor)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 11:17 AM
L26	24	(presence (battery NEAR presence) (battery NEAR status NEAR connect$3) NEAR circuit$2) WITH (optically NEAR coupled NEAR isolator NEAR phototransistor)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 11:19 AM
L27	106985	(lithium-ion (lithium ADJ ion)) NEAR battery SAME ((power NEAR supply) jumps-starter NEAR battery)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 12:25 PM
L28	28	L27 L4 L5 L6	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:26 PM
L29	24	L28 L21	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:26 PM
L30	4	L28 NOT L29	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:27 PM
L31	3352	(10 11) AND 27	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 12:28 PM
L32	53	L1 L2	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:29 PM
L33	7	L32 L31	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:29 PM
L34	0	lithium NEAR batter$3 NEAR back NEAR charge NEAR	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO);	OR	ON	ON	2021/08/18 01:47 PM

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		(protection prevention inhibition) NEAR (circuit$2 module)	FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L35	0	lithium NEAR batter$3 NEAR ((back NEAR charge) (current NEAR back flow)) NEAR (protection prevention inhibition) NEAR (circuit$2 module)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 01:49 PM
L36	0	lithium NEAR batter$3 NEAR ((back NEAR charge) (back ADJ flow) NEAR current) NEAR (protection prevention inhibition) NEAR (circuit$2 module)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 01:50 PM
L37	7	((back NEAR charge) (back ADJ flow) NEAR current) NEAR (protection prevention inhibition) NEAR (circuit$2 module)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 01:50 PM
L38	21994	((back NEAR charge) (back ADJ flow) NEAR current) (back NEAR current NEAR flow) NEAR (protection prevention inhibition) NEAR (circuit$2 module)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 02:55 PM
L39	941281	(Lithium lithium-ion (lithium NEAR polymer)) NEAR battery	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 02:57 PM
L40	42	L39 SAME L38 WITH diode$1	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 02:57 PM
L41	117	("10328808" OR "10604024" OR "20010025618" OR "20020041174" OR "20030141845" OR "20040066168" OR "20040130298" OR "20040150373" OR "20040239290" OR "20050040788" OR "20050110467" OR "20050116688" OR "20050252573" OR "20060176011" OR	(US-PGPUB; USPAT)	OR	ON	ON	2021/08/18 11:24 PM

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IPR2025-00885

		"20060220610" OR "20060244412" OR "20070278990" OR "20070285049" OR "20080143290" OR "20100301800" OR "20110068734" OR "20110175461" OR "20120025766" OR "20120091944" OR "20120319487" OR "20130154543" OR "20130162029" OR "20130241488" OR "20130314041" OR "20140084844" OR "20140159509" OR "20140210399" OR "20140368155" OR "20150054336" OR "20150137740" OR "20150306964" OR "20150340907" OR "20160001666" OR "20180111491" OR "20180215274" OR "20180269703" OR "20180342891" OR "20180345803" OR "20190308518" OR "3590357" OR "3638108" OR "3933140" OR "4041445" OR "4885524" OR "4910628" OR "4931731" OR "5083076" OR "5111130" OR "5189359" OR "5194799" OR "5281904" OR "5319298" OR "5486434" OR "5635817" OR "5635818" OR "5650974" OR "5793185" OR "5795182" OR "5820407" OR "5921809" OR "5953681" OR "5965998" OR "6054779" OR "6130519" OR "6140796" OR "6147471" OR "6212054" OR				

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L42	62	((("THE") near3 ("NOCO") near3 ("COMPANY"))).AS,AANM.	(USPAT)	OR	ON	ON	2021/08/18 11:28 PM
L43	135	((("NOOK") near3 ("Jonathan")) OR (("NOOK") near3 ("William")) OR (("STANFIELD") near3 ("James")) OR (("UNDERHILL") near3 ("Derek"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/08/18 11:29 PM

L44	1	WO ADJ "2016025869"	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/08/18 11:50 PM
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		"7736800" "7768236" "7785736" "7806943" "7850743" "7897279" "8003249" "8067114" "7897279" "8003249" "8067114" "8147999" "8263247" "8420247" "8450007" "8465874" "8470471" "8472164" "8564277" "8574008" "8617257" "8628876" "8691410" "8709642" "8734985" RE44960 "8822070" "8865270" "8877386" "8895174" "8945744" "8951658" "8952653" "8968910" "8980462" "8999540" "9012078" "9048490" "9048503" "9059469" "9105882" "9203123" "9209446" "9209491" "9219291" "9231271" "9249522" "9252452" RE45956 "9312723" "9318748" "9379418").pn.				
L46	23	L45 AND L2	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/08/18 11:58 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

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IPR2025-00885

Search History_16819831

Report Run Date: 2021-08-19 UTC
Queries: 2
Markers: 0

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Query #	Timestamp	Results	Page
1	2021-08-19 11:18 UTC	12,218,578	3
2	2021-08-19 11:36 UTC	970,295	4

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Content: Patent Publications (164)

US Patents | US Designs | US Applications | EPO Patents | EPO Applications | China Patents | China Applications | Japan Patents | Japan Applications | Korea Patents | Korea Applications | WIPO Applications | Argentina Patents | Argentina Applications | Brazil Patents | Brazil Applications | Canada Patents | Canada Applications | Chile Patents | Chile Applications | Colombia Applications | Costa Rica Applications | Cuba Patents | Cuba Applications | Dominican Republic Applications | Ecuador Patents | Ecuador Applications | El Salvador Applications | Guatemala Applications | Honduras Applications | Mexico Patents | Mexico Applications | Nicaragua Patents | Panama Applications | Peru Applications | Trinidad & Tobago Patents | Uruguay Applications | Austria Patents | Austria Applications | Belarus Patents | Belgium Patents | Belgium Applications | Bosnia & Herzegovina Patents | Bosnia & Herzegovina Applications | Bulgaria Patents | Bulgaria Applications | Croatia Patents | Croatia Applications | Czech Republic Patents | Czech Republic Applications | Czechoslovakia Patents | Czechoslovakia Applications | Denmark Patents | Denmark Applications | Estonia Patents | Estonia Applications | EUIPO Patents | Finland Patents | Finland Applications | France Patents | France Applications | Germany Patents | Germany Applications | Great Britain Patents | Great Britain Applications | Greece Patents | Greece Applications | Hungary Patents | Hungary Applications | Iceland Patents | Iceland Applications | Ireland Patents | Ireland Applications | Italy Patents | Italy Applications | Latvia Patents | Latvia Applications | Lithuania Patents | Lithuania Applications | Luxembourg Patents | Malta Patents | Monaco Patents | Montenegro Patents | Montenegro Applications | Netherlands Patents | Netherlands Applications | Norway Patents | Norway Applications | Poland Patents | Poland Applications | Portugal Patents | Portugal Applications | Republic of Moldova Patents | Republic of Moldova Applications | Romania Patents | Romania Applications | San Marino Patents | San Marino Applications | Serbia Patents | Serbia Applications | Slovakia Patents | Slovakia Applications | Slovenia Patents | Spain Patents | Spain Applications | Sweden Patents | Sweden Applications | Switzerland Patents | Switzerland Applications | Ukraine Patents | Yugoslavia/Serbia and Montenegro Patents | Yugoslavia/Serbia and Montenegro Applications | Armenia Patents | Australia Patents | Australia Applications | Cyprus Patents | Gulf Cooperation Council Patents | Hong Kong Patents | India Patents | India Applications | Indonesia Patents | Indonesia Applications | Israel Applications | Jordan Patents | Kyrgyzstan Patents | Macao Applications | Malaysia Patents | Mongolia Patents | New Zealand Patents | Philippines Patents | Philippines Applications | Saudi Arabia Patents | Singapore Patents | Singapore Applications | Taiwan Patents | Taiwan Applications | Tajikistan Patents | Tajikistan Applications | Thailand Applications | Uzbekistan Patents | Vietnam Patents | Algeria Patents | ARIPO Patents | ARIPO Applications | Egypt Patents | Kenya Patents | Malawi Patents | Morocco Patents | Morocco Applications | OAPI Patents | South Africa Patents | Tunisia Applications | Zambia Patents | Zimbabwe Patents | EAPO Patents | EAPO Applications | Georgia Patents | Georgia Applications | Kazakhstan Patents | Kazakhstan Applications | Russia Patents | Russia Applications | Turkey Patents | Turkey Applications

1 **2021-08-19 11:18 UTC | 12,218,578 results from**

De-Dup: None | **Cut-off:** None | **Sort:** Relevance

Main Concept: Text
jump starter or booster with power supply and alligator clips or battery terminal connector and controller or control system or circuit* and battery presence detector and reverse polarity sens* or detect* and correct or accurate or true polarity

Concept Modifiers: None

Filters: None

Content: Non-Patent Literature (23)

IEEE Xplore Publications: IEEE Periodicals | IEEE Xplore Publications: IEEE Conferences | IEEE Xplore Publications: IEEE

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Standards | IEEE Xplore Publications: IEEE Early Access | IEEE Xplore Publications: SMPTE Periodicals | IEEE Xplore Publications: SMPTE Conferences | IEEE Xplore Publications: SMPTE Standards | IEEE Xplore Publications: MIT Press eBooks | IEEE Xplore Publications: Wiley-IEEE eBooks | IEEE Xplore Publications: IBM Periodicals | IEEE Xplore Publications: URSI Periodicals | IEEE Xplore Publications: VDE Conferences | IEEE Xplore Publications: Periodicals from China | IP.com Prior Art Database: The IP.com Journal | IP.com Prior Art Database: Internet Society RFC | IP.com Prior Art Database: IBM TDB Archive | IP.com Prior Art Database: Legacy Journals | IP.com Prior Art Database: Software Patent Institute | OnePetro.org: Periodicals at OnePetro.org | OnePetro.org: Conferences at OnePetro.org | Other Literature: IBM Redbooks | Other Literature: PubMed Central | Other Literature: arXiv.org

2 **2021-08-19 11:36 UTC | 970,295 results from**

De-Dup: None | **Cut-off:** None | **Sort:** Relevance

Main Concept: Text
jump starter or booster with power supply and alligator clips or battery terminal connector and controller or control system or circuit* and battery presence detector and reverse polarity sens* or detect* and correct or accurate or true polarity

Concept Modifiers: None

Filters: None

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IPR2025-00885

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16819831
Filing Date	2020-03-16
First Named Inventor	Jonathan Lewis NOOK
Art Unit	2859
Examiner Name	M. Baye DIAO
Attorney Docket Number	054985-000055-US-02-01

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.D/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16819831 Page 1129 of 6315
	Filing Date	2020-03-16
	First Named Inventor	Jonathan Lewis NOOK
	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

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	Art Unit	2859
	Examiner Name	M. Baye DIAO
	Attorney Docket Number	054985-000055-US-02-01

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	Attorney Docket Number	054985-000055-US-02-01

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Art Unit	2859
Examiner Name	M. Baye DIAO
Attorney Docket Number	054985-000055-US-02-01

/M.D/	53	D746774	S	2016-01-05	Nook ET AL.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	Attorney Docket Number	054985-000055-US-02-01

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	Filing Date	2020-03-16
	First Named Inventor	Jonathan Lewis NOOK
	Art Unit	2859
	Examiner Name	M. Baye DIAO
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	Art Unit	2859
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IPR2025-00885

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
18 February 2016 (18.02.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/025869 A1

(51) International Patent Classification:
H02M 3/18 (2006.01) *H02J 7/02* (2016.01)

(21) International Application Number:
PCT/US2015/045335

(22) International Filing Date:
14 August 2015 (14.08.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/037,379 14 August 2014 (14.08.2014) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: COMPACT MULTIFUNCTIONAL BATTERY BOOSTER

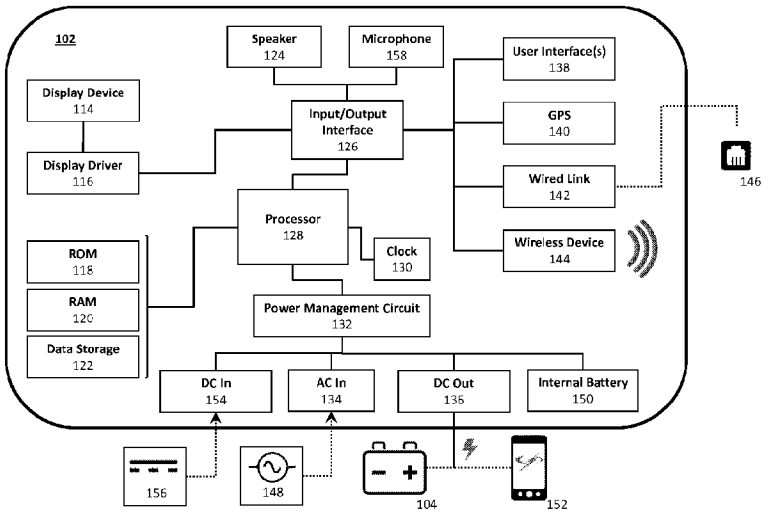


Figure 1

(57) **Abstract**: A compact battery charger for charging a battery comprising: a microprocessor; a set of terminals operatively coupled to said microprocessor and configured to electrically couple with an automotive battery; and an internal lithium ion battery, wherein the internal lithium ion battery is a lithium ion battery, wherein a single-ended primary-inductor converter may be configured to receive an input voltage of 5VDC to 20VDC and output a predetermined DC charge voltage to said internal lithium ion battery.

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COMPACT MULTIFUNCTIONAL BATTERY BOOSTER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 62/037,379 by Brian F. Butler et al., filed on August 14, 2014 and entitled "Compact Multifunctional Battery Booster." U.S. Provisional Patent Application No. 62/037,379 is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to a portable battery booster system and apparatus. More specifically, the present invention relates to systems, methods, and apparatuses for providing a compact multifunctional battery booster and charger.

BACKGROUND

[0003] It is well known that motorists from time to time find themselves with a battery of insufficient charge to start their vehicle. This is generally an occasion of extreme inconvenience and distress, particularly where one finds himself in this situation in an area where there are other vehicles and drivers, but no means for connecting the battery of the disabled vehicle to the battery of one of the other available vehicles. To remedy this, battery boosters were developed to jump start stranded cars. For example, U.S. Patent No. 4,079,304 discloses a battery booster system for jump starting an engine of a vehicle with a defective (or depleted) battery and interconnecting the same with a vehicle having a charged battery. Similarly, U.S. Patent Publication No. 2014/0159509 discloses a portable battery boost and jump starter apparatus for charging a vehicle battery. Typically, such battery booster systems rely on an internal lead acid battery, which is typically large, heavy, and cumbersome. Despite the advancements thus far, a need exists for an improved compact multifunctional battery booster, and, more particularly, to an improved lithium ion battery booster.

SUMMARY OF THE INVENTION

[0004] The present disclosure is directed to an improved compact multifunctional battery booster and charger, and, more particularly, to an improved lithium ion battery booster and charger.

[0005] According to a first aspect of the present invention, a compact battery booster comprises: a processor; a display device operatively coupled to the processor, wherein the display device displays a status of the compact battery booster; a storage capacitor and an internal lithium ion

battery, each of said storage capacitor and said internal lithium ion battery configured to provide a boosting energy to a vehicle coupled to an external battery; a direct current (DC) output terminal configured to electrically couple with the external battery; a single-ended primary-inductor converter configured to receive a variable input voltage between 5 volts DC and 20 volts DC and to output a predetermined output voltage to said storage capacitor and said internal lithium ion battery; and a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said storage capacitor or said internal lithium ion battery, thereby providing the boosting energy from said storage capacitor or said internal lithium ion battery to said vehicle.

[0006] According to a second aspect of the present invention, a compact battery charger comprises: a processor; a display device operatively coupled to the processor, wherein the display device displays a status of the compact battery charger; an internal lithium ion battery, said internal lithium ion battery configured to provide a predetermined output energy; a direct current (DC) output terminal, wherein the DC output terminal is configured to couple with an external battery; a single-ended primary-inductor converter configured to receive an input voltage within predetermined input voltage range and to output a predetermined charge voltage to said internal lithium ion battery; and a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said internal lithium ion battery, thereby providing the predetermined output energy from said internal lithium ion battery to said external battery.

[0007] According to a third aspect of the present invention, a compact battery charger comprises: an internal lithium ion battery, said internal lithium ion battery configured to provide a predetermined output energy; a direct current (DC) output terminal, wherein the DC output terminal is configured to couple with an external battery; an internal induction coil, wherein the internal induction coil receives energy from an electromagnetic field created by an external induction coil and converts the electromagnetic field to produce an input voltage; a DC to DC converter that receives the input voltage and outputs a predetermined output voltage to said internal lithium ion battery; and a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said internal lithium ion battery, thereby providing the predetermined output energy from said internal lithium ion battery to said external battery.

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[0008] In certain aspects, the storage capacitor is a supercapacitor.

[0009] In certain aspects, the storage capacitor draws a charging current from the external battery.

[0010] In certain aspects, the device further comprises a supercapacitor, wherein the single-ended primary-inductor converter charges the supercapacitor.

[0011] In certain aspects, the device further comprises a supercapacitor, wherein the supercapacitor draws current from the external battery to charge the supercapacitor.

[0012] In certain aspects, the predetermined input voltage range is 5 volts to 20 volts.

[0013] In certain aspects, the predetermined charge voltage is greater than the input voltage.

[0014] In certain aspects, the predetermined output energy is a boosting energy for starting an engine coupled to the external battery.

[0015] In certain aspects, the predetermined output energy is a charging energy for charging the external battery.

[0016] In certain aspects, the device further comprises (1) a reverse polarity sensor configured to detect a polarity of the external battery; (2) a temperature sensor configured to detect a temperature of said internal lithium ion battery and to provide a temperature signal to said processor; and (3) a voltage sensor configured to detect a voltage of said internal lithium ion battery.

[0017] In certain aspects, the device further comprises a removable internal data storage device.

[0018] In certain aspects, the device further comprises an internal induction coil, wherein the internal induction coil receives energy from an electromagnetic field created by an external induction coil and converts the electromagnetic field to produce the input voltage.

[0019] In certain aspects, the device further comprises a second DC output terminal, wherein the DC output terminal provides a boosting energy for starting an engine coupled to the external battery, and wherein the second DC output terminal provides a charging energy to a portable electronic device.

[0020] In certain aspects, the second DC output terminal is a Universal Serial Bus (USB) port.

[0021] In certain aspects, the display device enters into a sleep mode after a predetermined time period of inactivity.

[0022] In certain aspects, the DC output terminal runs a predetermined current through the external battery to preheat the external battery.

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[0023] In certain aspects, the device further comprises a DC to alternating current (AC) converter coupled between the internal lithium ion battery and an AC output terminal.

[0024] In certain aspects, the device further comprises an internal data storage device, wherein the internal data storage device backs up digital content stored to a portable electronic device via a USB port.

DESCRIPTION OF THE DRAWINGS

[0025] These and other advantages of the present invention will be readily understood with reference to the following specifications and attached drawings wherein:

[0026] Figure 1 illustrates an exemplary compact battery charger block diagram configured for use with a battery charging system.

[0027] Figure 2 illustrates a flow diagram of an example method for providing the jump start function using a compact battery charger.

[0028] Figure 3 illustrates an example schematic diagram of a charger having a single-ended primary-inductor converter circuit and a supercapacitor.

DETAILED DESCRIPTION

[0029] Preferred embodiments of the present invention will be described hereinbelow with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail because they may obscure the invention in unnecessary detail. The present invention relates to a compact battery charger system, method, and apparatus. For this disclosure, the following terms and definitions shall apply:

[0030] As used herein, the word "exemplary" means "serving as an example, instance, or illustration." The embodiments described herein are not limiting, but rather are exemplary only. It should be understood that the described embodiments are not necessarily to be construed as preferred or advantageous over other embodiments. Moreover, the terms "embodiments of the invention," "embodiments," or "invention" do not require that all embodiments of the invention include the discussed feature, advantage, or mode of operation.

[0031] The terms "communicate" and "communicating" as used herein, include both conveying data from a source to a destination and delivering data to a communications medium, system, channel, network, device, wire, cable, fiber, circuit, and/or link to be conveyed to a destination. The term "communication" as used herein means data so conveyed or delivered. The

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term "communications" as used herein includes one or more of a communications medium, system, channel, network, device, wire, cable, fiber, circuit, and/or link.

[0032] The terms "coupled," "coupled to," and "coupled with" as used herein, each mean a relationship between or among two or more devices, apparatuses, files, circuits, elements, functions, operations, processes, programs, media, components, networks, systems, subsystems, and/or means, constituting any one or more of: (i) a connection, whether direct or through one or more other devices, apparatuses, files, circuits, elements, functions, operations, processes, programs, media, components, networks, systems, subsystems, or means; (ii) a communications relationship, whether direct or through one or more other devices, apparatuses, files, circuits, elements, functions, operations, processes, programs, media, components, networks, systems, subsystems, or means; and/or (iii) a functional relationship in which the operation of any one or more devices, apparatuses, files, circuits, elements, functions, operations, processes, programs, media, components, networks, systems, subsystems, or means depends, in whole or in part, on the operation of any one or more others thereof.

[0033] The term "data" as used herein means any indicia, signals, marks, symbols, domains, symbol sets, representations, and any other physical form or forms representing information, whether permanent or temporary, whether visible, audible, acoustic, electric, magnetic, electromagnetic, or otherwise manifested. The term "data" is used to represent predetermined information in one physical form, encompassing any and all representations of corresponding information in a different physical form or forms.

[0034] The term "database" as used herein means an organized body of related data, regardless of the manner in which the data or the organized body thereof is represented. For example, the organized body of related data may be in the form of one or more of a table, map, grid, packet, datagram, frame, file, email, message, document, report, list, or any other form.

[0035] The term "network" as used herein includes both networks and inter-networks of all kinds, including the Internet, and is not limited to any particular network or inter-network.

[0036] The term "processor" as used herein means processing devices, apparatuses, programs, circuits, components, systems, and subsystems, whether implemented in hardware, tangibly embodied software, or both, and whether or not it is programmable. The term "processor" as used herein includes, but is not limited to, one or more computing devices, hardwired circuits, signal-modifying devices and systems, devices and machines for controlling systems, central processing units,

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programmable devices and systems, field-programmable gate arrays, application-specific integrated circuits, systems on a chip, systems comprising discrete elements and/or circuits, state machines, virtual machines, data processors, processing facilities, and combinations of any of the foregoing.

[0037] A compact battery charger 102, as disclosed herein, may be used to start (a/k/a "boost", "jump", or "jump start") an engine coupled to an external battery 104 (*e.g.*, a 6V/12V nominal voltage vehicular battery, which may be fully or partially depleted). In certain aspects, the compact battery charger 102 may be further configured to charge the external battery 104, and/or other electronic devices operatively coupled with the compact battery charger 102. Example vehicular batteries include, without limitation, lead-acid batteries (*e.g.*, wet/flooded batteries, calcium-calcium batteries, Valve-Regulated, Lead Acid (VRLA) batteries, gel cell, and Absorbed Glass Mat (AGM)) and other rechargeable batteries (*e.g.*, lithium ion, lithium ion polymer, Nickel-Metal Hydride (NiMH), Nickel Cadmium (NiCd)). Other electronic devices that may be operatively coupled with the compact battery charger 102 include, for example, portable electronic devices 152 (*e.g.*, phones, tablet computers, portable computers, etc.), toys, etc.

[0038] Figure 1 illustrates a block diagram of an example compact battery charger 102. Specifically, Figure 1 illustrates a compact battery charger 102 having a processor 128 (*e.g.*, a central processing unit (CPU)) that is operatively coupled to a Read-Only Memory (ROM) 118 for receiving one or more instruction sets, to a Random Access Memory (RAM) 120 having a plurality of buffers for temporarily storing and retrieving information, and to an internal data storage device 122 (*e.g.*, a hard drive, such a solid state drive, or other non-volatile data storage device, such as flash memory). A clock 130 is also coupled to the processor 128 for providing clock or timing signals or pulses thereto. Those skilled in the art will understand that the compact battery charger 102 includes one or more bus structures for interconnecting its various components. Further, to increase ease of use in mobile applications, the various components of a compact battery charger 102 may be housed in a single housing. In certain aspects, multiple processors 128 may be provided to facilitate operation of the compact battery charger 102, whether or not embodied within the compact battery charger 102 itself. Accordingly, serial communication may be employed to communicate information and data between multiple processors that may be used.

[0039] The internal battery 150 may be a rechargeable lithium ion battery for outputting a direct current (DC) voltage, such as lithium iron phosphate and lithium ion polymer batteries. The internal battery 150 should be sufficiently rated to boost (jump start) a vehicle coupled to an external

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battery 104. For example, the internal battery 150 may be rated from about 3,000 mah to 20,000 mah, or higher. A compact battery charger 102 having a 12,000 mah internal battery 150, for instance, may output 200 cranking amps / 400 peak amps during the jump start function, which is sufficient to start a vehicle, but higher power internal batteries are contemplated for larger vehicles and trucks. In certain embodiments, the internal battery 150 may comprise a plurality of electrically coupled batteries (*e.g.*, connected in parallel, or when multiple lower voltage batteries are to be summed, in series). For example, lithium ion batteries containing LiFePO, $LiFePO_4$, $LiFeMgPO_4$, and $LiFeYPO_4$ have a nominal cell voltage of about 3.2V to 3.3V each. Thus, internal battery 150 need not be limited to a single battery or single battery cell. Accordingly, four lithium ion cells may be connected in series to achieve a nominal voltage of 12.8V to 13.2V. To the extent that a higher nominal voltage is desired, additional lithium ion cells may be connected in series to achieve higher voltages.

[0040] The compact battery charger 102 may receive external power via a direct current (DC) input terminal 154 coupled to a DC power supply 156 and/or an alternating current (AC) input terminal 134 coupled to an AC power supply 148. AC power supply 148 may be wall current (*e.g.*, 110VAC), while the DC power supply 156 may be, for example, an automotive cigarette lighter (*e.g.*, 12VDC) or a USB port (*i.e.*, 5VDC). The compact battery charger 102 may provide a plurality of DC outputs 136 to facilitate charging energy (*e.g.*, to external battery 104 or one or more portable electronic devices 152) or boosting energy (*e.g.*, to a vehicle/external battery 104). In certain aspects, such as when a USB Port or 12V port is used, a DC connector may be used for both DC input terminal 154 and DC output terminal 136. That is, the compact battery charger 102 may draw power from a device coupled to the DC connector (functioning as a DC input terminal 154), or supply power to the device coupled to the DC connector (functioning as a DC output terminal 136). To convert the AC power supply 148, an AC to DC transformer may be provided, which may be integral with, or external to, the compact battery charger 102. An AC to DC transformer may removably coupled to wall current and removably coupled to the compact battery charger 102. In certain aspects, a power inverter and AC output terminal may be provided to output an AC voltage (*e.g.*, a 110VAC output). In such an embodiment, power from the DC power supply 156 or the internal battery 150 may be processed (*e.g.*, using a DC to AC inverter) and used to supply the AC voltage to the AC output terminal.

[0041] In operation, when the AC power supply 148 or DC power supply 156 is unavailable (*e.g.*, disconnected, out of service, when a circuit breaker is blown, the compact battery charger 102 is

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otherwise disconnected, etc.), the compact battery charger 102 may draw the power needed to operate the compact battery charger 102's components from the external battery 104 and/or internal battery 150, thereby enabling the user to determine the status of the compact battery charger 102 (and state of charge, or other parameters, of the external battery 104) when the AC power supply 148 and the DC power supply 156. To that end, the compact battery charger 102 may report a power supply failure (*e.g.*, as an alert) to one or more portable electronic devices 152 (*e.g.*, phones, tablet computers, portable computers, or other handheld terminals) within a battery monitoring system via a communication network. A suitable example battery monitoring system is disclosed by commonly owned U.S. Patent Serial No. 14/826,805 by Brian F. Butler et al, filed August 14, 2015 and titled "Battery Charger Status Control System And Method."

[0042] The battery charging method or technique can be any of a variety of charging techniques including conventional, fast charging, and the like. The compact battery charger 102 may be further configured to determine, automatically, different battery chemistry (*e.g.*, AGM, gel, lithium ion, etc.) and the battery's nominal voltage. The charging characteristics of a battery charger may be configured to match the battery chemistry of the battery to be charged. For example, lead acid batteries may be charged with constant power, constant current, constant voltage, or combination thereof. Such batteries are known to be charged with both linear as well as switched-mode battery chargers. U.S. Patent No. 7,808,211, assigned to the same assignee as the assignee of the present invention, discloses an example of a switched-mode battery charger for automotive and marine battery applications. Further, commonly owned U.S. Patent No. 8,947,054 discloses a battery charger and method utilizing alternating DC charging current, while commonly owned U.S. Patent No. 8,575,899 discloses a battery charger with automatic voltage detection.

[0043] The identified battery chemistry and voltage may be displayed on display device 114. The compact battery charger 102 may indicate to the user (*e.g.*, via display device 114) the number of ampere hours put into battery, and/or an indication of the state of health of the external battery 104. For example, if customer inputs a battery size/model number, the compact battery charger 102 can use the battery capacity to provide the state of health. The compact battery charger 102 may indicate to the user the state of charge or health of the internal battery 150 (*e.g.*, the number of coulombs) via display device 114.

[0044] The compact battery charger 102 may further include an input/output interface 126 that interfaces the processor 128 with one or more peripheral and/or communicative devices, such as

a user interface 138, a Global Positioning System (GPS) transmitter 140, a wired link 142, a wireless device 144, a microphone 158, and a speaker 124, which may be used to signal an alert (*e.g.*, charge complete, error, etc.) or other status information.

[0045] As illustrated, the processor 128 may be operatively coupled to a display device 114 via a display driver 116. The display device 114 may comprise, or otherwise employ, one or more light emitting diodes (LEDs) and/or a liquid crystal display (LCD) screen. The LCD screen may be an alphanumeric segmented LCD display, or a matrix LCD display, such as those used on portable electronic devices. In certain embodiments, the LCD screen may further provide touch screen functionality to facilitate user input device via a thin layer of sensing circuitry present either beneath the visible portion of display device 114's surface, or as part of a thin, clear membrane overlying the display device 114 that is sensitive to the position of a pen or finger on its surface. In operation, the display driver 116 may receive display data from the processor 128 via input/output interface 126 and display that display data via the display device 114. For example, interactive display device 114 may be provided on the housing to provide the user with status information and/or input capability (*e.g.*, via a touch screen or voice commands using, for example, wave files). Reminders, or other information (*e.g.*, status information), may be displayed to the user, via the display device 114, as a scrolling message or menu structure (*e.g.*, a graphical user interface (GUI)).

[0046] With regard to the internal data storage device 122, example flash memory devices include, for example, memory cards, such as RS-MMC, miniSD, microSD, etc. The internal data storage device 122 can function as an external hard drive or flash drive, thereby enabling the user to store digital files to the compact battery charger 102. In instances where the internal data storage device 122 is removable, as is the case with memory cards, the user can interchange, upgrade, or remove the memory card (*e.g.*, if the compact battery charger 102 becomes defective) to avoid data loss. The display device 114 may be used to display, for example, the contents of the internal data storage device 122, the remaining storage capacity (*e.g.*, as a percentage or in terms of available bytes), and, in certain aspects, the digital files themselves (*e.g.*, photos may be displayed, files accessed, etc.). In certain aspects, in addition to (or in lieu of) charging a portable electronic device (*e.g.*, a smart phone), the compact battery charger 102 may back up digital content stored to the portable electronic device 152 when the portable electronic device 152 is coupled to the compact battery charger 102 via, for example, the USB port.

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[0047] When an external battery 104 is connected to DC output terminal 136 (*e.g.*, via clamps), the display device 114 may display the external battery 104's voltage. The display device 114 may also indicate the state of charge in terms of percent of charge of the jump starter's internal battery 150. During user inactivity, such as when charging the external battery 104 or the internal battery 150, the display device 114 may enter a sleep mode and will not display any messages until activity is detected (*e.g.*, when devices are connected/disconnected from the compact battery charger 102 or the user interface 138 is actuated). As discussed below, if the external battery 104's voltage is too low to detect, the display device 114 may remain blank and the voltage will not display, but a manual start procedure may be selected to enable the jump start function. The jump start function may be used to start a vehicle having an external battery 104 (*e.g.*, a depleted automotive battery). The jump start function causes the compact battery charger 102 to output about 400-600 peak amperes (270-405 cranking amperes) via clamps coupled to the DC output terminal 136. One of skill in the art, however, would recognize that the internal battery 150 may be replaced with a higher capacity battery to facilitate higher output currents.

[0048] In one example, once an AC power supply 148 is connected, a first LED may be illuminated to indicate that the compact battery charger 102's internal battery 150 is charging. When the compact battery charger 102 is fully charged, a second LED on the unit may be illuminated. Finally, when the DC output terminal 136 is successfully coupled (*e.g.*, clamped or otherwise electrically coupled) to external battery 104, a third LED may be illuminated. Rather than employing separate LEDs, an LCD display or a single multi-color LED may be employed that changes color depending on the status of the compact battery charger 102. The compact battery charger 102 may be further equipped with a light, which functions as a map light, flash light, emergency light, etc. The light may be activated and deactivated via user interface 138. The light may be an LED that outputs, for example, about 1 Watt/90 Lm.

[0049] When an LCD display is employed, the display device 114 may be configured to display, in addition to, or in lieu of, the LEDs, a number of messages to indicate the current status, or operation of the compact battery charger 102 to the user. In selecting the message(s) to display, the compact battery charger 102 measures one or more parameters of the internal battery 150, external battery 104, or of the compact battery charger 102. Parameters include, for example, voltage, power capacity, temperature, connection status, etc. Example messages include those illustrated in Table A, where "[XX]" represents a measured or calculated value.

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Message	Status/Condition
Charging [XX]%	Coupled to AC power supply 148 or DC power supply 156 and internal battery 150 is charging.
Fully Charged	Coupled to AC power supply 148 and internal battery 150 is fully charged.
Battery Too Hot To Charge	Disconnect from AC power supply 148 or DC power supply 156 and allow internal battery 150 to cool down before charging.
Battery Too Cold To Charge	The temperature of the internal battery 150 is too low.
Charging - USB On	The USB port is in use while the internal battery 150 is charging.
Charging – 12V On	The 12V port is in use while the internal battery 150 is charging.
Fully Charged - USB On	The internal battery 150 is fully charged and the USB port is in use.
Fully Charged - 12V On	The internal battery 150 is fully charged and the 12V port is in use.
Unplug Charger	Attempting to use the jump starter function while the internal battery 150 is charging.
Charge Aborted	Charging cannot be completed normally.
Battery [XX]% - USB On	The USB port is in use. The percentage shows the internal battery 150's charge.
Battery [XX]% - 12V On	The 12V port is in use.
12V/USB Overload	The 12V/USB port is overloaded.
Battery Low - Recharge	While using the 12V/USB port, the internal battery 150's voltage has dropped. The 12V/USB power will shut off after

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	10 minutes.
Battery [XX]% - Clamps Disconnected	The compact battery charger 102 is turned on, but does not detect external battery 104.
Warning - Reverse Polarity	The DC output terminal 136 is connected backwards to an external battery 104 (*i.e.*, reverse polarity).
Battery Low-Recharge	The jump start function button has been selected, but the internal battery 150 has discharged below a predetermined level.
Turn Off 12V/USB	The jump start function button has been selected, but 12V/USB function is activated.
Off	The jump start button has been pressed twice.
Battery Too Hot	The internal temperature of the internal battery 150 is too warm. Allow internal battery 150 to cool down before attempting another jump start.
Jump Start Ready - Battery Cold : Reduced Performance	The temperature of the internal battery 150 is too low, which reduces cranking performance.
Jump Start Ready	The jump start button has been pressed, compact battery charger 102 is correctly connected to a vehicle battery, and the compact battery charger 102 is ready for jump start function.
Battery Cool Down - [XX] Seconds Remaining	Shows waiting time needed before attempting another engine start.

Table A

[0050] The user interface 138 may be used to enable the user to switch the output charge amperage (*e.g.*, 1A, 10A, 50A, 100A, etc.) or another setting (*e.g.*, charge, boost, other). Example user interface 138 devices may include, for example, physical buttons, physical switches, a digitizer (whether a touch pad, or transparent layer overlaying the display device 114), voice command (*e.g.* via the microphone 158 and speaker 124), and other input devices. For instance, using the digitizer, a

user may control or interact with the compact battery charger 102 by writing or tapping on the display device 114 using, a pen, stylus, or finger.

[0051] The GPS transmitter 140 may be used to track and/or monitor the location of the compact battery charger 102 and to relay the location information in the form of positional data (*e.g.*, geographic coordinate system data or Internet Protocol (IP) address) to a booster management server or another device in battery charging system or via a communication network. For example, a computer may be configured to track the activities, location, and/or charge history of a particular compact battery charger 102 in a battery charging system. The positional data may also be locally stored to the compact battery charger 102 (*e.g.*, to internal data storage device 122).

[0052] The wireless device 144 may be configured to manage communication and/or transmission of signals or data between the processor 128 and another device (*e.g.*, a remote interface device via a communication network or directly with a remote interface device) by way of a wireless transceiver. The wireless device 144 may be a wireless transceiver configured to communicate via one or more wireless standards such as Bluetooth (*e.g.*, short-wavelength, Ultra-High Frequency (UHF) radio waves in the Industrial, Scientific, and Medical (ISM) band from 2.4 to 2.485 GHz), near-field communication (NFC), Wi-Fi (*e.g.*, Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards), etc. For example, wireless connectivity (*e.g.*, RF 900MHz or Wi-Fi) may be integrated with the compact battery charger 102 to provide remote monitoring and control of the compact battery charger 102 via one or more portable electronic devices 152. Using a wireless device 144, a user may be able to start and/or stop the compact battery charger 102's charge cycle or otherwise change the settings.

[0053] That is, via a communication network and a booster management server, a user may monitor live charging status updates, charging conditions, historic data, remotely update software and firmware, and stay connected with the compact battery charger 102 manufacturer's news and updates. In certain aspects, an internal cellular modem may be implemented that utilizes standards-based wireless technologies, such as 2G, 3G, 4G, Code Division Multiple Access (CDMA), and Global System for Mobile Communications (GSM), to provide wireless data communication over worldwide cellular networks. An advantage of an internal cellular modem is that there is no reliance on a user's local network (*e.g.*, wireless router, modem, etc.), thereby enabling communication between the compact battery charger 102 and communication network, even in the event of a total power failure in a user's location.

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[0054] In certain aspects, a wired link 142 may be provided to manage communication and/or transmission of signals or data between the processor 128 and another device via, for example, a data port 146 (*e.g.*, RS-232, USB, and/or Ethernet ports) capable of being wiredly coupled with another data port 146 positioned outside the compact battery charger 102 housing. As noted above, a USB port or 12V supply may be provided as DC output terminals 136 on the charger to facilitate the charging of accessories, such as portable electronic devices 152. Thus, the compact battery charger's 102 internal battery 150 may also be used as a power source for one or more DC accessories. Charging while operating the accessories can extend run time of the compact battery charger 102, but will also extend recharge time. If the load exceeds the charging input amperage (*e.g.*, 1A), however, the accessory being charged may discharge the internal battery 150.

[0055] The USB port may provide, for example, up to 3.0A at 5VDC. To activate the USB port, a USB power button (or other user selectable element) may be provided via user interface 138. The USB port may be activated by pressing the USB power button, and disabled by, for example, pressing the USB power button a second time, two or more times in quick succession, or held for a predetermined period of time. The 12VDC power output may provide, for example, up to 6.0A a 12VDC.

[0056] The compact battery charger 102 may further comprise a plurality of sensors to provide measurement data descriptive of the surrounding environment. In certain aspects, the USB output may automatically shut off when no load is detected (*e.g.*, after 5-10 minutes of a no load state). The 12VDC power supply, however, may remain active until the compact battery charger 102 reaches a low battery state (*e.g.*, the internal battery 150's charge level is less than a predetermined threshold, *e.g.*, number of coulombs). The 12VDC power supply may be used to supply power to an integrated or remotely situated air compressor (*e.g.*, for tire inflation) and may further function as a memory saver. The 12VDC power supply may be limited to 6.0A with over current protection. In certain aspects, a user may wish to check the internal battery 150's charge level. To do so, a button (or other user selectable element) may be provided via user interface 138 that causes the charge level to be displayed on the display device 114. To ensure accuracy of the measurement, the user may be instructed (*e.g.*, via display device 114) to turn off the compact battery charger 102 before actuating the button (or displaying the charge level). In one aspect, the display device 114 can show the internal battery 150's percent of charge, or a battery icon indicating the same. For example, the display device 114 may display "100%" (or a solid battery icon) when the internal battery 150 is fully charged.

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[0057] The compact battery charger 102 may include a temperature or humidity sensor, or configured to monitor other appliances or devices, either directly (*e.g.*, using a sensor) or wirelessly (*e.g.*, using Wi-Fi). For example, the compact battery charger 102 may be configured to charge and monitor, in addition to automotive batteries, one or more portable electronic devices 152 being charged by said compact battery charger 102. Another temperature sensor may be provided to measure the temperature of a battery being charged (*e.g.*, a lithium-ion battery). If the measured temperature deviates from an operating range (*i.e.*, a range in which the measured value is acceptable), the charging or boosting operating may be prohibited.

[0058] A power management circuit 132 may be used to manage power needed to operate the compact battery charger 102 (and components thereof), start an engine, and to charge the external battery 104 or other device. That is, AC power may be drawn from an AC power supply 148, converted to DC power, and used to charge external battery 104 and/or internal battery 150. For instance, the compact battery charger 102 may be removably coupled with an AC power supply 148 located outside the housing (*e.g.*, a wall outlet) via an AC input terminal 134 and an AC to DC converter. In such an example, an AC wall charger may receive 120VAC from an electrical wall outlet and output, via an inverter, 12VDC to the compact battery charger 102's input socket. When charging, an LED (*e.g.*, a green LED) may light, and/or the display device 114 may display a message such as "Charging - [XX]%." When the charging has completed, the LED may pulse, and/or the display device 114 may display a message such as "Fully Charged."

[0059] In certain aspects, a Single-Ended Primary-Inductor Converter (SEPIC) circuit 302, in conjunction with an AC to DC converter 314, may be used to charge the internal battery 150. Generally speaking, a SEPIC circuit 302 is a type of DC to DC converter that allows the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The output of a SEPIC circuit 302 is controlled by the duty cycle of the control transistor. A SEPIC circuit 302 exchanges energy between capacitors and inductors in order to convert a variable input voltage to a predetermined output voltage. The amount of energy exchanged is controlled by a switch, which may be a transistor such as a Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET). As a result, a SEPIC circuit 302 enables a wide variation in input voltage both substantially higher and lower than nominal battery voltage. For example, to charge a 12 volt battery (nominal voltage) to 14.4V, the variable input voltage can be a voltage from a predetermined range, such as between 5VDC to 20VDC, thereby enabling internal battery 150 recharging functionality via a USB port, which is

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5VDC. That is, the input voltage may not be always known, but the predetermined range may be known. In certain aspects, the SEPIC circuit 302 may be shut off (*e.g.*, bypassed) to facilitate a higher efficiency charge. For example, if a 20V power supply is used, the compact battery charger 102 may bypass the SEPIC circuit 302, whereas, if 12VDC power supply (*e.g.*, a vehicle charger accessory) is used, the SEPIC circuit 302 may be employed.

[0060] Accordingly, as illustrated in Figure 3, a supercapacitor 308, or another storage capacitor, may be used in conjunction with the SEPIC circuit 302 to supply a large amount of power that is sufficient time to jump start a vehicle. Supercapacitors 308 are useful in that, unlike batteries, they do not necessarily suffer from ageing and temperature problems. Because the amount of energy in the capacitor is finite, however, supercapacitors 308 are primarily used for engine starting. Yet, when a supercapacitor is simply coupled to a depleted battery, the finite energy reserve is drained into the battery, often lowering the supercapacitor's 308 voltage to a level that cannot start an engine. A jump starter battery, on the otherhand, can start an engine as it has sufficient current to override the discharging effects of a depleted vehicle battery. In cold weather, however, the peak current that a battery can supply may be limited due to the temperature effecting the chemical reaction inside the jump starter battery. This limit in peak current may be such that the engine may not turn over. Thus, an improved system for starting the vehicle may be jump starter having both an internal battery 150 and a supercapacitor 308, where the battery can supplies sufficient current to overcome the effects of the depleted external battery 104, while the supercapacitor 308 may supply the peak current.

[0061] In general, a supercapacitor 308 can hold a very high charge that can be released relatively quickly, thereby making it suitable for jump starting a vehicle, since the vehicle cranking operation lasts for a very short period of time during which high cranking power is required. Moreover, supercapacitors 308 are relatively small in size and can be employed in the compact battery charger 102 to provide sufficient cranking power to jump-start a vehicle. In operation, the SEPIC circuit 302 would draw current from the depleted external battery 104, which would be used to charge the supercapacitor 308. A small lithium battery may be used in combination with the supercapacitor to prevent the supercapacitor 308 from discharging the current back to the depleted external battery 104 until the compact battery charger 102 determines that the user trying to start the vehicle. Existing supercapacitor jump starter systems are deficient because they would require the removal of one of the external battery 104 connections to prevent the capacitor from discharging back into the dead battery. The disclose arrangement, however, obviates the need to disconnect one of the

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external battery's 104 terminals. Thus, in one aspect of the present invention, a compact battery charger 102 is provided that employs a SEPIC circuit 302 in conjunction with a supercapacitor 308.

[0062] An example schematic diagram 300 of a charger having a SEPIC circuit 302 in conjunction with a supercapacitor 308 is illustrated in Figure 3. As illustrated, DC input power is received from a DC power supply 156 via DC input terminal 154, or either AC power supply 148 via an AC to DC converter 314. The DC input power is received by SEPIC circuit 302 and output to the internal battery 150 and the supercapacitor 308, in parallel, via an internal battery controller circuit 304 and a supercapacitor controller circuit 306, respectively. The internal battery controller circuit 304 and a supercapacitor controller circuit 306 may be used to monitor the parameters of the internal battery 150 and the supercapacitor 308, such as the charge level. Further, internal battery controller circuit 304 may monitor the temperature of the internal battery 150. The parameters may be communicated to the processor 128, which controlled, *inter alia*, the battery control relay 310, and supercapacitor controller 312.

[0063] The supercapacitor 308 and internal battery 150 may receive charging current from the DC input power. When DC input power is unavailable, for instance, the supercapacitor 308 may receive charging current from external battery 104 via the supercapacitor controller 312. For example, if an external battery 104 having a nominal voltage of 12VDC has depleted to 6VDC, the external battery 104 may be unable to start a vehicle, but the remaining power may be drawn from the depleted external battery 104 to the supercapacitor 308, which could then be used to boost the vehicle. As noted above, existing supercapacitor-only battery boosters were required to disconnect one of the external battery's 104 terminals so as to avoid premature discharge of the supercapacitor into the depleted battery. The lithium ion battery, however, may be used to output a current to the external battery 104, which may be monitored by the processor 128. If a drop in current is detected at the DC output terminal 136, the processor 128 may determines that the user is attempting to start the vehicle and the supercapacitor controller 312 may be instructed to electrically couple the supercapacitor 308 to the external battery 104 (via DC output terminal 136), thereby causing the supercapacitor 308 to quickly discharge into the external battery 104, thereby enabling the vehicle to start. The processor 128 may be similarly configured to control the battery control relay 310, which enables the internal battery 150 to discharge into the external battery 104.

[0064] Thus, the internal battery 150 and a supercapacitor 308 can each be recharged by a SEPIC circuit 302, which may any input voltage between, for example, 5VDC to 20VDC. The

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internal battery controller circuit 304 recharges the battery inside the compact battery charger 102 properly, while a separate supercapacitor controller circuit 306 charges the supercapacitor 308. The supercapacitor 308 may also be recharged from the internal battery 150, thereby providing multiple peak current starts. The jump starting function is controlled by one or more processors 108 (e.g., a microprocessor(s)) once the jump starter cables are attached to an external battery 104 and the jump start function is engaged (either manually or automatically) the internal jump starter battery is connected by a circuit or relay to the vehicle's battery. The internal battery 150 transfers energy into the external battery 104 and when the vehicle ignition is actuated (e.g., the key is turned, or the start button is pressed), current drawn from the starter motor will cause a voltage drop across the jump starter connection leads. This voltage drop will be detected by the one or more processors 108, at which point the one or more processors 108 will electrically couple the supercapacitor in parallel with its internal battery 150 to supply the peak current required to start the engine. If the engine starts, the jump starter function is done and the compact battery charger 102 can recharge itself (*e.g.,* the internal battery 150 and/or the supercapacitor 308) from an electrical connection to the vehicle's electrical system, which may continue until the internal battery 150 and/or the supercapacitor 308 are fully charged. Afterwhich the compact battery charger 102 may shut off its charging function, or the clamps are removed. If the vehicle does not start, once the starter is disengaged the voltage on the external battery 104 will stabilize and the supercapacitor 308 will recharge from the internal battery 150 (or any available power from the external battery 104), and prepare for the next attempt to start the engine, whereby the process is repeated.

[0065] There are a number of ways in which the internal battery 150 may be charged. The user may also charge the internal battery 150 while driving via the DC input terminal 154 using a 12VDC car charger that couples to the cigarette lighter. Accordingly, a 12VDC input socket may be used to recharge the compact battery charger 102 to a point where the compact battery charger 102 is charged. The compact battery charger 102 may then be used to jump start a vehicle having an external battery 104. In certain aspects, the compact battery charger 102 may be charged through the clamps, which may be retractable and/or configured to be housed in a recess of the compact battery charger 102's housing. For example, charging may be accomplished by leaving the relay closed, thereby allowing the alternator in the vehicle, which can provide up to 70A, to rapidly charge the internal battery 150. Thus, the compact battery charger 102 may be configured to sense the current in a bidirectional manner through the clamps (*e.g.*, (1) to measure current going from the compact battery

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charger 102 into the external battery 104, and (2) from the external battery 104 into the compact battery charger 102). To prevent overheating when current is passing into the compact battery charger 102, a temperature sensor may be coupled to the compact battery charger 102, whereby the relay is shut off if the compact battery charger 102, or the internal battery 150, reaches a predetermined shut-off temperature threshold. Indeed, a benefit of maximizing the amount of current going back into the compact battery charger 102 is that it yields a faster charge.

[0066] In lieu of clamps, the compact battery charger 102's charger cables may be fixedly coupled to the external battery 104 (*e.g.*, via a bolt and ring terminals) and configured to quick connect to compact battery charger 102 (*e.g.*, using quick connects/disconnect connectors). In certain instances, the quick connect connectors may not be compatible with different devices. For example, a battery maintainer (a/k/a trickle charger) may use a first type of connector, while a compact battery charger 102 may use a second type of connector. Such issues are common between different manufacturers. Due to the inconvenience of disconnecting and reconnecting the fixedly coupled connections, it may be advantageous to use a charger cable that fixedly couples to the external battery 104 at one end, but provides a plurality of different connectors at the second end. For example, the first end may be fixedly coupled to a battery terminal through the ring terminals, while the second end may be provided with two connecters, namely (1) an EC5 (male) connector configured to couple with an EC5 (female) connector of the compact battery charger 102 and (2) a second (male) connector configured to couple with a second (female) connector of a battery charger/maintainer. One or more end caps may be further provided to protect the unused connector from dirt and debris. Such a charger cable would be of particular use for vehicles that are not often used and typically require jump starting. While two connectors are described, such a charger cable need not be limited to two connectors, nor should it be limited to the example connector types described.

[0067] In another alterative, the entire compact battery charger 102 may be permanently coupled to an external battery 104 or a vehicle's electrical system (*e.g.*, installed under the hood or inside the vehicle). For example, the compact battery charger 102 may be fixedly coupled to the vehicle and remotely actuated using a physical button or controller (*e.g.*, one positioned under the hood, on the dashboard, in the glove box, etc.), or wirelessly. When integrated with the vehicle, the compact battery charger's 102 housing may be fabricated to mitigate damage from engine temperature or engine fluids. Wireless control may be accomplished using, for example, a portable electronic device 152 that is communicatively coupled to the compact battery charger 102 via a

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communication network. For instance, a smart phone may wirelessly send a signal to the compact battery charger 102, either directly or through the vehicle's control system, which causes the compact battery charger 102 to output boosting energy or charging energy to the external battery 104 of the vehicle. The wireless communication may employ one or more wireless standards such as Bluetooth (*e.g.*, short-wavelength, UHF radio waves in the ISM band from 2.4 to 2.485 GHz), NFC, Wi-Fi (*e.g.*, IEEE 802.11 standards), etc. When permanently coupled to the external battery 104 or vehicle's electrical system, the compact battery charger 102 may charge the internal battery 150 when the vehicle is running via the vehicle's electrical system (*e.g.*, 12VDC supply).

[0068] In certain aspects, the supercapacitor 308 may be integrated with the vehicle's electrical system and configured to receive any residual power from the vehicle's accessories for use in jump starting the vehicles. For example, vehicles often have sufficient power to power the vehicle's entertainment system, but insufficient power to turn over the engine. In this example, the power may be diverted from the entertainment system (or other accessory or auxiliary system) at the press of a button and used to charge an integrated supercapacitor, which may be used to jump start the vehicle.

[0069] In certain aspects, the compact battery charger 102 may employ inductive charging to facilitate wireless charging of the internal battery 150. For example, the compact battery charger 102 may be placed on a corresponding charging inductor pad to charge the compact battery charger 102's internal battery 150. In one aspect, the charging inductor pad may comprise an induction coil that creates an alternating electromagnetic field from within a charging inductor pad and a second induction coil in the compact battery charger 102 that receives power from the electromagnetic field and converts the received power into electric current to charge the internal battery 150. The two induction coils in proximity combine to form an electrical transformer. Greater distances between transmitter and receiver coils can be achieved when the inductive charging system uses resonant inductive coupling. The coils may be fabricated using a number of materials, such as silver plated copper (or aluminum) to minimize weight and decrease resistance resulting from the skin effect. The charging inductor pad and the compact battery charger 102 may operate in compliance with one or more wireless power transfer standards, such as the Power Matters Alliance (PMA) under the IEEE Standards Association (IEEE-SA) Industry Connections, Rezence, and Qi. The PMA interface standard describes analog power transfer (inductive and resonant), digital transceiver communication, cloud based power management, and environmental sustainability.

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[0070] Rezence is an interface standard developed by the Alliance for Wireless Power (A4WP) for wireless electrical power transfer based on the principles of magnetic resonance. The Rezence system comprises a single power transmitter unit (PTU) and one or more power receiver units (PRUs). The interface standard supports power transfer up to 50 Watts, at distances up to 5 centimeters. The power transmission frequency is about 6.78 MHz, and a plurality of devices can be powered from a single PTU depending on transmitter and receiver geometry and power levels. To use the Rezence system, the compact battery charger 102 (*i.e.*, PRU) is placed on top of the charging inductor pad (*i.e.*, PTU), which charges the compact battery charger 102's internal battery 150 via resonant inductive coupling. In addition to power transfer, the Rezence system may be used to transfer data from the compact battery charger 102 (*e.g.*, from the internal data storage device 122) to another device via the charging inductor pad. There exists, however, overlap between the PMA and Rezence specifications. For instance, PMA adopted the Rezence specification as the PMA magnetic resonance charging specification for both transmitters and receivers in both single and multi-mode configurations, while Rezence adopted the PMA inductive specification as a supported option for multi-mode inductive, magnetic resonance implementations. Akin to Rezence, Qi is an interface standard developed by the Wireless Power Consortium for inductive electrical power transfer over distances of up to 4 centimeters. The Qi system comprises a PTU and a PRU. To use the Qi system, the compact battery charger 102 (*i.e.*, PRU) is placed on top of the charging inductor pad (*i.e.*, PTU), which charges the compact battery charger 102's internal battery 150 via resonant inductive coupling.

[0071] Inductive charging offers advantages to the compact battery charger 102, beyond convenience of use. First, the connections on both the compact battery charger 102 and charging inductor pad are enclosed; therefore corrosion is avoided (or mitigated) because any electronic components are protected from water and oxygen in the atmosphere. Moreover, to mitigate water damage, the compact battery charger 102's housing may be waterproof and buoyant to facilitate, for example, marine applications. Second, inductive charging also lends durability to the compact battery charger 102 because the need to plug and unplug the device is obviated, resulting in significantly less wear and tear on the socket of the device and the attaching cable.

[0072] In certain aspects, the compact battery charger 102 may employ solar cells to facilitate a charging of the internal battery 150 and/or supercapacitor 308. The solar cell may be provided as a separate solar cell panel, or integrated with the compact battery charger 102. For example, solar cells may be positioned on an exterior surface of the compact battery charger's 102 housing or, when

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integrated with a vehicle, the solar cell may be positioned on the vehicle, such as the roof, hood, trunk, windows, etc.

[0073] The compact battery charger 102's housing may further comprise a metal (*e.g.*, aluminum) plate on a back side to facilitate exterior warming of the interior battery 150 via the user's hand. Conversely, a button may be provided on the user interface 138 that causes power to be diverted from the interior battery 150 to a heating apparatus, such as a flexible heater. Flexible heaters can conform to a surface, such as a the compact battery charger 102. Example flexible heaters include silicone rubber heaters, polyimide film heaters, heating tapes, etc. Suitable flexible heaters include, for example, polyimide film insulated flexible heaters, such as those available from OMEGA Engineering Inc, and Kapton heaters (a form of ultra-thin, ultra-flexible, semitransparent, lightweight heaters), such as those available from Bucan Electric Heating Devices Inc.

[0074] The DC power may be output to the external battery 104 or other devices by way of a DC output terminal 136 (*e.g.*, battery terminal cables/clamps). Thus, power management circuit 132 and processor 128 may control the charging operation of the external battery 104 to provide charging, maintaining, and, in certain embodiments, the jump start function. Further, power management circuit 132 and processor 128 may facilitate reverse hook-up protection, as well as automatic nominal battery voltage detection. While the power management circuit 132 and processor 128 are illustrated as separate components, one of skill in the art would appreciate that power management functionality (*e.g.*, battery charging, battery maintaining, etc.) may be provided as a single component that combines the functionality of the power management circuit 132 and processor 128.

[0075] The output power may be controlled by software (*e.g.*, via a relay, MOSFET, and/or a silicon-controlled rectifier). The output power may be controlled using one or more parameters, such as maximum current over time, maximum temperature of battery, maximum time alone and/or minimum voltage (with or without time). Thus, when a parameter value is exceeded (or a requirement isn't met), the output voltage may be shut off. The compact battery charger 102 may include the ability to sense, or otherwise detect, that a battery (or other load/power supply) is coupled to the clamps. When a battery is not detected, the power may be shut off; however, the user may be provided with a manual override option (*e.g.*, by holding a button for a predetermined amount of time, such as 2 to 10 seconds, or about 5 seconds). In certain aspects, the compact battery charger 102 may not charge an external battery 104 when the external battery 104 is too hot or cold, thereby avoiding potential hazards and maintaining efficiency.

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[0076] The compact battery charger 102 may further include the ability to sense the occurrence of a manual override, and, if voltage is still 0 after engine start, the user may be instructed to check and replace the vehicle battery. Further, an automatic shut-off function may be provided if a battery/load/power supply is not attached to the clamps within a predetermined amount of time (*e.g.*, about 1 to 60 minutes, more preferably about 5 to 30 minutes, most preferably about 15 minutes). The compact battery charger 102 may further preheat a cold battery by, for example, running amperes though the battery, or an internal heater. The compact battery charger 102 may further employ alternate power sources, such as a solar panel to enable battery maintaining and charging, as well as data monitoring through solar panels (*e.g.*, one or more 12-14 Watt panels). For example, solar cells may be used to charge or maintain fleet vehicles, such as vehicle dealership fleets, rental vehicles fleets, etc.

[0077] To use the jump start function, the DC output terminal 136 may be coupled to the external battery 104 (*i.e.*, the battery to be charged/jumped, whether directly or indirectly) and the user interface 138 may be used to activate the boost feature. If the compact battery charger 102 is being charged when the jump start function is selected, the display device 114 may indicate that the jump start function cannot be performed while the compact battery charger 102 is charging. If the clamps are improperly connected (*e.g.*, reverse polarity or disconnected), an aural alarm may sound, and the display device 114 may display a warning message, such as "Warning – Reverse Polarity" or "Warning - Battery Disconnected." Conversely, if the clamps are properly connected and the compact battery charger 102 is ready for use, the display device 114 may display a standby message, such as "Jump Start Ready."

[0078] If the compact battery charger 102's jump start function is attempted twice within a predetermined time period (*e.g.*, a minute), the jump start function may be prohibited until the compact battery charger 102 has cooled down. During the cool down period, the display device 114 may display a cool down message, which may also indicate the remaining time for the cool down period.

[0079] If the external battery 104's voltage is too low for the compact battery charger 102 to detect that the clamps are connected, a manual start procedure (*e.g.*, the manual override) may be selected to enable the jump start function. To use the manual start procedure, the DC output terminal 136 may be coupled to the external battery 104 and the user interface 138 may be used to activate the boost feature. For example, the same button may be used to trigger the jump start function, but

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instead of a momentary press, the button may be pressed and held for a predetermined period of time (*e.g.*, about 2 to 10 seconds, more preferably about 5 seconds) until the display device 114 displays the standby message. In certain aspects, the manual start procedure may override safety features to ensure that power is delivered regardless of connection status. Accordingly, the compact battery charger 102 may energize the clamps and cause sparking if they are touched together (*i.e.*, shorted).

[0080] Figure 2 illustrates a flow diagram 200 of an example method for providing the jump start function using a compact battery charger 102. The process starts at step 202, which may be initiated by the user actuating a jump start function button on the user interface 138. At step 204, the compact battery charger 102's processor 128 determines, using one or more sensors, whether the temperature of the internal battery 150 is within an operating range. For example, if the temperature of the internal battery 150 exceeds a first predetermined shut-off temperature threshold, a warning is provided at step 220 indicating that the internal battery 150 is too hot. Similarly, if the temperature of the internal battery 150 does not meet a first predetermined shut-off temperature threshold, a warning is provided at step 220 indicating that the internal battery 150 is too cold. Otherwise, the process proceeds to the next step.

[0081] At step 206, the compact battery charger 102's processor 128 determines whether the state of charge for the internal battery 150 is within an operating range. For example, if the internal battery 150's state of charge does not meet a predetermined charge level threshold, a warning is provided at step 220 indicating that the internal battery 150 is not adequately charged. Otherwise, the process proceeds to the next step.

[0082] At step 208, the compact battery charger 102's processor 128 determines whether the internal battery 150 is being charged. If the internal battery 150's is being charged, a warning is provided at step 220 indicating that the internal battery 150 is being charged and cannot be used to provide the jump start function. Otherwise, the process proceeds to the next step.

[0083] At step 210, the compact battery charger 102's processor 128 determines whether an external battery 104 is coupled to the compact battery charger 102 (*e.g.*, via clamps coupled to the DC output terminal 136). If no external battery 104 is detected (*e.g.*, by measuring a voltage or resistance across the battery terminals), a warning is provided at step 220 indicating that the external battery 104 is not detected. Otherwise, the process proceeds to the next step.

[0084] At step 212, the compact battery charger 102's processor 128 determines whether an accessory is currently coupled to, or otherwise using, the compact battery charger 102 (*e.g.*, via DC

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output terminal 136 or an AC output terminal). If an accessory is detected (*e.g.*, by detecting a load or other current draw at an output terminal), a warning is provided at step 220 indicating that the internal battery 150 is in use and cannot be used to provide the jump start function. Otherwise, the process proceeds to the next step.

[0085] At step 214, the compact battery charger 102's processor 128 determines whether an external battery 104 is properly coupled to the compact battery charger 102. If a reverse polarity condition is detected for the external battery 104, a warning is provided at step 220 indicating that the external battery 104 is improperly connected. Otherwise, the process proceeds to the next step.

[0086] At step 216, the compact battery charger 102's processor 128 determines whether the compact battery charger 102 is in a cool down period. For example, as noted above, if the compact battery charger 102's jump start function is attempted twice within a predetermined time period (*e.g.*, a minute), the jump start function may be prohibited until the compact battery charger 102 has cooled down (*i.e.*, the predetermine time period has elapsed). Accordingly, if the jump start function has been performed within a predetermined period of time, a warning is provided at step 220 indicating a cool down message, which may also indicate the remaining time for the cool down period. After the predetermined time period has elapsed at step 222 (*e.g.*, using a timer), the process may proceed to the next step.

[0087] At step 218, the compact battery charger 102 is ready to perform the jump start function, whereby boosting energy may be output to the external battery 104 upon actuating the jump start function button on the user interface 138, or automatically. The boosting energy may be provided for a predetermined period of time, before shutting off. For example, the boosting energy may be provided for 1 to 60 seconds, more preferably 5 to 30 seconds.

[0088] A warning may be provided at step 220 via one or more of a display device 114, a speaker 124, or to another device (*e.g.*, a portable electronic device 152) via a communication network. The message may indicate to the user one or more statuses/conditions of the internal battery 150, external battery 104, and/or of the compact battery charger 102, such as those illustrated in Table A.

[0089] At step 224, the process may be reset such that the process is repeated. The reset feature may be manually triggered (*e.g.*, via a button) or automatically once a predetermined condition is met. For example, if the temperature of the internal battery 150 is outside of the operating

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range, the system may be automatically reset once the temperature of the internal battery 150 returns to the operating range. If a reset is not selected at step 224, the processed exits at step 226.

[0090] In certain aspects, a manual override option may be selected (*e.g.*, at any time) that causes the compact battery charger 102 to proceed to step 218, the compact battery charger 102 is ready to perform the jump start function, regardless of the status of the internal battery 150, external battery 104, or of the compact battery charger 102. Further, the compact battery charger 102's processor 128 determines whether the voltage of the internal battery 150 or the external battery 104 exceeds a predetermined threshold, in which case charging and/or boosting is prohibited to prevent overcharging.

[0091] The above-cited patents and patent publications are hereby incorporated by reference in their entirety. Although various embodiments have been described with reference to a particular arrangement of parts, features, and the like, these are not intended to exhaust all possible arrangements or features, and indeed many other embodiments, modifications, and variations will be ascertainable to those of skill in the art. Thus, it is to be understood that the invention may therefore be practiced otherwise than as specifically described above.

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What is claimed is:

Claim 1. A compact battery booster comprising:

a processor;

a display device operatively coupled to the processor, wherein the display device displays a status of the compact battery booster;

a storage capacitor and an internal lithium ion battery, each of said storage capacitor and said internal lithium ion battery configured to provide a boosting energy to a vehicle coupled to an external battery;

a direct current (DC) output terminal configured to electrically couple with the external battery;

a single-ended primary-inductor converter configured to receive a variable input voltage between 5 volts DC and 20 volts DC and to output a predetermined output voltage to said storage capacitor and said internal lithium ion battery; and

a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said storage capacitor or said internal lithium ion battery, thereby providing the boosting energy from said storage capacitor or said internal lithium ion battery to said vehicle.

Claim 2. The compact battery charger of claim 1, wherein the storage capacitor is a supercapacitor.

Claim 3. The compact battery charger of claim 1, wherein the storage capacitor draws a charging current from the external battery.

Claim 4. A compact battery charger comprising:

a processor;

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a display device operatively coupled to the processor, wherein the display device displays a status of the compact battery charger;

an internal lithium ion battery, said internal lithium ion battery configured to provide a predetermined output energy;

a direct current (DC) output terminal, wherein the DC output terminal is configured to couple with an external battery;

a single-ended primary-inductor converter configured to receive an input voltage within predetermined input voltage range and to output a predetermined charge voltage to said internal lithium ion battery; and

a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said internal lithium ion battery, thereby providing the predetermined output energy from said internal lithium ion battery to said external battery.

Claim 5. The compact battery charger of claim 4, further comprising a supercapacitor, wherein the single-ended primary-inductor converter charges the supercapacitor.

Claim 6. The compact battery charger of claim 4, further comprising a supercapacitor, wherein the supercapacitor draws current from the external battery to charge the supercapacitor.

Claim 7. The compact battery charger of claim 4, wherein the predetermined input voltage range is 5 volts to 20 volts.

Claim 8. The compact battery charger of claim 4, wherein the predetermined charge voltage is greater than the input voltage.

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Claim 9. The compact battery charger of claim 4, wherein the predetermined output energy is a boosting energy for starting an engine coupled to the external battery.

Claim 10. The compact battery charger of claim 4, wherein the predetermined output energy is a charging energy for charging the external battery.

Claim 11. The compact battery charger of claim 4, further comprising (1) a reverse polarity sensor configured to detect a polarity of the external battery; (2) a temperature sensor configured to detect a temperature of said internal lithium ion battery and to provide a temperature signal to said processor; and (3) a voltage sensor configured to detect a voltage of said internal lithium ion battery.

Claim 12. The compact battery charger of claim 4, further comprising a removable internal data storage device.

Claim 13. The compact battery charger of claim 4, further comprising an internal induction coil, wherein the internal induction coil receives energy from an electromagnetic field created by an external induction coil and converts the electromagnetic field to produce the input voltage.

Claim 14. The compact battery charger of claim 4, further comprising a second DC output terminal, wherein the DC output terminal provides a boosting energy for starting an engine coupled to the external battery, and wherein the second DC output terminal provides a charging energy to a portable electronic device.

Claim 15. The compact battery charger of claim 14, wherein said second DC output terminal is a Universal Serial Bus (USB) port.

Claim 16. The compact battery charger of claim 4, wherein the display device enters into a sleep mode after a predetermined time period of inactivity.

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Claim 17. The compact battery charger of claim 4, wherein the DC output terminal runs a predetermined current through the external battery to preheat the external battery.

Claim 18. The compact battery charger of claim 4, further comprising a DC to alternating current (AC) converter coupled between the internal lithium ion battery and an AC output terminal.

Claim 19. The compact battery charger of claim 4, further comprising an internal data storage device, wherein the internal data storage device backs up digital content stored to a portable electronic device via a USB port.

Claim 20. A compact battery charger comprising:

an internal lithium ion battery, said internal lithium ion battery configured to provide a predetermined output energy;

a direct current (DC) output terminal, wherein the DC output terminal is configured to couple with an external battery;

an internal induction coil, wherein the internal induction coil receives energy from an electromagnetic field created by an external induction coil and converts the electromagnetic field to produce an input voltage;

a DC to DC converter that receives the input voltage and outputs a predetermined output voltage to said internal lithium ion battery; and

a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said internal lithium ion battery, thereby providing the predetermined output energy from said internal lithium ion battery to said external battery.

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Claim 21. The compact battery charger of claim 19, further comprising a removable data storage device.

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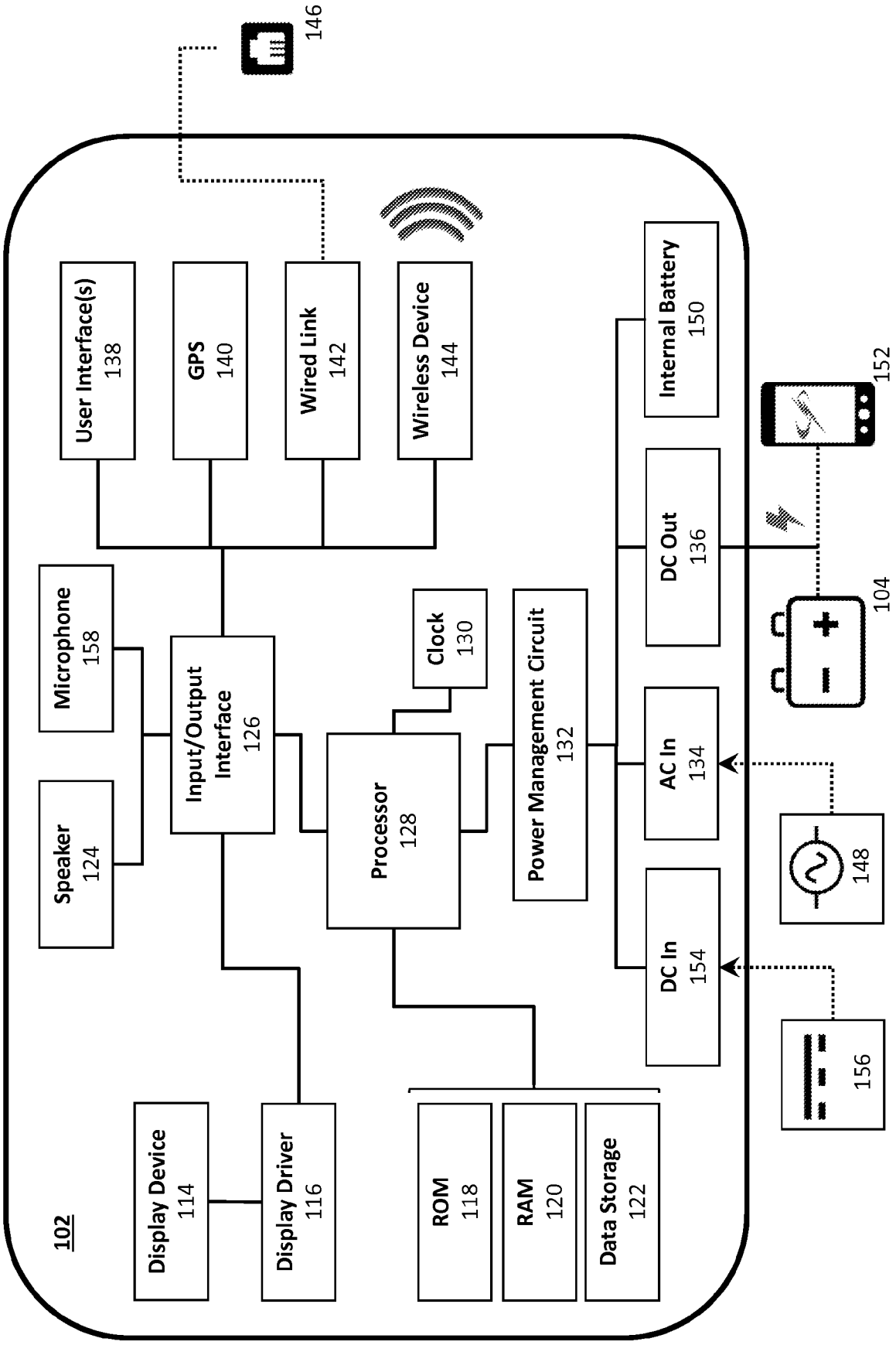

146
User Interface(s) 138
GPS 140
Wired Link 142
Wireless Device 144
Internal Battery 150
152
Microphone 158
Input/Output Interface 126
Clock 130
Power Management Circuit 132
DC Out 136
104
Speaker 124
Processor 128
AC In 134
148
DC In 154
156
102
Display Device 114
Display Driver 116
ROM 118
RAM 120
Data Storage 122

Figure 1

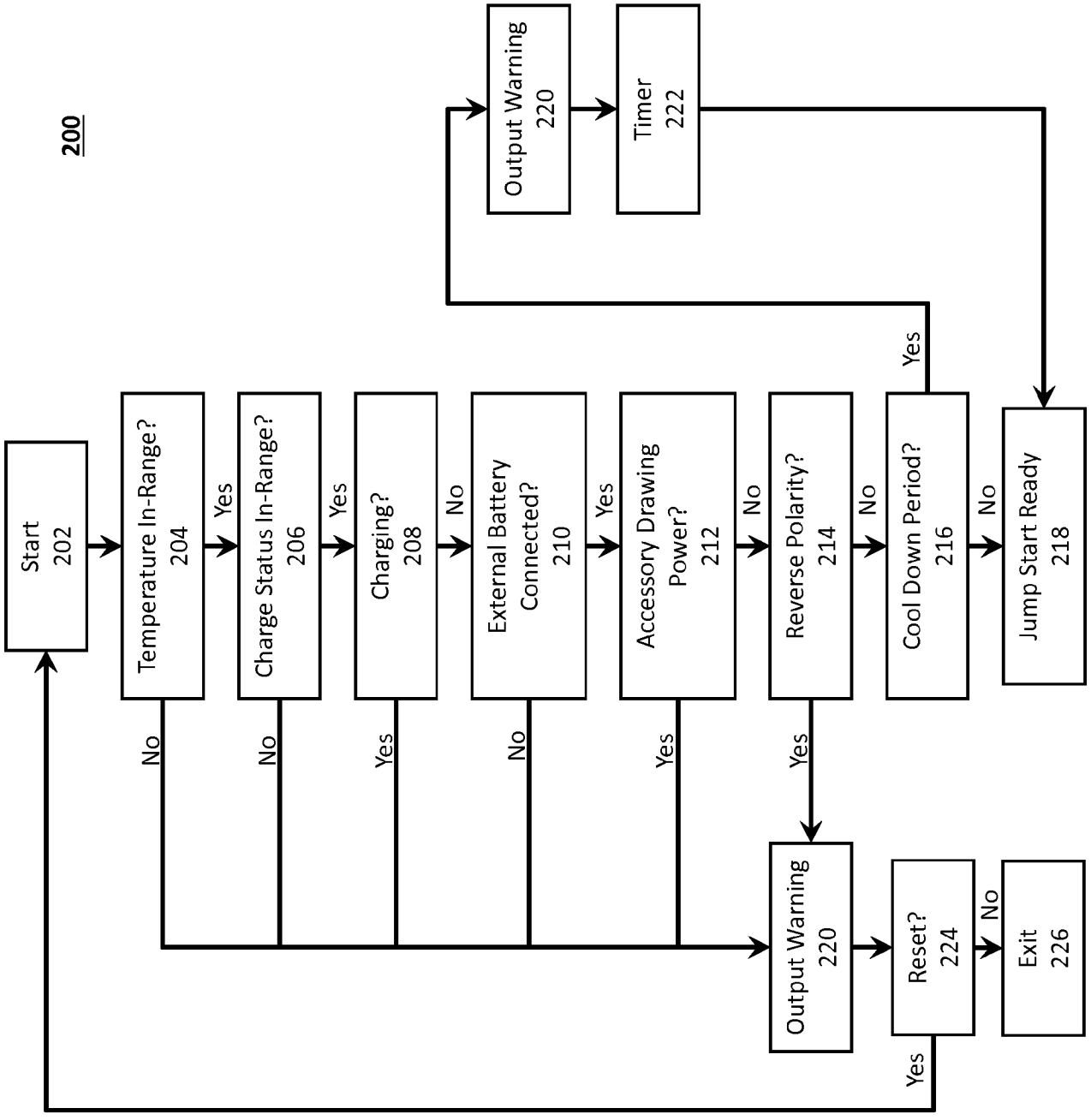

200
Start 202
Temperature In-Range? 204
Charge Status In-Range? 206
Charging? 208
External Battery Connected? 210
Accessory Drawing Power? 212
Reverse Polarity? 214
Cool Down Period? 216
Jump Start Ready 218
Output Warning 220
Timer 222
Reset? 224
Exit 226
Yes
No

Figure 2

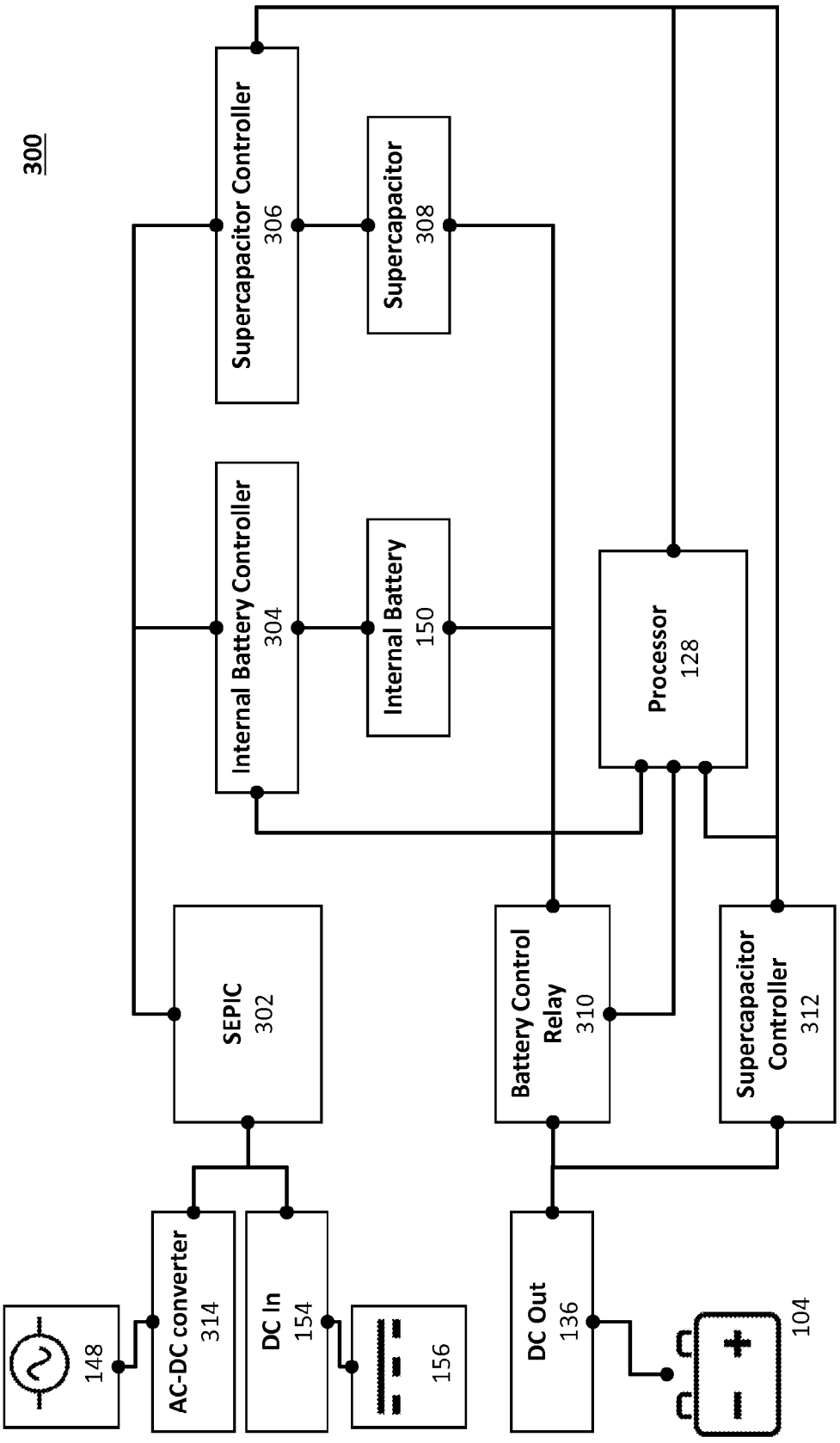

300
Supercapacitor Controller 306
Supercapacitor 308
Internal Battery Controller 304
Internal Battery 150
Processor 128
SEPIC 302
Battery Control Relay 310
Supercapacitor Controller 312
148
AC-DC converter 314
DC In 154
156
DC Out 136
104

Figure 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/045335

A. CLASSIFICATION OF SUBJECT MATTER
IPC (2015.01) H02M 3/18, H02J 7/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC (2015.01) H02M 3/18, H02J 7/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Databases consulted: THOMSON INNOVATION, Esp@cenet, Google Patents, Google Scholar, FamPat database
Search terms used: battery, booster, starter, crank, auxiliary power unit (APU), ground power unit (GPU), Supercapacitor (SC), electric double-layer capacitor (EDLC), ultracapacitor, Pseudocapacitance, Processor, display, user interface (UI), DC/DC converter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012068662 A1 DURANDO RONALD A [US]; ALLEN FRED?[US]; SIMON STEVE [US]; ERGUL NECDET [US]; MPHASE TECHNOLOGIES INC 22 Mar 2012 (2012/03/22) Entire document	1-21
A	US 2013264875 A1 MAXWELL TECHNOLOGIES INC [US] 10 Oct 2013 (2013/10/10) Figs 11-15	1-21
A	US 2011100735 A1 ISE CORP [US] 05 May 2011 (2011/05/05) Figs 1-7	1-21
A	US 2010315046 A1 TPL INC [US] 16 Dec 2010 (2010/12/16) Fig 3	1-21
A	US 2008246443 A1 DOLJACK FRANK ANTHONY, COOPER TECHNOLOGIES COMPANY 09 Oct 2008 (2008/10/09) Figs 1B, 5-6	1-21

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
10 Nov 2015	23 Nov 2015
Name and mailing address of the ISA: Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616	Authorized officer COHAY Mattan Telephone No. 972-2-5651611

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2015/045335

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Information on patent family members

International application No.
PCT/US2015/045335

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		WO 2008124510 A1	16 Oct 2008

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	892	08/23/2021	054985-000055-US-02-01
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Application Serial No: 16/819,831

Attorney Docket No: 054985-000055-US-02-01
Customer Number: 20230
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 054985-000055-US-02-01

Application Number: 16/819,831

Filed: March 16, 2020

For: PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Art Unit: 2859

Examiner: DIAO

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$220	$110	$55	$
☑ Two months (37 CFR 1.17(a)(2))	$640	$320	$160	$ 320
☐ Three months (37 CFR 1.17(a)(3))	$1,480	$740	$370	$
☐ Four months (37 CFR 1.17(a)(4))	$2,320	$1,160	$580	$
☐ Five months (37 CFR 1.17(a)(5))	$3,160	$1,580	$790	$

☑ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☐ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number _____.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☐ attorney or agent of record. Registration number _____.

☑ attorney or agent acting under 37 CFR 1.34. Registration number 32422.

/Wiliam L. Klima/ — Signature

December 27, 2021 — Date

William L. Klima — Typed or printed name

202-467-8800 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	16819831
Filing Date:	16-Mar-2020
Title of Invention:	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION
First Named Inventor/Applicant Name:	Jonathan Lewis NOOK
Filer:	William Leonard Klima/Lisa Elliott
Attorney Docket Number:	054985-000055-US-02-01

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2202	2	50	100
INDEPENDENT CLAIMS IN EXCESS OF 3	2201	1	240	240
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 2 months with $0 paid	2252	1	320	320
Miscellaneous:				
		Total in USD ($)		**660**

Electronic Acknowledgement Receipt

EFS ID:	44611079
Application Number:	16819831
International Application Number:	
Confirmation Number:	1630
Title of Invention:	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION
First Named Inventor/Applicant Name:	Jonathan Lewis NOOK
Customer Number:	20230
Filer:	William Leonard Klima/Lisa Elliott
Filer Authorized By:	William Leonard Klima
Attorney Docket Number:	054985-000055-US-02-01
Receipt Date:	27-DEC-2021
Filing Date:	16-MAR-2020
Time Stamp:	12:17:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$660
RAM confirmation Number	E2021BQC17494635
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	RNFOA.pdf	202924 cdee19e59a31fe80b78059fffe469013c4459adc	no	25
Warnings:					
Information:					
2	Extension of Time	EOT.pdf	164969 f845709df8a01aa0aa1f9d7c8a5ecac7edeab2e0	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	42747 06061ca77f5b020b21f9de52806455b30b2a0af6	no	2
Warnings:					
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		Total Files Size (in bytes):	410640		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
NOOK et al.
Appl. No.: 16/819,831
Filing Date: March 16, 2020
Exam: DIAO
Art Unit: 2859
Conf.: 1630
Title: **PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION**

AMENDMENT AND RESPONSE

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22315

Dear Commissioner:

This paper is submitted in response to the Non-Final Office Action dated August 23, 2021, making a response due on or before November 23, 2021. Accordingly, this paper is timely filed.

Amendments to the claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

1.-23. (Cancelled)

24. (Currently amended) A jump starter apparatus for boosting or charging a depleted or discharged battery having a positive battery terminal and a negative battery terminal, the apparatus comprising:

a power supply;

a positive battery terminal connector for electrically connecting the jump starter apparatus to the positive battery terminal of the depleted or discharged battery;

a negative battery terminal connector for electrically connecting the jump starter apparatus to the negative battery terminal of the depleted or discharged battery;

a power switch configured to electrically connect the power supply to the depleted or discharged battery when boosting or charging the depleted or discharged battery; and

a control system or circuit electrically connected to and controlling the power switch, the control system or circuit configured to automatically detect both presence ~~of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and to detect~~ and polarity of the depleted or discharged battery when the depleted or discharged battery is electrically connected between the positive and negative battery terminal connectors and the jump starter apparatus becomes operational or is turned-on, ~~the control system or circuit switching~~ and then

automatically switching on power from the power supply to the depleted or discharged battery only when the presence of the depleted or discharged battery connected between the positive and negative terminal connectors is detected and a proper polarity connection between the positive and negative battery terminal connectors and the positive and negative battery terminals of the depleted or discharged battery is detected.

~~the following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are connected to the depleted or discharge battery; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity.~~

25. (Currently amended) A jump starter apparatus for boosting or charging a depleted or discharged battery having a positive battery terminal and a negative battery terminal, the apparatus comprising:

a power supply;

a positive battery terminal connector for electrically connecting the jump starter apparatus to the positive battery terminal of the depleted or discharged battery;

a negative battery terminal connector for electrically connecting the jump starter apparatus to the negative battery terminal of the depleted or discharged battery;

a power switch configured to electrically connect the power supply to the depleted or discharged battery when boosting or charging the depleted or discharged battery; and

a control system or circuit electrically connected to and controlling the power

switch, the control system or circuit configured to automatically detect both presence ~~of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and to detect~~ and polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit automatically detecting both presence and polarity of the connection between the positive and negative battery terminal connectors and the depleted or discharged battery when the jump starter apparatus becomes operational or is turned-on, and then the control system or circuit automatically switching on power from the power supply to the depleted or discharged battery only when the following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are connected to the depleted or discharge battery; and ii) the positive and negative battery terminal connectors are connected to the depleted or discharged battery with correct polarity.

26. (Currently amended) A jump starter apparatus for boosting or charging a depleted or discharged battery having a positive battery terminal and a negative battery terminal, the apparatus comprising:

a power supply;

a positive battery terminal connector for electrically connecting the jump starter apparatus to the positive battery terminal of the depleted or discharged battery;

a negative battery terminal connector for electrically connecting the jump starter apparatus to the negative battery terminal of the depleted or discharged battery;

a power switch configured to electrically connect the power supply to the

depleted or discharged battery when boosting or charging the depleted or discharged battery; and

a control system or circuit electrically connected to and controlling the power switch, the control system or circuit comprising both a presence circuit configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and a polarity circuit configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit automatically detecting both presence and polarity of the connection between the positive and negative battery terminal connectors and the depleted or discharged battery when the jump starter apparatus becomes operational or is turned on, and then the control system or circuit automatically switching on power from the power supply to the depleted or discharged battery only when the following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are connected to the depleted or discharge battery; and ii) the positive and negative terminal connectors are connected to the depleted or discharged battery with correct polarity.

27. (Currently amended) A jump starter apparatus for boosting or charging a depleted or discharged battery having a positive battery terminal and a negative battery terminal, the apparatus comprising:

a power supply;

a positive battery terminal connector for electrically connecting the jump starter

apparatus to the positive battery terminal of the depleted or discharged battery;

a negative battery terminal connector for electrically connecting the jump starter apparatus to the negative battery terminal of the depleted or discharged battery;

a power switch configured to electrically connect the power supply to the depleted or discharged battery when boosting or charging the depleted or discharged battery; and

a control system or circuit connected to and controlling the power switch, the control system or circuit comprising a presence circuit and a polarity circuit, the presence circuit comprising a presence sensor configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the polarity circuit comprising a polarity sensor configured to automatically detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit automatically detecting both presence and polarity of the connection between the positive and negative battery terminal connectors and the depleted or discharged battery when the jump starter apparatus becomes operational or is turned on, the control system or circuit automatically switching on power from the power supply to the depleted or discharged battery only when the following two (2) conditions are achieved, including i) the positive and negative battery terminal connectors are electrically connected to the depleted or discharge battery; and ii) the positive and negative battery terminal connectors are connected to the depleted or discharged battery with correct polarity.

28. (Cancelled)

29. (Currently amended) The apparatus according to claim 24, further comprising a manual switch to allow a user to manually switch on power from the power supply to the ~~deplete~~ depleted or discharged battery.

30. (Currently amended) The apparatus according to claim [[28]] 24, further comprising a manual switch to allow a user to manually switch on power from the power supply to the ~~deplete~~ depleted or discharged battery.

31. (Currently amended) The apparatus according to claim [[28]] 24, further comprising a manual switch to allow a user to override the automatic ~~switching~~ switch and manually switch on power from the power supply to the deplete or discharged battery.

32. (Previously presented) The apparatus according to claim 31, wherein the manual switch comprises a manual override button.

33. (Previously presented) The apparatus according to claim 32, wherein the manual switch is configured so that a user presses and holds down the manual override button for a predetermined period of time to prevent inadvertent actuation of a manual mode.

34. (Previously presented) The apparatus according to claim 24, further comprising a manual switch for manually switching on power from the power supply to the deplete or discharged battery in the event the control system or circuit is unable to automatically switch on power from the power supply to the depleted or discharged battery.

35. (Previously presented) The apparatus according to claim 29, wherein the manual switch is configured to prevent manual override if the depleted or discharged battery is connected in reverse to the positive and negative battery terminal connectors.

36. (Previously presented) The apparatus according to claim 29, wherein the manual switch is configured to allow a user to jump start a vehicle having either a missing battery, or the depleted or discharged battery of the vehicle having a battery voltage so low that automatic detection of the battery voltage and switching by the control system or circuit is not possible.

37. (Previously presented) The apparatus according to claim 24, wherein the control system or circuit comprises a presence circuit configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and a polarity circuit configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors.

38. (Previously presented) The apparatus according to claim 26, wherein the presence circuit comprises a presence sensor and the polarity circuit comprises a polarity sensor.

39. (Previously presented) The apparatus according to claim 26, wherein the presence circuit is a presence sensor and the polarity circuit is a polarity sensor.

40. (Previously presented) The apparatus according to claim 27, wherein the presence circuit comprises a presence sensor and the polarity circuit comprises a polarity sensor.

41. (Previously presented) The apparatus according to claim 27, wherein the presence circuit is a presence sensor and the polarity circuit is a polarity sensor.

42. (Previously presented) The apparatus according to claim 24, wherein the control system or circuit comprises a microcontroller.

43. (Previously presented) The apparatus according to claim 25, wherein the control system or circuit comprises a microcontroller.

44. (Previously presented) The apparatus according to claim 26, wherein the control system or circuit comprises a microcontroller electrically connected to and receiving inputs from the presence circuit and the polarity circuit.

45. (Previously presented) The apparatus according to claim 27, wherein the control system or circuit comprises a microcontroller electrically connected to and receiving inputs from the presence circuit and the polarity circuit.

46. (Previously presented) The apparatus according to claim 24, wherein the control system or circuit comprising a presence circuit or sensor configured to detect presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, a polarity circuit or sensor configured to detect polarity of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, and a microcontroller electrically connected to the presence circuit or sensor and the polarity circuit sensor and receiving signals from the presence circuit or sensor and the polarity circuit or sensor.

47. (Previously presented) The apparatus according to claim 42, wherein the control system or circuit is configured so that microcontroller determines when it is safe to turn on the power switch.

48. (Previously presented) The apparatus according to claim 47, wherein the control system or circuit is configured so that microcontroller software of the microcontroller determines when it is safe to turn on the power switch.

49. (Previously presented) The apparatus according to claim 42, wherein the microcontroller is a programmable microcontroller configured to allow updates in functionality and system parameters.

50. (Previously presented) The apparatus according to claim 42, wherein the microcontroller is a programmable microcontroller configured to allow updates in functionality and system parameters, without requiring any change in hardware.

51. (Previously presented) The apparatus according to claim 42, wherein the microcontroller comprises flash memory, and wherein the microcontroller with flash memory is used to control the control system or circuit.

52. (Previously presented) The apparatus according to claim 42, wherein the control system or circuit further comprises a voltage regulator providing regulation of internal operating voltage for the microcontroller and sensors.

53. (Previously presented) The apparatus according to claim 26, wherein the presence circuit comprises a first optically coupled isolator phototransistor and the polarity circuit comprises a second optically coupled isolator phototransistor.

54. (Currently amended) The apparatus according to claim 26, wherein the presence circuit further comprises a first diode connected between the first optically coupled phototransistor and the depleted or discharged battery, and the polarity circuit further

comprises a second diode connected between the second optically coupled phototransistor and the depleted or discharged battery.

55. (Previously presented) The apparatus according to claim 24, wherein the power supply is a rechargeable battery.

56. (Previously presented) The apparatus according to claim 55, wherein the rechargeable battery is a lithium ion rechargeable battery.

57. (Previously presented) The apparatus according to claim 56, wherein the lithium ion battery comprises a battery pack of multiple lithium ion batteries.

58. (Previously presented) The apparatus according to claim 24, wherein the power switch is a FET switch.

59. (Previously presented) The apparatus according to claim 58, wherein the FET switch comprises a plurality of FETs in parallel.

60. (Previously presented) The apparatus according to claim 24, wherein the positive battery terminal connector is a positive battery clamp releasably connectable to the positive terminal of the depleted or discharged battery, and wherein the negative battery terminal connector is a negative battery clamp releasably connectable to the negative terminal of the depleted or discharged battery.

61. (Previously presented) The apparatus according to claim 24, further comprising a plurality of power diodes coupled between an output of the jump starting apparatus to the depleted or discharged battery and the power supply to prevent back-charging of the power supply from an electrical system connected to the output.

62. (Previously presented) The apparatus according to claim 24, further comprising a temperature sensor configured to detect temperature of the power supply and to provide a temperature signal to a microcontroller.

63. (Previously presented) The apparatus according to claim 24, further comprising a voltage measurement circuit configured to measure output voltage of the power supply and to provide a voltage measurement signal to the microcontroller.

64. (Previously presented) The apparatus according to claim 24, further comprising a voltage regulator configured to convert output voltage of the power supply to a voltage level appropriate to provide operating power to internal components of the jump starting apparatus.

65. (Previously presented) The apparatus according to claim 26, wherein the polarity circuit is a reverse polarity circuit.

66. (Previously presented) The apparatus according to claim 26, wherein the polarity circuit comprises a reverse polarity sensor.

67. (Previously presented) The apparatus according to claim 24, wherein the positive battery connector and negative battery connector together form a jumper cable device comprising a plug connected to one of the cables and configured to plug into an output port of the battery jump starting apparatus.

68. (Previously presented) The apparatus according to claim 67, wherein an output port and the plug are dimensioned so that the plug fits into the output port only in one specific orientation.

69. (Previously presented) The apparatus according to claim 24, further comprising a USB charging port configured to provide charging power from an external power source to the power supply.

70. (Previously presented) The apparatus according to claim 69, further comprising a USB charging circuit connecting the USB charging port to the power supply.

71. (Previously presented) The apparatus according to claim 70, wherein the USB charging circuit comprises a DC-DC converter.

72. (Previously presented) The apparatus according to claim 71, wherein the DC-DC converter increases the voltage from a USB charger to charge the power supply.

73. (Currently amended) The apparatus according to claim 72, wherein the DC-DC converter is configured to convert 5V potential provided from a USB charger to 12.4VDC.

74. (Previously presented) The apparatus according to claim 70, wherein the DC-DC converter is configured to be turned on and off via a circuit by an output from a microcontroller.

75. (New) The apparatus according to claim 24, wherein the positive battery terminal connector is configured to directly or indirectly electrically connect the jump starter apparatus to the positive battery terminal of the depleted or discharged battery, and wherein the negative battery terminal connector is configured to directly or indirectly electrically connect the jump starter apparatus to the negative battery terminal of the depleted or discharged battery.

76. (New) The apparatus according to claim 24, further comprising another switch configured to turn on the jump starter apparatus to become operational.

77. (New) A jump starter apparatus, comprising:

a power supply;

a positive battery terminal connector;

a negative battery terminal connector;

a power switch configured to electrically connect the power supply to a depleted

or discharged battery; and

a control system or circuit electrically connected to and controlling the power switch, the control system or circuit configured to detect both presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and proper polarity between the positive and negative battery terminal connectors and the positive and negative battery terminals of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit is configured to automatically execute the following steps when the jump starting apparatus becomes operational or is turned on, including:

(i) detect the presence of the depleted or discharged battery connected between the positive and negative battery connectors;

(ii) detect the proper polarity of a depleted or discharged battery when connected between the positive and negative battery terminal connectors; and

(iii) switch on power from the power supply to the depleted or discharged battery only when both the presence of the depleted or discharged battery connected between the positive and negative battery terminal connectors is detected and a proper polarity connection between the positive and negative battery terminal connectors and the positive and negative battery terminals is detected.

Remarks

Upon entry of the above amendments, claims 24-27 and 29-77 are pending in the present application prior to entry of the above amendments to the claims.

Claims 1-23 have previously been cancelled without prejudice or disclaimer of the subject matter contained therein.

Claim 28 is now cancelled without prejudice or disclaimer of the subject matter contained therein.

Claims 24-27, 29, 30, 31, 54, and 73 are amended above, and claims 75-77 are newly added above. No new matter has been added.

Applicant, by amending any claims and/or canceling any claims, makes no admission as to the validity of any rejection made by the Examiner against any of these claims. Applicant reserves the right to reassert any of the claims canceled or the original or previous claim scope of any claim amended, during the prosecution of this application, in a continuing application. Further, Applicant acknowledges but does not acquiesce or agree with any Examiner assertion regarding this application and expressly reserves the right to rebut or otherwise address any such assertion.

In view of the following, further and favorable consideration is respectfully requested.

I. Objection to the claims - beginning on page 2

Claim 54 is missing a period at its end and thus is in an improper format. Additionally, the limitations of, "and the polarity circuit further comprises second diode connected between the second optically coupled phototransistor and the depleted or discharged battery" should read -- and the polarity circuit further comprises a second diode connected between the second optically coupled phototransistor and the depleted or discharged battery.--.

Please find amendments to the claim 54 filed herein.

In view of the foregoing, it is submitted that claims are no longer objectionable. Accordingly, reconsideration and withdrawal of this objection is respectfully requested.

II. Rejection under 35 USC § 102(a)(1): Claims 24-52,60,62-66 are rejected under 35 U.S.C. 102(a)(1)|(a)(2) as being anticipated by Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) - beginning on page 3

The Examiner asserts that Richardson teaches each and every element of each of claims 24-52, 60, and 62-66.

In view of the following, this rejection is respectfully traversed.

Richardson discloses a method and apparatus for providing supplemental power to an engine.

Importantly, the apparatus and method of ***Richardson***, requires an additional user interaction (i.e. additional step) to trigger the switch to close in addition to the step of turning-on the apparatus. Specifically, in ***Richardson***, after the apparatus is connected to the vehicle and turned-on, the user must attempt to start the vehicle by engaging the starter motor causing a voltage drop which is detected by the microcontroller at step 264 in FIG. 6 of ***Richardson***.

Thus, ***Richardson*** fails to teach each and every element of the presently claimed subject matter as required for anticipation under 35 USC § 102(a)(1). In particular, Richardson does not teach the claimed subject matter as required by present claims 24-52, 60, and 62-66, including "a control system or circuit electrically connected to and controlling the power switch, the control system or circuit configured to automatically detect both presence and polarity of the depleted or discharged battery when the depleted or discharged battery is electrically connected between the positive and negative battery terminal connectors and the jump starter apparatus becomes operational or is turned-on, and then automatically switching on power from the power supply to the depleted or discharged battery only when the presence of the depleted or discharged battery connected between the positive and negative terminal connectors is detected and a proper polarity connection between the positive and negative battery terminal connectors and the positive and negative battery terminals of the depleted or discharged battery is detected."

In view of the forgoing, Applicants submit that ***Richardson*** does not teach each and every element of the subject matter described in claims 24-52, 60, and 62-66, as required for anticipation under 35 USC § 102(a)(1). Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

III. Rejection under 35 USC § 103: Claims 53,58-59 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Krieger et al., (Krieger) US 2004/0130298(Exhibit 1009 on IPR2020-00944) - beginning on page 18

The Office Action asserts that "[I]t would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to incorporate the teaching of Krieger into the jump starter apparatus of Richardson . . ."

In view of the following, this rejection is respectfully traversed.

Regarding motivation to modify properly combined references, **MPEP 2143.01** states that a proposed modification cannot render the prior art unsatisfactory for its intended purpose. If it does, then there is no suggestion or motivation to make the proposed modification. Further, the proposed modification cannot change the principle operation of a reference.

Regarding teaching away, **MPEP 2141.02** states that prior art must be considered in its entirety, including disclosures that teach away from the claims. See also **MPEP 2145(X)(D)**.

Richardson has been discussed above, which discussion is incorporated herein in its entirety. As discussed above, ***Richardson*** fails to teach or suggest all of the limitations of the claims as required by In re Vaeck, because none of the foregoing references, taken alone or together, teach or suggest the base claimed subject matter of independent claim 24.

Krieger is cited in the rejection only for the purpose of disclosing a first and second optically coupled isolator phototransistor, and does not anything relevant to cure the deficiencies of ***Richardson*** to teach or suggest the base claimed subject matter of independent claim 24.

In view of the foregoing, it is submitted that nothing in Richardson and Krieger, taken alone or together, renders the presently claimed subject matter obvious within the meaning of 35 USC § 103. Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

IV. Rejection under 35 USC § 103: Claims 55-57 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Butler et al., (Butler) WO 2016/025869) - beginning on page 20

The Office Action asserts that "it would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have incorporated the teachings of Butler into the apparatus of Richardson by selecting a rechargeable lithium ion battery for the internal power supply since it is known in the art that lithium ion batteries have a sufficient and highly rated boost jump start energy."

In view of the following, this rejection is respectfully traversed.

Appropriate legal precedent is discussed above and is incorporated herein in its entirety by reference.

Richardson has been discussed above, which discussion is incorporated herein in its entirety. As discussed above, ***Richardson*** fails to teach or suggest all of the limitations of the claims as required by In re Vaeck, because none of the foregoing references, taken alone or together, teach or suggest the base claimed subject matter of independent claim 24.

Butler is cited in the rejections only for the purpose of disclosing a rechargeable lithium ion battery, and does not anything relevant to cure the deficiencies of ***Richardson*** to teach or suggest the base claimed subject matter of independent claim 24.

In view of the foregoing, it is submitted that nothing in Richardson and Butler, taken alone or together, renders the presently claimed subject matter obvious within the meaning of 35 USC § 103. Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

V. Rejection under 35 USC § 103: Claim 61 is rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Wanzong et al., (Wanzong) USPAT 5,319,298(Exhibit 1010 on IPR2021-00309) - beginning on page 20

The Office Action asserts that "it would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have included a plurality of power diodes like the single power diode disclosed by Wanzong into the apparatus of Richardson in order to prevent back-charging and damage to the charging circuit during or after [the] charging process."

In view of the following, this rejection is respectfully traversed.

Appropriate legal precedent is discussed above and is incorporated herein in its entirety by reference.

Richardson has been discussed above, which discussions are incorporated herein in their entirety. As discussed above, ***Richardson*** fails to teach or suggest all of the limitations of the claims as required by In re Vaeck, because none of the foregoing references, taken alone or together, teach or suggest the base claimed subject matter of independent claim 24.

Wanzong is cited in the rejection only for the purpose of disclosing an isolation diode 160, which acts as the power diode to prevent back-charging of the internal power supply from an electrical system connected to the output port.

Wanzong does not add anything relevant to cure the deficiencies of ***Richardson***, because Wanzong also does not teach or suggest the base claimed subject matter of independent claim 24.

In view of the foregoing, it is submitted that nothing in Richardson and Wanzong, taken alone or together, renders the presently claimed subject matter obvious within the meaning of 35 USC § 103. Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

VI. Rejection under 35 USC § 103: Claims 67-68 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Xinfang USPAT 9,506,446 Exhibit 1008 on IPR2020-01387) - beginning on page 21

The Office Action asserts that "it would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have incorporate the teachings of Xinfang into the apparatus of Richardson by having the positive battery connector and negative battery connector together form a jumper cable device comprising a plug connected to one of the cables and configured to plug into an output port of the battery jump starting apparatus, as recited so as to provide additionally convenience to users of using another commonly used power input for charging the jump starter device.

In view of the following, this rejection is respectfully traversed.

Appropriate legal precedent is discussed above and is incorporated herein in its entirety by reference.

Richardson has been discussed above, which discussions are incorporated herein in their entirety. As discussed above, ***Richardson*** fails to teach or suggest all of the limitations of the claims as required by In re Vaeck, because none of the foregoing references, taken alone or together, teach or suggest the base claimed subject matter of independent claim 24.

Xinfang is cited in the rejection only for the purpose of disclosing a jumper cable with a plug at one end and a pair of cables at the other end configured to be connected to terminals of a battery.

Xinfang does not add anything relevant to cure the deficiencies of Richardson, because Xinfang also does not teach or suggest the base claimed subject matter of independent claim 24.

In view of the foregoing, it is submitted that nothing in Richardson and Xinfang, taken alone or together, renders the presently claimed subject matter obvious within the meaning of 35 USC § 103. Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

VII. Rejection under 35 USC § 103: Claims 69-71, and 74 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362(Exhibit 1010 on IPR2020-01387) in view of Epower-20 Brochure (IPR2020-00944 Exhibit 1012) - beginning on page 22

The Office Action asserts that "[I]t would have been obvious to one having ordinary skill in the art before the effective filing date of the claimed invention to have incorporate the USB charging port providing charging power from an external power source to an internal power supply into the apparatus of Richardson as modified by Krieger so as to provide additional convenience to users of using another commonly used power input for charging the jump starter device."

In view of the following, this rejection is respectfully traversed.

Appropriate legal precedent is discussed above and is incorporated herein in its entirety by reference.

Richardson and ***Krieger*** have been discussed above, which discussions are incorporated herein in their entirety. As discussed above, ***Richardson*** and ***Krieger*** fail to teach or suggest all of the limitations of the claims as required by In re Vaeck, because none of the foregoing references, taken alone or together, teach or suggest the base claimed subject matter of independent claim 24.

Epower-20 Brochure does not add anything relevant to cure the deficiencies of Richardson, because Epower-20 Brochure also does not teach or suggest the base claimed subject matter of independent claim 24.

In view of the foregoing, it is submitted that nothing in ***Richardson and Epower-20 Brochure***, taken alone or together, renders the presently claimed subject matter obvious within the meaning of 35 USC § 103. Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

VIII. Rejection under 35 USC § 103: Claims 72-73 are rejected under 35 U.S.C. 103 as being unpatentable over Richardson et al., (Richardson) US 2009/0174362 (Exhibit 1010 on IPR2020-01387) in view of Epower-20 Brochure (IPR2020-00944 Exhibit 1012) and in further view of Tinaphong US 2011/0175461) - beginning on page 24

In view of the following, this rejection is respectfully traversed.

Appropriate legal precedent is discussed above and is incorporated herein in its entirety by reference.

Richardson and ***Epower-20 Brochure*** have been discussed above, which discussions are incorporated herein in their entirety. As discussed above, ***Richardson*** and ***Epower-20 Brochure***, taken alone or together, fails to teach or suggest all of the limitations of the claims as required by In re Vaeck, because none of the foregoing references, taken alone or together, teach or suggest the base claimed subject matter of independent claim 24.

Tinaphong is cited in the rejection only for the purpose of disclosing a USB input charge circuit connected to the power supply.

Tinaphong does not add anything relevant to cure the deficiencies of ***Richardson*** and ***Epower-20 Brochure***, because ***Tinaphong*** also does not teach or suggest the base claimed subject matter of independent claim 24.

In view of the foregoing, it is submitted that nothing in ***Richardson, Epower-20 Brochure*** and ***Tinaphong***, taken alone or together, renders the presently claimed subject matter obvious within the meaning of 35 USC § 103. Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

IX. Double Patenting: Claims 2 [24]-74 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-10,12-15,19-21,23, and 29-30,32-44,48-51 of copending Application No. 16/450,422 (reference application) - beginning at page 27

The Examiner states that Claims [24]-74 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-10,12-15,19-21,23, and 29-30,32-44,48-51 of copending Application No. 16/450,422 (reference application).

The Applicant respectfully requests that these rejections be held in abeyance until

an indication of allowable subject matter is made in this application, at which time the Applicant will either address these rejections or file a terminal disclaimer.

X. Allowable Subject Matter: Claim 54 - beginning at page 27

The Examiner asserts that Claim 54 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Please find amendments to the Claims filed herein.

In view of the foregoing, it is submitted that all claims are allowable. Accordingly, immediate indication of allowance is respectfully requested.

Conclusion

In view of the foregoing, Applicant submits that the application is in condition for immediate allowance. Early notice to that effect is earnestly solicited. The Examiner is invited to contact the undersigned attorney if it is believed that such contact will expedite the prosecution of the application.

In the event this paper is not timely filed, Applicant petitions for an appropriate extension of time. Please charge any fee deficiency or credit any overpayment to Deposit Account No. 22-0585.

Respectfully submitted,

VORYS, SATER, SEYMOUR and PEASE LLP

/William L. Klima/
William L. Klima, Registration No.: 32422
Customer No.: 20230

Date: December 27, 2021

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/819,831	03/16/2020	Jonathan Lewis NOOK	054985-000055-US-02-01	1630

20230 7590 01/31/2022

Vorys, Sater, Seymour and Pease LLP
1909 K St., NW
9th Floor
Washington, DC 20006-1152

EXAMINER	
DIAO, M BAYE	

ART UNIT	PAPER NUMBER
2859	

NOTIFICATION DATE	DELIVERY MODE
01/31/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patlaw@vorys.com

ADC EX1002
IPR2025-00885

Office Action Summary	Application No. 16/819,831	Applicant(s) NOOK et al.	
	Examiner M'BAYE DIAO	Art Unit 2859	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 12/27/2021.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 24-27 and 29-77 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 24-27 and 29-77 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 03/16/2020 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Amendment

2. Acknowledgement is made of amendment filed on 12/27/2021 in which claims 24-27, 29-31, 54, and 73 are currently amended, claims 1-23 and 28 have been canceled while claims 75-77 have been newly added. By this amendment, claims 24-27,29-77 are still pending in the application.

Claim Objections

3. Claims 31 and 34 are objected to because of the following informalities: In claim 31, for examination purpose, the limitations of, "the automatic switch" should and would read -- the automatic switching-- .

4. In claim 31, **replace** "deplete" **with** --depleted --.

5. In claim 34, **replace** "deplete" **with** --depleted --.

6. Appropriate correction is required.

Claim Rejections - 35 USC § 112

7. The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claims 31-33 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject

matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.

9. Claim 31 recites the limitations of, "the automatic switch". There is insufficient antecedent basis for this limitation in the claim.

10. Claims 32-33 depend either directly or indirectly from claim 31 and thus are rejected for the same reasons since they inherit the same deficiencies as their parent claim.

11. **Claims 24-74 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-10,12-15,19-21,23, and 29-30,32-44,48-51 of copending Application No. 16/450,422 (reference application)**. Although the claims at issue are not identical, they are not patentably distinct from each other because they two applications are directed to the same inventive concept. Rewriting or rearranging the terms in a claim would not make the two applications patentably distinct.

This is a nonstatutory double patenting rejection because the patentably indistinct claims have in fact been found patentable.

Allowable Subject Matter

12. Claims 24-27,29-77 (renumbered 1-53) would be allowable subjected to a timely filed and approved terminal disclaimer over copending application 16/450,422 now found allowable and subjected to obviating the 112(b) rejections over claims 31-33.

13. Regarding claims 24-27, the prior art of record either taken alone or in combination thereof fails to teach or reasonably suggest, in the claimed combination, *""a control system or circuit electrically connected to and controlling the power switch, the control system or circuit configured to automatically detect both presence and polarity of the depleted or discharged battery when the depleted or discharged battery is electrically connected between the positive*

and negative battery terminal connectors and the jump starter apparatus becomes operational or is turned-on, and then automatically switching on power from the power supply to the depleted or discharged battery only when the presence of the depleted or discharged battery connected between the positive and negative terminal connectors is detected and a proper polarity connection between the positive and negative battery terminal connectors and the positive and negative battery terminals of the depleted or discharged battery is detected".

14. Regarding claim 77, patentability exists at least in part, *"a control system or circuit electrically connected to and controlling the power switch, the control system or circuit configured to detect both presence of the depleted or discharged battery when connected between the positive and negative battery terminal connectors and proper polarity between the positive and negative battery terminal connectors and the positive and negative battery terminals of the depleted or discharged battery when connected between the positive and negative battery terminal connectors, the control system or circuit is configured to automatically execute the following steps when the jump starting apparatus becomes operational or is turned on, including: (i) detect the presence of the depleted or discharged battery connected between the positive and negative battery connectors; (ii) detect the proper polarity of a depleted or discharged battery when connected between the positive and negative battery terminal connectors; and (iii) switch on power from the power supply to the depleted or discharged battery only when both the presence of the depleted or discharged battery connected between the positive and negative battery terminal connectors is detected and a proper polarity connection between the positive and negative battery terminal connectors and the positive and negative battery terminals is detected".*

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Arguments

20. Applicant's arguments, see remarks, filed 12/27/2021, with respect to claims 24-27,29-77 have been fully considered and are persuasive. The previous art rejections have been withdrawn in view of the amendments. However, new rejection under 112(b) has been made in view of the amendments made to claim 31.

Conclusion

21. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

22. Any inquiry concerning this communication or earlier communications from the examiner should be directed to M'BAYE DIAO whose telephone number is (571)272-6127. The examiner can normally be reached M-F; 9:00AM-6:30PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DREW A DUNN can be reached on 571-272-2312. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

M'BAYE DIAO
Primary Examiner
Art Unit 2859

/M BAYE DIAO/
Primary Examiner, Art Unit 2859
January 25, 2022

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/819,831	NOOK et al.
	Examiner	Art Unit
	M'BAYE DIAO	2859

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	08/17/2021	01/25/2022							
	1	-	-							
	2	-	-							
	3	-	-							
	4	-	-							
	5	-	-							
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	24	✓	✓							
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	36	✓	✓							
	37	✓	✓							
	38	✓	✓							
	39	✓	✓							
	40	✓	✓							
	41	✓	✓							
	42	✓	✓							

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/819,831	NOOK et al.
	Examiner	**Art Unit**
	M'BAYE DIAO	2859

CLAIM		DATE								
Final	Original	08/17/2021	01/25/2022							
	43	✓	✓							
	44	✓	✓							
	45	✓	✓							
	46	✓	✓							
	47	✓	✓							
	48	✓	✓							
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	70	✓	✓							
	71	✓	✓							
	72	✓	✓							
	73	✓	✓							
	74	✓	✓							
	75		✓							
	76		✓							
	77		✓							

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/819,831	NOOK et al.
	Examiner	Art Unit
	M'BAYE DIAO	2859

CPC - Searched*		
Symbol	Date	Examiner
B60L53/14 H02J7/342 H02J7/0047 H02J7/0034 H02J7/0029 H02J1/122 H02J7/00 H02J7/0048 H02J7/00302 H02J7/00309 H02J7/00306 Y02T90/14 Y02T10/7072 Y02T10/70 H02J2310/46	08/18/2021	MD

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
320	105	08/18/2021	MD

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

/M BAYE DIAO/ Primary Examiner, Art Unit 2859	

ADS EX1002
IPR2025-00885

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/819,831	NOOK et al.
	Examiner	Art Unit
	M'BAYE DIAO	2859

Search Notes		
Search Notes	**Date**	**Examiner**
SEARCH(Search Notes attached).	08/18/2021	MD
Inventor Name and Assignee search (SEARCH).	08/18/2021	MD
PLUS Search conducted..	09/25/2020	MD
IP.COM search conducted.	08/18/2021	MD
Parent Applications noted.	08/18/2021	MD
IPR2018-00503 Reviewed Petition for Inter Partes Review of U.S. Patent No. 9,007,015.	08/18/2021	MD
IPR2020-00944 Reviewed Petition for Inter Partes Review of U.S. Patent No. 9,007,015.	08/18/2021	MD
IPR2020-01387 Reviewed Petition for Inter Partes Review of U.S. Patent No. 9,007,015.	08/18/2021	MD
IPR2021-00309 Reviewed Petition for Inter Partes Review of U.S. Patent No. 9,007,015.	08/18/2021	MD
Updated Search above.	01/25/2022	MD

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

/M BAYE DIAO/ Primary Examiner, Art Unit 2859	

ADC EX1002
IPR2025-00885

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	156178	(automobile vehicle car locomotive motorcycle motorbike EV (electric$2 NEAR vehicle) HEV (hybrid NEAR electric$2 NEAR vehicle)) NEAR charg$2	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:25 PM
L2	628	(jump boost) NEAR start$3 NEAR (apparatus device)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:26 PM
L3	1227683	output NEAR port	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:26 PM
L4	84	battery NEAR isolat$3 NEAR sens$2	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:27 PM
L5	1070	reverse NEAR polarity NEAR (sens$2 detect$2)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:27 PM
L6	101	battery NEAR isolat$3 NEAR (sens$2 detect$2)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:28 PM
L7	1427283	power NEAR switch	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:28 PM
L8	24049223	(microcontroller microprocessor controller processor)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:29 PM
L9	8	L1 L2 L3 L5 L6 L7 L8	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/06/17 01:29 PM
L10	3904	320/109,105.ccls.	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO);	OR	ON	ON	2021/06/17 01:36 PM

			FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L11	97030	(B60L53/00 B60L53/53 H02J7/0034 H02J7/0068 H02J2207/20 H02J7/0029 H02J9/005).cpc.	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:37 PM
L12	8	L1 L2 L3 L4 (L5 OR L6)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/06/17 01:38 PM
L13	10	L1 L2 L6 L7	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/06/17 01:39 PM
L14	2	"10875410".pn.	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 01:50 PM
L15	19	Richardson.inv. AND (jump ADJ start$3)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/06/17 03:15 PM
L16	94	("0000001" OR "0000002" OR "0000008" OR "0000075" OR "0000359" OR "0000926" OR "0006344" OR "10046653" OR "10328806" OR "17236260" OR "17236279" OR "17236339" OR "20010038276" OR "20020075003" OR "20030096158" OR "20040066168" OR "20040130298" OR "20050110467" OR "20050162124" OR "20050258797" OR "20090008374" OR "20090174362" OR "20100013302" OR "20100055546" OR "20100173182" OR "20100181959" OR "20100244766" OR "20100301800" OR	(US-PGPUB; USPAT)	OR	ON	ON	2021/06/17 09:50 PM

		"20110127947" OR "20110279089" OR "20120013189" OR "20120025763" OR "20120068662" OR "20120139498" OR "20130015814" OR "20130154543" OR "20130241488" OR "20140159509" OR "20150012174" OR "20150032312" OR "20150212135" OR "20150340907" OR "20210107365" OR "3267452" OR "3343057" OR "3950668" OR "3950688" OR "4871957" OR "5319298" OR "5487002" OR "5793185" OR "5831350" OR "6057667" OR "6130519" OR "6144110" OR "6160381" OR "6212054" OR "6249106" OR "6262492" OR "6271605" OR "6351102" OR "6362599" OR "6424158" OR "6426606" OR "6632103" OR "6774607" OR "6803743" OR "6919704" OR "7199555" OR "7339347" OR "7345450" OR "7579811" OR "7656118" OR "7675261" OR "8072900" OR "8125181" OR "8172603" OR "8183821" OR "8447543" OR "8565930" OR "8692513" OR "8723477" OR "8994327" OR "9007015" OR "9007023" OR "9248746" OR					

		"9263907" OR "9287725" OR "9333865" OR "9352652" OR "9412994" OR "9496728" OR "9506446" OR "9525297" OR "9871392" OR "9874611" OR "9954391").pn.					
L17	136	((("PILOT") near3 ("INC"))).AS,AANM.	(USPAT)	OR	ON	ON	2021/06/17 10:14 PM
L18	237	((("WANG") near3 ("Calvin")) OR (("WANG") near3 ("Chung-Hsin"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/06/17 10:14 PM
L19	17	L1 L2 L5 L8	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/06/17 10:15 PM
L20	2	"20090174362".pn.	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/17 07:27 PM
L21	35973	polarity NEAR detect$3	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 10:39 AM
L22	1	(battery NEAR presence NEAR (detect$3 sens$3)) WITH ((polarity (reverse NEAR polarity)) NEAR (detect$3 sens$3))	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 10:45 AM
L23	0	(jump-start$3 boost$3) NEAR (device apparatus) SAME (battery NEAR (presence (connect$3 NEAR status)) NEAR (detect$3 sens$3)) SAME ((polarity (reverse NEAR polarity)) NEAR (detect$3 sens$3))	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 10:49 AM
L24	4	((jump-start$3 boost$3) NEAR (device apparatus)) AND (battery NEAR (presence (connect$3 NEAR status)) NEAR	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 10:52 AM

		(detect$3 sens$3)) AND ((polarity (reverse NEAR polarity)) NEAR (detect$3 sens$3))					
L25	1	(presence NEAR circuit$2) WITH (optically NEAR coupled NEAR isolator NEAR phototransistor)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 11:17 AM
L26	24	(presence (battery NEAR presence) (battery NEAR status NEAR connect$3) NEAR circuit$2) WITH (optically NEAR coupled NEAR isolator NEAR phototransistor)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 11:19 AM
L27	106985	(lithium-ion (lithium ADJ ion)) NEAR battery SAME ((power NEAR supply) jumps-starter NEAR battery)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 12:25 PM
L28	28	L27 L4 L5 L6	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:26 PM
L29	24	L28 L21	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:26 PM
L30	4	L28 NOT L29	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:27 PM
L31	3352	(10 11) AND 27	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 12:28 PM
L32	53	L1 L2	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:29 PM
L33	7	L32 L31	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2021/08/18 12:29 PM
L34	0	lithium NEAR batter$3 NEAR back NEAR charge NEAR	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO);	OR	ON	ON	2021/08/18 01:47 PM

		(protection prevention inhibition) NEAR (circuit$2 module)	FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L35	0	lithium NEAR batter$3 NEAR ((back NEAR charge) (current NEAR back flow)) NEAR (protection prevention inhibition) NEAR (circuit$2 module)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 01:49 PM
L36	0	lithium NEAR batter$3 NEAR ((back NEAR charge) (back ADJ flow) NEAR current) NEAR (protection prevention inhibition) NEAR (circuit$2 module)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 01:50 PM
L37	7	((back NEAR charge) (back ADJ flow) NEAR current) NEAR (protection prevention inhibition) NEAR (circuit$2 module)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 01:50 PM
L38	21994	((back NEAR charge) (back ADJ flow) NEAR current) (back NEAR current NEAR flow) NEAR (protection prevention inhibition) NEAR (circuit$2 module)	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 02:55 PM
L39	941281	(Lithium lithium-ion (lithium NEAR polymer)) NEAR battery	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 02:57 PM
L40	42	L39 SAME L38 WITH diode$1	(US-PGPUB; USPAT; USOCR; FIT (CN, EP, FR, JP, KR, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/08/18 02:57 PM
L41	117	("10328808" OR "10604024" OR "20010025618" OR "20020041174" OR "20030141845" OR "20040066168" OR "20040130298" OR "20040150373" OR "20040239290" OR "20050040788" OR "20050110467" OR "20050116688" OR "20050252573" OR "20060176011" OR	(US-PGPUB; USPAT)	OR	ON	ON	2021/08/18 11:24 PM

		"20060220610" OR "20060244412" OR "20070278990" OR "20070285049" OR "20080143290" OR "20100301800" OR "20110068734" OR "20110175461" OR "20120025766" OR "20120091944" OR "20120319487" OR "20130154543" OR "20130162029" OR "20130241488" OR "20130314041" OR "20140084844" OR "20140159509" OR "20140210399" OR "20140368155" OR "20150054336" OR "20150137740" OR "20150306964" OR "20150340907" OR "20160001666" OR "20180111491" OR "20180215274" OR "20180269703" OR "20180342891" OR "20180345803" OR "20190308518" OR "3590357" OR "3638108" OR "3933140" OR "4041445" OR "4885524" OR "4910628" OR "4931731" OR "5083076" OR "5111130" OR "5189359" OR "5194799" OR "5281904" OR "5319298" OR "5486434" OR "5635817" OR "5635818" OR "5650974" OR "5793185" OR "5795182" OR "5820407" OR "5921809" OR "5953681" OR "5965998" OR "6054779" OR "6130519" OR "6140796" OR "6147471" OR "6212054" OR					

		"6262492" OR "6262559" OR "6344733" OR "6362599" OR "6386907" OR "6424158" OR "6426606" OR "6632103" OR "6648701" OR "6650086" OR "6679212" OR "6756764" OR "6759833" OR "6803743" OR "6822425" OR "7148580" OR "7301303" OR "7345450" OR "7749031" OR "7872361" OR "7893657" OR "8076900" OR "8172603" OR "8199024" OR "8362745" OR "8376775" OR "8493021" OR "9007015" OR "9041244" OR "9153978" OR "9243601" OR "9506446" OR "9525297" OR "9770992" OR "9809183" OR "9954391" OR "D597029" OR "D625265" OR "D649116" OR "D689020" OR "D726109" OR "D726114" OR "D726121" OR "D735665" OR "D746774").pn.					
L42	62	((("THE") near3 ("NOCO") near3 ("COMPANY"))).AS,AANM.	(USPAT)	OR	ON	ON	2021/08/18 11:28 PM
L43	135	((("NOOK") near3 ("Jonathan")) OR (("NOOK") near3 ("William")) OR (("STANFIELD") near3 ("James")) OR (("UNDERHILL") near3 ("Derek"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/08/18 11:29 PM

L44	1	WO ADJ "2016025869"	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/08/18 11:50 PM
L45	417	("9007015" "9770992" "10328808" "10604024" "20160001666" "20180111491" "20180215274" "20180345803" "20190308518" "20200028368" "20200169114" "20200215926" "20200259340" "20200317068" "5534369" "5749927" "5772934" "5836981" "4853305" "4999576" "5411592" "5498489" "5592069" "5694024" "5698147" "5725822" "5827331" "5867006" "5883495" "6007938" "6018228" "6157171" "4285751" "4296461" "4343312" "4373531" "4437769" "4767682" "4794056" "4830936" "4855781" "4871956" "4966822" "4970451" "5008161" "5008165" "5026615" "5043235" "5179337" "5230967" "5240655" "5250370" "5281491" "5300373" "5441825" "5525441" "5569553" "5618318" "5656393" "5667909" "5731106" "5889385" "5905363" "5949218" "5949215" "5965997" "6016105" "6019803" "6036639" "6056415" "6080507" "6147472" "6174628" "6180280" "6181107" "6203938" "6322921" "6335114" "6346346" "6348282" "6372380" "6376109" "6444354" "6667132" "6724593" "6749649" "6836095" "6953642" "6958199" "7169505" "7201997" "7235333" "7402361" "7666545" "7682754" "7687194" "7719233" "7727674"	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/08/18 11:57 PM

		"7736800" "7768236" "7785736" "7806943" "7850743" "7897279" "8003249" "8067114" "7897279" "8003249" "8067114" "8147999" "8263247" "8420247" "8450007" "8465874" "8470471" "8472164" "8564277" "8574008" "8617257" "8628876" "8691410" "8709642" "8734985" RE44960 "8822070" "8865270" "8877386" "8895174" "8945744" "8951658" "8952653" "8968910" "8980462" "8999540" "9012078" "9048490" "9048503" "9059469" "9105882" "9203123" "9209446" "9209491" "9219291" "9231271" "9249522" "9252452" RE45956 "9312723" "9318748" "9379418").pn.					
L46	23	L45 AND L2	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/08/18 11:58 PM
L47	2	"20090174362".pn.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/01/25 07:33 PM
L48	1063	L38 L39	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO,	AND	ON	ON	2022/01/25 10:16 PM

			RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L49	43	L31 L48	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2022/01/25 10:17 PM
L50	0	(automatic NEAR detect$3) WITH (reverse NEAR polar$5) SAME (presence NEAR detect$3)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	AND	ON	ON	2022/01/25 10:18 PM
L51	0	(automatic NEAR detect$3) WITH (reverse NEAR polar$5) SAME (presence NEAR detect$3)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/01/25 10:18 PM
L52	3	(automatic NEAR detect$3) SAME (reverse NEAR polar$5)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY,	OR	ON	ON	2022/01/25 10:19 PM

		SAME (presence NEAR detect$3)	CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

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The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

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Application	Document	Mailroom Date	Attorney Docket No.
16819831	CTFR	01/31/2022	054985-000055-US-02-01

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Washington, DC 20006-1152

202.467.8800 | www.vorys.com

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint: Practitioner(s) associated with the Customer Number: **20230**

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

The address associated with the above-mentioned Customer Number: **20230**

Applicant Name and Address:

THE NOCO COMPANY
30339 Diamond Parkway, #102,
Glenwillow, Ohio 44139,
United States of America

Signature of Applicant of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the Applicant

Signature _____ Date 8/7/13

Name Jonathan Rock Telephone (216) 464-8131

Title President

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: THE NOCO COMPANY

Application No./Patent No.: 16/819,831 Filed/Issue Date: March 16, 2020

Titled: PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

THE NOCO COMPANY, a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 048539, Frame 0629, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

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This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**.

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STATEMENT UNDER 37 CFR 3.73(c)

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☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/William L. Klima/	April 28, 2022
Signature	Date
William L. Klima	32422
Printed or Typed Name	Title or Registration Number

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
16/819,831	**04/28/2022 01:48:39 PM ET**	**054985-000055-US-02-01**

Title of Invention

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	1630	FILED BY	Lisa Elliott
PATENT CENTER #	60642579	FILING DATE	03/16/2020
CUSTOMER #	20230	FIRST NAMED INVENTOR	Jonathan Lewis NOOK
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	William Klima

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
373 Statement - Noco - aia373c.pdf	3	Assignee showing of ownership per 37 CFR 3.73	205 KB
POA_Noco_exe.PDF	1	Power of Attorney	56 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
373 Statement - Noco - aia373c.pdf	6F3AAB12026B98D52137B6FD41D390D5F0217CB724400C988EB459093CF7EB3E232994AC218509A92FB00124B0CB266580DE03F0AEC1E26AC8F115C068FAAEFE

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/819,831	03/16/2020	Jonathan Lewis NOOK	054985-000055-US-02-01

CONFIRMATION NO. 1630

20230
Vorys, Sater, Seymour and Pease LLP
1909 K St., NW
9th Floor
Washington, DC 20006-1152

POA ACCEPTANCE LETTER

OC000000133526248

Date Mailed: 05/02/2022

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/28/2022.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

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/tlulu/

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION**
Application Number	16819831
Filing Date	16-Mar-2020
First Named Inventor	Jonathan NOOK
Attorney Docket Number	054985-000055-US-02-01
Title of Invention	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
THE NOCO COMPANY	100%

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

16450422 filed on 06/24/2019

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In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term of any patent granted on said reference application, "as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application," in the event that any such patent granted on the pending reference application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○	I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicant claims the following fee status:

- (◉) Small Entity
- (○) Micro Entity
- (○) Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

- (◉) An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

  Registration Number 32422

- (○) A sole inventor
- (○) A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application
- (○) A joint inventor; all of whom are signing this request

Signature	/William L. Klima/
Name	William L. Klima

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	16819831
Filing Date:	16-Mar-2020
Title of Invention:	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION
First Named Inventor/Applicant Name:	Jonathan Lewis NOOK
Filer:	William Leonard Klima/Lisa Elliott
Attorney Docket Number:	054985-000055-US-02-01

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	2814	1	170	170
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**170**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16819831

Filing Date: 16-Mar-2020

Applicant/Patent under Reexamination: NOOK

Electronic Terminal Disclaimer filed on May 2, 2022

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt

EFS ID:	45607529
Application Number:	16819831
International Application Number:	
Confirmation Number:	1630
Title of Invention:	PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION
First Named Inventor/Applicant Name:	Jonathan Lewis NOOK
Customer Number:	20230
Filer:	William Leonard Klima/Lisa Elliott
Filer Authorized By:	William Leonard Klima
Attorney Docket Number:	054985-000055-US-02-01
Receipt Date:	02-MAY-2022
Filing Date:	16-MAR-2020
Time Stamp:	10:51:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$170
RAM confirmation Number	E202252A51292270
Deposit Account	
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	43804 4f21eee8205463d2d982cab7858376be6c5cace2	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37981 6ed955b747333f0f1daa6493960b2e8e90f3d8ac	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	81785		

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New International Application Filed with the USPTO as a Receiving Office

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(12) UK Patent Application (19) GB (11) 2 265 267 (13) A

(43) Date of A publication 22.09.1993

(21) Application No 9305280.1

(22) Date of filing 15.03.1993

(30) Priority data
(31) 9205888 (32) 17.03.1992 (33) GB

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(51) INT CL[5]
H02J 7/00, F02N 11/14, H02J 7/14

(52) UK CL (Edition L)
H2H HBCB HBCH HBCJ HB8

(56) Documents cited
GB 2254205 A EP 0229722 A2 EP 0152118 A2
US 4847545 A US 4831321 A US 4638236 A
US 4233552 A

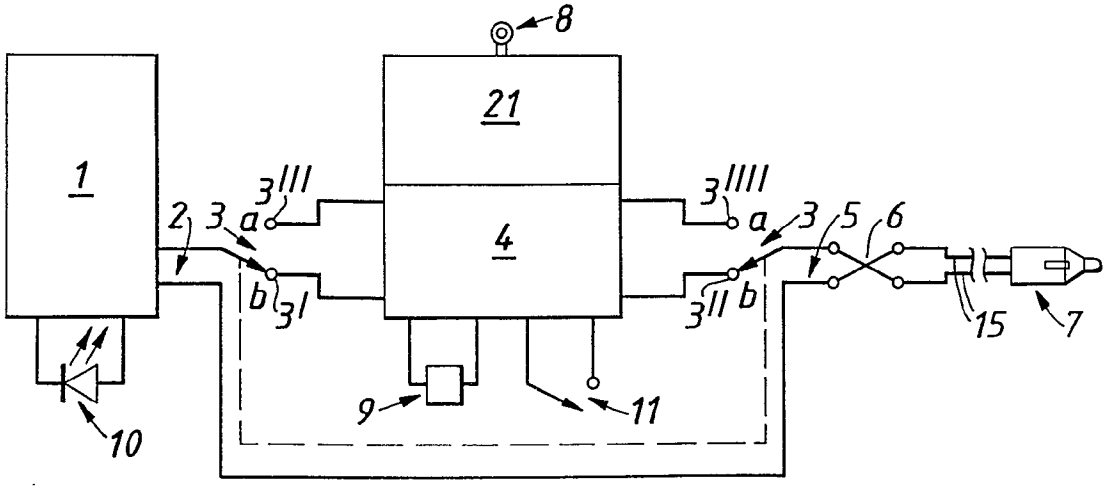
(58) Field of search
UK CL (Edition L) H2H HBCB HBCD HBCE HBCF HBCG HBCH HBD HSM
INT CL[5] F02N 11/08 11/12 11/14, H02J 7/00 7/14 7/34

(54) Apparatus for in-situ charging of a vehicle battery from an external power source

(57) The apparatus contains a rechargeable battery 1 which can be connected via switches 3, a charging current/voltage regulator 4, a polarity reversing switch 6, and connecting means 7 to charge the vehicle battery. A switch 11 allows selection of a triple charge current (25 to 1 150 mA) or a boost charge current (150 to 500 mA). The regulator 4 also adjust charging current in response to ambient temperature sensed by a detector 9. Switches 3 may be changed over to allow battery 1 to be charged from the vehicle electrical system. A connector 8 and circuit 21 allows battery 1 to be recharged from an external A.C. or D.C. supply. The voltage of battery 1 may be lower than the vehicle battery voltage, regulator 4 then also stepping up the voltage for charging the vehicle battery.

A microprocessor (12), (Fig 2), with a keypad (13) and display (14), may be used to control switches 3, 6, 11, switch 6 being charged automatically on detection of incorrect polarity.

FIG. 1.



GB 2 265 267 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

ADC EX1002
IPR2025-00885

1/3

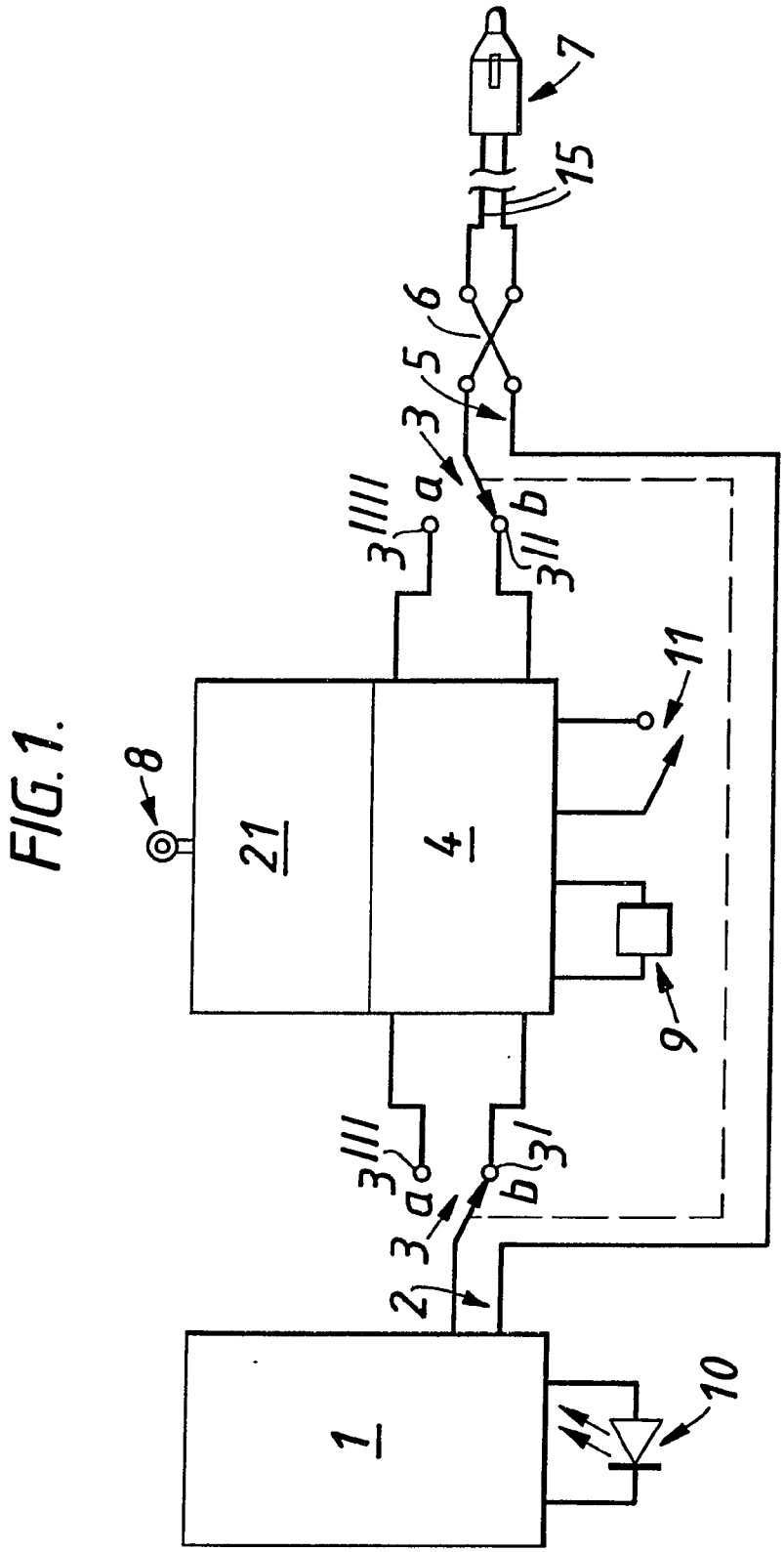
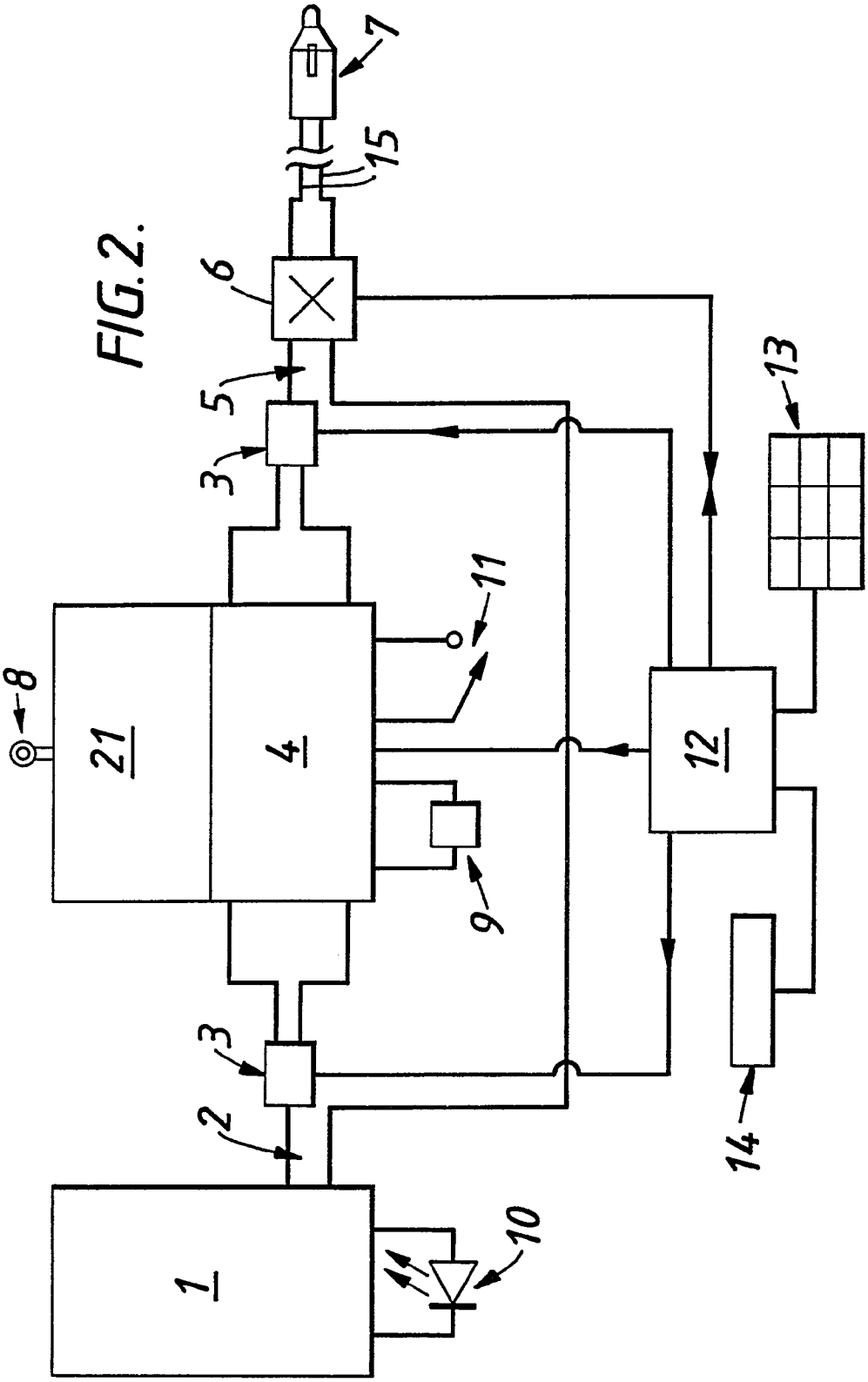


FIG. 1.

FIG.2.



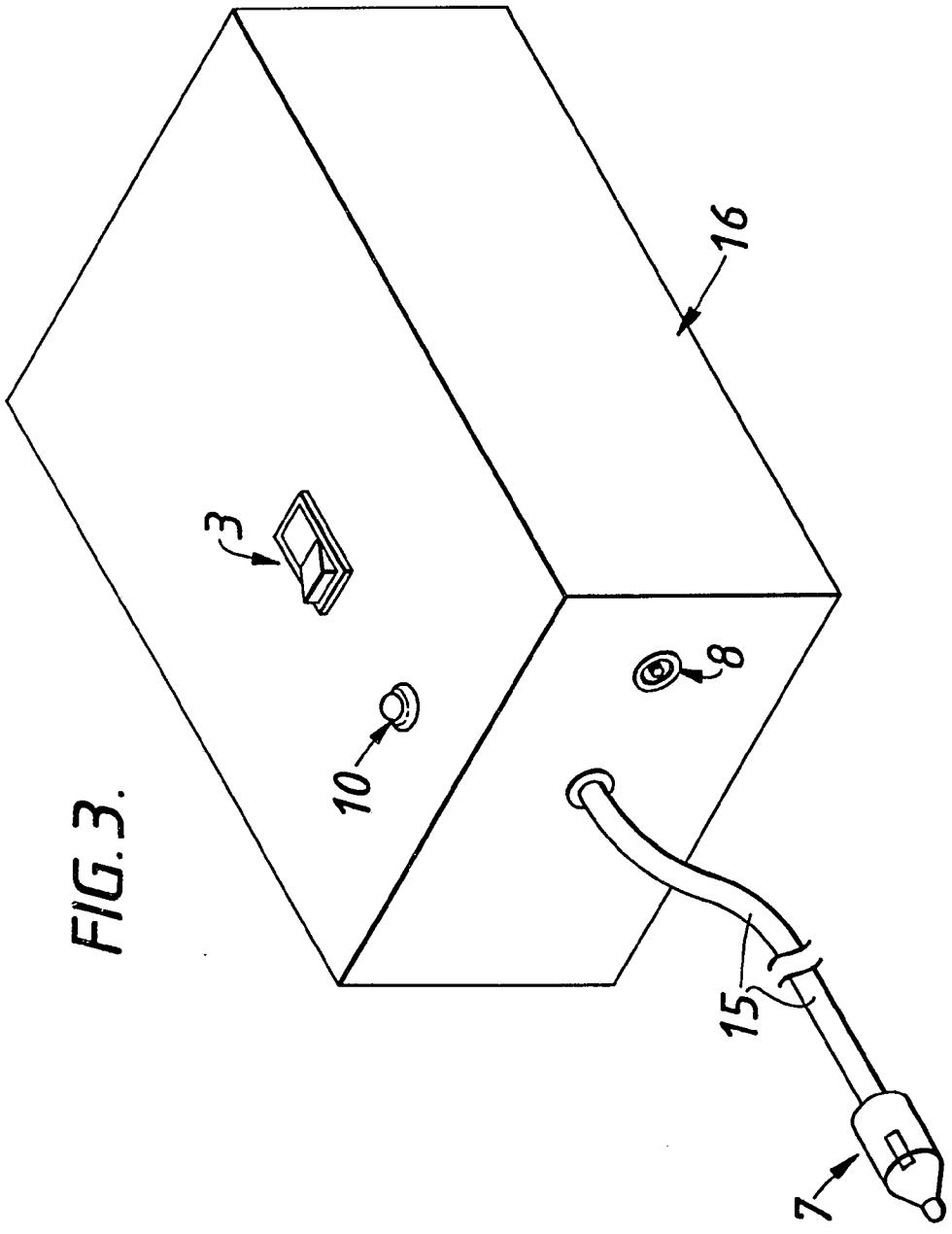


FIG.3.

IMPROVEMENTS IN BATTERY CHARGERS

The present invention relates to apparatus for use in charging batteries, particularly vehicle batteries.

It is well known that on a morning following a very cold night a vehicle will not start or may start only with some difficulty. One of the reasons for this is that the cold weather performance of lead-acid batteries is poor. A vehicle battery often cannot deliver enough power to start the vehicle, especially if the battery is cold and not in a good condition and/or not fully charged. If a vehicle has been used primarily for short journeys then such journeys do not allow the vehicle battery sufficient time to recharge, and consequently starting from cold, particularly in cold weather, can prove problematic.

If the vehicle is located convenient to a domestic mains supply then a conventional charger can be used to charge the battery in situ. In many cases, however, this is not the case and the only solution then is to remove and transport the battery to a location convenient to a mains supply. Clearly this is an inconvenience and since a vehicle battery is usually heavy the task can be arduous.

There are several battery powered devices available that use various techniques to boost or recharge a flat vehicle battery, the most common of these being the parallel - series connection of batteries. These generally consist of two high power batteries of a lower voltage than the vehicle battery, typically six volts, connected in parallel for charging from a twelve volt vehicle system via current limiting devices. These batteries are then switched to be in series to provide the twelve volts which is then available for either boost charging a flat battery or for jump-starting the vehicle. This technique involves the use of a high current in operation, in the order of amps or even tens of amps. Provided a vehicle battery is not defective, it has been found that to a large degree the above problems can be mitigated by subjecting the vehicle battery to a trickle charge overnight or for one or two hours at a higher charge prior to use. It has been found that the trickle charging of a battery in such a fashion maintains the battery in a suitable condition for cold weather starting. It is believed that a small trickle current does not charge the battery to any appreciable degree, but is sufficient to keep the electrolyte active and thus

maintain the efficiency of the battery.

A general object of the present invention is to provide an improved apparatus for charging batteries, and which is capable of maintaining the efficiency of batteries. The invention is of particular relevance to a battery for a vehicle especially for a vehicle subject to adverse weather conditions.

According to the invention there is provided an apparatus for charging a vehicle battery in-situ, comprising a power source unit comprising one or more re-chargeable electrical cells, and preferably providing a voltage no greater than the voltage of the vehicle battery; a controller for regulating the current and/or voltage delivered to the vehicle battery; and switch means operable to change the output from the controller between a lower trickle charge mode and a higher boost current mode. In the case where the power source unit is composed of a number of cells these may be arranged in series or in parallel.

The invention provides an apparatus which is preferably self-contained and independent of the mains supply yet serves to charge a vehicle battery in situ. Although the apparatus employs a power source unit, itself in the form of one or more re-chargeable batteries

or cells, it is capable of delivering a voltage at two current levels sufficient to be able to either trickle or boost charge a vehicle battery with both currents below one ampere. The apparatus can thus trickle charge a battery over a longer period of time or can charge a battery at a higher level for a shorter period of time. The controller regulates, inter alia, the current and/or voltage applied between the power source unit and the vehicle battery. The apparatus can be provided with another switch means to selectively connect the power source unit to a vehicle battery through the controller in order that the vehicle battery may be charged or to connect the vehicle electrical system to the power source unit via the controller so that the power source can itself be charged as well as the vehicle battery or to connect the power source unit to another charging power source. If the voltage of the power source is lower than that of the battery the controller must also step-up the voltage of the apparatus to a level suitable for trickle charging the battery.

The apparatus is preferably compact and light in weight so that in the event of the power source of the apparatus requiring charge further to that as provided by the vehicle, the apparatus may easily be removed from

the vehicle for external charging, by for example a charger connected to a domestic electrical supply. The apparatus may also include a mains powered charger or transformer-rectifier circuit for this purpose.

Conveniently a cigarette lighter socket or other auxiliary electrical socket of the vehicle is employed for electrically connecting the apparatus with the electrical system of the vehicle. Preferably a polarity detecting means is provided together with means for automatically reversing the polarity of the interface between the apparatus and the electrical system of the vehicle.

The apparatus may employ an indicator, such as a (LED) light emitting diode, to give a visual indication that the power source unit is in a state of readiness and fully charged.

The invention may be understood more readily and various other features of the invention may become apparent from consideration of the following description.

Embodiments of the invention will now be described by way of examples only, with reference to the accompanying drawings wherein:

Figure 1 is a block schematic diagram representing one embodiment of the invention; and

Figure 2 is a block schematic diagram representing another embodiment of the invention.

Figure 3 is a perspective view of the first embodiment of the present invention.

As shown in Figure 1, an apparatus constructed in accordance with the invention is composed of a self-contained power source unit 1 containing one or a number of proprietary re-chargeable cells or batteries with an input/output 2 enabled with a two position function select switch 3 with terminals 3' 3" connected to a controller 4. The controller 4 is connected through terminals 3"' 3"" of the switch 3 via a polarity-charging switch 6 and leads 15 to some form of connector 7 providing an input/output interface with the apparatus. A connector 8 leads to means 21 for recharging the unit 1 from an external supply other than that of the vehicle. The connector 8 can be a mains connector and the means 21 can comprise a conventional mains transformer and rectifier circuit. Alternatively the connector 8 may be a socket receiving a plug with a d.c. charging voltage from a separate charger.

A sensor 9 is used to detect the local ambient temperature, and, in conjunction with the controller 4,

adjusts the rate of current flow. An indicator 10, typically in the form of a light emitting diode (LED), displays the charging state of the internal power source unit 1.

The controller 4 serves to regulate the charging current and/or voltage supplied to the connector 7 as well as the charging current supplied back to the power source unit 1 in dependence on the position of switch 3. With the switch 3 in the first position a with the terminals 3"' and 3"" connected through the switch 3 and when no electrical external connections have been made, the apparatus is in an off state. However, the internal power source unit 1 may be recharged whilst the switch 3 is in this first position a). More particularly, when an external charging source is connected via the connector 8, or the connector 7 is connected to a vehicle battery circuit, say via an auxiliary electrical socket of the vehicle then the battery or batteries of the internal power source unit 1 can be recharged. Typically the auxiliary electrical socket is a cigarette lighter socket. The connector 7 can however be replaced by clip connectors (not shown) which can be directly connected to a vehicle battery. The polarity change switch 6 may be used if the polarity of connector 7 needs reversing to

match the polarity of vehicle's earth.

With the switch 3 in the second position b and the terminals 3' and 3" connected through the switch 3 connection is made with the vehicle battery and charging of the vehicle battery can take place. In this mode the apparatus can deliver a trickle charge current which is preferably used overnight or for a few hours prior to the vehicle being used.

The controller 4 has another switch 11 which can be used to boost the current delivered by the controller 4 for a limited time. This is useful when there is insufficient time to provide a few hours trickle charge. Typically, on trickle charge, the charge current delivered by the apparatus of the present invention is of the order of 25 to 150 milliamps (mA) whilst in the boost mode the charge current is between 150 and 500 milliamps (mA). Provision can be made so that in the event of the internal power source 1 being discharged to a preset level, the apparatus will switch off automatically thus preventing the internal power source unit 1 from being discharged to too great an extent.

In the version of the apparatus shown in Figure 2, the same reference numerals have been used as in Figure 1. The various switching modes are here selected by

electromechanical or electronic switches 3, 6, 11 instead of manual switches 3, 6, 11. The switches are controlled by a microprocessor 12 which is programmed to set up predetermined operational cycles. A key pad 13 co-operating with a display 14 can be used to vary the operation of the apparatus. A polarity detecting means 6 determine the polarity of the vehicle's auxiliary socket in relation to the leads 15 of the apparatus and alters the polarity of the leads 15 automatically if the detected polarity is incorrect. Since not all vehicles are equipped with a negative earth, this feature may avoid expensive disablement of a vehicle's electrical system.

The key pad 13 can also be used to set up the boost function with the switch 11. Although the LED 10 is shown in Figure 2 this function can also be taken over by the display 14.

Figure 3 shows a perspective view of a housing 16 of the first embodiment but many modifications may be made. Preferably, the dimensions are such that the apparatus may conveniently be placed in a glove-box or under a seat. Typically the base dimensions of the housing 16 are 8 cm x 16 cm and the height 5 cm.

CLAIMS

1. An apparatus for charging a vehicle battery in-situ, comprising a power source unit comprising one or more re-chargeable electrical cells, a controller for regulating the current and/or voltage delivered to the vehicle battery; and switch means operable to change the output from the controller between a lower trickle charge mode and a higher boost current mode.

2. An apparatus according to Claim 1, wherein the current delivered by the apparatus in either mode is below one ampere.

3. An apparatus according to Claim 1 or 2, wherein the current delivered to the battery when the output of the controller is at the lower trickle charge mode is of the order of 25 to 150 milliamps.

4. An apparatus according to Claim 1, 2 or 3, wherein the current delivered to the battery when the output of the controller is at the higher boost charge mode is of the order of 150 to 500 milliamps.

5. An apparatus according to any one of Claims 1 to 4, and further comprising a second switch means for connecting the power source unit to the vehicle battery to enable energy to be transferred from the unit to the

vehicle battery or to enable energy to be transferred to the unit from either the vehicle charging system or another charging system.

6. An apparatus according to any one of the preceding claims wherein the electrical cells of the power source unit are low power proprietary rechargeable batteries.

7. An apparatus according to Claim 6, wherein the proprietary batteries comprise dry rechargeable cells.

8. An apparatus according to any one of the preceding claims and further comprising another or a third switch means for changing the polarity of the interface between the apparatus and the electrical system of the vehicle.

9. An apparatus according to Claim 8 and further comprising a polarity detecting means which actuates the other or third switch means automatically.

10. An apparatus according to any one of the preceding claims and further comprising a microprocessor for controlling the operation of the apparatus over various time cycles and a key pad and display for setting up the functions of the microprocessor.

11. An apparatus according to any one of the preceding claims wherein there is provided indicating means to indicate the condition of charge of the power source unit.

12. An apparatus according to any one of the preceding claims and further comprising transforming and rectifying means to enable the power source to be recharged from a domestic electrical supply.

13. An apparatus according to any one of the preceding claims further comprising temperature sensing means which can vary the rate of charging depending on the ambient temperature.

14. An apparatus according to any one of the preceding claims, wherein the power source unit provides a voltage no greater than the voltage of the vehicle battery.

15. An apparatus substantially as described with reference to and as illustrated in Figure 1, 2 or 3 of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
GB 9305280.1

Relevant Technical fields

(i) UK Cl (Edition L) H2H HBCB,HBCD,HBCE,HBCF,HBCG, HBCH,HBD,HSM

(ii) Int Cl (Edition 5) F02N 11/08,11/12,11/14; H02J 7/00, 7/14, 7/34

Databases (see over)

(i) UK Patent Office

(ii)

Search Examiner

M J BILLING

Date of Search

6 MAY 1993

Documents considered relevant following a search in respect of claims 1 TO 14

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X,P	GB 2254205 A (COLE) whole document; puplished 30 September 1992	1 at least
Y	EP 0229722 A2 (YANG) eg see figures 1, 2, 15, 16, 20	1,5 to 14 at least
Y	EP 0152118 A2 (ENERGY EXCHANGE) eg see figures 1, 2, 3; page 10 lines 10-11	1,5 to 14 at least
X, Y	US 4847545 (REID) eg see Abstract, column 9 lines 9-17; figure 1	X: 1 Y: 5 to 14 at least
Y	US 4831321 (COOPER) eg see figure 6	1,5 to 14 at least
Y	US 4638236 (BUSCH) eg see Abstract, column 1 lines 12-14; figure 1	1, 5 to 14 at least
X, Y	US 4233552 (BAUMBACH) eg see column 3 line 30 - column 4 line 49	X: 1 Y: 5 to 14 at least

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IPR2025-00885

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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IPR2025-00885

Published 1993 at The Patent Office, Concept House, Cardiff Road, Newport. Gwent NP9 1RH. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.

Espacenet

JP2003112586A BATTERY CABLE FOR STARTER

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Classifications:
IPC ***B60R16/04; H01B7/00; H01M2/30;*** (IPC1-7): B60R16/04; H01B7/00; H01M2/30;

CPC Y02E60/10 (EP);

Priorities: JP2001310877A 2001-10-09

Application: JP2001310877A·2001-10-09

Publication: JP2003112586A·2003-04-15

Published as: JP2003112586A

BATTERY CABLE FOR STARTER

Abstract

PROBLEM TO BE SOLVED: To provide a structure of a battery cable 1 capable of steeply reducing impact force transmitted to a battery terminal through the battery cable 1 when the impact is applied to a vehicle from an outside. SOLUTION: A terminal 4 of the battery cable 1 is provided with a cutout 4c as a breakable part between an electrically conducted part 4a connected to a core wire 1a of the battery cable 1 and a ring shaped terminal part 4b connected to the battery terminal. When the impact applied to the vehicle from the outside is transmitted to the battery terminal through the battery cable 1 and external force is excessively applied to the terminal 4 at that time, the breakable part (the cutout 4c) of the terminal 4 is broken, and thereby the terminal 4 is divided into the electrically conducted part 4a side and the terminal part 4b side. As a result, the impact force applied to the battery terminal through the battery cable 1 can be shut-off. Therefore, the impact force applied to the starter can be reduced.

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号
特開2003－112586
（P2003－112586A）
(43)公開日　平成15年４月15日(2003.4.15)

(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード（参考）
Ｂ６０Ｒ　16/04		Ｂ６０Ｒ　16/04	Ｔ	５Ｇ３０９
Ｈ０１Ｂ　7/00	３０６	Ｈ０１Ｂ　7/00	３０６	５Ｈ０２２
Ｈ０１Ｍ　2/30		Ｈ０１Ｍ　2/30	Ｄ	

審査請求　未請求　請求項の数４　ＯＬ　（全　５　頁）

(21)出願番号　特願2001－310877(P2001－310877)

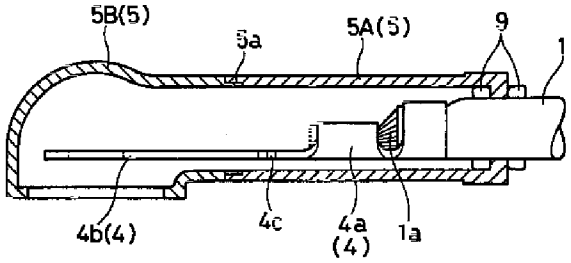
(22)出願日　平成13年10月９日(2001.10.9)

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Ｆターム(参考)　5G309 FA06
5H022 CC10 CC12

(54)【発明の名称】　スタータ用のバッテリケーブル

(57)【要約】
【課題】　例えば車両が外部より衝撃を受けた時に、バッテリケーブル１を介してバッテリ端子に伝達される衝撃力を大幅に低減できるバッテリケーブル１の構造を提供すること。
【解決手段】　バッテリケーブル１のターミナル４は、バッテリケーブル１の芯線１ａに接続される導通部分４ａと、バッテリ端子に接続されるリング状の端子部分４ｂとの間に破断可能部としての切欠き４ｃが設けられている。これにより、外部より車両に加わった衝撃がバッテリケーブル１を介してバッテリ端子に伝達される際にターミナル４に過大な外力が加わると、ターミナル４の破断可能部（切欠き４ｃ）が破断することにより、ターミナル４が導通部分４ａ側と端子部分４ｂ側とに分断される。その結果、バッテリケーブル１を介してバッテリ端子に加わる衝撃力を遮断できるので、スタータに加わる衝撃力を低減できる。



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【特許請求の範囲】
【請求項１】車載バッテリとスタータのバッテリ端子とを接続するスタータ用のバッテリケーブルであって、
このバッテリケーブルのスタータ側端部に具備されるターミナルには、前記バッテリケーブルの芯線に接続される導通部分と前記バッテリ端子に接続される端子部分との間に、前記ターミナルに外力が加わった時に破断して前記導通部分と前記端子部分との間を分断する破断可能部が設けられていることを特徴とするスタータ用のバッテリケーブル。
【請求項２】請求項１に記載したスタータ用のバッテリケーブルにおいて、
前記バッテリ端子に前記ターミナルが接続された状態で、その両者を覆って外部から絶縁保護する絶縁カバーを具備し、
前記バッテリケーブルまたは前記ターミナルの導通部分側には、前記絶縁カバーの移動を規制する移動規制部が設けられていることを特徴とするスタータ用のバッテリケーブル。
【請求項３】請求項２に記載したスタータ用のバッテリケーブルにおいて、
前記絶縁カバーには、自身に外力が加わった時に所定の位置で破断して、その両者間を分断する破断可能部が設けられ、この破断可能部が前記ターミナルの破断可能部より前記バッテリ端子寄りの位置に設けられていることを特徴とするスタータ用のバッテリケーブル。
【請求項４】請求項１～３に記載した何れかのスタータ用のバッテリケーブルにおいて、
前記ターミナルは、第１のターミナル部材と第２のターミナル部材とに分割されて、両ターミナル部材を嵌合して組み合わされ、その嵌合部が前記破断可能部として設けられていることを特徴とするスタータ用のバッテリケーブル。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、車載バッテリとスタータのバッテリ端子とを接続するスタータ用のバッテリケーブルに関する。
【０００２】
【従来の技術】例えば、図３に示すスタータ２は、電磁スイッチ７に設けられるバッテリ端子３にバッテリケーブル１が接続され、そのバッテリケーブル１を介して車載バッテリから電力の供給を受けている。バッテリケーブル１は、自身の端部に金属製のターミナル４が設けられ、このターミナル４がバッテリ端子３に嵌合して、ナット１０により締め付け固定されている。また、バッテリケーブル１には、バッテリ端子３にターミナル４が接続された状態で、その両者を覆って外部から絶縁保護する絶縁カバー５が取り付けられている。
【０００３】
【発明が解決しようとする課題】ところが、電磁スイッチ７に設けられるバッテリ端子３は、樹脂製のスイッチカバー８に設置されているため、例えば外部より車両に加わった衝撃がバッテリケーブル１を介してバッテリ端子３に伝達されると、その衝撃の影響を受けてスイッチカバー８が損傷する可能性がある。スイッチカバー８の内部には、スタータモータ６の通電回路を開閉するモータスイッチが設けられているため、スイッチカバー８が損傷を受けてモータスイッチの開閉動作に影響が生じると、スタータ２によるエンジン始動ができなくなる恐れがあった。本発明は、上記事情に基づいて成されたもので、その目的は、例えば車両が外部より衝撃を受けた時に、バッテリケーブルを介してバッテリ端子に伝達される衝撃力を大幅に低減できるバッテリケーブルの構造を提供することにある。
【０００４】
【課題を解決するための手段】（請求項１の発明）バッテリケーブルのスタータ側端部に具備されるターミナルには、バッテリケーブルの芯線に接続される導通部分とバッテリ端子に接続される端子部分との間に、ターミナルに外力が加わった時に破断して導通部分と端子部分との間を分断する破断可能部が設けられている。この構成によれば、例えばバッテリケーブルを介してターミナルに過大な外力（衝撃力）が加わった時に、ターミナルの破断可能部が破断することにより、ターミナルの導通部分と端子部分との間が分断される。その結果、バッテリケーブルからターミナルを介してバッテリ端子に加わる衝撃力を遮断できるので、スタータへの衝撃力の影響を低減できる。
【０００５】（請求項２の発明）請求項１に記載したスタータ用のバッテリケーブルにおいて、バッテリ端子にターミナルが接続された状態で、その両者を覆って外部から絶縁保護する絶縁カバーを具備し、バッテリケーブルまたはターミナルの導通部分側には、絶縁カバーの移動を規制する移動規制部が設けられている。この構成によれば、ターミナルの破断可能部が破断して導通部分と端子部分との間が分断された場合に、移動規制部によって絶縁カバーがバッテリケーブルから脱落することを防止できるため、分断されたターミナルの導通部分を絶縁カバーによって絶縁保護することができる。
【０００６】（請求項３の発明）請求項２に記載したスタータ用のバッテリケーブルにおいて、絶縁カバーには、自身に外力が加わった時に所定の位置で破断して、その両者間を分断する破断可能部が設けられ、この破断可能部がターミナルの破断可能部よりバッテリ端子寄りの位置に設けられている。
【０００７】この構成によれば、バッテリケーブルに過大な外力が加わった時に、ターミナルの破断可能部が破断して導通部分と端子部分との間が分断されるだけでなく、絶縁カバーも自身の破断可能部が破断して分断され

る。この時、絶縁カバーの破断可能部がターミナルの破断可能部よりバッテリ端子寄りの位置に設けられているので、分断されたターミナルの導通部分が分断された絶縁カバーの内部に隠れるため、ターミナルの導通部分が外部に露出することはなく、バッテリが不用意に短絡することを防止できる。

【０００８】（請求項４の発明）請求項１～３に記載した何れかのスタータ用のバッテリケーブルにおいて、ターミナルは、第１のターミナル部材と第２のターミナル部材とに分割されて、両ターミナル部材を嵌合して組み合わされ、その嵌合部が破断可能部として設けられている。この構成によれば、第１のターミナル部材と第２のターミナル部材とが両者の嵌合部で分断されても、ターミナル自体が破壊されている訳ではないので、再度第１のターミナル部材と第２のターミナル部材とを嵌合して使用することが可能である。

【０００９】

【発明の実施の形態】次に、本発明の実施形態を図面に基づいて説明する。

（第１実施例）図１はバッテリケーブルのターミナルと絶縁カバーの断面図である。本実施例のバッテリケーブル１は、スタータ２（図３参照）のバッテリ端子３と車載バッテリ（図示しない）とを接続するもので、自身の端部に金属製のターミナル４が取り付けられると共に、このターミナル４全体を覆うゴム製の絶縁カバー５が組付けられている。

【００１０】なお、スタータ２は、例えば図３に示す様に、スタータモータ６の通電電流をON/OFF制御する電磁スイッチ７を備え、この電磁スイッチ７に設けられる樹脂製のスイッチカバー８にバッテリ端子３が設置されている。ターミナル４は、図２に示す様に、バッテリケーブル１の芯線１ａに接続される導通部分４ａと、バッテリ端子３に接続されるリング状の端子部分４ｂとの間に破断可能部としての切欠き４ｃが設けられている。この切欠き４ｃは、図２に示す様に、ターミナル４の横幅が狭くなる様に、ターミナル４の両辺にそれぞれ１箇所ずつ設けられている。

【００１１】絶縁カバー５は、図１に示す様に、ターミナル４の導通部分４ａ側を覆う第１カバー体５Ａとターミナル４の端子部分４ｂ側を覆う第２カバー体５Ｂとに二分割され、両カバー体５Ａ、５Ｂを嵌合して組み合わされている。また、両カバー体の嵌合部５ａは、絶縁カバー５に外力が加わった時に破断して第１カバー体５Ａと第２カバー体５Ｂとに分断する破断可能部として機能している。但し、絶縁カバー５の破断可能部（嵌合部５ａ）は、ターミナル４の破断可能部（切欠き４ｃ）よりバッテリ端子３寄りの位置に設けられている（図１参照）。

【００１２】バッテリケーブル１には、絶縁カバー５を位置決めする一組の位置決めリング９が装着されている。この位置決めリング９は、図１に示す様に、絶縁カバー５の根元部分の両側に取り付けられて絶縁カバー５を位置決めすると共に、バッテリケーブル１に対して絶縁カバー５の移動を規制している。このバッテリケーブル１は、図３に示す様に、ターミナル４の端子部分４ｂをバッテリ端子３に嵌合して、バッテリ端子３の螺子部にナット１０を締め付けて固定される。

【００１３】次に、本実施例の作用及び効果について説明する。例えば、外部より車両に加わった衝撃がバッテリケーブル１を介してバッテリ端子３に伝達される際にターミナル４に過大な外力が加わると、ターミナル４の破断可能部（切欠き４ｃ）が破断することにより、ターミナル４が導通部分４ａ側と端子部分４ｂ側とに分断される。また、ターミナル４を覆う絶縁カバー５も自身の破断可能部（嵌合部５ａ）が破断して第１カバー体５Ａと第２カバー体５Ｂとに分断される。これにより、バッテリケーブル１を介してバッテリ端子３に加わる衝撃力を遮断できるので、スタータ２（特にバッテリ端子３を有する電磁スイッチ７のスイッチカバー８）に加わる衝撃力を低減できる。

【００１４】また、ターミナル４が導通部分４ａと端子部分４ｂとの間で分断されても、絶縁カバー５の破断可能部（嵌合部５ａ）がターミナル４の破断可能部（切欠き４ｃ）よりバッテリ端子３寄りの位置に設けられているので、分断されたターミナル４の導通部分４ａが第１カバー体５Ａの内部に隠れることができる。このため、ターミナル４の導通部分４ａが外部に露出することはなく、バッテリが不用意に短絡することを防止できる。なお、絶縁カバー５は、第１カバー体５Ａが一組の位置決めリング９によりバッテリケーブル１に対して移動規制されているため、分断された後、第１カバー体５Ａがバッテリケーブル１から脱落することはなく、ターミナル４の導通部分４ａを確実に絶縁保護することができる。

【００１５】（第２実施例）図４はバッテリケーブル１のターミナル４と絶縁カバー５の断面図である。本実施例は、ターミナル４を分割構造とした場合の一例である。ターミナル４は、図４に示す様に、バッテリ側の第１のターミナル部材４Ａとバッテリ端子３側の第２のターミナル部材４Ｂとに分割されて、両ターミナル部材４Ａ、４Ｂを嵌合して組み合わされている。また、第２のターミナル部材４Ｂには、第１実施例と同様に破断可能部（切欠き４ｃ）が設けられている。この構成においても第１実施例と同様の効果を得ることができる。

【００１６】（第３実施例）図５はバッテリケーブル１のターミナル４と絶縁カバー５の断面図である。本実施例は、第２実施例と同様に、ターミナル４を第１のターミナル部材４Ａと第２のターミナル部材４Ｂとに分割して、両ターミナル部材４Ａ、４Ｂを嵌合して組み合わせたものであり、且つ両ターミナル部材４Ａ、４Ｂの嵌合部４ｄを破断可能部とした一例である。この構成によれ

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ば、第１のターミナル部材４Ａと第２のターミナル部材４Ｂとが両者の嵌合部４ｄで分断されても、ターミナル４自体が破壊されている訳ではないので、再度第１のターミナル部材４Ａと第２のターミナル部材４Ｂとを嵌合して使用することが可能である。

【００１７】（変形例）第１実施例では、バッテリケーブル１に対して絶縁カバー５の移動を規制するために、一組の位置決めリング９を使用しているが、位置決めリング９の替わりに、絶縁カバー５の移動を規制する規制部をターミナル４に設けても良い。

【図面の簡単な説明】

【図１】バッテリケーブルのターミナルと絶縁カバーの断面図である（第１実施例）。

【図２】ターミナルの平面図である。

【図３】スタータの全体図である。

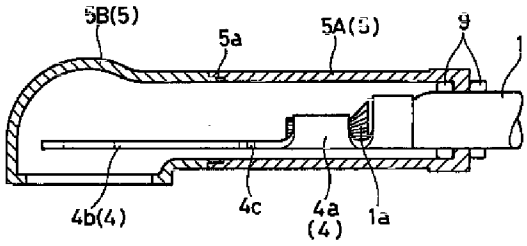
【図４】バッテリケーブルのターミナルと絶縁カバーの断面図である（第２実施例）。

【図５】バッテリケーブルのターミナルと絶縁カバーの断面図である（第３実施例）。

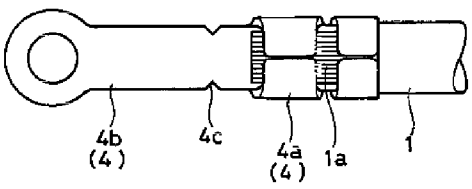
【符号の説明】

１　バッテリケーブル
１ａ　バッテリケーブルの芯線
２　スタータ
３　バッテリ端子
４　ターミナル
４Ａ　第１のターミナル部材
４Ｂ　第２のターミナル部材
４ａ　ターミナルの導通部分
４ｂ　ターミナルの端子部分
４ｃ　切欠き（ターミナルの破断可能部）
４ｄ　嵌合部（ターミナルの破断可能部）
５　絶縁カバー
５ａ　嵌合部（絶縁カバーの破断可能部）
９　位置決めリング（移動規制部）

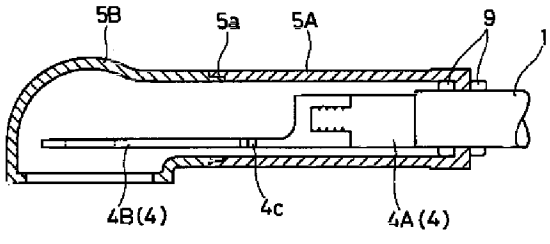
【図１】



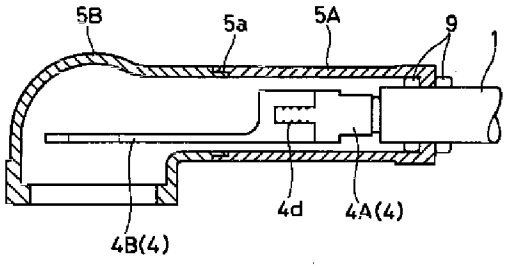
【図２】



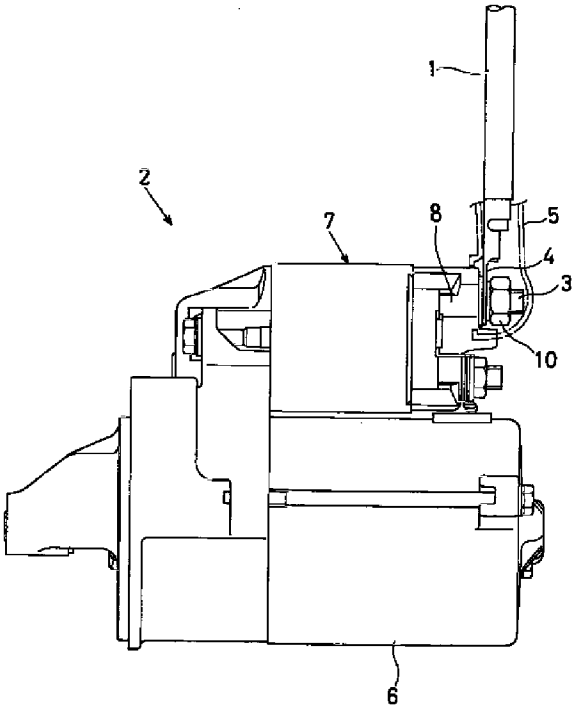
【図４】



【図５】



【図3】



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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
16/819,831	**05/02/2022 11:37:48 AM ET**	**054985-000055-US-02-01**

Title of Invention

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	1630	FILED BY	Lisa Elliott
PATENT CENTER #	60647503	FILING DATE	03/16/2020
CUSTOMER #	20230	FIRST NAMED INVENTOR	Jonathan Lewis NOOK
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	William Klima

Documents

TOTAL DOCUMENTS: 40

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
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NPL-- GroundsInvalidity-AnnexA-Projecta-Carku.pdf	24	Non Patent Literature	5914 KB
FOR-- IDS_CN1440892A.pdf	21	Foreign Reference	3633 KB
FOR-- IDS_CN102447288A.pdf	12	Foreign Reference	1595 KB
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Digest

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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Espacenet

CN202918052U Hybrid battery

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Classifications:
IPC ***H02J7/00; H02J9/06;***

Priorities: CN201220612671U 2012-11-19

Application: CN201220612671U·2012-11-19

Publication: CN202918052U·2013-05-01

Published as: CN202918052U

Hybrid battery

Abstract

The utility model relates to a hybrid battery. The hybrid battery comprises a casing, and also comprises a first energy storing device, a second energy storing device, a detection control circuit, a battery state detection display device, an equalization circuit, and a charging circuit connected between the first energy storing device and the second energy storing device, a cathode pole is led out from cathode ends of the first and second energy storing devices, an anode end of the first energy storing device is connected with a first static contact of a relay, an anode end of the second energy storing device is connected with a second static contact of the relay, the detection control circuit is connected with a coil of the relay, an anode pole is led out from an input end of the relay, the first energy storing device, the second energy storing device, the equalization circuit, the charging circuit, and the relay are arranged inside the casing, and the anode pole and the cathode pole are connected with an anode and a cathode of an electrical device respectively. The hybrid battery has the advantages of high reliability, long service life and environmental friendliness.

(19)中华人民共和国国家知识产权局

(12)实用新型专利

(10)授权公告号 CN 202918052 U
(45)授权公告日 2013.05.01

(21)申请号 201220612671.X

(22)申请日 2012.11.19

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(51)Int.Cl.
H02J 9/06(2006.01)
H02J 7/00(2006.01)

(ESM)同样的发明创造已同日申请发明专利

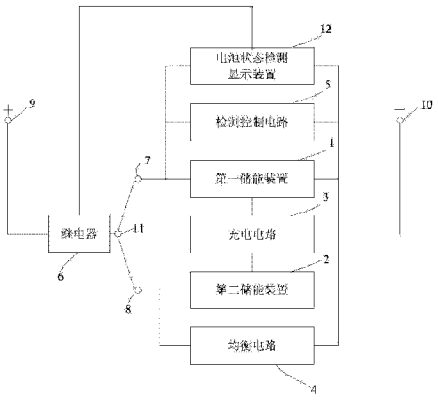
权利要求书1页 说明书4页 附图1页

(54)实用新型名称

一种混合电池

(57)摘要

本实用新型涉及一种混合电池，包括外壳，还包括第一储能装置，第二储能装置，检测控制电路，电池状态检测显示装置，均衡电路，连接于第一储能装置与第二储能装置之间的充电电路，所述第一储能装置与第二储能装置的负极端引出负极极柱，所述第一储能装置的正极端与继电器的第一静触点连接，所述第二储能装置的正极端与继电器的第二静触点连接，所述检测控制电路与继电器的线圈连接，所述继电器的输入端引出正极极柱；所述第一储能装置、第二储能装置、检测控制电路、均衡电路、充电电路、继电器设置于外壳的内部，所述正极极柱、负极极柱分别与电气设备的正极、负极连接。该混合电池可靠性高、使用寿命长且环保。



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1. 一种混合电池，包括外壳，其特征在于，还包括用于小电流时供电的第一储能装置(1)，与用于瞬间启动时供电的第二储能装置(2)，与第一储能装置(1)并联连接的检测控制电路(5)、用于检测及显示第一储能装置(1)使用状态的电池状态检测显示装置(12)，与第二储能装置(2)并联连接的用于保护第二储能装置(2)的均衡电路(4)，连接于第一储能装置(1)与第二储能装置(2)之间、用于对第二储能装置(2)充电的充电电路(3)，所述第一储能装置(1)与第二储能装置(2)的负极端引出负极极柱(10)，所述第一储能装置(1)的正极端与继电器(6)的第一静触点(7)连接，所述第二储能装置(2)的正极端与继电器(6)的第二静触点(8)连接，所述检测控制电路(5)与继电器(6)的线圈连接，所述继电器(6)的输入端引出正极极柱(9)，所述正极极柱(9)、负极极柱(10)分别与汽车用电设备的正极、负极连接；所述检测控制电路(5)检测经过第一储能装置(1)的电流，当该电流为小电流时，继电器(6)中的衔铁的动触点(11)与第一静触点(7)连通，动触点(11)与第二静触点(8)断开，此时，第一储能装置(1)与正极极柱(9)、负极极柱(10)连通，由第一储能装置(1)给汽车供电；当该电流为大电流时，继电器(6)中的衔铁的动触点(11)与第一静触点(7)断开，动触点(11)与第二静触点(8)连通，此时，第二储能装置(2)与正极极柱(9)、负极极柱(10)连通，由第二储能装置(2)给汽车供电；所述第一储能装置(1)、第二储能装置(2)、检测控制电路(5)、均衡电路(4)、充电电路(3)、继电器(6)均设置于外壳的内部。

2. 根据权利要求 1 所述的一种混合电池，其特征在于，所述小电流的范围为 20A ～ 100A，所述大电流为大于 100A。

3. 根据权利要求 1 所述的一种混合电池，其特征在于，所述继电器(6)中的衔铁的动触点(11)与第一静触点(7)或第二静触点(8)连通后，保持 1 ～ 10s 后复位。

4. 根据权利要求 1 所述的一种混合电池，其特征在于，所述第一储能装置(1)为铅酸蓄电池或锂电池组，第二储能装置(2)为超级电容器组或锂电池组。

5. 根据权利要求 4 所述的一种混合电池，其特征在于，所述铅酸蓄电池的标称电压为 12V ～ 24V。

6. 根据权利要求 4 所述的一种混合电池，其特征在于，所述锂电池组由 4 ～ 12 个锂电池串联连接而成，所述锂电池组中的锂电池容量为 1Ah ～ 80Ah。

7. 根据权利要求 4 所述的一种混合电池，其特征在于，所述超级电容器组由 4 ～ 12 个超级电容器串联连接而成。

8. 根据权利要求 4 所述的一种混合电池，其特征在于，所述超级电容器组中的超级电容器的规格为 50 ～ 3000F。

9. 根据权利要求 1 所述的一种混合电池，其特征在于，所述充电电路(3)的输出电压范围为 12V ～ 36V，输出电流为 0.1A ～ 10A。

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一种混合电池

技术领域

[0001] 本实用新型涉及一种新能源电池，尤其涉及一种用于启动内燃机和其他电气设备的混合电池。

背景技术

[0002] 汽车通常利用起动机来启动发动机，起动机由电池提供电能，例如铅酸蓄电池。发动机工作时，汽车发电机通过铅酸蓄电池向汽车内用电设备供电，起到稳压的作用；发动机停机后，由铅酸蓄电池直接给车内设备供电；发动机启动时，需要铅酸蓄电池瞬间提供高达几百安的电流以保证汽车顺利启动；然而，瞬间大电流放电对铅酸蓄电池的寿命和性能均会产生极大的损害，而且铅酸蓄电池本身功率密度低，瞬间放电能力不足，又不属于环保产品。相比之下，超级电容器具有快充快放的功能，使用寿命高达 50 万次。如能结合两者的优势，将铅酸蓄电池与超级电容器结合起来使用，既能满足技术需要，又具有经济环保的社会效益。

[0003] 现有中国专利文献 CN 201927685U 公开的一种新能源电池，包括壳体，所述的壳体包括有电池壳体、电容器壳体，电池壳体内设有串联在一起的铅酸电池组，铅酸电池组内设有隔板，其上连接有铅酸极柱，电容器壳体内设有超级电容器，超级电容器上连接有电容极柱，铅酸极柱与电容极柱之间通过金属线连接在一起。该申请主要是解决现有技术所存在的铅酸蓄电池功率密度低，瞬间放电能力不足，为保证起动能力，选择高于实际需求的容量，大电流充放电造成蓄电池寿命短，成本高，重量重，体积大等的技术问题。但在发动机启动过程中，仍然是由铅酸蓄电池与超级电容一起供电，导致瞬间经过铅酸蓄电池的电流也不会太低，并没有完全起到保护铅酸蓄电池的作用；仅仅将铅酸蓄电池和超级电容器简单并联，并没有充分发挥超级电容器的优势。

实用新型内容

[0004] 本实用新型的目的在于提出一种混合电池，该混合电池可根据电流大小，有效地在第一储能装置与第二储能装置之间切换，在小电流时，通过第一储能装置供电，在启动瞬间需要大电流时，通过第二储能装置供电，避免第一储能装置在启动瞬间因大电流放电造成损伤，有效地保护第一储能装置，并充分利用第二储能装置的快充快放特性，保证在第一储能装置出现故障时汽车仍能正常启动，该混合电池使用寿命长且环保。

[0005] 为达到此目的，本实用新型采用以下技术方案：

[0006] 一种混合电池，包括外壳，还包括用于小电流时供电的第一储能装置，与用于瞬间启动时供电的第二储能装置，与第一储能装置并联连接的检测控制电路、用于检测及显示第一储能装置使用状态的电池状态检测显示装置，与第二储能装置并联连接的用于保护第二储能装置的均衡电路，连接于第一储能装置与第二储能装置之间、用于对第二储能装置充电的充电电路，所述第一储能装置与第二储能装置的负极端引出负极极柱，所述第一储能装置的正极端与继电器的第一静触点连接，所述第二储能装置的正极端与继电器的第二

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静触点连接，所述检测控制电路与继电器的线圈连接，所述继电器的输入端引出正极极柱，所述正极极柱、负极极柱分别与汽车用电设备的正极、负极连接；所述检测控制电路检测经过第一储能装置的电流，当该电流为小电流时，继电器中的衔铁的动触点与第一静触点连通，动触点与第二静触点断开，此时，第一储能装置与正极极柱、负极极柱连通，由第一储能装置给汽车供电；当该电流为大电流时，继电器中的衔铁的动触点与第一静触点断开，动触点与第二静触点连通，此时，第二储能装置与正极极柱、负极极柱连通，由第二储能装置给汽车供电；所述第一储能装置、第二储能装置、检测控制电路、均衡电路、充电电路、继电器均设置于外壳的内部。

[0007] 其中，所述小电流的范围为 20A ～ 100A，所述大电流为大于 100A。

[0008] 其中，所述继电器中的衔铁的动触点与第一静触点或第二静触点连通后，保持 1 ～ 10s 后复位。

[0009] 其中，所述第一储能装置为铅酸蓄电池或锂电池组，第二储能装置为超级电容器组或锂电池组。

[0010] 其中，所述铅酸蓄电池的标称电压为 12V ～ 24V。

[0011] 其中，所述锂电池组由 4 ～ 12 个锂电池串联连接而成，所述锂电池组中的锂电池的容量为 1Ah ～ 80Ah。

[0012] 其中，所述超级电容器组由 4 ～ 12 个超级电容器串联连接而成。

[0013] 其中，所述超级电容器组中的超级电容器的规格为 50 ～ 3000F。

[0014] 其中，所述充电电路的输出电压范围为 12V ～ 36V，输出电流为 0.1A ～ 10A。

[0015] 本实用新型的有益效果为：本实用新型的混合电池利用检测控制电路实时检测流经第一储能装置的电流大小，并控制继电器的连通与断开，当汽车正常行驶或发动机停机使用车内设备时，流经第一储能装置的电流为小电流，继电器中的衔铁的动触点与第一静触点连通，动触点与第二静触点断开，此时，第一储能装置与正极极柱、负极极柱连通，由第一储能装置给汽车供电和实现稳压功能；当汽车启动瞬间，需要储能装置瞬间放电，形成大电流时，继电器中的衔铁的动触点与第一静触点断开，动触点与第二静触点连通，此时，第二储能装置与正极极柱、负极极柱连通，由第二储能装置向汽车供电；而当汽车处于任意时刻，第一储能装置通过充电电路持续给第二储能装置充电，使得电能有效存储不致被浪费；同时，第二储能装置两端并联连接有均衡电路，该均衡电路将第二储能装置两端的电压稳定在一定值，起到保护第二储能装置的作用。本实用新型的混合电池的第一储能装置为铅酸蓄电池或锂电池组，第二储能装置为超级电容器组或锂电池组，该混合电池有效地将传统铅酸蓄电池的成熟低成本与超级电容器的优越的充放电性能结合起来，并通过继电器在铅酸蓄电池与超级电容器组之间切换，不仅切换及时准确，而且继电器本身没有输入电压，不会形成分压，延长混合电池的使用寿命，实现绿色环保的目的。该混合电池即使当第一储能装置由于寿命终结、内阻增大、停转发动机在车内休息时导致第一储能装置电量耗尽，也还有第二储能装置中已经储存的电量用于启动汽车。

附图说明

[0016] 图 1 是本实用新型的混合电池电路连接示意图。

[0017] 图中：1- 第一储能装置；2- 第二储能装置；3- 充电电路；4- 均衡电路；5- 检测控

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制电路 ;6- 继电器 ;7- 第一静触点 ;8- 第二静触点 ;9- 正极极柱 ;10- 负极极柱 ;11- 动触点 ;12- 电池状态检测显示装置。

具体实施方式

[0018] 下面结合附图和具体实施例对本实用新型作进一步说明。

[0019] 如图 1 所示,一种混合电池,包括外壳,还包括用于小电流时供电的第一储能装置 1,与用于瞬间启动时供电的第二储能装置 2,与第一储能装置 1 并联连接的检测控制电路 5、用于检测及显示第一储能装置 1 使用状态的电池状态检测显示装置 12,与第二储能装置 2 并联连接用于保护第二储能装置 2 的均衡电路 3,连接于第一储能装置 1 与第二储能装置 2 之间、用于对第二储能装置 2 充电的充电电路 3,第一储能装置 1 与第二储能装置 2 的负极端引出负极极柱 10,第一储能装置 1 的正极端与继电器 6 的第一静触点 7 连接,第二储能装置 2 的正极端与继电器 6 的第二静触点 8 连接,检测控制电路 5 与继电器 6 的线圈连接,继电器 6 的输入端引出正极极柱 9,正极极柱 9、负极极柱 10 分别与汽车的正极、负极连接 ;检测控制电路检测经过第一储能装置 1 的电流,当该电流为小电流时,继电器 6 中的衔铁的动触点 11 与第一静触点 7 连通,动触点 11 与第二静触点 8 断开,此时,第一储能装置 1 与正极极柱 9、负极极柱 10 连通,由第一储能装置 1 向汽车供电 ;当该电流为大电流时,继电器 6 中的衔铁的动触点 11 与第一静触点 7 断开,动触点 11 与第二静触点 8 连通,此时,第二储能装置与正极极柱 9、负极极柱 10 连通,由第二储能装置 2 向汽车供电 ;第一储能装置 1、第二储能装置 2、检测控制电路 5、均衡电路 4、充电电路 3、继电器 6 均设置于外壳的内部。

[0020] 进一步地,小电流与大电流的切换范围可以自由设定,在本实施例中,小电流的范围为 20A ～ 100A,大电流为大于 100A 以上的电流。当继电器 6 的第一静触点 7 或第二静触点 8 连通后,设定保持 1 ～ 10s 后复位。

[0021] 优选的,在本实施例中,继电器 6 的初始状态为衔铁的动触点 11 与第一静触点 7 连通,与第二静触点 8 断开的状态 ;当继电器 6 的线圈两端施加输入电压,衔铁的动触点 11 与第一静触点 7 断开,与第二静触点 8 连通,保持 1 ～ 10s 后复位,线圈两端的电压消失,继电器 6 恢复到初始状态,即衔铁的动触点 11 与第一静触点 7 连通,与第二静触点 8 断开。

[0022] 具体地,第一储能装置 1 为铅酸蓄电池或锂电池组,第二储能装置 2 为超级电容器组或锂电池组 ;锂电池组由 4 ～ 12 个锂电池串联连接而成,锂电池的容量为 1Ah ～ 80Ah ;优选的,在本实用新型中的锂电池也即锂离子电池。铅酸蓄电池的标称电压为 12V ～ 24V ;超级电容器组由 4 ～ 12 个超级电容器串联连接而成,超级电容器的规格为 50 ～ 3000F。优选的,在本实施例中,第一储能装置 1 为铅酸蓄电池,第二储能装置 2 为超级电容器组。充电电路 3 为 DC-DC 充电电路,该充电电路 3 的输出电压范围为 12V ～ 36V,输出电流为 0.1A ～ 10A。

[0023] 本实用新型的混合电池外部设置有外壳,将第一储能装置 1、第二储能装置 2、检测控制电路 5、均衡电路 4、充电电路 3、继电器 6 均设置于外壳内部,外壳对内部装置和电路起到保护作用 ;另外,将内部电路的正极端和负极端分别穿过外壳,引出正极极柱 9 和负极极柱 10,该正极极柱 9 与负极极柱 10 与汽车用电设备的正负极线材连接。

[0024] 本实用新型的混合电池利用检测控制电路 5 实时检测汽车是否处于启动状态,即

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实时检测流经第一储能装置 1 的电流大小，并控制继电器 6 中的衔铁的动触点 11 与第一静触点 7、第二静触点 8 的连通与断开。当汽车正常行驶或发动机停机使用车内设备时，流经第一储能装置 1 的电流为小电流，检测控制电路不提供切换电信号给继电器 6，此时，继电器 6 中的线圈两端没有输入电压，则继电器 6 不动作，保持在初始连接状态，即继电器 6 中的衔铁的动触点 11 与第一静触点 7 连通，动触点 11 与第二静触点 8 断开，第一储能装置 1 与正极极柱 9、负极极柱 10 连通，由第一储能装置 1 向汽车供电和稳压；当汽车启动的瞬间，需要第一储能装置 1 瞬间放电，形成瞬间大电流时，检测控制电路 5 发出切换电信号给继电器 6，在继电器 6 中的线圈两端施加电压，线圈中随即产生电流，从而产生电磁效应，衔铁在电磁力的吸引作用下克服返回弹簧的拉力吸向铁芯，从而带动衔铁的动触点 11 与第二静触点 8 连通，同时与第一静触点 7 断开，此时，第二储能装置 2 与正极极柱 9、负极极柱 10 连通，由第二储能装置 2 向汽车供电；而当汽车处于任意时刻，第一储能装置 1 通过充电电路 3 持续给第二储能装置 2 充电，使得电能快速有效地存储在第二储能装置 2 中；同时，第二储能装置 2 两端并联连接有均衡电路 4，该均衡电路 4 将第二储能装置 2 两端的电压稳定在一定数值范围，起到保护第二储能装置 2 的作用。本实用新型的混合电池的第一储能装置 1 为铅酸蓄电池或锂电池组，第二储能装置 2 为超级电容器或锂电池组，该混合电池有效地将传统铅酸蓄电池的成熟低成本优势与超级电容器的优越的充放电性能结合起来，并通过继电器在铅酸蓄电池与超级电容器之间切换，不仅能做到切换及时准确，而且继电器 6 本身没有输入电压，不会形成分压，延长混合电池的使用寿命，实现绿色环保的目的。该混合电池在第一储能装置 1 的两端并联设置电池状态检测显示装置 12，可以实时检测和显示第一储能装置 1 的使用状态，如电量的饱和度或者使用寿命等，可以辅助判断该混合电池是否能正常使用；该混合电池即使当第一储能装置 1 由于寿命终结、内阻增大、停转发动机在车内休息导致第一储能装置 1 电量耗尽，也还有第二储能装置 2 中已经储存的电量可用以启动汽车，可靠性高。

[0025] 以上所述仅为本实用新型的优选实施例而已，并不用于限制本实用新型，对于本领域的技术人员来说，本实用新型可以有各种更改和变化。凡在本实用新型的精神和原则之内，所作的任何修改、等同替换、改进等，均应包含在本实用新型的保护范围之内。

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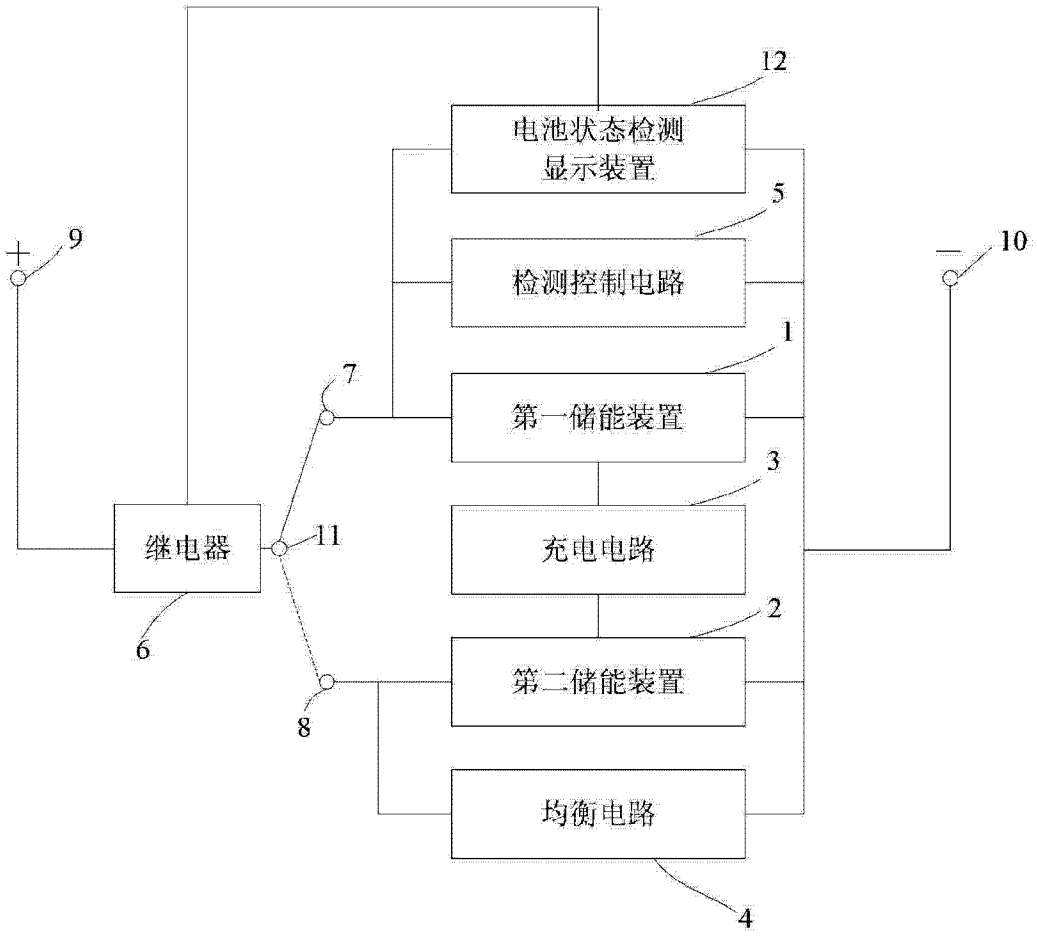


图 1

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CN102447288A Power lithium-ion battery pack intelligent management system specially used for electric automobile

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Classifications:
IPC ***H02J7/00;***

Priorities: CN201110399879A 2011-12-05

Application: CN201110399879A·2011-12-05

Publication: CN102447288A·2012-05-09

Published as: CN102447288A

Power lithium-ion battery pack intelligent management system specially used for electric automobile

Abstract

The invention discloses a power lithium-ion battery pack intelligent management system specially used for an electric automobile. The power lithium-ion battery pack intelligent management system comprises a controller, a charging module, a balancing module, a data acquisition module, an electric quantity calculating module, a data display module and a storage communication module, wherein the charging module, the balancing module, the data acquisition module, the electric quantity calculating module, the data display module and the storage communication module are respectively connected with the controller; and the data acquisition module comprises a voltage acquisition module, a current acquisition module and a temperature acquisition module. The power lithium-ion battery pack intelligent management system disclosed by the invention takes a singlechip as a control core, and energy of each lithium battery is balanced while overcharging, overdischarging, overcurrent and temperature protection and short circuit protection can be realized.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 102447288 A
(43)申请公布日 2012.05.09

(21)申请号 201110399879.8

(22)申请日 2011.12.05

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(51)Int.Cl.
H02J 7/00(2006.01)

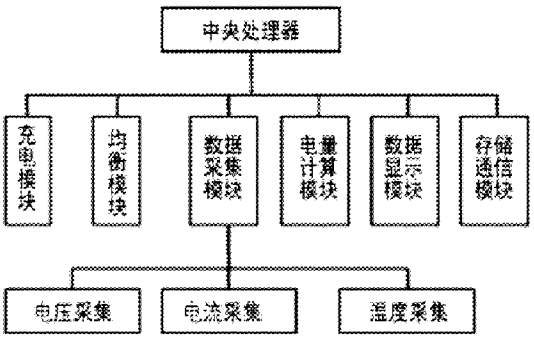
权利要求书 1 页 说明书 4 页 附图 5 页

(54)发明名称

一种电动汽车专用的动力锂电池组智能管理系统

(57)摘要

本发明公开了一种电动汽车专用的动力锂电池组智能管理系统，其中，包括控制器、充电模块、均衡模块、数据采集模块、电量计算模块、数据显示模块和存储通信模块；所述的充电模块、均衡模块、数据采集模块、电量计算模块、数据显示模块和存储通信模块分别与控制器连接；所述数据采集模块包括电压采集模块、电流采集模块和温度采集模块。本发明以单片机为控制核心，在实现对各节锂电池能量均衡的同时，还可以实现过充、过放、过流、温度保护及短路保护。



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1. 一种电动汽车专用的动力锂电池组智能管理系统，其特征在于：包括控制器、充电模块、均衡模块、数据采集模块、电量计算模块、数据显示模块和存储通信模块；所述的充电模块、均衡模块、数据采集模块、电量计算模块、数据显示模块和存储通信模块分别与控制器连接；所述数据采集模块包括电压采集模块、电流采集模块和温度采集模块。

2. 根据权利要求 1 所述的一种电动汽车专用的动力锂电池组智能管理系统，其特征在于：所述均衡模块采用 DC/DC 开关电源模块。

3. 根据权利要求 1 或 2 所述的一种电动汽车专用的动力锂电池组智能管理系统，其特征在于：所述充电模块为间歇式充电。

4. 根据权利要求 3 所述的一种电动汽车专用的动力锂电池组智能管理系统，所述数据显示模块采用 DM12864M 汉字图形点阵液晶显示模块。

5. 一种电动汽车专用的动力锂电池组智能管理方法，其特征在于：包括如下步骤：

第一步，系统初始化，执行状态判断步骤，然后进行相应的充电处理步骤、空闲处理步骤或放电步骤；

第二步，进行数据检测步骤和数据存储步骤；

第三步，数据显示步骤；

第四步，判断是否需要均衡处理步骤，如需要，则进行均衡处理，执行第五步；如不需要，则直接进入第五步；

第五步，判断状态是否改变，若状态改变，则执行第一步的状态判断步骤，继续判断，若状态未改变，则执行第二步。

6. 根据权利要求 5 所述的一种电动汽车专用的动力锂电池组智能管理方法，其特征在于：还包括第六步，若数据检测步骤检测到的数据需要对外通信，则由数据存储通信模块发送数据。

7. 根据权利要求 5 或 6 所述的一种电动汽车专用的动力锂电池组智能管理方法，其特征在于：所述第二步的数据检测步骤包括对电压、电流和温度的检测处理。

8. 根据权利要求 7 所述的一种电动汽车专用的动力锂电池组智能管理方法，其特征在于：所述第三步的数据显示步骤，在 LCD 上显示数据。

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一种电动汽车专用的动力锂电池组智能管理系统

技术领域

[0001] 本发明涉及一种动力锂电池组管理系统，具体涉及一种电动汽车专用的动力锂电池组智能管理系统。

背景技术

[0002] 动力电池技术是电动汽车发展的一个技术瓶颈，锂电池由于具有体积小、重量轻、电压高、功率大、自放电少以及使用寿命长等优点，逐渐成为动力电池的主流。由于锂离子电池具有明显的非线性、不一致性和时变特性，在应用时需要进行一定的管理。另外锂电池对充放电的要求很高，当出现过充电、过放电、放电电流过大或电路短路时，会使锂电池温度上升，严重破坏锂电池性能，导致电池寿命缩短。当锂电池串联使用于动力设备中时，由于各单节锂电池间内部特性的不一致，会导致各节锂电池充、放电的不一致。一节性能恶化时，整个电池组的行为特征都会受到此电池的限制，降低整体电池组性能。为使锂电池组能够最大程度地发挥其优越性能，延长使用寿命，必须要对锂电池在充、放电时进行实时监控，提供过压、过流、温度保护和电池间能量均衡。

发明内容

[0003] 本发明的目的在于提供一种电动汽车专用的动力锂电池组智能管理系统，以单片机为控制核心，在实现对各节锂电池能量均衡的同时，还可以实现过充、过放、过流、温度保护及短路保护。

[0004] 为了达到上述目的，本发明采用的技术方案是：

一种电动汽车专用的动力锂电池组智能管理系统，其中，包括控制器、充电模块、均衡模块、数据采集模块、电量计算模块、数据显示模块和存储通信模块；所述的充电模块、均衡模块、数据采集模块、电量计算模块、数据显示模块和存储通信模块分别与控制器连接；所述数据采集模块包括电压采集模块、电流采集模块和温度采集模块。

[0005] 进一步，所述均衡模块采用 DC/DC 开关电源模块。

[0006] 进一步，所述充电模块为间歇式充电。

[0007] 进一步，所述数据显示模块采用 DM12864M 汉字图形点阵液晶显示模块。

[0008] 一种电动汽车专用的动力锂电池组智能管理方法，其中，包括如下步骤，第一步，系统初始化，执行状态判断步骤，然后进行相应的充电处理步骤、空闲处理步骤或放电步骤；

第二步，进行数据检测步骤和数据存储通信步骤，数据存储通信步骤由数据存储通信模块实现；

第三步，数据显示步骤；

第四步，判断是否需要均衡处理步骤，如需要，则进行均衡处理，执行第五步；如不需要，则直接进入第五步；

第五步，判断状态是否改变，若状态改变，则执行第一步的状态判断步骤，继续判断，若

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状态未改变，则执行第二步。

[0009] 进一步，还包括第六步，若数据检测步骤检测到的数据需要对外通信，则由数据存储通信模块发送数据。

[0010] 进一步，所述第二步的数据检测步骤包括对电压、电流和温度的检测处理。

[0011] 进一步，所述第三步的数据显示步骤，在 LCD 上显示数据。

[0012] 本发明的有益效果为：

本发明设计的动力锂电池组管理系统安装在锂电池组的内部，以单片机为控制核心，在实现对各节锂电池能量均衡的同时，还可以实现过充、过放、过流、温度保护及短路保护；通过 LCD 显示器显示电池组的各种状态，并可以通过预留的通信端口读取各节锂电池的历史性能状态。

[0013] 本发明的其他优点、目标和特征在某种程度上将在随后的说明书中进行阐述，并且在某种程度上，基于对下文的考察研究对本领域技术人员而言将是显而易见的，或者可以从本发明的实践中得到教导。本发明的目标和其他优点可以通过下面的说明书或者附图中所特别指出的结构来实现和获得。

附图说明

[0014] 图 1 为本发明的结构框图；

图 2 为本发明充电模块的间歇式充电的示意图；

图 3 为本发明电压采样与均衡模块的原理图；

图 4 为本发明电流采集模块电流传感器 LTSR25-NP 工作特性曲线图；

图 5 为本发明存储通信模块 FLASH 存储器电路原理图；

图 6 为本发明的流程图。

具体实施方式

[0015] 以下结合附图对本发明作进一步的详细描述：

参见图 1，本发明包括控制器、充电模块、均衡模块、数据采集模块、电量计算模块、数据显示模块和存储通信模块；充电模块、均衡模块、数据采集模块、电量计算模块、数据显示模块和存储通信模块分别与控制器连接；数据采集模块包括电压采集模块、电流采集模块和温度采集模块；主控制器即图中的中央处理器。

[0016] 整个系统以单片机为主控制器，通过采集电流信息，判断出电池组是在充电、放电还是在闲置状态及是否有过流现象，并对其状态做出相应处理。对各节电池电压进行采集分析后，系统决定是否启动均衡模块对整个电池组进行能量均衡，同时判断是否有过充或过放现象。温度的采集主要用于系统的过温保护。整个系统的工作状态、电流、各节电压、剩余电量及温度信息都会通过液晶显示模块实时显示。

[0017] 本系统采用的微控制器是一种高性能 8 位单片机 ATmega8 的元器件。该单片机具备 AVR 高档单片机系列的全部性能和特点，支持在线编程 (ISP)，只需要一条可自制的下载线就可以进行单片机系统的开发。其中 ATmega8 单片机有 6 路 A/D 转换通道，其中有 4 路为 10 位精度，可直接用于电池电压的测量，其各项性能使其成为适应性强、灵活性高、成本低的嵌入式高效微控制器。

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[0018] 如图 2 所示，本发明的充电模块采用间歇式充电法，间歇式充电法是在预充和保持阶段通过间歇地打开和关闭充电回路，等效地改变充电电流的大小，进而实现在预充和保持状态时需要小电流、在正常充电时需要大电流的的性能要求。

[0019] 在对带有管理系统的电池组进行充电时，需要外接与之匹配的恒压电源充电器，对其恒压值 U 的要求为 :U=4.2V×N+ 损耗电压，其中 N 为电池节数。限流值为该动力锂电池的常规充电电流 0.3C(C 为电池容量)，在进行充电前必须先进行系统的初始化，然后按照间歇式充电法对电池组自动充电。锂离子电池在充电时要求其端电压控制在 4.2V 以下，为防止过充损坏电池，要求必须在充电时实时检测各单节锂电池电压。

[0020] 如图 3 所示，离子电池在充电时要求其端电压控制在 4.2V 以下，为防止过充损坏电池，要求必须在充电时实时检测各单节锂电池电压。电压采样模块的工作原理是 :首先把单刀双掷开关 K1、K2 向上打到电压测量档，并通过 MCU 控制的多路开关 Kn-1、Kn-2 (n=1、2、3、4、5、6、7)，同步地将电容分别接到各单节电池两端，使电容充电至电容电压等于被测单节电池的电压 ;然后断开 MCU 控制的多路开关 Kn-1、Kn-2，同时合上开关 K3 和 K4 接入 A/D 转换器进行测量。电压采样模块可直接使用微处理器内的 10 位 A/D 转换器，不需要另外加入 A/D 芯片，节省了设计成本。

[0021] 本发明的均衡模块采用 DC/DC 开关电源模块。由于开关电源模块具有功耗小、效率高、体积小、质量轻等优点，将其直接作为均衡模块使用是一个很好的选择。在具体使用时，根据检测到的各单节电池的电压值判断是否需要对电池组进行能量均衡。若需要，闭合均衡总开关 K5，开关 K1、K2 向下打到均衡档，用电池组的整体能量、对电压最低节电池进行额外的均衡充电，直到各节电池电压值的差别在系统要求范围之内。

[0022] 如图 4 所示，VREF 为参考点电压，默认为 2.5V，IP 为被测量电流，电流采集模块采用闭环电流传感器 LTSR25-NP，具有出色的精度、良好的线性度和最佳的反应时间。其额定电流为 25A，最高可测 80A 的电流，满足系统设计的要求。该电流传感器可把充放电电流转换为 0V~5V 的电压信号，送至单片机的 10 位 A/D 转换器进行转换后可测得充放电电流，测量精度为 0.2A。

[0023] 如图 5 所示，本发明在锂电池充放电过程中把充放电信息，包括各节电池的电压、充放电电流、工作温度、电池电量等通过采样实时写入 Flash 存储芯片 SST25VF020 中保存。在需要时，可通过串口与上位 PC 机通信把存储在 Flash 中的历史数据读到 PC 上。

[0024] 温度采样模块数字温度传感器 DS18B20 的元器件。数据显示模块选用 DM12864M 汉字图形点阵液晶显示模块，该模块可显示汉字及图形，内置 8192 个中文汉字 (16×16 点阵)、128 个字符 (8×16 点阵) 及 64×256 点阵显示 RAM。

[0025] 如图 6 所示，本发明包括如下步骤 :

第一步，系统初始化，执行状态判断步骤，然后进行相应的充电处理步骤、空闲处理步骤或放电步骤 ;

第二步，进行数据检测步骤和数据存储步骤，数据检测步骤包括对电压、电流和温度的检测处理 ;

第三步，数据显示步骤，在 LCD 上显示数据 ;

第四步，判断是否需要均衡处理步骤，如需要，则进行均衡处理，执行第五步 ;如不需要，则直接进入第五步 ;

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第五步，判断状态是否改变，若状态改变，则执行第一步的状态判断步骤，继续判断，若状态未改变，则执行第二步；

第六步，若数据检测步骤检测到的数据需要对外通信，则由数据存储通信模块发送数据。

[0026] 通过单片机的 10 位 A/D 转换模块测量单节电池的电压值。为了提高测量的精度，电压检测采用“筛值平均”的软件滤波方法，在对每节电池的模拟量进行测量时，连续测量多次，然后筛去最高值和最低值，再对剩余的测量值取平均值，以获得最佳的测量结果。然后根据电压的计算方式，获得电池的电压。在电压测量完成后，对所有的电池电压进行排序，标记出最低、最高的单体电池，为均衡模块服务。 通过检测到的单节电池电压判断电池所处的充电阶段，并利用单片机的脉宽调制输出 (PWM) 来控制 MOSFET 以实现预充阶段的小电流充电和保持充电阶段的脉冲充电。当检测到电池充电完毕后，自动断开充电回路。充电管理模块通过检测到的电压、电流、温度值判断电池是否工作在正常状态，如出现过压、过流或温度过高等现象，立刻通过 MOSFET 关闭充放电回路，并点亮故障提示灯。 本发明为动力锂电池组提供了智能控制管理系统，通过该系统为电池组提供了各种保护及能量均衡控制，最大限度地发挥了锂电池组的整体性能。均衡效率为 80% 左右，性能完全满足动力锂电池组能量均衡的控制管理要求。

[0027] 以上实施例仅用于说明本发明的优选实施方式，但本发明并不限于上述实施方式，在所述领域普通技术人员所具备的知识范围内，本发明的精神和原则之内所作的任何修改、等同替代和改进等，其均应涵盖在本发明请求保护的技术方案范围之内。

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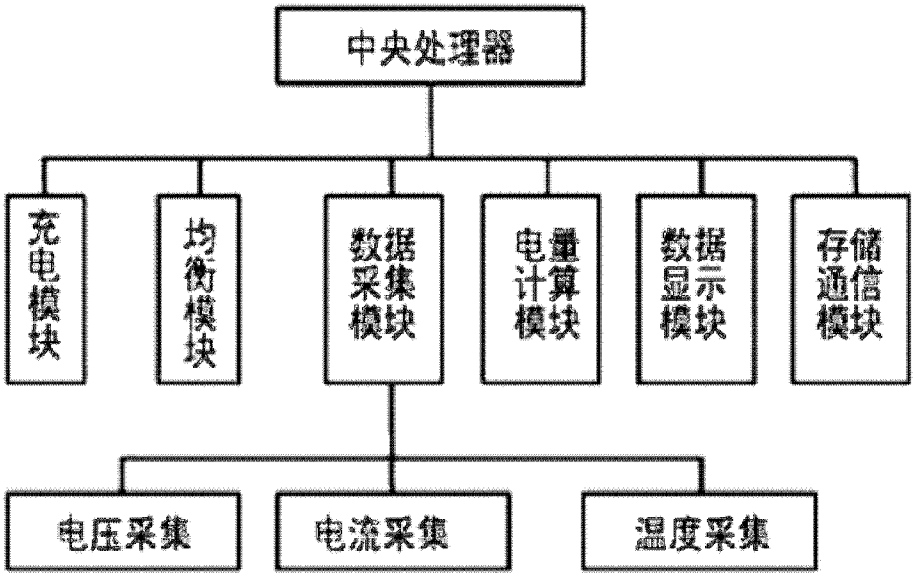


图 1

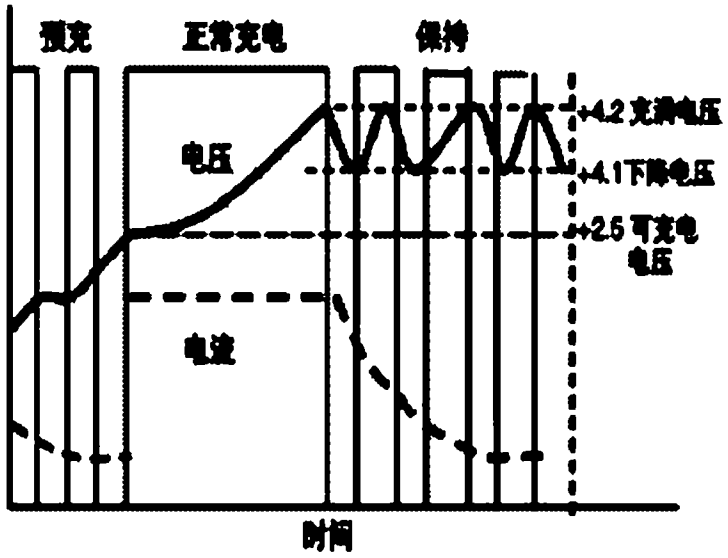


图 2

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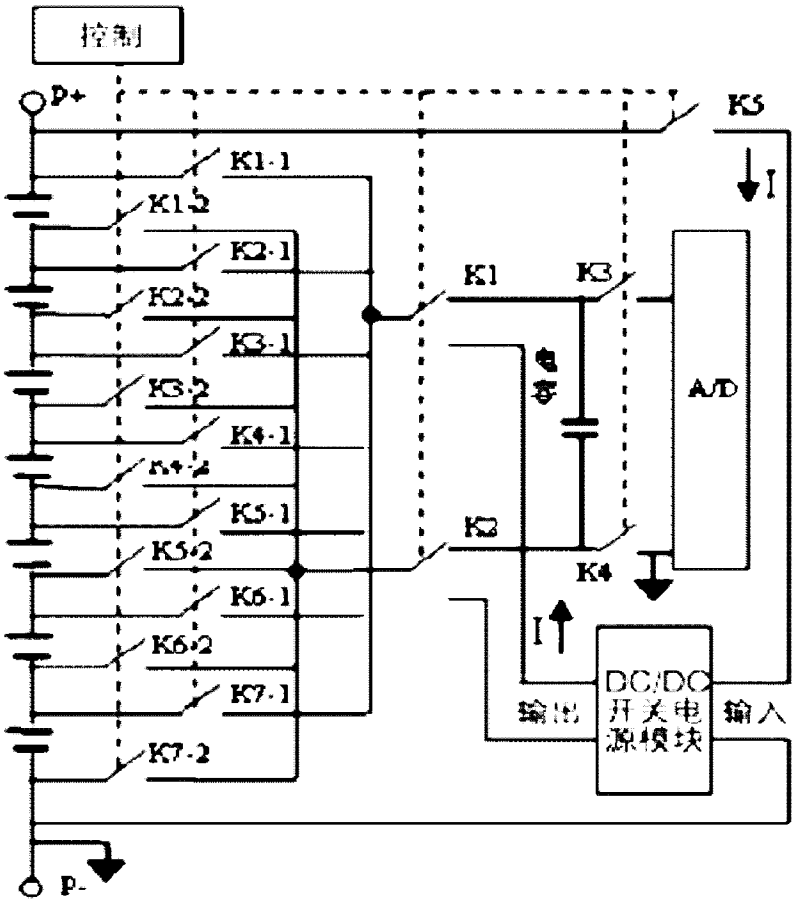


图 3

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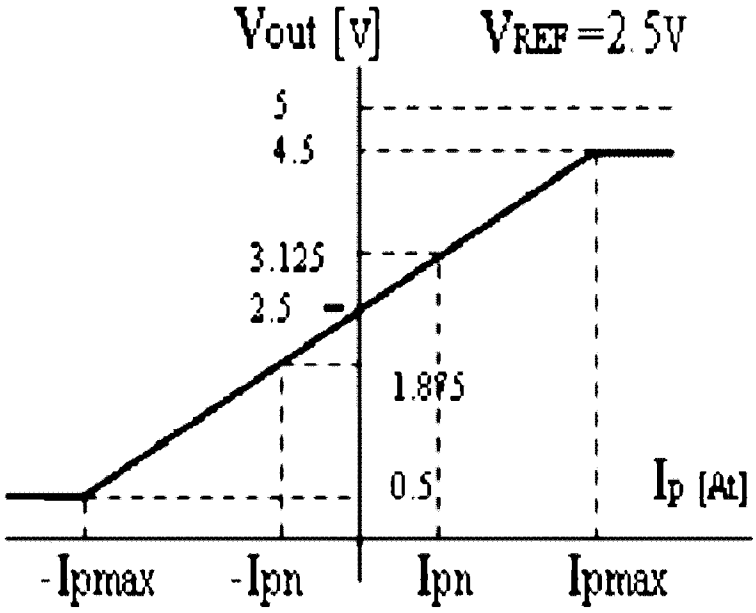


图 4

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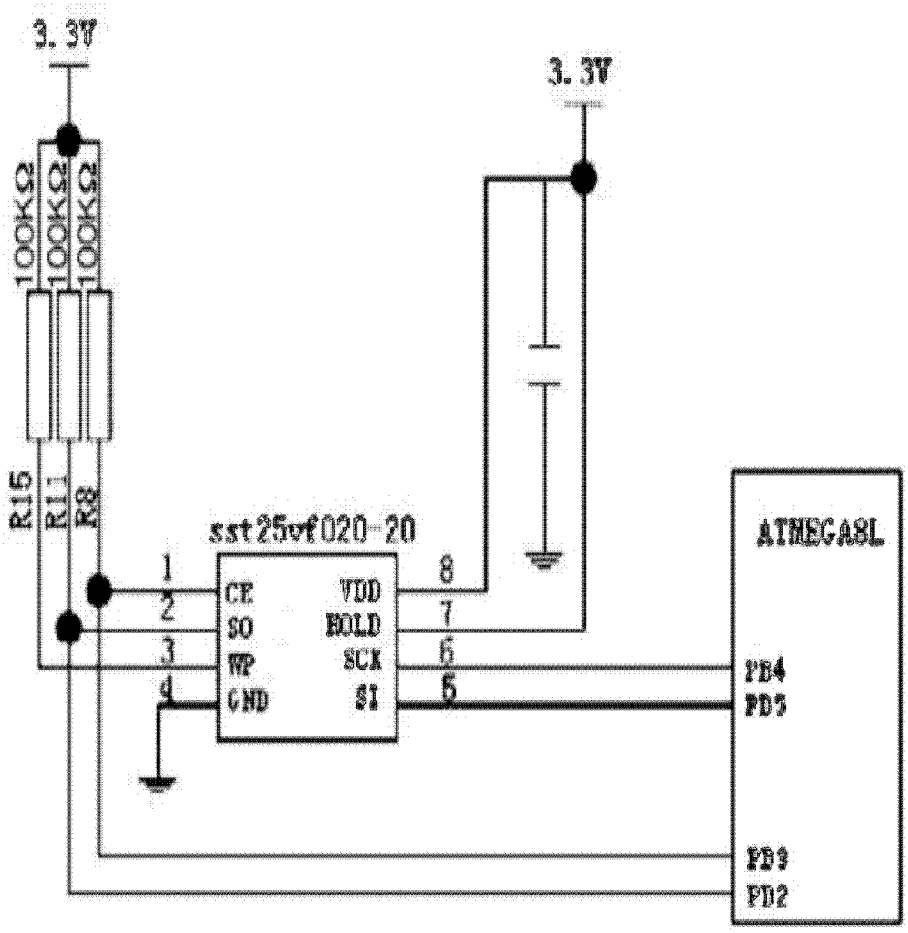


图 5

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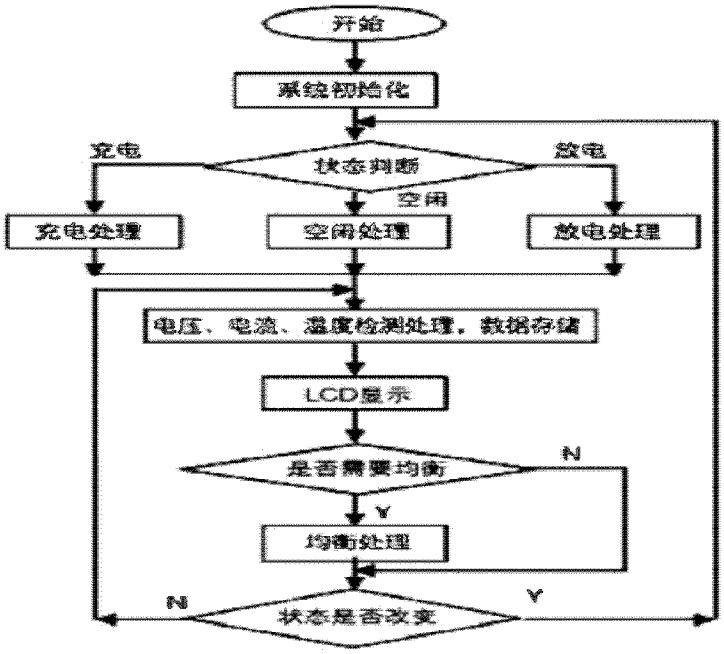


图 6

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IN THE HIGH COURT OF JUSTICE **HP-2020-000022**
BUSINESS AND PROPERTY COURTS OF ENGLAND AND WALES
INTELLECTUAL PROPERTY LIST (ChD)
PATENTS COURT

B E T W E E N :

THE NOCO COMPANY
(a company incorporated under the laws of Ohio, United States of America)
Claimant

and

RING AUTOMOTIVE LIMITED
Defendant

GROUNDS OF INVALIDITY

---

1. The following are the Grounds of Invalidity referred to in the Defence and Counterclaim upon which the Defendant relies.

2. The alleged inventions claimed in UK Patent No. GB 2 527 858 (the '**Patent**') are not new and/or do not involve an inventive step, being obvious to a person skilled in the art, having regard to the matters comprising the state of the art before the priority date of the Patent and in particular:

   (1) the making available to the public by supply, description and/or use of the HP2200 jump starter described in the manual dated August 2013 at **Annex A** before 3 July 2014 including in and after August 2013 ('**HP2200**');

   (2) the publication prior to the earliest claimed priority date of the Patent of International Patent Application WO 2004/0 36 714 on or after about 29 April 2004 ('**Krieger April 2004**');

   (3) the making available to the public prior to the earliest claimed priority date of the Patent (as alleged in the Grounds of Invalidity in the Earlier Proceedings referred to in the Defence and Counterclaim) of:

      (a) Chinese Patent Application CN 103 066 662 A on or after about 24 April 2013 ('**Carku CN**'),

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(b) US Patent Application US 2004/0 130 298 on or after about 8 July 2004 (**'Krieger July 2004'**),

(c) US Patent Application US 2013/0 154 543 on or after about 20 June 2013 (**'Richardson'**),

(d) the Carku E-Power 21 device in so far as it is established to have been made available to the public in the Earlier Proceedings (**'Carku E-Power 21'**);

(e) US Patent No. 6 424 158 (**'Klang'**), and

(f) US Patent No. 8 172 603 (**'Richardet'**).

(4) common general knowledge.

JAMES ST.VILLE

STATEMENT OF TRUTH

The Defendant believes that the facts stated in these Grounds of Invalidity are true. I understand that proceedings for contempt of court may be brought against anyone who makes, or causes to be made, a false statement in a document verified by a statement of truth without an honest belief in its truth. I am duly authorised to sign this Statement of Truth on the Defendant's behalf.

Signed 

Name: Theresa Spencer

Date: August 3, 2020

Position: Director

Served: August 3, 2020

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IN THE HIGH COURT OF JUSTICE **HP-2020-000022**
BUSINESS AND PROPERTY COURTS OF ENGLAND AND WALES
INTELLECTUAL PROPERTY LIST (ChD)
PATENTS COURT

B E T W E E N :

THE NOCO COMPANY
(a company incorporated under the laws of Ohio, United States of America)
Claimant

and

RING AUTOMOTIVE LIMITED
Defendant

Annex A to the Grounds of Invalidity

PROJECTA

2 x 22 AMP HOUR HIGH PERFORMANCE

JUMPSTARTER



P/No.s HP2012, HP2200

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IMPORTANT SAFETY INFORMATION

Please read this manual thoroughly before use and store in a safe place for future reference.

WARNINGS

Risk of explosive gas. Working in the vicinity of a lead-acid battery can be dangerous. Batteries release explosive gases during normal operation, charging and while jumpstarting a battery. Before using this jumpstarter, read and follow the instructions carefully. Follow all manufacturer's instructions and warnings of the vehicle's battery and other equipment being used.

Jumpstart lead-acid batteries only. Do not use to jumpstart dry-cell batteries commonly found in household appliances. These batteries may burst and cause injury and/or property damage.

Do not smoke, use matches, use a cigarette lighter, or allow a spark or flame near the battery.

Do not allow metal to come in contact with the battery posts. It may spark or short-circuit the battery and cause an explosion.

Always wear eye protection when operating the jumpstarter

Remove rings, bracelets, necklaces and watches when working with a lead-acid battery.

Contains a sealed non-spillable lead acid battery and must be disposed of properly.

Ensure correct polarity when connecting to vehicle.

Do not submerge jumpstarter in water.

IMPORTANT CHARGING INFORMATION

Charge jumpstarter prior to first use, this may take up to 24 hours.

Fully recharge the jumpstarter after every use and follow charging instructions.

When jumpstarter is not in use ensure jumpstarter is always on charge.

Do not allow jumpstarter to become very flat. If the jumpstarter's battery is below 12.6V in 12V mode or below 25.2V in 24V mode, ensure the jumpstarter is charged immediately.

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FEATURES

ENGINE STARTING CAPABILITIES

HP2012

The HP2012 is suitable for starting 12V vehicles.
12V: Petrol vehicles up to 6 litres and diesel vehicles up to 4.5 litres

HP2200

The HP2200 is suitable for starting both 12V and 24V vehicles.
12V: Petrol vehicles up to 6 litres and diesel vehicles up to 4.5 litres
24V: Petrol & Diesel vehicles up to 7 litres in capacity.

TOTAL SAFEGUARD PROTECTION

POLARITY & SURGE PROTECTION

Prevents sparking from accidental reverse connection, as well as protecting your vehicle from spikes in voltage levels.

CRANKING PROTECTION

Prevents your jumpstarter batteries from being over discharged often caused by over cranking.

DISCHARGE PROTECTION

Discharge protection disconnects power to all 12V accessories when the battery voltage reaches low levels.

UNDER & OVER VOLTAGE PROTECTION

The jumpstarter will deactivate and sound an alarm if connected to a battery of a different voltage to the setting of the jumpstarter, preventing reverse charge and damage to the jumpstarter battery. This feature will also disconnect the jumpstarter if the vehicles alternator is malfunctioning with high voltage.

LCD DIGITAL DISPLAY

The jumpstarter is fitted with an LCD digital display that displays the batteries state of charge, battery voltage mode, correct connection and other warning messages during operation.

HEAVY-DUTY FULLY INSULATED LEADS

Long 1.6m leads allow easy connection to the vehicles battery while the jumpstarter is on the ground. Quality cable ensures optimal performance.

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HIGH PERFORMANCE BATTERY

High quality AGM battery delivers instant starting power to vehicles. Maintenance free and fully sealed battery ensures convenience and safety.

240V AND 12V RECHARGING

4A adaptor allows recharging from a 240 Volt AC outlet.
The DC lead allows charging from either the 12V or 24V accessory socket.

5 STAGE AUTOMATIC CHARGE CONTROL

Both the HP2012 and HP2200 feature in-built 5 stage charge control that delivers a complete and thorough charge to the jumpstarter batteries in both 240VAC and 12/24VDC charge modes. 5 stage charging gives your jumpstarter batteries longer life, better performance and can be left connected permanently without risk of overcharging.

REVERSE POLARITY PROTECTION & ALARM

Prevents sparking from accidental reverse connection. The alarm sounds when the jumpstarter clamps are connected incorrectly.

SURGE PROTECTED

The HP2012/HP2200 features built in surge protection so you can safely jump start vehicles with EFI and computer management systems.

PORTABLE POWER

The accessory socket & heavy duty accessory sockets can be used to power 12 Volt DC appliances such as camping lights, radios, MP3 players and computers.

INBUILT L.E.D WORK LIGHT

An inbuilt L.E.D work light provides illumination for safer, more convenient operation at night.

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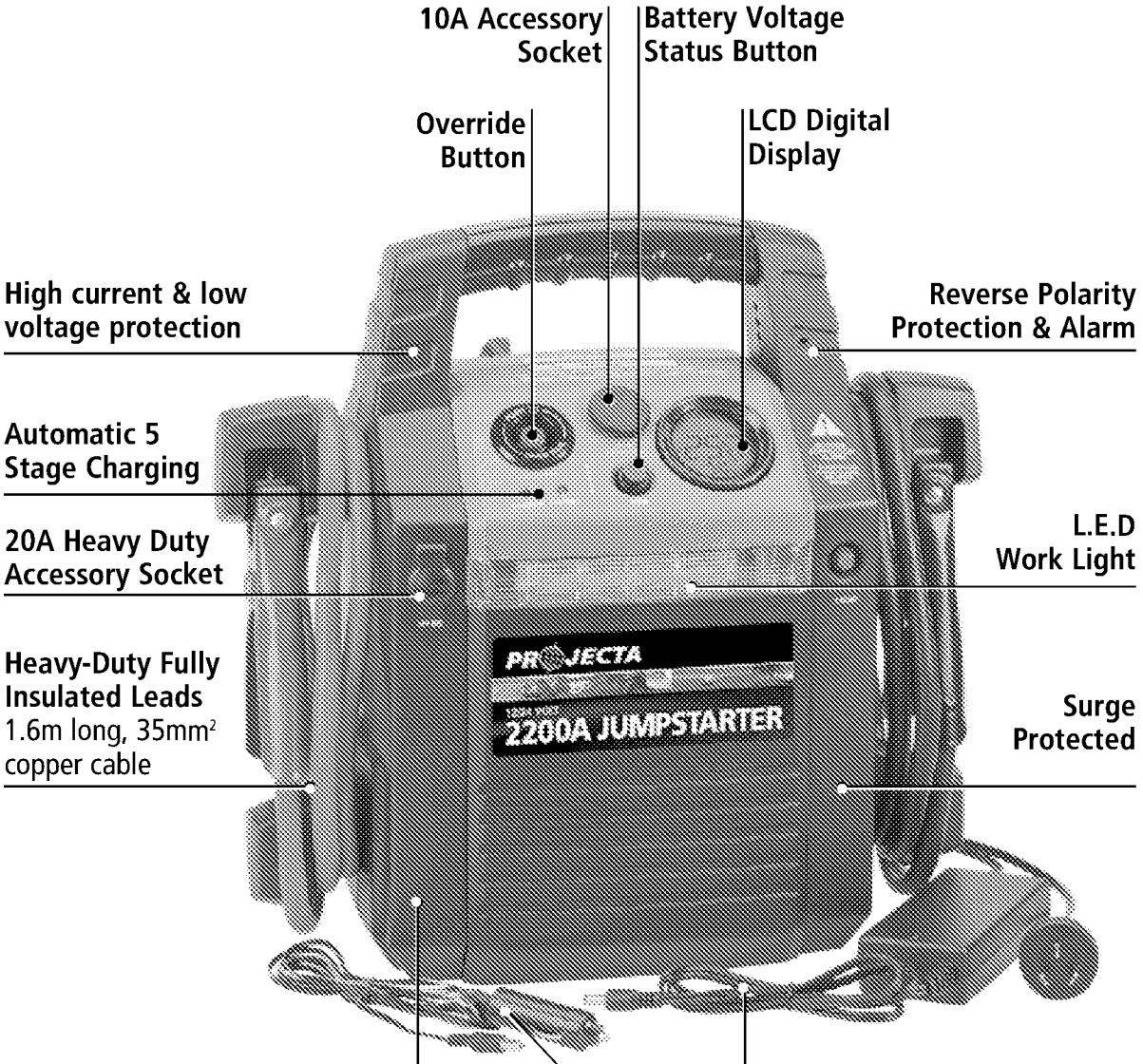
SPECIFICATIONS

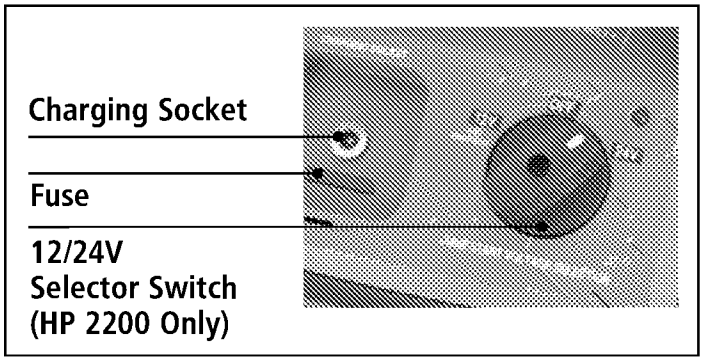
Part No.	HP2012	HP2200
Battery		
Battery Capacity	2 x 12V 22Ah AGM	2 x 12V 22Ah AGM
Battery Short Circuit Current	2000A	2200A at 12V,1100A at 24V
Clamp Output	600A	640A at 12V, 500A at 24V
12V DC Power outlets		
Accessory Socket	10A	10A
Heavy Duty Accessory Socket	20A	20A
Protection	20A overload, 11.0V LVD (25A ATS Fuse)	20A overload, 11.0V LVD (25A ATS Fuse)
Jumpstarter Leads		
Length	1.6 meters	1.6 meters
Cable	35mm2	35mm2
Polarity Protection	MCU controlled solenoid	MCU controlled solenoid
Overload Protection	MCU controlled solenoid	MCU controlled solenoid
Recharging		
240V	4A	4A
DC Charging	12V–24V 4A	12V–24V 4A
Control	Automatic 5 Stage	Automatic 5 Stage
Jumpstart connection voltages		
12V Mode	1.2V–15.0V	1.2V–15.0V
24V Mode	N/A	15.1V–30V
Override	0V–1.2V	0V–1.2V
LCD Display		
Jumpstart Mode	12V	12V & 24V
Jumpstarter Battery Voltage	Battery test button	Battery test button
L.E.D Charge Indication		
Blue	Charging	Charging
Green	Fully Charged	Fully Charged
Dimensions & Weight		
Height	370mm	370mm
Width	390mm	390mm
Depth	200mm	200mm
Weight	16.3Kg	17.5Kg

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PRODUCT OVERVIEW

Image of HP2200 (HP2012 not shown)





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VEHICLE JUMPSTARTING INSTRUCTIONS

NOTE: Instructions for negatively earthed vehicles only

1. Insert supplied fuse into fuse holder below charging socket.
2. Your jumpstarter should be charged for 24 hours prior to first use and as soon as possible after each use.
3. Before making any connections, check the jumpstarter battery status by pressing the red INTERNAL BATTERY STATUS button. The jumpstarter's battery voltage should be above 12.6V in 12V mode and above 25.2V in 24V mode.
4. Turn your vehicle's ignition OFF before connecting the jumpstarter's clamps to your vehicle.

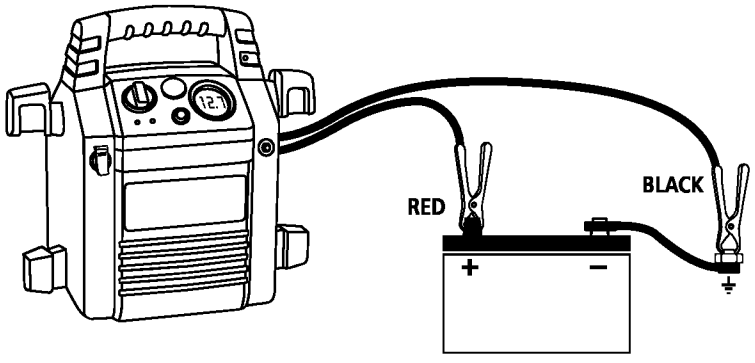
5a. To operate the HP2012 rotate the switch at the back of the unit to ON AND CHARGING. The HP2012 will jumpstart 12V vehicles only.

5b. If operating the HP2200 select the required voltage to suit the vehicle by rotating the switch on the back of the jumpstarter to 12V AND CHARGING or 24V.

6. Connect the Red Positive (+) clamp to the positive (+) terminal of the battery in the vehicle and the Black Negative (-) clamp to any non-moving metal part of the engine block. DO NOT CONNECT TO FUEL LINE. Always double check that you have the proper connections.

   If the jumpstarter fails to start your vehicle refer to the LCD screen for any error it may indicate & check that the clamps are correctly connected with good contact. If the vehicle's battery is below 1.2V ensure all connections are correct and then press the OVER RIDE button to manually engage the jumpstarter.

7. Turn the vehicle's ignition to ON and start the vehicle. After the engine has started, rotate the power switch to the OFF position.
8. Disconnect the Black clamp and then the Red clamp
9. Recharge the jumpstarter.



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UNDERSTANDING YOUR JUMPSTARTER

STATUS	SCREEN DISPLAY	SCREEN ILLUMINATION
Incorrect Battery Voltage	ERR / v24.0* (Scrolling Display) *Example only: Display shows actual battery voltage.	Screen flashing
Reverse Connection	- OR + (+/- Alternating) REV / CON (Scrolling Display)	Screen flashing
Low Battery Voltage **12V Mode:** less than 12.0V **24V Mode:** less than 24.0V	LO / BAT (Scrolling Display)	ON
Low Battery Voltage **Switched Off:** less than 11.5V	LO / BAT (Scrolling Display)	OFF
Input Charge Voltage Above 30.0V	OVL	Screen flashing
Jumpstarter Over Temperature	OL	Screen flashing
Accessories Current Overload	ACC / OL (Scrolling Display)	Screen flashing
Accessories Low Voltage Disconnect (LVD)	ACC / LVO (Scrolling Display)	OFF
Battery Charging Bulk Timed Out	BAT / ERR (Scrolling Display)	Screen flashing
Positive (Red) Clamp Connected	- OR +	ON
Negative (Black) Clamp Connected	- OK +	ON
Jumpstarter Connected	- OK +	ON
Internal Battery Voltage (Battery Status Button)	v 12.8 MODE 12 v	ON
Jumpstarter Mode (When switched to 12V)	MODE 12 v	OFF
Jumpstarter Mode (When switched to 24V, HP2200 only)	MODE 24 v	OFF

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ALARM	REMEDY
Beeping Intermittently	Check voltage of battery being jumpstarted. Ensure the jumpstarter voltage is switched to the same voltage as the vehicle being jumpstarted
Constantly On	Check the jumpstarter clamps are connected correctly to the battery
Beeping Intermittently	Recharge jumpstarter
Beeping Intermittently	Recharge jumpstarter **OR** to override/cancel warning hold the BATTERY STATUS button while the jumpstarter is switched to the off position
OFF	Check input charge voltage is below 30V
OFF	Allow jumpstarter temperature to cool down
Beeping Intermittently	Check current draw of appliance being used
OFF	Recharge jumpstarter or press Override button
OFF	Disconnect any appliance connected to the jumpstarter. If no load is connected to the jumpstarter the batteries may be faulty and require replacing
OFF	No action required
OFF	No action required
OFF	No action required
OFF	No action required
OFF	No action required
OFF	No action required

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CHARGING WITH AC ADAPTOR

IMPORTANT: DO NOT POWER ANY APPLIANCE FROM THE JUMPSTARTER WHILE IT IS BEING CHARGED USING THE AC CHARGER.

1. To charge, rotate the switch on the back of the unit to ON AND CHARGING (HP2012) or 12V AND CHARGING (HP2200).
2. Plug the output end of the AC charger into the charging socket (back of jumpstarter) and connect the charger to a 240VAC outlet and turn ON.
3. The CHARGING LED will illuminate blue when charging & the FULL LED will illuminate solid green when the jumpstarter is fully charged. The jumpstarter will automatically stop charging and the jumpstarter will initiate maintenance charge mode keeping the battery fully charged and ready for use without the risk of overcharging.

   Charging time: 15 hours if the battery is completely flat.

WHEN TO CHARGE

Your jumpstarter is shipped fully charged, however, an extended period of time may elapse in shipment or storage before the jumpstarter is purchased. Therefore you should charge the jumpstarter before using it for the first time. It is recommended to charge fully after each use. If the jumpstarter is not being used, it is recommended to leave the jumpstarter permanently on charge ensuring the battery is always maintained fully charged and ready for use.

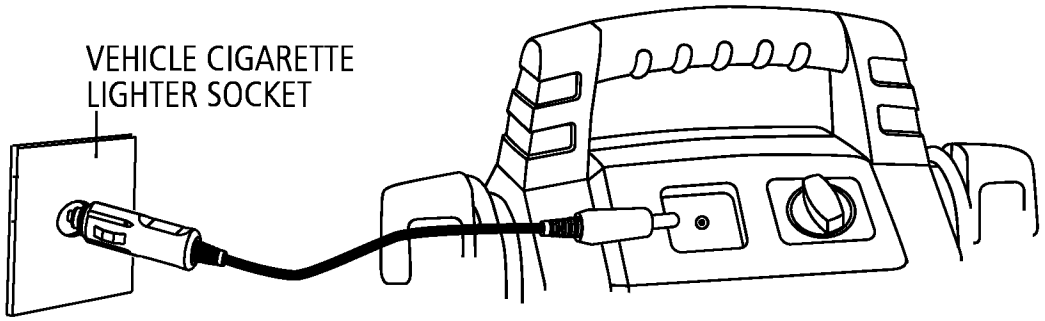
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CHARGING WITH 12V DC

Your Jumpstarter can be recharged from a 12V DC socket. A single-ended accessory plug and lead is included for recharging while driving.

1. To charge, rotate the switch on the back of the unit to ON AND CHARGING (HP2012) and 12V AND CHARGING (HP2200).
2. Connect the 12V charging lead to your vehicles cigarette lighter socket and to the jumpstarter's charging socket.
3. Start the car. The vehicle's alternator will charge both the jumpstarter and the vehicle battery at the same time. The CHARGING LED will illuminate blue while charging and the FULL LED will illuminate solid green when fully charged. The jumpstarter's charge control will automatically stop charging and initiate maintenance mode keeping the battery fully charged and ready for use without risk of overcharging. Once the vehicle is turned off the jumpstarter will stop charging.

Note: Appliances can be run from the jumpstarter during DC charging, for example a fridge or light.



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L.E.D CHARGE INDICATORS

Your jumpstarter unit features two coloured L.E.D's that illuminate various signals to indicate different stages of charging.

L.E.D	L.E.D SIGNAL & STAGES OF CHARGING				
	Bulk	Absorption	Analysis	Recondition	Float
Charging (Blue)	Solid On ———	Solid On ———	Off	Flashing - - - - -	Off
Charged (Green)	Off	Flashing - - - - -	Flashing - - - - -	Flashing - - - - -	Solid On ———

5 STAGES OF CHARGING:

BULK (CONSTANT CURRENT)

The bulk stage reduces charging time by charging the battery at the maximum rate (constant current) to a set voltage, at which point the battery is approximately 80% charged.

ABSORPTION (CONSTANT VOLTAGE)

The absorption stage charges the battery to 100% by adjusting the charge rate allowing the battery to absorb more power.

ANALYSIS

The analysis mode tests the battery to ensure that it has taken the charge; if the battery passes the test the charger will proceed to the float stage, but if the battery fails the test, the charger will apply a recondition charge to try to return the battery to full charge.

RECONDITION

If after charging, the battery is unable to hold the charge the battery reconditioning function is initiated automatically. This is most likely to take place on batteries that have been deeply discharged, prior to charging.

FLOAT

The float stage maintains the battery at 100% charge without overcharging or damaging the battery. This means the charger can be left connected to the battery indefinitely.

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USING THE PROJECTA HP2012/HP2200 JUMPSTARTER AS A POWER SUPPLY

These jumpstarter's utilise 2 x 22Ah AGM batteries and can be used as a power supply by connecting a cigarette lighter or accessory plug into the 12V DC socket at the front of the jumpstarter.
It is recommended to check the battery capacity before running accessories.

Below is a list of approximate run times for various appliances.

Appliance	Estimated power consumption (Watts)	Estimated time* (Hours)
Car phones, fluorescent lights	4	77
Radios, depth finders	9	54
Fridges (portable compressor style)	14	39
Camcorders, portable TVs	15	31
Electrical tools, bilge pumps	24	18
Cooler/warmers, spotlights	48	8
Air compressors, car vacuum cleaners	80	4

*Estimated time is based on a fully charged jumpstarter

IMPORTANT: OVER CURRENT & LOW VOLTAGE PROTECTION

Over Current Protection: If the power demand on the jumpstarter exceeds 20 Amps an alarm will sound & the power to the appliance will be automatically disconnected. Check the current draw of the appliance connected to the jumpstarter is not greater than 20A.

Low Voltage Protection: If the jumpstarter's battery voltage falls below 11V while running an appliance, the appliance will be automatically disconnected. It is recommended to recharge the jumpstarter immediately. Once the battery voltage reaches 13V the appliance will automatically reconnect.
Note: As a result of the appliance being disconnected the jumpstarter batteries may increase in voltage slightly above 11V. In circumstances where it is essential to keep the appliance running the OVER RIDE button can be pressed allowing you to continue powering the appliance for a short period of time before the 11V disconnect point is reached again.

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CHECKING BATTERY CAPACITY

The jumpstarter is equipped with a LCD DIGITAL DISPLAY. When the BATTERY VOLTAGE STATUS button is pressed the display will indicate the battery voltage level.

To check the battery capacity :

Step 1 Disconnect any appliance and accessories that might be running from the jumpstarter, as this will effect the reading. Ensure the jumpstarter is not being charged.

Step 2 Press the battery voltage button and read the LED voltage display (displayed as volts).

Step 3 Refer to the table below for the conversion of volts to battery capacity as a percentage.

Battery Capacity	Battery voltage reading (12V)	Battery voltage reading (24V)
100%	12.6 Volt or greater	25.2 Volt
75%	12.4 Volt	24.8 Volt
50%	12.2 Volt	24.4 Volt
25%	12.0 Volt	24.0 Volt
0%	11.0 Volt	22.0 Volt

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FREQUENTLY ASKED QUESTIONS

Q. How do I work out how long my appliance will run from the Jumpstarter

A. When the jumpstarter is fully charged the battery will be able to provide 44 Amp hours of 12V power. If you have an appliance that uses 2.5 Amps and you use it for one hour, you have just used 2.5 Amp hours.

For example:-
The jumpstarter is powered by 2 x 22Ah (44Ah) batteries and you are powering a small TV drawing approximately 2.5 Amps

Equation: 44 Amp hours ÷ 2.5 Amps = 17.6 Hours (18 hours)

Q. How can I improve the charging time when charging from my vehicle?

A. Disconnect any appliances connected to the jumpstarter. Car cigarette lighter sockets are usually connected to the battery with small (light) cable. If your jumpstarter is taking longer than 11–13 hours to recharge, the cable between the vehicle's battery and cigarette lighter socket may require upgrading.

Q. When I use the 12 Volt DC sockets the appliance does not work?

A. Check to make sure the appliance does not exceed the rated current of the socket used.

Accessory Socket:	Max 10A
Heavy Duty Accessory Socket:	Max 20A
Maximum Combined Load:	20A

If the load on your jumpstart exceeds 20A the jumpstarter will disengage the power accessories. To restart the jumpstarter and continue powering your appliance press the OVER RIDE button on the front of the jumpstarter.

Q. When I connect the jumpstarter up to the battery the alarm is going off?

A. The jumpstarter is designed to give off an alarm in the following circumstances.

1. If the positive and negative clamps are touching each other.
2. Reverse connection i.e. positive clamp connected to negative terminal or negative clamp connected to positive terminal.
3. If the jumpstarter voltage is different to the vehicle's voltage.
4. Over temperature protection, jumpstarter has reached high operating temperature's. Cease operation of the jumpstarter for 10 minutes to allow the unit to cool down before resuming operation.
5. The battery is very flat & jumpstarter may need recharging.

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Q. Why didn't my jumpstarter start my vehicle?

A. There could be a number of reasons why the jumpstarter did not start your vehicle.

Check the following:

1. Ensure the jumpstarter battery is fully charged. Press the INTERNAL BATTERY STATUS button to check the condition of the battery (state of charge). Refer to page 13 ("Checking Battery Capacity") for further information.
2. Ensure you have followed the correct operating procedure. Refer to page 7 ("Vehicle Jumpstarting Instructions").
3. Ensure the correct voltage is selected on the jumpstarter for the type of vehicle being jumpstarted, 12V mode for 12V vehicles & 24V mode for 24V vehicles (HP2200 Only).
4. The vehicle's battery may be below 1.2V, the minimum start voltage for the jumpstarter. Ensure all connections are correct, then press the OVER RIDE button, to manually activate the jumpstarter. Refer to page 7 ("Vehicle Jumpstarting Instructions, Step 5") for further information.
5. Ensure the vehicle being jumpstarted does not require more than:

   HP2012: 600 Amps Clamp Output

   HP2200: 640 Amps Clamp Output at 12V OR
   500 Amps Clamp Output at 24V.

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WARRANTY STATEMENT

Brown & Watson International Pty Ltd ("BWI") of 1500 Ferntree Gully Road, Knoxfield, Vic., telephone (03) 9730 6000, fax (03) 9730 6050, warrants that all products described in its current catalogue will under normal use and service be free of failures in material and workmanship for a period of one (1) year from the date of the original purchase by the customer as marked on the invoice. This warranty does not cover ordinary wear and tear, abuse, alteration of products or damage caused by the purchaser.

To make a warranty claim the consumer must deliver the product at their cost to the original place of purchase or to any other place which may be nominated by either BWI or the retailer from where the product was bought in order that the warranty assessment may be performed. The consumer must also deliver the original invoice evidencing the date and place of purchase together with an explanation in writing as to the nature of the claim.

In the event that the claim is determined to be for a minor failure of the product then BWI reserves the right to repair or replace it at its discretion. In the event that a major failure is determined the consumer will be entitled to a replacement or a refund as well as compensation for any other reasonably foreseeable loss or damage.

This warranty is in addition to any other rights or remedies that the consumer may have under State or Federal legislation.

IMPORTANT NOTE

Our goods come with guarantees that cannot be excluded under the Australian Consumer Law. You are entitled to a replacement or refund for a major failure and compensation for any other reasonably foreseeable loss or damage. You are also entitled to have the goods repaired or replaced if the goods fail to be of acceptable quality and the failure does not amount to a major failure.

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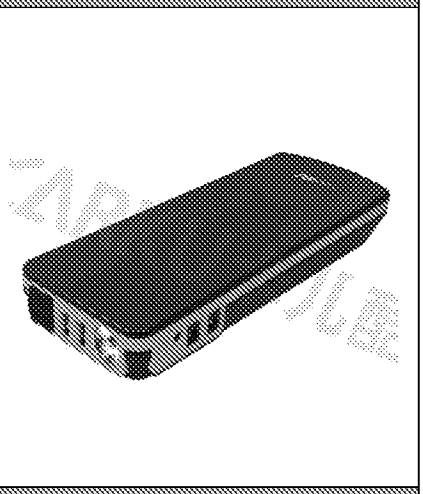
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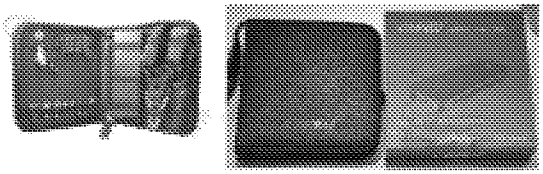
Model: Epower-21

Specification		
Battery Capacity	66.6Wh (18000mAh)	
Dimension	230*87*27mm	
Weight	615g	
Output	5V/1A ---mobile phone, tablet PC, other digital devices 5V/2A --- tablet PC 12V/10A ---12V car electronic products（car air-compressor etc.） 19V/3.5A ---Laptop 12V car Jump Start	
Input	14V/1A	
Start Current	300A	
Peak Current	600A	
Operation Temp.	-20℃~60℃/-4℉~140℉	

Standard Accessories	
1pc Home charger	Input: AC/100V-240V ， Output: DC/14V1A
1pc Car charger	Input / Output: DC 14V1A
1pc Smart cable	For Jump start 12V vehicle use
8pcs Notebook connectors + 1pc switch cable	LENOVO，SONY，IBM，ACER，HP，DELL，SAMSUNG，NEC，…
3-in-1 Mobile Phone Cable	Micro USB, iPhone4, iPhone5
1pc User Manual	



Accessories for choice		
Cigar Socket Cable	12V10Aoutput switch cable	

Packing	
Individual Packing : PU Bag + Color box Size：250*267*62mm Whole set Weight: 1.5KG	
Carton	Size : 51.5*32*29.5cm, 0.07cbm/CTN
	Packing Rate: 10sets/CTN
	G.W.= 17 KG

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Espacenet

WO2016003471A1 PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Applicants: NOCO COMPANY [US]

Inventors: NOOK JONATHAN LEWIS [US],NOOK WILLIAM KNIGHT [US],STANFIELD JAMES RICHARD [US],UNDERHILL DEREK MICHAEL [US]

Classifications:
IPC ***H02J7/00;***

CPC **F02N11/12 (EP); F02N11/14 (EP); H02J7/00302 (EP,GB); H02J7/00306 (EP,GB); H02J7/0034 (EP,GB); H02J7/0036 (EP,GB); H02J7/342 (EP,GB);** F02N11/10 (EP); H02J7/00309 (EP,GB);

Priorities: US2014045434W 2014-07-03

Application: US2014045434W·2014-07-03

Publication: WO2016003471A1·2016-01-07

Published as: **AU2015258229A1; AU2016269555A1; AU2016269555B2; AU2019201559A1; AU2019201559B2; AU2019201559B9; AU2020201222A1; AU2020201222B2; AU2020201223A1; AU2020201223B2; AU2020201223C1; AU2020201224A1; AU2021101535A4; AU2021101537A4; AU2021202399A1; AU2021258059A1; AU2021258059B2; AU2022200612A1; AU2022200746A1; AU2022201338A1; CA2916782A1; CA2916782C; DE102014114997A1; DE102014114997B4; DE202014011347U1; DE202014011413U1; DE202014011416U1; GB2527858A; GB2527858B;** WO2016003471A1

PORTABLE VEHICLE BATTERY JUMP START APPARATUS WITH SAFETY PROTECTION

Abstract

A handheld device for jump starting a vehicle engine includes a rechargeable lithium ion battery pack and a microcontroller. The lithium ion battery is coupled to a power output port of the device through a FET smart switch actuated by the microcontroller. A vehicle battery isolation sensor connected in circuit with positive and negative polarity outputs detects the presence of a vehicle battery connected between the positive and negative polarity outputs. A reverse polarity sensor connected in circuit with the positive and negative polarity outputs detects the polarity of a vehicle battery connected between the positive and negative polarity outputs, such that the microcontroller will enable power to be delivered from the lithium ion power pack to the output port only when a good battery is connected to the output port and only when the battery is connected with proper polarity of positive and negative terminals.

(19) Deutsches Patent- und Markenamt

(10) **DE 20 2014 011 413 U1** 2020.06.04

(12) # Gebrauchsmusterschrift

(21) Aktenzeichen: **20 2014 011 413.7**
(22) Anmeldetag: **15.10.2014**
(67) aus Patentanmeldung: **10 2014 114 997.1**
(47) Eintragungstag: **27.04.2020**
(45) Bekanntmachungstag im Patentblatt: **04.06.2020**

(51) Int Cl.: ***H02H 3/18*** (2006.01)

(30) Unionspriorität:
PCT/US2014/45434 03.07.2014 US

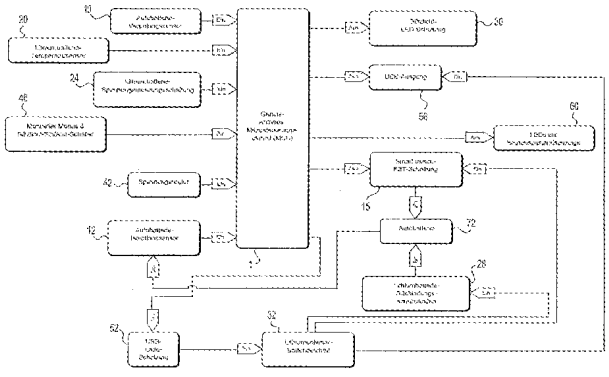
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Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen.

(54) Bezeichnung: **Tragbare Starthilfevorrichtung für Fahrzeugbatterien mit Sicherheitsschutzvorrichtung**

(57) Hauptanspruch: Starthilfevorrichtung zum Boosten oder Aufladen einer verbrauchten oder entladenen Batterie, die einen positiven und negativen Batterieanschluss aufweist, die Starthilfevorrichtung umfasst:
- eine Spannungsversorgung (32);
- einen positiven Batterieverbinder zur Verbindung der Starthilfevorrichtung mit dem positiven Batterieanschluss der verbrauchten oder entladenen Batterie (72);
- einen negativen Batterieverbinder zur Verbindung der Starthilfevorrichtung mit dem negativen Batterieanschluss der verbrauchten oder entladenen Batterie (72);
- einen Leistungsschalter (15), der über eine Schaltung mit der Spannungsversorgung (32) und den positiven und negativen Batterieverbindern verbunden ist,
- wobei der Leistungsschalter (15) eingerichtet ist, die Spannung von der Spannungsversorgung (32) zur verbrauchten oder entladenen Batterie (72) ein- oder auszuschalten, wenn diese mit den positiven und negativen Batterieverbindern verbunden ist,
- ein Leistungsschaltersteuerungssystem oder eine Leistungsschaltersteuerungsschaltung, die mit dem Leistungsschalter (15) verbunden ist und zur Steuerung des Leistungsschalters (15) vorgesehen ist,
- wobei das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung eingerichtet ist, das Vorhandensein der verbrauchten oder entladenen Batterie (72) und die Polarität der verbrauchten oder entladenen Batterie (72) zu detektieren, wenn diese zwischen die positiven und negativen Batterieverbinder geschaltet ist,
- wobei ...



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Beschreibung

Hintergrund der Erfindung

[0001] Die vorliegende Erfindung bezieht sich im Allgemeinen auf eine Starthilfevorrichtung für ein Fahrzeug, das eine verbrauchte oder entladene Batterie aufweist. Gemäß dem Stand der Technik sind Vorrichtungen bekannt, die entweder ein Paar von elektrischen Verbindungskabeln aufweisen, die eine vollständig aufgeladene Batterie eines anderen Fahrzeugs mit der Fahrzeugstartschaltung des Fahrzeugs verbinden, das die erschöpfte Batterie enthält, oder tragbare Starthilfevorrichtungen, die eine vollständig geladene Batterie aufweisen, und die mit der Startvorrichtung des Fahrzeugmotors über ein Kabelpaar in einer Schaltung verbunden werden können

[0002] Probleme entstanden beim Stand der Technik, wenn entweder die Drahtbrückenanschlüsse oder -klemmen der Kabel irrtümlich miteinander in Kontakt gebracht wurden, während die anderen Enden an eine geladenen Batterie angeschlossen waren, oder wenn die positiven und negativen Anschlüsse mit den Anschlüssen entgegengesetzter Polung im zu überbrückenden Fahrzeug verbunden wurden, wodurch ein Kurzschluss verursacht wurde, der zu einer Funkenbildung und einer potentiellen Beschädigung der Batterien und/oder einem körperlichen Schaden führte.

[0003] Gemäß dem Stand der Technik wurden unterschiedliche Versuche zur Beseitigung dieser Probleme unternommen. US 6,212,054 B1, erteilt am 3. April 2001, offenbart eine Batteriestarthilfeeinheit, die empfindlich auf die Polung reagiert und passende oder unpassende Verbindungen detektieren kann, bevor ein Pfad für den elektrischen Ladungsfluss bereitgestellt wird. Die Vorrichtung verwendet einen Satz von LEDs, die mit durch eine Steuerschaltung ausgerichteten optischen Kopplern verbunden sind. Die Steuerschaltung steuert eine Spulenanordnung, die den Pfad eines Leistungsstroms steuert. Der Steuerschaltkreis lässt einen Leistungsstromfluss durch die Spulenanordnung nur dann zu, wenn die Kontaktpunkte der Starthilfekabelklemmenverbindungen richtig angelegt wurden.

[0004] US 6,632,103 B1, erteilt am 14. Oktober 2003, offenbart ein adaptives Starthilfekabel, das durch zwei Klemmenpaare verbunden ist, wobei die beiden Klemmenpaare jeweils an zwei Batterien angeschlossen sind, um Strom von einer Batterie zu einer anderen Batterie zu übertragen. Das adaptive Starthilfekabel enthält eine mit jeder Klemme verbundene Polungsdetektionseinheit, eine Schalteinheit und eine Stromdetektionseinheit, die beide zwischen den beiden Klemmenpaaren vorhanden sind. Nachdem die Polung jeder Klemme durch die Polungsdetektionseinheit abgetastet wurde, erzeugt die Schalteinheit eine geeignete Verbindung zwischen den beiden Batterien. Daher sind die positiven und negativen Anschlüsse der beiden Batterien basierend auf dem detektierten Ergebnis der Polungsdetektionseinheit passend verbunden.

[0005] US 8,493,021 B2, erteilt am 23. Juli 2013, offenbart eine Vorrichtung, die die Spannung einer Fahrzeugbatterie, welche Starthilfe bekommt und den durch die Starthilfebatterien gelieferte Strom überwacht, um zu bestimmen, ob eine passende Verbindung hergestellt wurde und um eine Fehlerüberwachung bereitzustellen. Nur wenn die geeignete Polung detektiert wird, kann das System betrieben werden. Die Spannung wird überwacht, um einen offenen Stromkreis, getrennte leitende Klemmen, Nebenschlusskabelfehler und Spulenfehlerzustände zu erfassen. Der Strom durch das Nebenschlusskabel wird überwacht, um das Bestehen eines Batterieexplosionsrisikos und eines einen Überhitzungszustand darstellenden Überschussstromzustands zu erkennen, der zu einem Feuer führen kann. Das System enthält eine interne Batterie zum Bereitstellen der Spannung für die Batterie des Fahrzeugs, das Starthilfe bekommen soll. Sobald das Fahrzeug gestartet ist, findet eine automatische elektrische Trennung der Einheit von der Fahrzeugbatterie statt.

[0006] US 5,189,359 A, veröffentlicht am 23. Februar 1993, offenbart eine Starthilfekabelvorrichtung, die zwei Brückengleichrichter zum Ausbilden einer Referenzspannung, einen Dekodierer mit vier Eingängen zum Erkennen, welche Anschlüsse verbunden werden sollen, basierend auf einem Vergleich der Spannung an jedem der vier Anschlüsse mit der Referenzspannung, und ein Relaispaar aufweist, zum Bewirken der passenden Verbindung in Abhängigkeit von der Erkennung durch den Dekodierer. Es wird keine Verbindung hergestellt, es sei denn, dass nur ein Anschluss einer jeden Batterie eine höhere Spannung als die Referenzspannung aufweist, so dass „positive" Anschlüsse angezeigt werden, und ein Anschluss eine geringere Spannung als die Referenzspannung aufweist, so dass „negative" Anschlüsse angezeigt werden, und dass deshalb die beiden Hochspannungsanschlüsse und die beiden Niedrigspannungsanschlüsse verbunden werden können. Der Strom fließt, sobald die entsprechende Relaisvorrichtung geschlossen wird. Die Relaisvorrichtung ist vorzugsweise eine Metall-Oxid-Halbleiter-Feldeffekttransistor (MOSFET), der mit einer Serienanordnung von Photodioden, die ein MOSFET-gate-Schließ-Potential entwickeln, wenn der Dekodierer-Ausgang eine LED zum Leuchten bewirkt.

[0007] US 5,795,182 A, veröffentlicht am 18. August 1998, offenbart einen polungsunabhängigen Satz von Batteriestarthilfekabeln, um eine erste Batterie mit einer zweiten Batterie zu überbrücken. Die Vorrichtung weist einen Detektor der relativen Polung

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auf, um zu detektieren, ob zwei Batterien über Kreuz oder parallel angeordnet sind. Ein Drei-Punkt-Hochspannungskapazitätsquerriegeldrehschalter reagiert auf den Detektor der relativen Polung zum automatischen Verbinden des Plus-Anschlusses der beiden Batterien miteinander und der Minus-Anschlüsse der beiden Batterien miteinander, ungeachtet dessen, ob die detektierte Anordnung über Kreuz oder parallel ist, und ein Unterstrom-Detektor und eine Verzögerungsschaltung zum Zurücksetzen der Vorrichtung in ihren Anfangs- und nicht angeschlossenen Zustand, nachdem die Vorrichtung von einer der Batterien getrennt wurde. Der Querriegeldrehschalter weist zwei Kontaktpaare und einen Dreharm auf, der sich um zwei getrennte Punkte dreht, um vollen elektrischen Kontakt zwischen den Kontaktpaaren zu sichern. Die Erfindung kann auch verwendet werden, um eine Batterieladevorrichtung herzustellen, die mit einer Batterie ungeachtet der Batteriepolung verbunden werden kann

[0008] US 6,262,492 B1, erteilt am 17. Juli 2001, offenbart ein Autobatteriestarterkabel zur passenden Kopplung einer effektiven Spannungsquelle an eine fehlerhafte oder ungeladene Batterie, die eine Relaisschaltungsstromkreis aufweist, welcher mit der Spannungsquelle und der Batterie durch zwei Stromleitungspaare verbunden ist. Erste und zweite Spannungspolungserkennungsschaltungen werden jeweils mit der Spannungsquelle und der Batterie durch ein entsprechendes Spannungsleitungspaar verbunden, um die Polung der Spannungsquelle und der Batterie zu erkennen. Eine Logikerkennungsschaltung erzeugt ein Steuersignal, das abhängig von der Polung der Spannungsquelle und der Batterie ist, und eine Treiberschaltung, die durch ein Steuersignal des Logikerkennungsschaltung gesteuert wird, steuert den Relaisschaltungsstromkreis an, so dass das genaue Koppeln der beiden Pole der Spannungsquelle an die beiden Pole der Batterie ermöglicht wird.

[0009] US 5,635,817A, veröffentlicht am 3. Juni 1997, offenbart eine Fahrzeugbatterie-Ladevorrichtung, die ein Steuergehäuse aufweist, das Kabel enthält und, die eine Strombegrenzungsvorrichtung zum Verhindern des Überschreitens eines vorbestimmten maximalen Ladestroms von ungefähr 40 bis 60 A enthält. Das Steuergehäuse weist eine Polungsdetektionsvorrichtung zur Überprüfung der passenden Polung der Verbindung der Anschlüsse der beiden Batterien und zur elektrischen Trennung der beiden Batterien im Falle des Vorliegens einer falschen Polung auf.

[0010] US 8,199,024 B2, erteilt am 12. Juni 2012, offenbart eine Sicherheitsschaltung in einem Niedrigspannungsverbindungssystem, das die beiden Niedrigspannungssysteme getrennt lässt, bis es bestimmt, dass es sicher ist, eine Verbindung aufzubauen. Wenn die Sicherheitsschaltung bestimmt, dass keine unsicheren Bedingungen vorliegen, und dass es sicher ist, die beiden Niedrigspannungssysteme zu verbinden, kann die Sicherheitsschaltung die beiden Niedrigspannungssysteme durch einen „sanften Start" verbinden, der eine Verbindung zwischen den beiden Systemen über eine Zeitdauer bereitstellt, die induzierte Spannungsspitzen auf einem oder mehreren der Niedrigspannungssysteme reduziert oder verhindert. Wenn in einem der Niedrigspannungssysteme eine vollständig entladene Batterie eingebaut ist, wird ein Verfahren für die Detektion der passenden Polung der Verbindungen zwischen den Niedrigspannungssystemen verwendet. Die Bestimmung der Polung der entladenen Batterie erfolgt durch das Durchschicken von einem oder mehreren Testströmen durch die entladene Batterie und durch die Bestimmung, ob ein entsprechender Spannungsanstieg beobachtet wird.

[0011] US 5,793,185 A, veröffentlicht am 11. August 1998, offenbart eine tragbare Starthilfevorrichtung, die Steuerkomponenten und Schaltungen zur Verhinderung von Überladung und falscher Verbindung von Batterien aufweist.

[0012] US 5,820,407 A beschreibt Starthilfekabelklemmen.

[0013] Während der Stand der Technik Lösungen für die obengenannten Probleme, wie oben diskutiert, vorschlägt, leidet jede der Lösungen des Stands der Technik an anderen Defiziten, entweder in Bezug auf Komplexität, Kosten oder die Anfälligkeit für Fehlfunktionen. Folglich existiert ein Bedarf in diesem technischen Gebiet nach weiteren Verbesserungen für Starthilfevorrichtungen von Fahrzeugen. Zusammenfassung der Erfindung.

[0014] Die Aufgabe der Erfindung wird durch die Merkmale der unabhängigen Ansprüche gelöst. Vorteilhafte Ausgestaltungen sind den Unteransprüchen zu entnehmen.

[0015] Gemäß einem Aspekt der Erfindung, wird eine Vorrichtung zur Starthilfe eines Fahrzeugmotors bereitgestellt, die Folgendes aufweist: eine interne Spannungsversorgung; einen positiv und negativ gepolte Ausgänge aufweisenden Ausgangsanschluss; einen Fahrzeugbatterie-Isolationssensor, der mit den positiv und negativ gepolten Ausgängen in einer Schaltung verbunden ist und zur Detektion des Vorhandenseins einer Fahrzeugbatterie konfiguriert ist, die zwischen den positiv und negativ gepolten Ausgängen angeschlossen ist; einen Verpolungssensor, der in einer Schaltung mit den positiv und negativ gepolten Ausgängen verbunden ist und zur Detektion der Polarität einer Fahrzeugbatterie konfiguriert ist, die zwischen den positiv und negativ gepolten Ausgängen angeschlossen ist; einen Spannungs-FET-

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Schalter, der zwischen der internen Spannungsversorgung und dem Ausgangsanschluss angeschlossen ist; und ein Mikrocontroller, der zum Empfangen von Eingabesignalen vom Fahrzeug-Isolationssensor und Verpolungssensor und zum Bereitstellen eines Ausgabesignals an den Spannungs-FET-Schalter so konfiguriert ist, dass der Spannungs-FET-Schalter als Antwort auf Signale der Sensoren, die das Vorhandensein einer Fahrzeugbatterie am Ausgangsanschluss und die passende Polverbindung von positiven und negativen Anschlüssen der Fahrzeugbatterie mit positiv und negativ gepolten Ausgängen anzeigen, eingeschaltet wird, um die interne Spannungsversorgung mit dem Ausgangsanschluss zu verbinden.

[0016] Gemäß einem weiteren Aspekt der Erfindung, besteht die interne Spannungsversorgung aus einer wieder aufladbaren Lithiumionenbatterieeinheit.

[0017] Gemäß noch einem weiteren Aspekt der Erfindung, wird eine Starthilfekabelvorrichtung bereitgestellt, die einen Stecker aufweist, der zum Einstecken in einen Ausgangsanschluss einer tragbaren Vorrichtung zur Batterieladestarthilfe, die eine interne Spannungsversorgung aufweist, konfiguriert ist; ein Kabelpaar, an dessen jeweiligem einen Ende der Stecker integriert ist; wobei das Kabelpaar zum getrennten Anschließen an die Anschlüsse einer Batterie an dessen jeweiligem anderen Ende konfiguriert ist.

Figurenliste

Fig. 1 stellt einen Funktionsplan einer tragbaren Vorrichtung zur Batteriestarthilfe von Fahrzeigen gemäß einem Aspekt der vorliegenden Erfindung dar;

Fig. 2A-Fig. 2C stellen schematische Schaltpläne einer beispielhaften Ausführungsform einer tragbaren Vorrichtung zur Batteriestarthilfe von Fahrzeugen gemäß einem Aspekt der vorliegenden Erfindung dar;

Fig. 3 stellt eine perspektivische Ansicht einer tragbaren Vorrichtung zur Starthilfe gemäß einer beispielhaften Ausführungsform der vorliegenden Erfindung dar; und

Fig. 4 stellt eine Draufsicht eines Starthilfekabels dar, das mit der tragbaren Vorrichtung zur Starthilfe gemäß einem weiteren Aspekt der vorliegenden Erfindung verwendbar ist.

Detaillierte Beschreibung der Erfindung

[0018] **Fig. 1** stellt einen Funktionsplan einer tragbaren Vorrichtung zur Batteriestarthilfe gemäß einem Aspekt der vorliegenden Erfindung dar. Das Herzstück der tragbaren Vorrichtung zur Batteriestarthilfe ist eine Lithiumpolymerbatterieeinheit **32** , die genügend Energie speichert, um einem Fahrzeugmotor Starthilfe zu leisten, welcher von einer konventionellen 12 Volt Bleisäure- oder von einer durch ein Ventil regulierten Bleisäure-Batterie beliefert wird. In einer beispielhaften Ausführungsform weist eine Überspannungslithiumpolymerbatterieeinheit drei 3,7 V, 2666 mAh Lithiumpolymerbatterien in einer 3S1P-Konfiguration auf. Die sich ergebende Batterieeinheit liefert 11,1 V, 2666 Ah (8000 Ah bei 3,7 V, 29,6 Wh). Ein kontinuierlicher Entladungsstrom beträgt 25 C (oder 200 A), und eine Entladungsstromspitze beträgt 50 C (oder 400 A). Der maximale Ladungsstrom der Batterieeinheit beträgt 8000 mA (8 A).

[0019] Eine programmierbare Mikrocontrollereinheit (MCU) 1 erhält verschiedene Eingaben und erzeugt Informations- als auch Steuerungsausgaben. Die programmierbare MCU 1 stellt ferner eine Flexibilität für das System bereit, in dem es Aktualisierungen der Funktionalität und der Systemparameter zulässt, ohne eine Änderung der Hardware zu benötigen. Gemäß einer beispielhaften Ausführungsform wird ein 8-bit-Mikrocontroller mit einem 2K × 15-bit-Flash-Speicher verwendet, um das System zu steuern. Ein solcher Mikrocontroller ist HT67F30, der kommerziell bei Holtek Semiconductors Inc. erhältlich ist.

[0020] Eine Autobatterie-Verpolungssensor **10** überwacht die Polung der Fahrzeugbatterie **72**, wenn die tragbare Vorrichtung zur Batteriestarthilfe mit dem elektrischen System des Fahrzeugs verbunden wird. Wie unten erklärt, verhindert die Starthilfevorrichtung, dass die Lithiumbatterieeinheit mit der Fahrzeugbatterie **72** verbunden wird, wenn die Anschlüsse der Batterie **72** mit den falschen Anschlüssen der Starthilfevorrichtung verbunden sind. Ein Autobatterie-Isolationssensor **12** detektiert, ob ein eine Fahrzeugbatterie **72** mit der Starthilfevorrichtung verbunden ist oder nicht, und verhindert, dass die Lithiumbatterieeinheit mit den Ausgangsanschlüssen der Starthilfevorrichtung verbunden wird, es sei denn, dass eine gute (z. B. aufladbare) Batterie an die Ausgangsanschlüsse angeschlossen ist.

[0021] Ein smart-switch-FET-Schaltung **15** schaltet die Lithiumbatterie der tragbaren Vorrichtung zur Batteriestarthilfe elektrisch an das elektrische System des Fahrzeugs, nur wenn bestimmt wird, dass die Fahrzeugbatterie durch die MCU **1** als vorhanden erfasst wird (als Antwort auf ein von einem Isolationssensor **12** bereitgestelltes Detektionssignal) und mit der passenden Polung angeschlossen ist (als Antwort auf ein von einem Verpolungssensor **10** bereitgestelltes Detektionssignal). Ein Lithiumbatterie-Temperatursensor **20** überwacht die Temperatur der Lithiumbatterieeinheit **32**, um eine Überhitzung aufgrund von hohen Umgebungstemperaturbedingungen und übermäßiger Stromabgabe während des Starthilfevorgangs zu detektieren. Eine Lithiumbatterie-Spannungsmessungsschaltung **24** überwacht

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die Spannung der Lithiumbatterieeinheit **32**, um das Spannungspotential daran zu hindern, während eines Ladevorgangs zu hoch zusteigen, und während eines Entladevorgangs zu tief zu fallen

[0022] Lithiumbatterie-Rückladungsschutzdioden **28** verhindern, dass irgendein Ladungsstrom, der an die Fahrzeugbatterie **72** geliefert wird, vom elektrischen System des Fahrzeugs in die Lithiumbatterieeinheit **32** zurückfließt. Eine Blitzlicht-LED-Schaltung **36** wird bereitgestellt, um eine Blitzlicht-Funktion zur Verstärkung des Lichts unter der Fahrzeughaube bei dunklen Bedingungen zu liefern, sowie SOS- und Stroboskoplichtfunktionen aus Sicherheitsgründen bereitzustellen, wenn ein Fahrzeug an einem potentiell gefährlichen Ort fahruntauglich wird. Ein Spannungsregler **42** stellt eine Regulierung der internen Betriebsspannung für den Mikrocontroller und die Sensoren bereit. Ein manueller Modus- und Blitzlicht-Ein/Aus-Schalter **46** erlauben es dem Nutzer, das Einschalten der tragbaren Vorrichtung zur Batterieladestarthilfe zu steuern, um den manuellen Starthilfebetrieb zu steuern, wenn das Fahrzeug keine Batterie aufweist, und die Blitzlichtfunktion zu steuern. Der manuelle Knopf funktioniert nur, wenn die Starthilfevorrichtung eingeschaltet ist. Dieser Knopf erlaubt es dem Nutzer, Fahrzeugen Starthilfe zu leisten, denen entweder eine Batterie fehlt, oder deren Batteriespannung so niedrig ist, dass eine automatische Detektion durch die MCU nicht möglich ist. Wenn der Nutzer den manuellen Starthilfeknopf drückt und für eine vorbestimmte Zeit (wie z. B. drei Sekunden) gedrückt hält, um eine ungewollte Betätigung des manuellen Modus zu verhindern, wird die Spannung der internen Lithiumionenbatterie auf den Fahrzeugbatterie-Verbindungsanschluss geschaltet. Die einzige Ausnahme zum manuellen Starthilfebetrieb erfolgt, wenn die Autobatterie verpolt wurde. Wenn die Autobatterie verpolt wurde, sollte die Spannung der internen Lithiumbatterie niemals auf den Fahrzeugbatterie-Verbindungsanschluss geschaltet werden.

[0023] Eine USB-Ladeschaltung **52** wandelt eine Spannung von irgendeiner der USB-Ladespannungsquellen um, so dass Spannung und Strom zum Laden der Lithiumbatterieeinheit **32** geladen werden. Ein USB-Ausgang **56** stellt eine tragbare USB-Ladevorrichtung zum Laden von Smartphones, Tablet-Computern (im Folgenden Tablet genannt) und weiteren wieder aufladbaren elektronischen Vorrichtungen bereit. LEDs zur Betriebszustandsanzeige **60** stellen eine visuelle Anzeige des Lithiumbatterie-Kapazitätsstatus sowie eine Anzeige des Aktivierungsstatus des smart-switchs dar (die anzeigt, dass dem elektrischen System eine Spannung bereitgestellt wird).

[0024] Ein detaillierter Betrieb der tragbaren Starthilfevorrichtung wird nun gemäß den schematischen Diagrammen der **Fig. 2A** bis **Fig. 2C** beschrieben werden. Wie in **Fig. 2A** gezeigt, stellt die Mikrocontrollereinheit **1** das Zentrum aller Ein- und Ausgänge dar. Der Batterie-Verpolungssensor **10** umfasst einen optisch gekoppelten Isolationsphototransistor (**4N27**), der mit den Anschlüssen der Fahrzeugbatterie **72** an den Eingangspins **1** und **2** mit einer Diode **D8** im Leiterdraht des Pins **1** (der am negativen Anschluss **CB-** angeschlossen ist), so dass, falls die Batterie **72** mit den Anschlüssen der Starthilfevorrichtung mit passender Polung verbunden ist, die LED des optischen Kopplers **11** keinen Strom leiten wird, und deshalb ausgeschaltet wird, wobei der MCU **1** eine „**1**" oder ein hohes Ausgabesignal bereitgestellt wird. Der Autobatterie-Isolationssensor **12** umfasst einen optisch gekoppelten Isolationsphototransistor (**4N27**), der mit den Anschlüssen der Fahrzeugbatterie **72** an den Eingangspins **1** und **2** mit einer Diode **D7** im Leitungsdraht des Pins **1** (angeschlossen an den positiven Anschluss **CB+**) verbunden ist, so dass, falls die Batterie **72** an die Anschlüsse der Starthilfevorrichtung mit der passenden Polung verbunden ist, die LED des optischen Kopplers **11A** einen Strom leiten wird, und deshalb eingeschaltet wird, wobei der MCU eine „0" oder ein niedriges Ausgabesignal bereitgestellt wird, und das Vorhandensein einer Batterie über die Starthilfeausgangsanschlüsse der tragbaren Starthilfevorrichtung anzeigt.

[0025] Falls die Autobatterie **72** mit der tragbaren Starthilfevorrichtung verpolt verbunden ist, wird die LED des optischen Kopplers **11** des Verpolungssensors **10** den Strom leiten, wobei der Mikrocontrollereinheit **1** eine „0" oder ein niedriges Signal bereitgestellt wird. Ferner, falls keine Batterie mit der tragbaren Starthilfevorrichtung verbunden ist, wird die LED des optischen Kopplers **11A** des Isolationssensors **12** keinen Strom leiten und wird deshalb ausgeschaltet, wobei der MCU eine „1" oder ein hohes Ausgabesignal bereitgestellt wird, das die Abwesenheit irgendeiner mit der tragbaren Starthilfevorrichtung verbundener Batterie anzeigt. Unter Verwendung dieser spezifischen Eingaben kann die Mikrocontrollersoftware der MCU **1** bestimmen, wann es sicher ist, den smart-switch-FET **15** einzuschalten, wodurch die Lithiumbatterieeinheit mit den Starthilfeanschlüssen der Starthilfevorrichtung verbunden wird. Folglich kann die MCU **1** den smart-switch-FET-Schaltung **15** davor bewahren, eingeschaltet zu werden und somit das Erzeugen von Funken/Kurzschlüssen der Lithiumbatterieeinheit verhindert werden, wenn die Autobatterie **72** entweder überhaupt nicht mit der Starthilfevorrichtung verbunden ist oder verpolt verbunden ist.

[0026] Wie in **Fig. 2B** gezeigt, wird der smart-switch-FET **15** durch eine Mikrocontrollerausgabe **1** angesteuert. Der FET-smart-switch **15** weist drei FETs (**Q15**, **Q18** und **Q19**) in Parallelschaltung auf, die die Spannung der Lithiumbatterieeinheit verteilt. Wenn diese Mikrocontrollerausgabe in einen logisch niedrigen Zustand gesteuert wird, befinden sich die FETs

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16 alle in einem Hochwiderstandszustand, weswegen kein Stromfluss vom negativen Kontakt **17** der internen Lithiumbatterie zum negativen Kontakt der Autobatterie **72** zugelassen wird. Wenn die Mikrocontrollerausgabe in einen logisch hohen Zustand gesteuert wird, sind die FETs **16** (**Q15**, **Q18**, **Q19**) in einem Niedrigwiderstandszustand, der einen freien Stromfluss vom negativen Kontakt **17** (LB-) der internen Lithiumbatterieeinheit zum negativen Kontakt (**CB-**) der Autobatterie **72** zulässt. Auf diese Art steuert die Mikrocontrollersoftware die Verbindung der internen Lithiumbatterieeinheit **32** mit der Fahrzeugbatterie **72**, um dem Fahrzeugmotor Starthilfe zu leisten.

[0027] Gemäß **Fig. 2A**, kann die Spannung der internen Lithiumbatterieeinheit unter Verwendung der Schaltung **24** und einem der Analog-zu-Digital-Eingänge des Mikrocontrollers **1** präzise gemessen werden. Die Schaltung **24** ist vorgesehen, um zu erfassen, wann die Spannung des Haupt-3,3 V-Reglers **42** eingeschaltet ist und den Transistor **23** einzuschalten, wenn die Spannung des Reglers **42** eingeschaltet ist. Wenn der Transistor **23** leitet, schaltet er den FET **22** ein, womit dem positiven Kontakt (LB+) der internen Lithiumbatterie ein leitender Pfad zu einem Spannungsteiler **21** bereitgestellt wird, der es zulässt, der Mikrocontroller einen niedrigeren Spannungsbereich zum Einlesen zuzuführen. Durch Verwendung dieser Eingabe kann die Mikrocontrollersoftware bestimmen, ob die Lithiumbatteriespannung während des Entladevorgangs zu niedrig oder während des Aufladevorgangs zu hoch ist, und sie kann eine entsprechende Maßnahme zur Verhinderung der Beschädigung der elektronischen Komponenten unternehmen.

[0028] Weiterhin kann gemäß **Fig. 2A** durch zwei Vorrichtungen **20** mit negativem Temperaturkoeffizienten (NTC) die Temperatur der internen Lithiumbatterieeinheit **32** präzise gemessen werden. Dies sind Vorrichtungen, die ihren Widerstand verringern, wenn ihre Temperatur steigt. Die Schaltung stellt einen Spannungsteiler dar, der das Ergebnis den beiden Analog-zu Digital-(A/D)-Eingänge dem Mikrocontroller zuführt. Die Mikrocontrollersoftware kann dann bestimmen, wann die interne Lithiumbatterie zu heiß ist, um einen Starthilfevorgang zuzulassen, wodurch der Aufbau Betriebssicherheit erhält.

[0029] Die Hauptspannungsreglerschaltung **42** ist so gestaltet, dass die Spannung der internen Lithiumbatterie in einen geregelten Wert von 3,3 V umgewandelt wird, der vom Mikrocontroller **1** sowie von anderen Komponenten der Starthilfevorrichtung für die interne Betriebsspannung verwendet wird. Drei Lithiumbatterie-Rückaufladungs-(back-charging)-Schutzdioden **28** (siehe **Fig. 2B)** werden eingesetzt, um den Stromfluss nur von der internen Lithiumbatterieeinheit **32** zur Autobatterie **72** zuzulassen, und nicht von der Autobatterie zur internen Lithiumbatterie. Auf diese Art kann, falls das elektrische System des Autos von seiner Lichtmaschine geladen wird, die interne Lithiumbatterie nicht rückaufladen (und hierbei beschädigt werden), was eine weitere Stufe der Betriebssicherheit bereitstellt.

[0030] Der Hauptspannungseinschalter **46** (**Fig. 2A)** ist eine Kombination, die einen Doppelpol- oder Zweiwegebetrieb zulässt, so dass das Produkt mit einem Drücken eingeschaltet werden kann, wenn es sich im Aus-Zustand befindet, oder ausgeschaltet werden kann, wenn es sich im EIN-Zustand befindet. Diese Schaltung verwendet auch einen Mikrocontrollerausgang **47**, um die Spannung aufrecht zu erhalten, wenn die Schaltung durch den Ein-Schalter aktiviert wurde. Wenn der Schalter gedrückt wird, schiebt der Mikrocontroller diesen Ausgang auf eine Hochlogikstufe, um die Spannung „am Leben" zu erhalten, wenn der Schalter losgelassen wird. Auf diese Art behält der Mikrocontroller die Kontrolle, wenn die Spannung ausgeschaltet wird, wenn der Ein-/Aus-Schalter wieder aktiviert wird, oder wenn die Lithiumbatteriespannung zu niedrig wird. Die Mikrocontrollersoftware weist auch einen Zeitschalter auf, der die Spannung nach einer vorbestimmten Zeitdauer (wie z. B. 8 Stunden) bei Nichtverwendung ausschaltet.

[0031] Die Blitzlicht-LED-Schaltung **45**, die in **Fig. 2B** gezeigt wird, steuert den Betrieb der Blitzlicht-LEDs. Zwei Ausgänge des Mikrocontrollers **1** sind den beiden separaten LEDs zugeordnet. Daher können die LEDs zur Ausbildung von Stroboskopen und SOS-Mustern unabhängig software-gesteuert werden, was der Starthilfevorrichtung noch ein weiteres Sicherheitsmerkmal hinzugefügt. LED-Anzeigen geben dem Betreiber die Rückmeldung, die dieser braucht, um zu verstehen, was mit dem Produkt passiert. Vier separate LEDs **61** (**Fig. 2A)** werden durch entsprechende einzelne Ausgänge des Mikrocontrollers **1** gesteuert, um eine Anzeige der verbleibenden Kapazität der internen Lithiumbatterie bereitzustellen. Diese LEDs werden in einem Format vergleichbar dem einer „Kraftstoffanzeige" mit 25%-, 50%-, 75%- und 100%-(rot, rot, gelb, grün)-Kapazitätsanzeigen gesteuert. Eine LED-Anzeige **63** (**Fig. 2B)** gibt dem Benutzer eine visuelle Warnung, wenn die Fahrzeugbatterie **72** verpolt angeschlossen worden ist. Starthilfe- und Ein-/Aus-LEDs **62** stellen jeweils visuelle Anzeigen bereit, wenn die Starthilfevorrichtung Starthilfespannung bereitstellt, und wenn die Starthilfevorrichtung eingeschaltet wird.

[0032] Eine USB-Ausgangsschaltung **56** (**Fig. 2C**) weist einen USB-Ausgang auf, zum Laden von tragbaren elektronischen Vorrichtungen, wie z. B. Smartphones durch die interne Lithiumbatterieeinheit **32**. Eine Steuerschaltung **57** des Mikrocontrollers **1** lässt es zu, den USB-Ausgang **56** durch die Softwaresteuerung ein- oder auszuschalten, um zu verhindern, dass die interne Lithiumbatterie eine zu niedrige

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Kapazität erreicht. Die USB-Ausgabe wird mittels einer Standard-USB-Verbindung **58** an das Äußere der Vorrichtung geführt, wobei die Standard-USB-Verbindung **58** den erforderlichen Standardspannungsteiler aufweist, um es zu ermöglichen, Smartphones eine bestimmte Spannung zuzuführen, die sie benötigenden

[0033] Die USB-Ladeschaltung **52** lässt es zu, dass die interne Batterieeinheit **32** durch eine Standard-USB-Ladevorrichtung geladen wird. Dieser Spannungseingang verwendet eine Standard-Mikro-USB-Verbindung **48**, die es erlaubt, Standardkabel zu verwenden. Das von der Standard-USB-Ladevorrichtung bereitgestellte Potential von 5 V wird in 12,4 V DC-Spannung hochgewandelt, das zum Laden der internen Lithiumbatterieeinheit unter Verwendung eines DC-DC-Konverters **49** benötigt wird. Der DC-DC-Konverter **49** kann durch die Schaltung **53** mittels eines Mikrocontrollerausgangs **1** ein- und ausgeschaltet werden.

[0034] 036 Auf diese Art kann die Mikrocontrollersoftware den Ladevorgang ausschalten, falls die Batteriespannung durch den A/D-Eingang **22** als zu hoch bestimmt worden ist. Zusätzliche Betriebssicherheit wird zur Abhilfe der Beseitigung von Überladung der internen Lithiumbatterie durch Verwendung einer Lithiumbatterie-Ladesteuerung **50** bereitgestellt, die einen Ladungsausgleich der internen Lithiumbatteriezellen **51** bereitstellt. Diese Steuerung stellt auch eine redundante Betriebssicherheit zur Beseitigung von Überladung der internen Lithiumbatterie bereit.

[0035] **Fig. 3** stellt eine perspektivische Ansicht einer tragbaren Vorrichtung **300** gemäß einer beispielhaften Ausführungsform der Erfindung dar. **301** ist ein Spannungseinschalter. **302** zeigt die LED-„Kraftstoff"-Anzeigen **61** . **303** zeigt einen 12 V-Ausgangsanschluss, der mit einer weiter unten beschriebenen Kabelvorrichtung **400** verbindbar ist. **304** zeigt einen Blitzlichtsteuerungsschalter zum Aktivieren der Blitzlicht-LEDs **45**. **305** stellt einen USB-Eingangsanschluss zum Laden der internen Lithiumbatterie dar, und **306** ist ein USB-Ausgangsanschluss, um anderen tragbaren Vorrichtungen, wie z. B. Smartphones, Tablets, Musikspieler, usw., Ladung durch die Lithiumbatterie bereitzustellen. **307** stellt eine „Starthilfe-Ein"-Anzeige dar, die anzeigt, dass die Spannung dem 12 V-Ausgangsanschluss bereitgestellt wird. **308** stellt eine Verpolungsanzeige dar, die anzeigt, dass die Fahrzeugbatterie in Bezug auf die Polung falsch verbunden ist. **309** stellt eine „Spannung-Ein"-Anzeige dar, die anzeigt, dass die Vorrichtung für den Betrieb hochgefahren ist.

[0036] **Fig. 4** zeigt eine Starthilfekabelvorrichtung **400**, die insbesondere für eine Verwendung mit der tragbaren Vorrichtung **300** ausgestaltet ist. Die Vorrichtung **400** weist einen Stecker **401** auf, der so gestaltet ist, dass er in den 12 V-Ausgangsanschluss **303** der tragbaren Vorrichtung **300** einsteckt werden kann. Der Stecker **401** ist in einem Kabelpaar **402a** und **402b** integriert, und die Kabel sind jeweils mit den Batterieanschlussklemmen **403a** und **403b** mittels Ringanschlüssen **404a** und **404b** verbunden. Der Anschluss **303** und der Stecker **401** können so dimensioniert werden, dass der Stecker **401** nur in den Anschluss **303** in einer bestimmten Orientierung passt, wodurch gesichert ist, dass die Klemme **403a** einer positiven Polung entsprechen wird, und die Klemme **403b** einer negativen Polung entsprechen wird, wie darauf angegeben. Zusätzlich können die Ringanschlüsse **404a** und **404b** von den Klemmen getrennt werden und direkt mit den Anschlüssen der Fahrzeugbatterie verbunden werden. Dieses Merkmal kann nützlich sein, um beispielsweise die Kabel **402a** bis **402b** dauerhaft mit der Fahrzeugbatterie zu verbinden. Im Falle einer Erschöpfung der Batteriespannung könnte die tragbare Starthilfevorrichtung **300** durch Einstecken des Steckers **401** in den Anschluss **303** in sehr einfacher Weise passend mit der Batterie verbunden werden.

[0037] Es folgen Ausführungsbeispiele:

1. Vorrichtung zur Starthilfe eines Fahrzeugmotors, umfassend: eine interne Spannungsversorgung (**32**); einen positiv und negativ gepolte Ausgänge (**CB-**, **CB+**) aufweisenden Ausgangsanschluss (**303**); einen Fahrzeugbatterie-Isolationssensor (**12**), der mit den positiv und negativ gepolten Ausgängen (**CB-**, **CB+**) in einer Schaltung verbunden ist, und zur Detektion des Vorhandenseins einer Fahrzeugbatterie (**32**), die zwischen den positiv und negativ gepolten Ausgängen (**CB-**, **CB+**) angeschlossen ist, konfiguriert ist; einen Verpolungssensor (**10**), der in einer Schaltung mit den positiv und negativ gepolten Ausgängen (**CB-**, **CB+**) verbunden ist, und zur Detektion der Polarität einer Fahrzeugbatterie (**72**), die zwischen den positiv und negativ gepolten Ausgängen (**CB-**, **CB+**) angeschlossen ist, konfiguriert ist; ein Spannungs-FET-Schalter (**15**), der zwischen der internen Spannungsversorgung (**32**) und dem Ausgangsanschluss (**305**) angeschlossen ist; und ein Mikrocontroller (**1**), der zum Empfangen von Eingabesignalen vom Fahrzeug-Isolationssensor (**12**) und vom Verpolungssensor (**10**) und zum Bereitstellen eines Ausgabesignals an den Spannungs-FET-Schalter (**15**) so konfiguriert ist, dass der Spannungs-FET-Schalter (**15**) als Antwort auf Signale der Sensoren, die das Vorhandensein einer Fahrzeugbatterie (**72**) am Ausgangsanschluss (**303**) und die passende Polverbindung von positiven und negativen Anschlüssen der Fahrzeugbatterie (**72**) mit positiv und negativ gepolten Ausgängen (**CB-**, **CB+**) anzeigen, eingeschaltet wird, um die interne Spannungsver-

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sorgung (**32**) mit dem Ausgangsanschluss (**303**) zu verbinden.

2. Die Vorrichtung gemäß Ausführungsbeispiel 1, wobei die interne Spannungsversorgung (**32**) eine Lithiumionenbatterie umfasst.

3. Vorrichtung gemäß Ausführungsbeispiel **2**, wobei die Lithiumionenbatterie eine Batterieeinheit aus mehreren Lithiumionenbatterien umfasst.

4. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, wobei der Spannungs-FET-Schalter (**15**) eine Vielzahl von FETs in Parallelschaltung (**16**) umfasst.

5. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, wobei der Fahrzeug-Isolationssensor (**12**) und der Verpolungssensor (**10**) optisch gekoppelte Isolationsphototransistoren umfassen.

6. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend eine Vielzahl von Spannungsdioden (**28**), die zwischen den Ausgangsanschluss (**303**) und der internen Spannungsversorgung (**32**) gekoppelt sind, um eine Rückaufladung der internen Spannungsversorgung (**32**) durch ein an den Ausgangsanschluss (**303**) angeschlossenes elektrisches System zu verhindern.

7. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend einen Temperatursensor (**20**) zur Detektion der Temperatur der internen Spannungsversorgung (**32**) und zum Bereitstellen eines Temperatursignals an den Mikrocontroller (**1**).

8. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend eine Spannungsmessungsschaltung (**24**), die zur Messung der Ausgabespannung der internen Spannungsversorgung (**32**) und zum Bereitstellen eines Spannungsmessungssignals an den Mikrocontroller (**1**) konfiguriert ist.

9. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend ein Spannungsregler (**42**), der zur Umwandlung der Ausgabespannung der internen Spannungsversorgung (**32**) in einen Spannungspegel konfiguriert ist, der geeignet ist, um internen Komponenten der Vorrichtung eine Betriebsspannung bereitzustellen.

10. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispielen, ferner umfassend einen USB-Ausgangsanschluss (**56**), der zum Bereitstellen einer Ladungsspannung der internen Spannungsversorgung (**32**) an eine USB-ladbare Vorrichtung konfiguriert ist.

11. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend einen USB-Ladeanschluss (**52**), der zum Bereitstellen einer Ladespannung von einer externen Spannungsquelle an die interne Spannungsversorgung (**32**) konfiguriert ist.

12. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend einen Blitzlicht-Schaltung (**36**, **45**), die zum Bereitstellen einer Lichtquelle für einen Nutzer konfiguriert ist.

13. Vorrichtung gemäß Ausführungsbeispiel **12**, wobei die Lichtquelle mindestens eine LED ist.

14. Vorrichtung gemäß Ausführungsbeispiel **13**, wobei der Mikrocontroller (**1**) zur Kontrolle der mindestens einen LED konfiguriert ist, um einen visuellen Alarm zur Anzeige einer Notsituation bereitzustellen.

15. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend eine Vielzahl von visuellen Anzeigen (**61**), die zur Anzeige des verbleibenden Kapazitätszustands der internen Spannungsversorgung (**32**) konfiguriert sind.

16. Vorrichtung gemäß Ausführungsbeispiel **15**, wobei die Vielzahl von visuellen Anzeigen (**61**) eine Vielzahl von LEDs umfassen, die Licht verschiedener Farben ausgeben.

17. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend eine visuelle Anzeige (**63**), die zur Warnung eines Benutzers konfiguriert ist, wenn eine Batterie verpolt angeschlossen ist.

18. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend getrennte visuelle Anzeigen (**62**), die zur Anzeige des Spannung-An-Status der Vorrichtung und zur Anzeige des Status der Starthilfespannung der dem Ausgangsanschluss (**303**) bereitgestellten Spannung konfiguriert ist.

19. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend einen manuelle Starthilfeschalter, der zum Aktivieren eines manuellen Starthilfemodus konfiguriert ist, der es einem Benutzer ermöglicht, die Starthilfespannung mit dem Ausgangsanschluss (**303**) zu verbinden, wenn der Fahrzeugbatterie-Isolationssensor (**12**) das Vorhandensein einer Fahrzeugbatterie nicht detektieren kann.

20. Vorrichtung gemäß Ausführungsbeispiel **19**, wobei der Mikrocontroller (**1**) zur Detektion der manuellen Starthilfeschaltung für mindestens eine vorbestimmte Zeitdauer vor dem Aktivieren des manuellen Starthilfemodus konfiguriert ist.

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21. Vorrichtung gemäß irgendeinem der vorangehenden Ausführungsbeispiele, ferner umfassend eine Starthilfekabelvorrichtung (**400**), die einen Stecker (**401**) umfasst, zum Einstecken in den Ausgangsanschluss, ein Kabelpaar (**402a**, **402b)**, an dessen jeweiligem einen Ende der Stecker (**401**) integriert ist und zum Anschließen an die Anschlüsse einer Batterie an dessen jeweiligem anderen Ende konfiguriert sind.

22. Vorrichtung gemäß Ausführungsbeispiel **21**, wobei das Starthilfekabel ferner ein Paar von Ringanschlüssen (**404a**, **404b)** umfasst, die zum jeweiligen Verbinden des Kabelpaars (**402a**, **402b**) an dessen anderem Ende mit einem Ende eines Batterieanschlusses oder einer Batterieanschlussklemme konfiguriert sind.

23. Vorrichtung gemäß irgendeinem der Ausführungsbeispiele **21** oder **22**, wobei der Ausgangsanschluss (**303**) und der Stecker (**401**) so dimensioniert sind, dass der Stecker (**401**) nur in einer bestimmten Orientierung in den Ausgangsanschluss (**303**) passt.

24. Eine Starthilfekabelvorrichtung (**400**), umfassend: einen Stecker (**401**), der zum Stecken in einen Ausgangsanschluss (**303**) einer tragbaren Vorrichtung zur Batterieladestarthilfe (**300**) konfiguriert ist, die eine interne Spannungsversorgung aufweist; ein Kabelpaar (**402a**, **402b)**, das mit dem Stecker (**401**) an dessen einen entsprechenden Ende integriert ist; wobei das Kabelpaar (**402a**, **402b)** so konfiguriert ist, dass es gesondert an Anschlüssen einer Batterie mit dessen entsprechend anderem Ende angeschlossen werden soll.

25. Starthilfekabelvorrichtung (**400**) gemäß Ausführungsbeispiel **24**, ferner umfassend ein Paar von Ringanschlüssen (**404a**, **404b)**, die zum jeweiligen Verbinden des Kabelpaars (**402a**, **402b)** an dessen anderen Ende mit einem Batterieanschluss oder einer Batterieanschlussklemme konfiguriert sind.

26. Starthilfekabelvorrichtung (**400**) gemäß irgendeinem der Ausführungsbeispiele **24** oder **25**, wobei der Ausgangsanschluss (**303**) und der Stecker (**401**) so dimensioniert sind, dass der Stecker (**401**) nur in einer bestimmten Richtung in den Ausgangsanschluss (**303**) passt.

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ZITATE ENTHALTEN IN DER BESCHREIBUNG

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Schutzansprüche

1. Starthilfevorrichtung zum Boosten oder Aufladen einer verbrauchten oder entladenen Batterie, die einen positiven und negativen Batterieanschluss aufweist, die Starthilfevorrichtung umfasst:
- eine Spannungsversorgung (32);
- einen positiven Batterieverbinder zur Verbindung der Starthilfevorrichtung mit dem positiven Batterieanschluss der verbrauchten oder entladenen Batterie (72);
- einen negativen Batterieverbinder zur Verbindung der Starthilfevorrichtung mit dem negativen Batterieanschluss der verbrauchten oder entladenen Batterie (72);
- einen Leistungsschalter (15), der über eine Schaltung mit der Spannungsversorgung (32) und den positiven und negativen Batterieverbindern verbunden ist,
- wobei der Leistungsschalter (15) eingerichtet ist, die Spannung von der Spannungsversorgung (32) zur verbrauchten oder entladenen Batterie (72) ein- oder auszuschalten, wenn diese mit den positiven und negativen Batterieverbindern verbunden ist,
- ein Leistungsschaltersteuerungssystem oder eine Leistungsschaltersteuerungsschaltung, die mit dem Leistungsschalter (15) verbunden ist und zur Steuerung des Leistungsschalters (15) vorgesehen ist,
- wobei das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung eingerichtet ist, das Vorhandensein der verbrauchten oder entladenen Batterie (72) und die Polarität der verbrauchten oder entladenen Batterie (72) zu detektieren, wenn diese zwischen die positiven und negativen Batterieverbinder geschaltet ist,
- wobei das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung die Spannungsversorgung (32) nur dann einschaltet, um die Spannungsversorgung (32) mit der verbrauchten oder entladenen Batterie (72) zu verbinden, wenn die verbrauchte oder entladene Batterie (72) vorhanden ist und zwischen den positiven und negativen Batterieverbinder verbunden ist, und wenn die verbrauchte oder entladene Batterie (72) mit der richtigen Polarität zwischen den positiven und negativen Batterieverbinder verbunden ist.

2. Die Vorrichtung gemäß Anspruch 1, wobei das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung einen Mikrocontroller (1) enthält, der eingerichtet ist, eine Ausgabe zur Steuerung des Leistungsschalters (15) bereitzustellen.

3. Die Vorrichtung gemäß Anspruch 2, wobei der Mikrocontroller (1) eine Eingabe von einem oder mehreren Sensoren empfängt, die eingerichtet sind, das Vorhandensein der verbrauchten oder entladenen Batterie (72) und eine Polarität der verbrauchten oder entladenen Batterie (72) zu detektieren, wenn diese zwischen den positiven und negativen Batterieverbinder verbunden ist.

4. Die Vorrichtung gemäß Anspruch 3, wobei der eine oder die mehreren Sensoren (10, 12) einen Sensor (12) umfassen, der eingerichtet ist, das Vorhandensein der verbrauchten oder entladenen Batterie (72) zu detektieren, wenn diese zwischen den positiven und negativen Batterieverbinder verbunden ist und einen anderen Sensor (10), der eingerichtet ist, die Polarität der verbrauchten oder entladenen Batterie (72) zu detektieren, wenn diese zwischen den positiven und negativen Batterieverbinder verbunden ist.

5. Die Vorrichtung gemäß Anspruch 3 oder 4, wobei der eine oder die mehreren Sensoren (10, 12) eine oder mehrere Erfassungsschaltungen enthalten.

6. Die Vorrichtung gemäß Anspruch 2, wobei der Mikrocontroller (1) den Leistungsschalter (15) nur dann einschaltet, um eine Spannung von der Spannungsversorgung (32) zu der verbrauchten oder entladenen Batterie (72) zu liefern, wenn die verbrauchte oder entladene Batterie (72) vom Mikrocontroller (1) als vorhanden und mit der richtigen Polarität verbunden erkannt wird.

7. Die Vorrichtung gemäß Anspruch 2, wobei der Mikrocontroller (1) ein programmierbarer Mikrocontroller (1) ist, der eingerichtet ist, Funktionsupdates und Systemparameterupdates zu ermöglichen.

8. Die Vorrichtung gemäß Anspruch 7, wobei der programmierbare Mikrocontroller (1) einen Speicher enthält.

9. Die Vorrichtung gemäß Anspruch 1, wobei der positive Batterieverbinder ein positives Batteriekabel (402a) und der negative Batterieverbinder ein negatives Batteriekabel (402b) enthält.

10. Die Vorrichtung gemäß Anspruch 9, wobei das positive Batteriekabel (402a) eine positive Batterieklemme (403a) und das negative Batteriekabel (402b) eine negative Batterieklemme (403b) aufweist.

11. Die Vorrichtung gemäß Anspruch 1, wobei die Spannungsversorgung (32) eine Lithiumionenbatterie enthält, die in der Starthilfevorrichtung vorhanden ist.

12. Die Vorrichtung gemäß Anspruch 11, wobei die Lithiumionenbatterie ein Batteriepack enthält, welches mehrere Lithiumionenbatterien aufweist.

13. Die Vorrichtung gemäß Anspruch 1, wobei der Leistungsschalter (15) mehrere FETs enthält, die parallel geschaltet sind.

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14. Die Vorrichtung gemäß Anspruch 4, wobei der eine Sensor (12) ein Sensor ist, der das Vorhandensein einer verbrauchten oder entladenen Batterie (72) erfasst und der andere Sensor (10) ein Verpolungssensor ist.

15. Die Vorrichtung gemäß Anspruch 14, wobei der Fahrzeugisolationssensor (12) und der Verpolungssensor (10) optisch gekoppelte Isolationsphototransitoren enthalten.

16. Die Vorrichtung gemäß Anspruch 1, weiter umfassend mehrere Leistungsdioden (28), die zwischen die positiven und negativen Batterieverbinder und die Spannungsversorgung (32) gekoppelt sind, um eine Rückaufladung der Spannungsversorgung (32) durch ein an die verbrauchte oder entladene Batterie (72) angeschlossenes elektrisches System zu verhindern.

17. Die Vorrichtung gemäß Anspruch 1, weiter enthaltend einen Ausgangsanschluss (303), der positive und negative gepolte Anschlüsse zu den positiven und negativen Batterieverbindern aufweist.

18. Die Vorrichtung gemäß Anspruch 2, weiter enthaltend einen Temperatursensor (20) zur Detektion der Temperatur der Spannungsversorgung (32) und zum Bereitstellen eines Temperatursignals an den Mikrocontroller (1).

19. Die Vorrichtung gemäß Anspruch 2, ferner umfassend eine Spannungsmessungsschaltung (24), die zur Messung der Ausgabespannung der Spannungsversorgung (32) und zum Bereitstellen eines Spannungsmessungssignals an den Mikrocontroller (1) konfiguriert ist.

20. Die Vorrichtung gemäß Anspruch 1, weiter enthaltend einen Spannungsregler (42), der zur Umwandlung der Ausgabespannung der Spannungsversorgung (32) in einen Spannungspegel konfiguriert ist, der geeignet ist, um internen Komponenten der Vorrichtung eine Betriebsspannung bereitzustellen.

21. Vorrichtung gemäß Anspruch 1, ferner umfassend einen USB-Ausgangsanschluss (56) und eine USB-Ausgangsladeschaltung, die zum Bereitstellen einer Ladungsspannung von der Spannungsversorgung (32) an eine USB-ladbare Vorrichtung konfiguriert sind.

22. Vorrichtung gemäß Anspruch 1, ferner umfassend einen USB-Ladeanschluss (52), der zum Bereitstellen einer Ladespannung von einer externen Spannungsquelle an die Spannungsversorgung (32) konfiguriert ist.

23. Vorrichtung gemäß Anspruch 22, ferner umfassend: eine USB Ladeschaltung, die den USB-Ladeanschluss (52) mit der Spannungsversorgung (32) verbindet.

24. Vorrichtung gemäß Anspruch 23, wobei die USB Ladeschaltung einen DC-DC Konverter (49) enthält.

25. Vorrichtung gemäß Anspruch 24, wobei der DC-DC Konverter (49) eingerichtet ist, ein 5V Potenzial von einem USB Ladegerät auf 12.4V DC umzuwandeln.

26. Vorrichtung gemäß Anspruch 24, wobei der DC-DC Konverter (49) eingerichtet ist, über eine Schaltung durch eine Ausgabe von einem Mikrocontroller (1) ein und ausgeschaltet zu werden.

27. Vorrichtung gemäß Anspruch 14, weiter enthaltend einen manuellen Starthilfeschalter (46), der eingerichtet ist, einen manuellen Starthilfemodus zu aktivieren, um es einem Benutzer zu ermöglichen, eine Starhilfespannung an eine verbrauchte oder entladene Batterie (72) anzulegen, wenn diese zwischen den positiven und negativen Batterieverbindern verbunden ist, und wenn der Sensor (12), der das Vorhandensein der verbrauchten oder entladenen Batterie (72) erfasst, nicht in der Lage ist, das Vorhandensein der verbrauchten oder entladenen Batterie (72) zu detektieren.

28. Vorrichtung gemäß Anspruch 27, wobei der Mikrocontroller (1) eingerichtet ist, eine Betätigung des manuellen Starthilfeschalters (46) für wenigstens eine vorbestimmte Zeitperiode zu erkennen, bevor der manuelle Starthilfemodus aktiviert wird.

29. Vorrichtung gemäß Anspruch 1, wobei die positiven und negative Batterieverbinder durch ein Starthilfekabel (400) gebildet sind, das einen Stecker (401), der eingerichtet ist, in einen Ausgangsanschluss (303) gesteckt zu werden, und ein Kabelpaar (420a, 402b) aufweist, das mit dem Stecker (401) an einem Ende vom Kabel (400) integriert ist und eingerichtet ist, an die positiven du negativen Batterieanschlüsse der verbrauchten oder entladenen Batterie (72) am anderen Ende vom Kabel (400) verbunden zu werden.

30. Vorrichtung gemäß Anspruch 29, wobei der Ausgangsanschluss (303) und der Stecker (401) so dimensioniert sind, dass der Stecker (401) nur in einer spezifischen Orientierung in den Ausgangsanschluss (303) passt.

31. Starthilfevorrichtung zum Boosten oder Aufladen einer verbrauchten oder entladenen Batterie (72), die einen positiven Batterieanschluss und negativen Batterieanschluss aufweist, die Starthilfevorrichtung umfasst:
- eine Spannungsversorgung (32);

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- einen positiven Batterieverbinder zur Verbindung der Starthilfevorrichtung mit dem positiven Batterieanschluss der verbrauchten oder entladenen Batterie (72);
- einen negativen Batterieverbinder zur Verbindung der Starthilfevorrichtung mit dem negativen Batterieanschluss der verbrauchten oder entladenen Batterie (72);
- einen Leistungsschalter (15), der über eine Schaltung mit der Spannungsversorgung (32) und den positiven und negativen Batterieverbindern verbunden ist,
- wobei der Leistungsschalter (15) eingerichtet ist, die Spannung von der Spannungsversorgung (32) zur verbrauchten oder entladenen Batterie (72) ein- oder auszuschalten, wenn diese mit den positiven und negativen Batterieverbindern verbunden ist,
- ein Leistungsschaltersteuerungssystem oder eine Leistungsschaltersteuerungsschaltung, die mit dem Leistungsschalter (15) verbunden ist und zur Steuerung des Leistungsschalters (15) vorgesehen ist,
- wobei das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung eingerichtet ist, das Vorhandensein der verbrauchten oder entladenen Batterie (72) und die Polarität der verbrauchten oder entladenen Batterie (72) zu detektieren, wenn diese zwischen den positiven und negativen Batterieverbinder verbunden ist,
- wobei das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung die Spannungsversorgung (32) nur dann einschaltet, um die Spannungsversorgung (32) mit der verbrauchten oder entladenen Batterie (72) zu verbinden, wenn das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung sowohl erkennt, dass die verbrauchte oder entladene Batterie (72) vorhanden ist und zwischen den positiven und negativen Batterieverbinder verbunden ist, und die verbrauchte oder entladene Batterie (72) mit der richtigen Polarität zwischen den positiven und negativen Batterieanschlüssen verbunden ist.

32. Vorrichtung gemäß Anspruch 31, wobei das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung die Spannungsversorgung (32) nicht einschaltet, um die Spannungsversorgung (32) mit der verbrauchten oder entladenen Batterie (72) zu verbinden, wenn das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung erkennt, dass entweder (i) die verbrauchte oder entladene Batterie (72) nicht vorhanden ist oder nicht zwischen den positiven und negativen Batterieverbindern verbunden ist oder (ii) die verbrauchte oder entladene Batterie (72) nicht mit der richtigen Polarität zwischen den positiven und negativen Batterieanschlüssen verbunden ist

33. Vorrichtung gemäß Anspruch 31, wobei das Leistungsschaltersteuerungssystem oder die Leistungsschaltersteuerungsschaltung eingerichtet ist, das Vorhandensein der verbrauchten oder entladenen Batterie (72) zu erkennen, wenn diese zwischen die positiven und negativen Batterieverbinder geschaltet ist und die Polarität der verbrauchten oder entladenen Batterie zu erkennen, wenn diese zwischen die positiven und negativen Batterieverbinder geschaltet ist bevor die Spannung von der Spannungsversorgung (32) zu der der verbrauchten oder entladenen Batterie (72) eingeschaltet wird

Es folgen 13 Seiten Zeichnungen

ADC EX1002
IPR2025-00885

Anhängende Zeichnungen

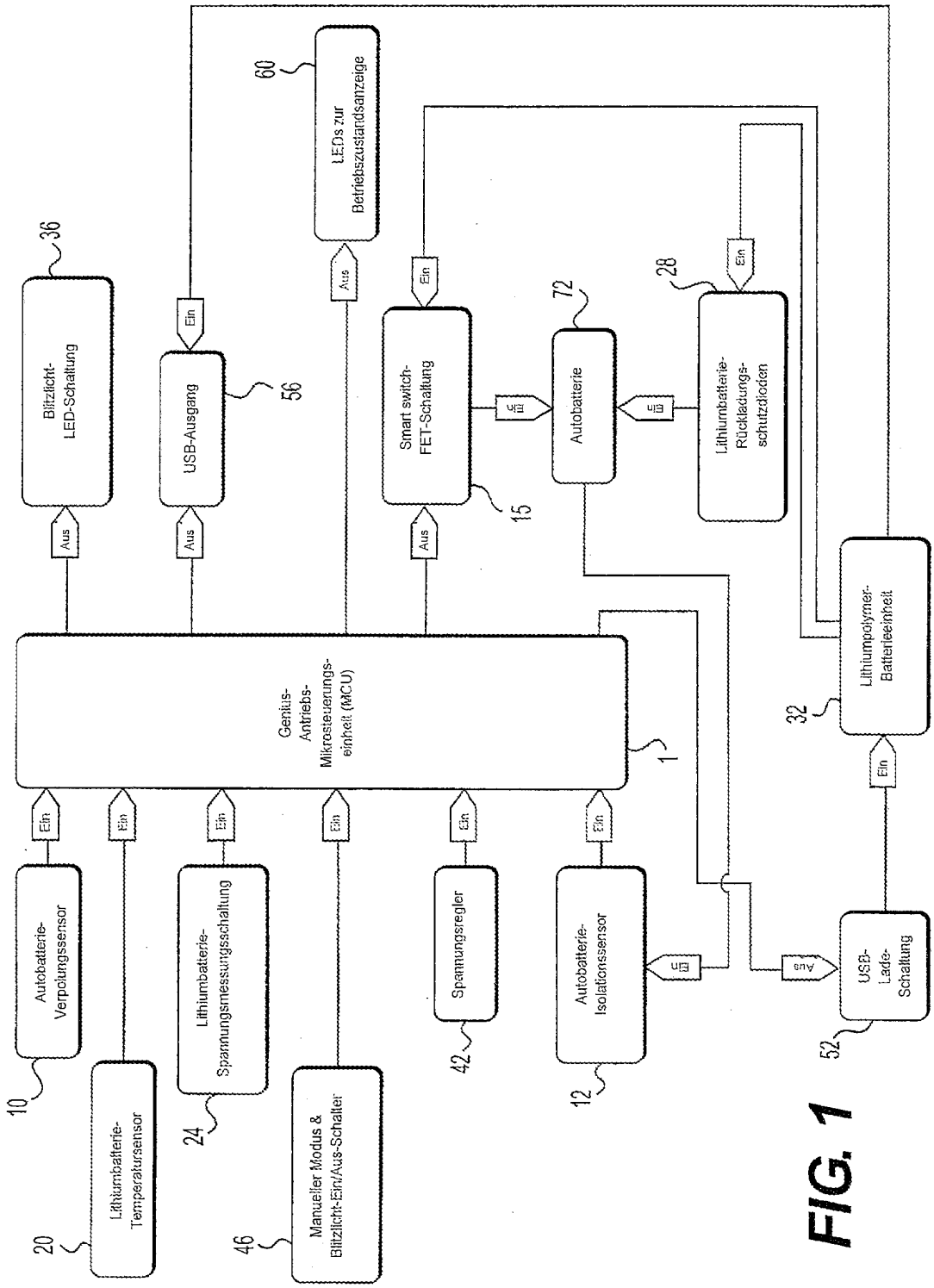


FIG. 1

ADC EX1002
IPR2025-00885

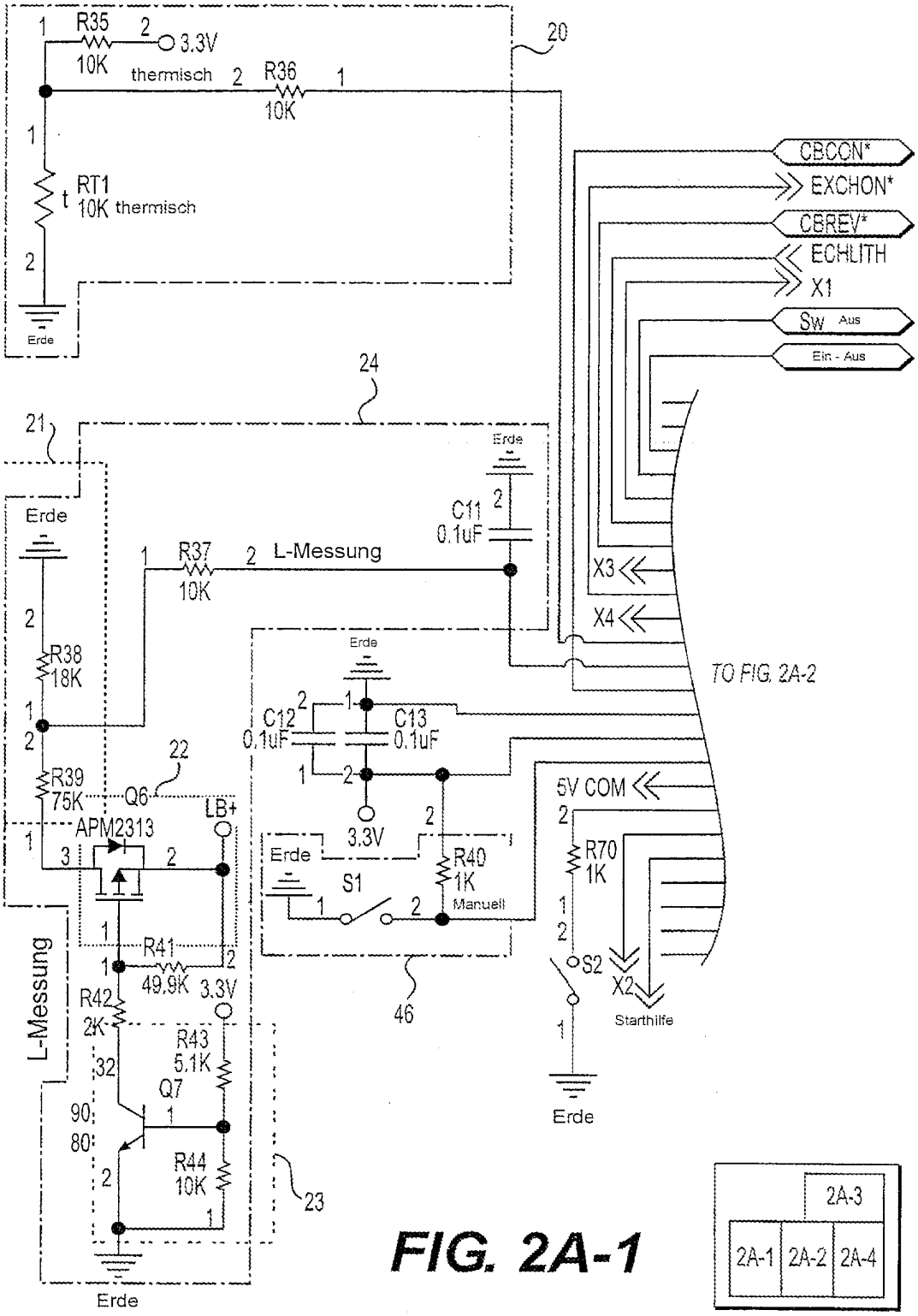


FIG. 2A-1

ADC EX1002
IPR2025-00885

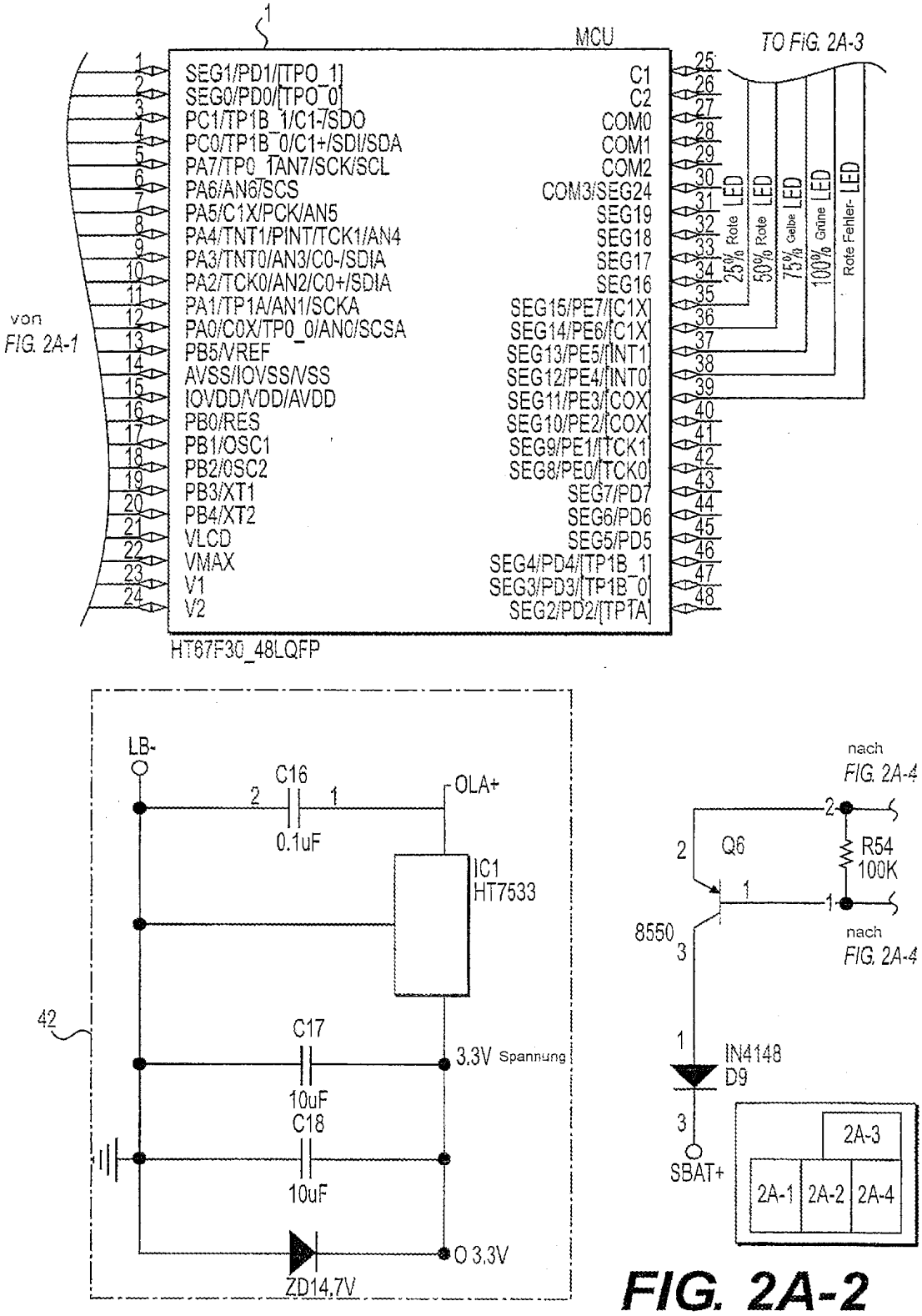

1
MCU
TO FIG. 2A-3
von
FIG. 2A-1
SEG1/PD1/[TPO_1]
SEG0/PD0/[TPO_0]
PC1/TP1B_1/C1-/SDO
PC0/TP1B_0/C1+/SDI/SDA
PA7/TP0_1AN7/SCK/SCL
PA6/AN6/SCS
PA5/C1X/PCK/AN5
PA4/TNT1/PINT/TCK1/AN4
PA3/TNT0/AN3/C0-/SDIA
PA2/TCK0/AN2/C0+/SDIA
PA1/TP1A/AN1/SCKA
PA0/C0X/TP0_0/AN0/SCSA
PB5/VREF
AVSS/IOVSS/VSS
IOVDD/VDD/AVDD
PB0/RES
PB1/OSC1
PB2/OSC2
PB3/XT1
PB4/XT2
VLCD
VMAX
V1
V2
C1
C2
COM0
COM1
COM2
COM3/SEG24
SEG19
SEG18
SEG17
SEG16
SEG15/PE7/[C1X]
SEG14/PE6/[C1X]
SEG13/PE5/[INT1]
SEG12/PE4/[INT0]
SEG11/PE3/[COX]
SEG10/PE2/[COX]
SEG9/PE1/[TCK1]
SEG8/PE0/[TCK0]
SEG7/PD7
SEG6/PD6
SEG5/PD5
SEG4/PD4/[TP1B_1]
SEG3/PD3/[TP1B_0]
SEG2/PD2/[TP1A]
25% Rote LED
50% Rote LED
75% Gelbe LED
100% Grüne LED
Rote Fehler- LED
HT67F30_48LQFP
LB-
C16
0.1uF
OLA+
IC1
HT7533
42
C17
10uF
3.3V Spannung
C18
10uF
3.3V
ZD14.7V
nach
FIG. 2A-4
Q6
8550
R54
100K
nach
FIG. 2A-4
IN4148
D9
SBAT+
2A-3
2A-1
2A-2
2A-4

FIG. 2A-2

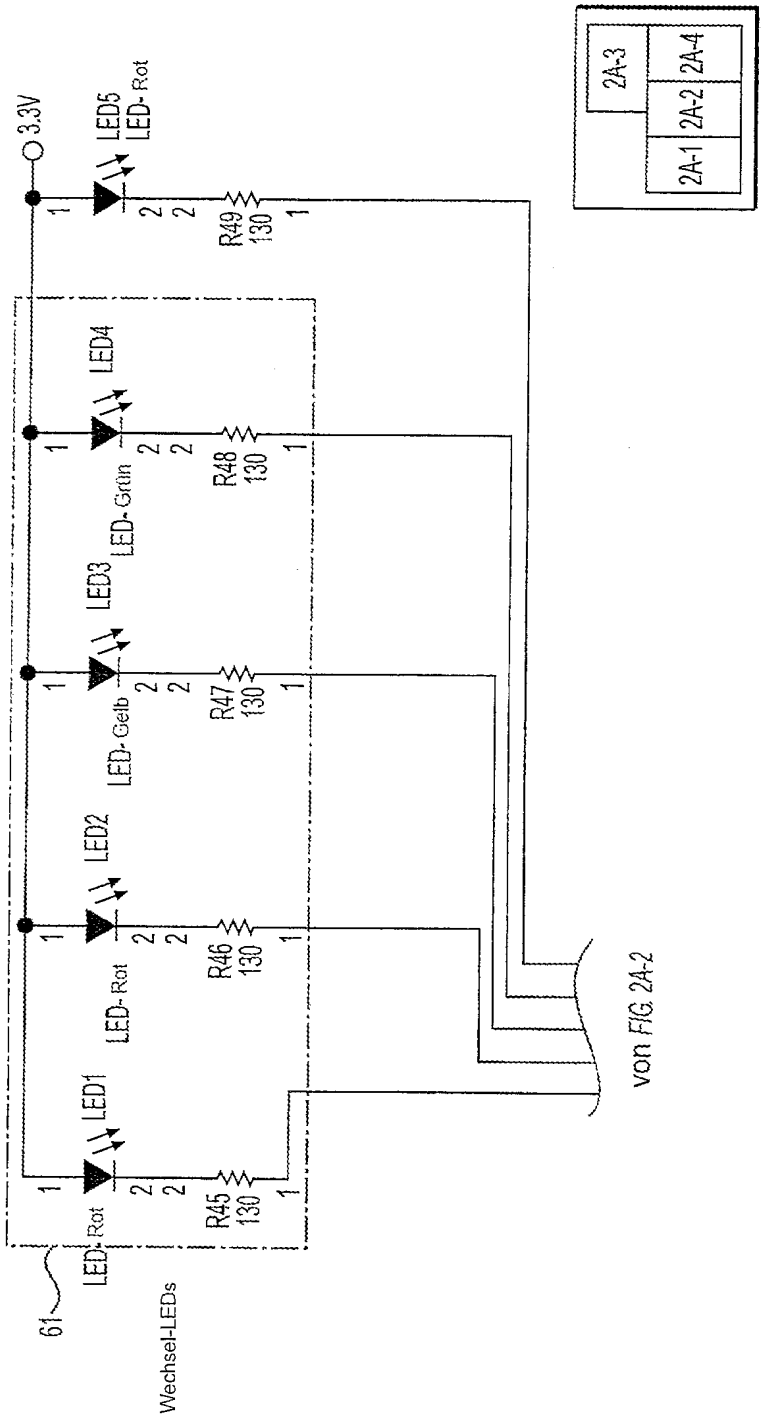


FIG. 2A-3

ADC EX1002
IPR2025-00885

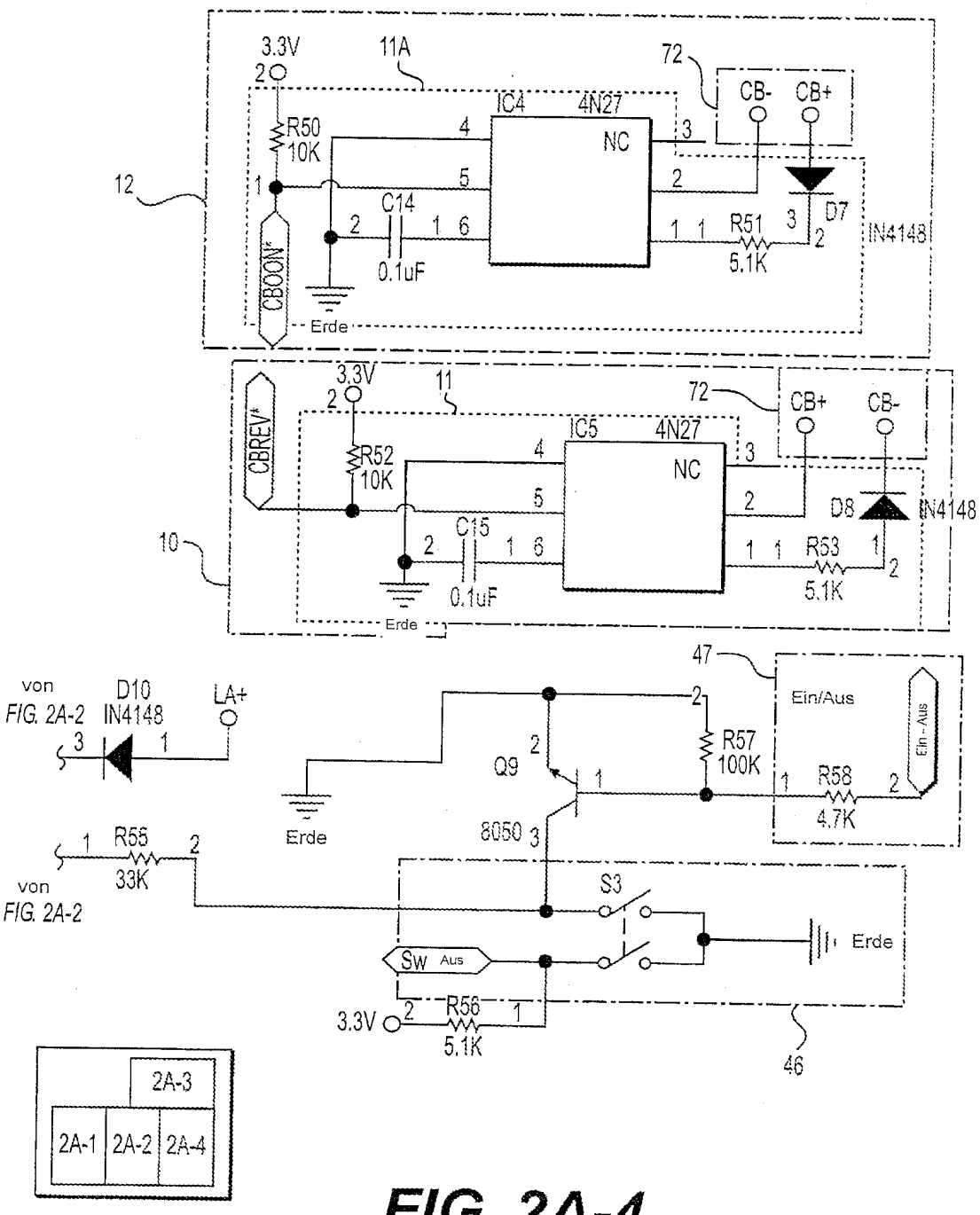


FIG. 2A-4

ADC EX1002
IPR2025-00885

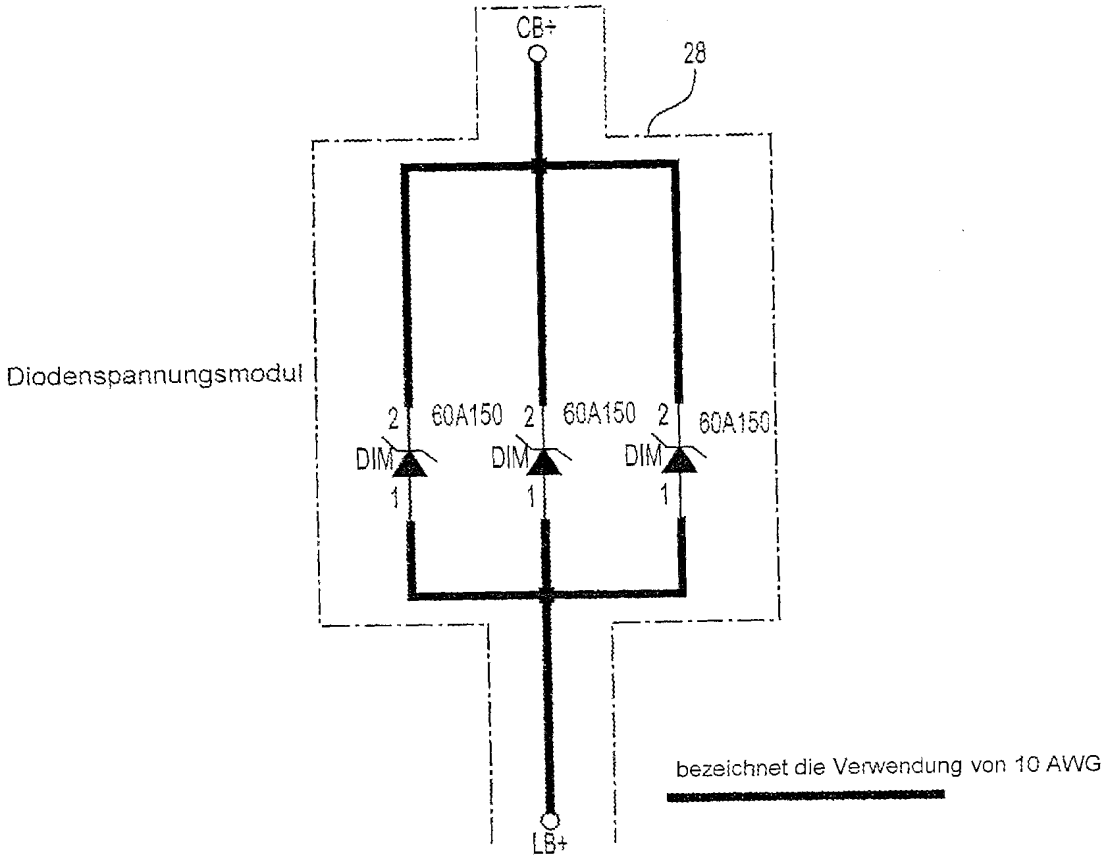
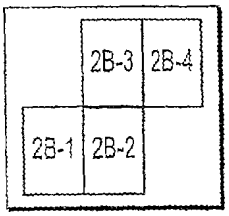

CB+
28
Diodenspannungsmodul
2
60A150
2
60A150
2
60A150
DIM
DIM
DIM
1
1
1
bezeichnet die Verwendung von 10 AWG
LB+

FIG. 2B-1


2B-3
2B-4
2B-1
2B-2

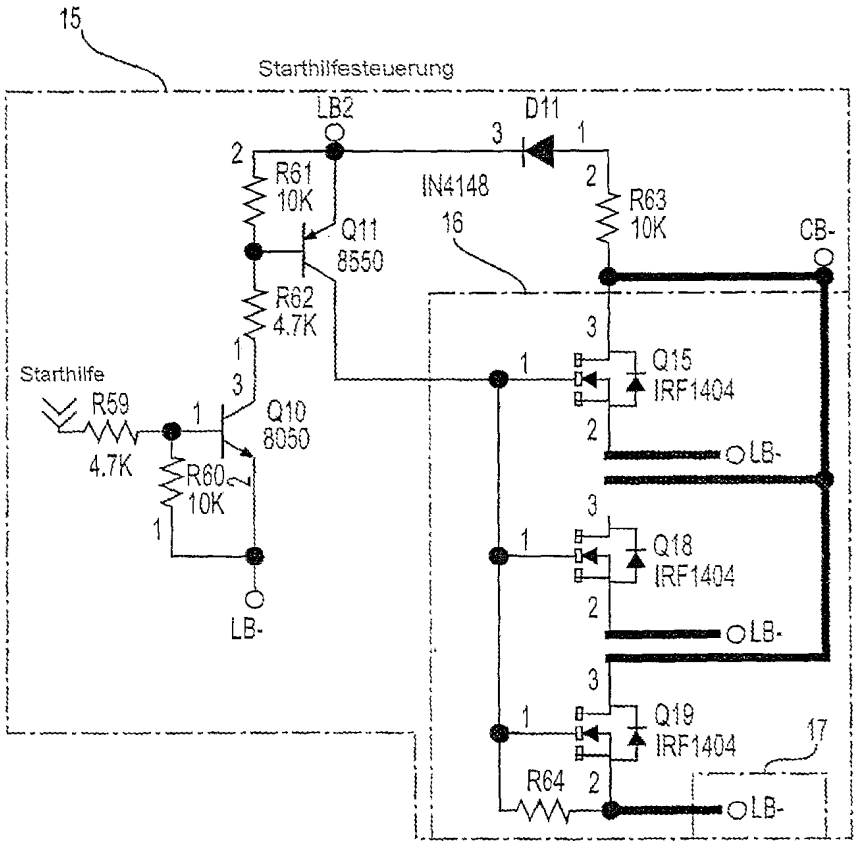
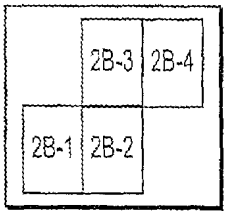


FIG. 2B-2



ADC EX1002
IPR2025-00885

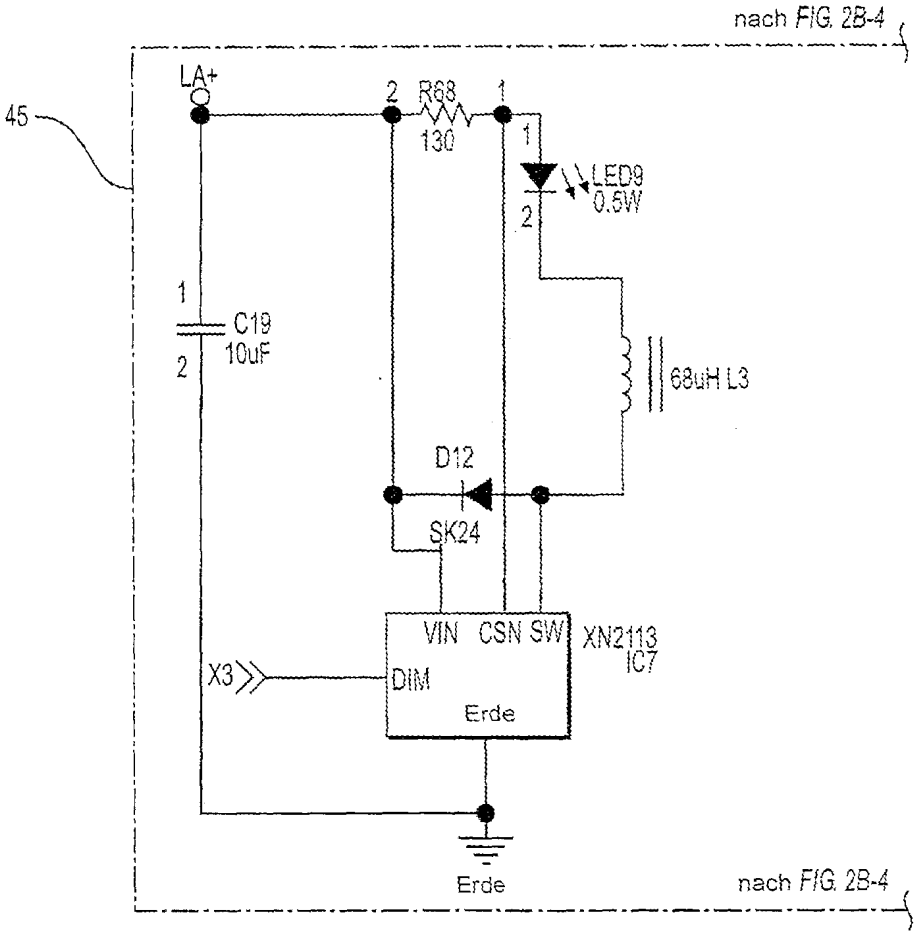
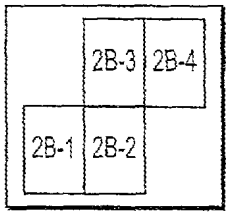


FIG. 2B-3



ADC EX1002
IPR2025-00885

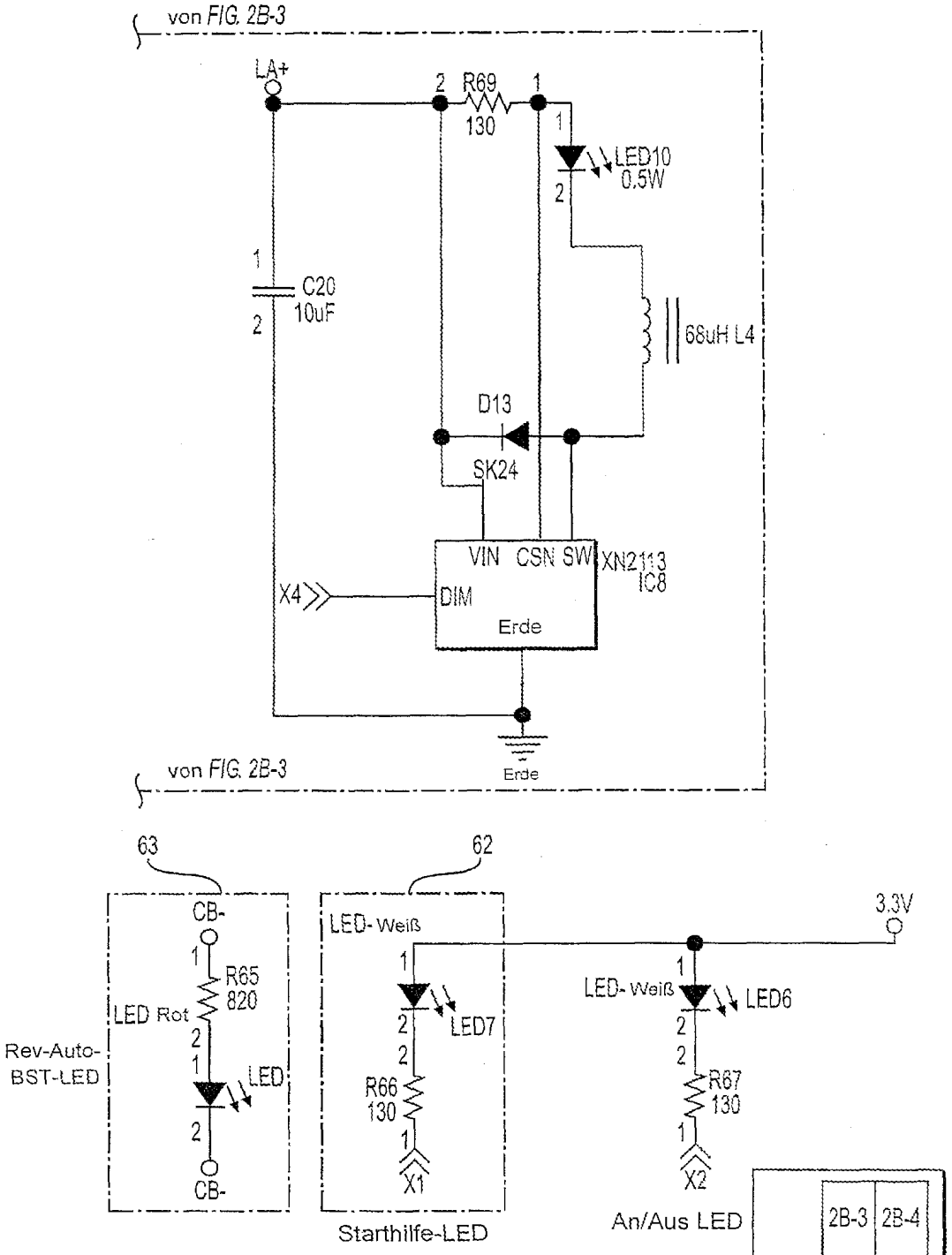


FIG. 2B-4

ADC EX1002
IPR2025-00885

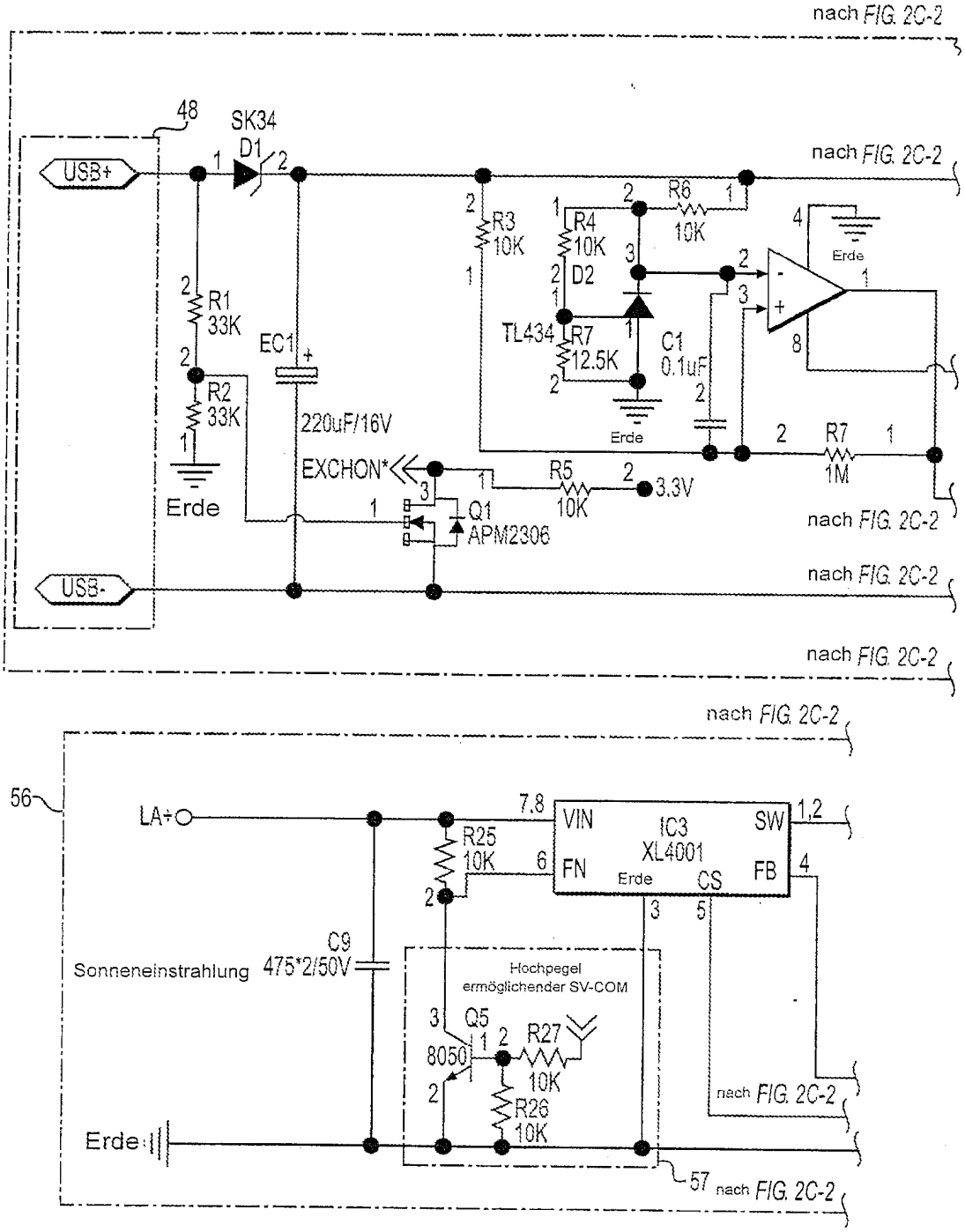
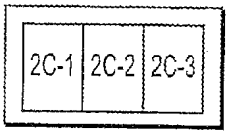

nach FIG. 2C-2
48
SK34
D1
USB+
USB-
R1
33K
R2
33K
Erde
EC1
220uF/16V
EXCHON*
Q1
APM2306
R3
10K
R4
10K
D2
TL434
R7
12.5K
R6
10K
Erde
C1
0.1uF
R5
10K
3.3V
R7
1M
nach FIG. 2C-2
56
LA+
R25
10K
IC3
XL4001
VIN
FN
Erde
CS
SW
FB
C9
475*2/50V
Sonneneinstrahlung
Hochpegel
ermöglichender SV-COM
Q5
8050
R27
10K
R26
10K
Erde
57
nach FIG. 2C-2

FIG. 2C-1


2C-1
2C-2
2C-3

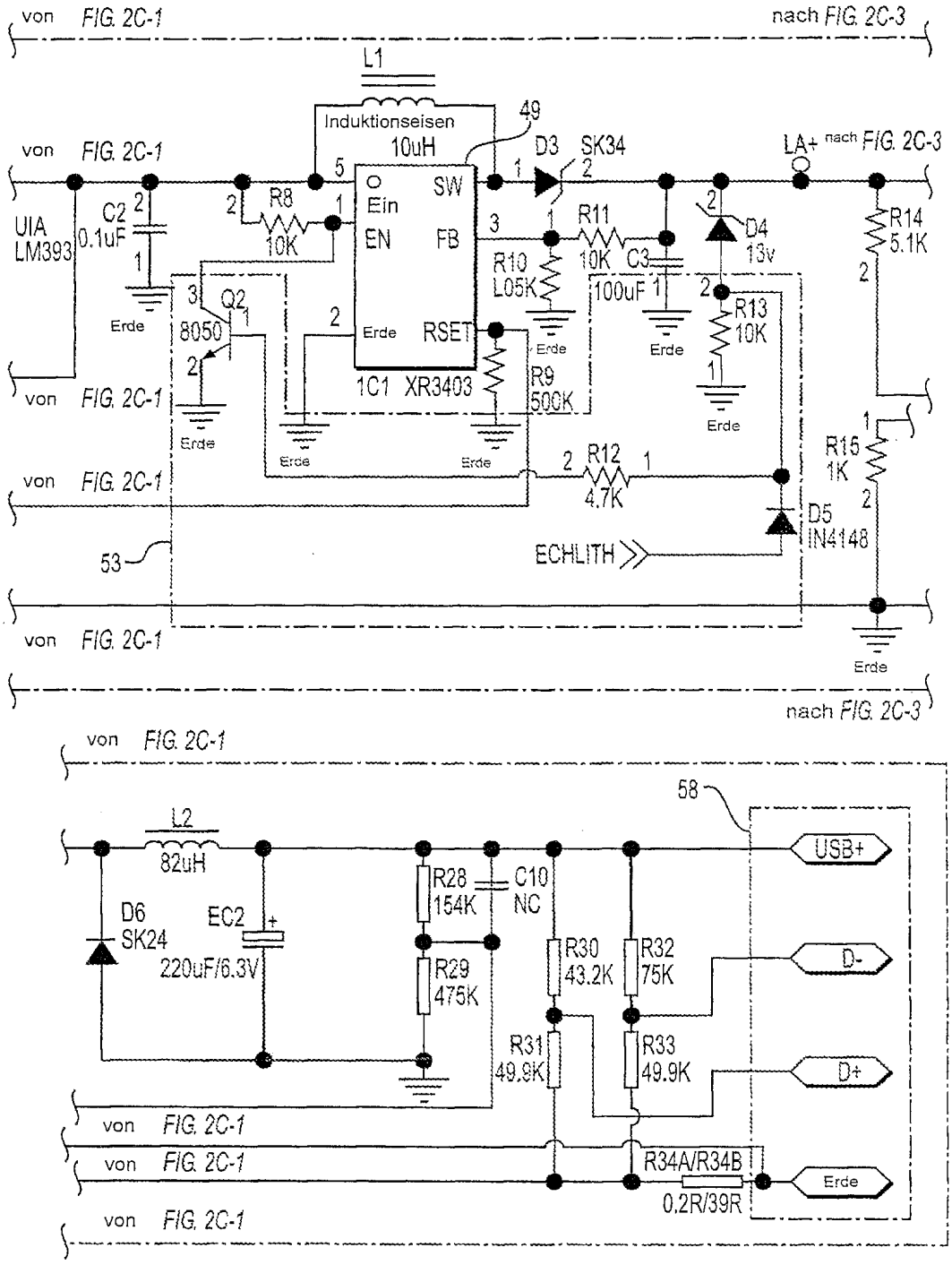
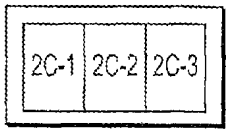
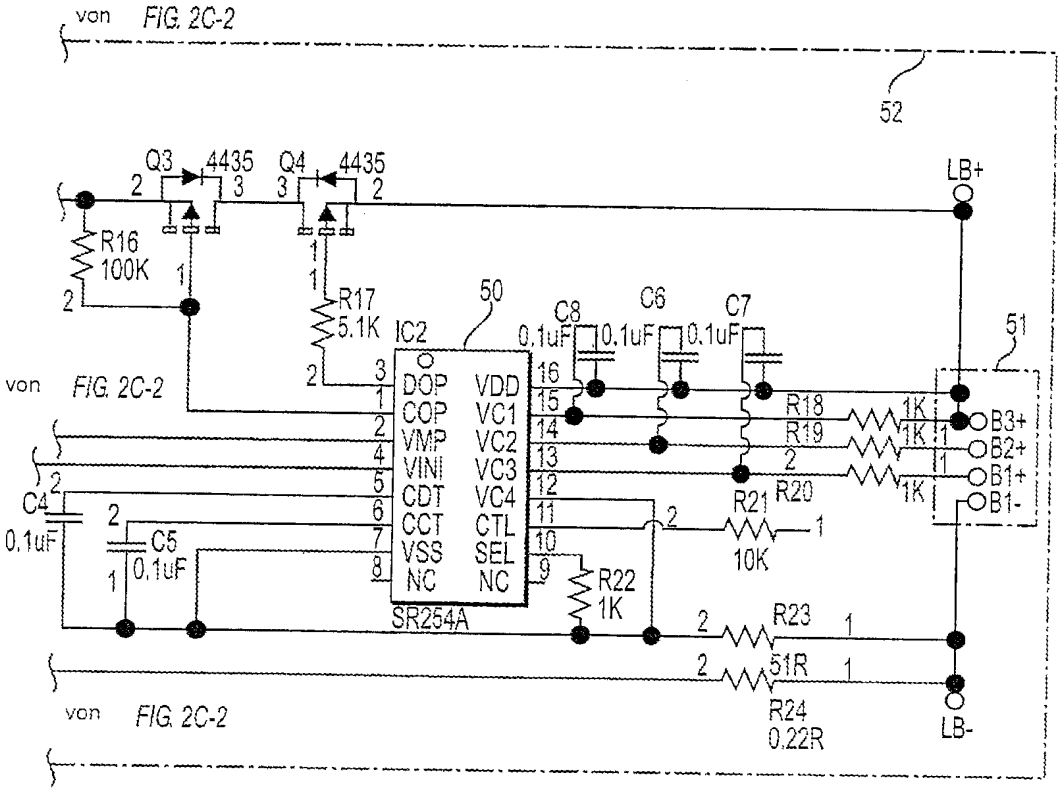

von FIG. 2C-1
nach FIG. 2C-3
L1
Induktionseisen
10uH
49
D3 SK34
LA+
nach FIG. 2C-3
UIA
LM393
C2
0.1uF
R8
10K
SW
Ein
EN
FB
R11
10K
C3
100uF
D4
13v
R14
5.1K
R10
L05K
R13
10K
Q2
8050
Erde
RSET
R9
500K
1C1 XR3403
R12
4.7K
R15
1K
D5
IN4148
ECHLITH
53
von FIG. 2C-1
nach FIG. 2C-3
58
L2
82uH
D6
SK24
EC2
220uF/6.3V
R28
154K
C10
NC
R29
475K
R30
43.2K
R32
75K
R31
49.9K
R33
49.9K
USB+
D-
D+
R34A/R34B
0.2R/39R
Erde

FIG. 2C-2


2C-1
2C-2
2C-3


von FIG. 2C-2
52
Q3 4435
Q4 4435
LB+
R16
100K
R17
5.1K
IC2
50
C8
C6
C7
0.1uF
51
von FIG. 2C-2
DOP
COP
VMP
VINI
CDT
CCT
VSS
NC
VDD
VC1
VC2
VC3
VC4
CTL
SEL
NC
SR254A
R18
R19
R20
R21
R22
R23
R24
1K
10K
51R
0.22R
B3+
B2+
B1+
B1-
LB-
C4
C5
0.1uF
von FIG. 2C-2

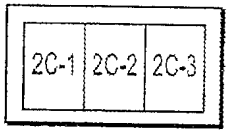

2C-1
2C-2
2C-3

FIG. 2C-3

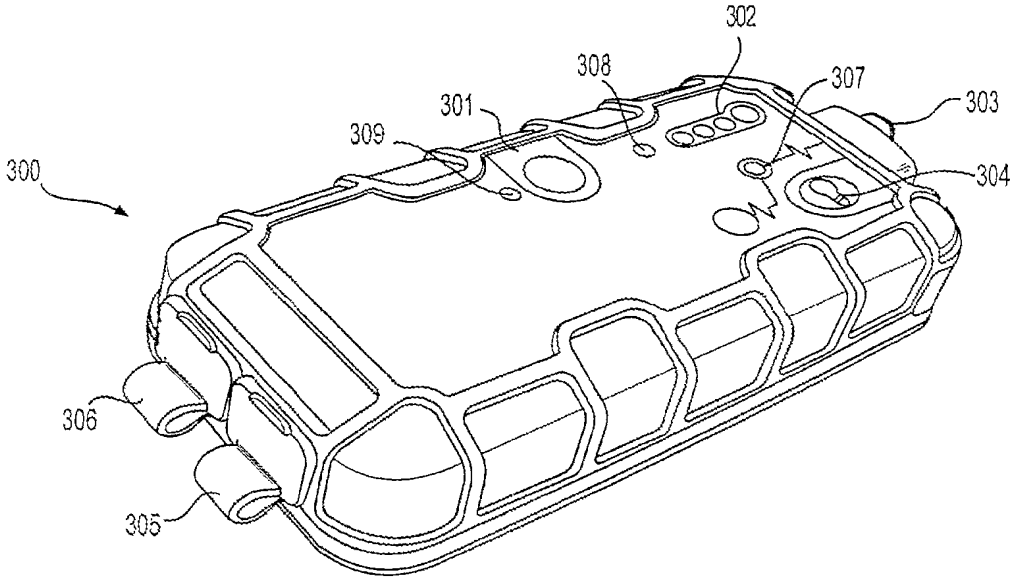


FIG. 3

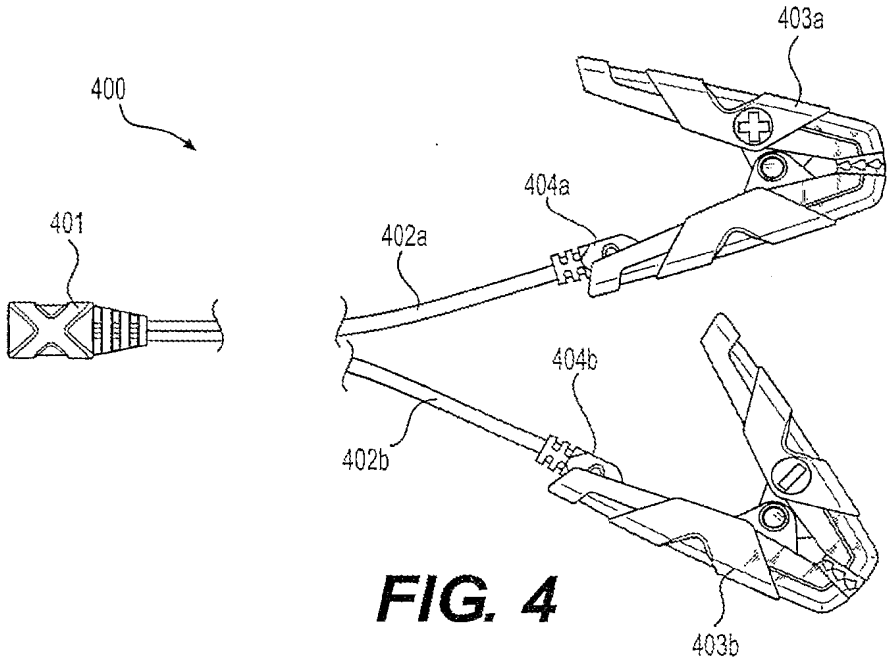


FIG. 4

Das Dokument wurde durch die Firma 1000 erstellt.
ABC EX1002
IPR2025-00885

(12) 特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2012 年 6 月 21 日(21.06.2012)

WIPO | PCT

(10) 国際公開番号
WO 2012/081140 A1

(51) 国際特許分類:
H01M 2/10 (2006.01) *H01M 2/20* (2006.01)

(21) 国際出願番号: PCT/JP2011/004202

(22) 国際出願日: 2011 年 7 月 26 日(26.07.2011)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

(30) 優先権データ:
特願 2010-276485 2010 年 12 月 13 日(13.12.2010) JP

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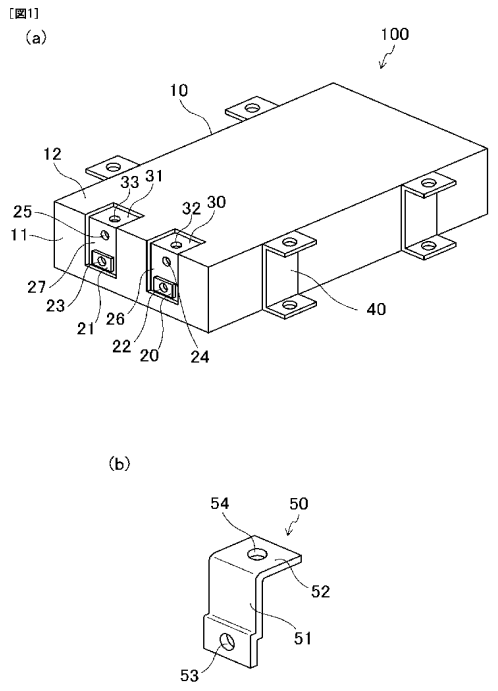
(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), ヨーロッパ (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI

[続葉有]

(54) **Title**: BATTERY MODULE AND BATTERY PACK

(54) 発明の名称 : 電池モジュール及び電池パック



(57) **Abstract**: A battery module (100) in which a plurality of unit cells are arranged and housed within a case (10), wherein: a positive electrode external terminal (20) and a negative electrode external terminal (21) connected to the electrodes in the plurality of unit cells are arranged in parallel at a prescribed interval on the first side surface (11) of the case (10); a pair of grooves (30, 31) are formed at the same prescribed interval from one another on the second side surface (12), adjacent to the first side surface (11) of the case (10); and the first part (51) of an L-shaped electrode piece (50) is selectively attachable to the positive electrode external terminal (20) or the negative electrode external terminal (21), and the second part (52) is selectively attachable to either one of the grooves (30, 31) in the pair thereof.

(57) 要約: 複数の素電池が配列されてケース１０内に収容された電池モジュール１００であって、ケース１０の第１の側面１１に、複数の素電池の各電極に接続された正極外部端子２０及び負極外部端子２１が、所定の間隔で並列に配設されており、ケース１０の第１の側面１１に隣接する第２の側面１２に、所定の間隔と同じ間隔で一対の溝部３０、３１が形成されており、Ｌ字型の電極片５０の第１の片５１が、正極外部端子２０又は負極外部端子２１と、電極片５０の第２の片５２が、一対の溝部３０、３１のいずれか一方と、それぞれ選択的に取付可能になっている。

WO 2012/081140 A1

(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

添付公開書類:

— 国際調査報告（条約第 21 条(3)）

明　細　書

発明の名称 ： 電池モジュール及び電池パック

技術分野

[0001] 本発明は、複数の電池を備えた電池モジュール、及びそれを積層した電池パックに関する。

背景技術

[0002] 複数の電池をケースに収容して、所定の電圧及び容量を出力できるようにした電池パックは、種々の機器、車両等の電源として広く使用されている。中でも、汎用的な電池を並列・直列接続して、所定の電圧及び容量を出力する組電池をモジュール化し、この電池モジュールを種々組み合わせることによって、多種多様な用途に対応可能とする技術が採用され始めている。このモジュール化技術は、電池モジュールに収容する電池を高性能化することによって、電池モジュール自身の小型・軽量化が図られるため、電池パックを組み立てる際の作業性が向上するとともに、車両等の限られた空間へ搭載する際の自由度が向上するなど、様々なメリットと有する。

[0003] 一般的に、電池モジュールは、複数の電池が電池ケース内に収容され、各電池の電極を電気的に直列又は並列接続した配線が、電池ケースの一側面に取り付けられた外部端子に接続された構成になっている（例えば、特許文献１を参照）。そして、複数の電池モジュールを配列して電池パックを構成するとき、各電池モジュールの一側面に配設された外部端子同士を電気的に直列又は並列に接続して、所定の電圧及び容量を備えた電池パックを得ることができる。

先行技術文献

特許文献

[0004] 特許文献1：特開２００７－０２６８９４号公報

発明の概要

発明が解決しようとする課題

[0005] 電池モジュールは、その外形寸法や外部端子が、所定の大きさや位置に定まっているために、必要な個数の電池モジュールを配列することによって、容易に電池パックを組み立てることができる。そのとき、電池モジュールを、その外部端子が同じ方向を向くように配列することによって、各電池モジュール間の電気的接続も容易となる。

[0006] また、このように組み立てられた電池パックは、通常、パックケースに収容されて、所定の空間に設置されるが、外部端子が同じ方向を向いて配列しているため、電池パックが所定の空間に設置された状態でも、外部端子が配列した側のパックケースの一側面を開口することによって、外部端子の接続等のメンテナンスを行うことができる。

[0007] しかしながら、電池パックが収容されたパックケースを、一旦、所定の空間に設置した後は、空間の制約等から、外部端子が配列した側のパックケースの側面を開口することができない場合がある。この場合、パックケースを設置した状態ではメンテナンス等の作業をすることができないため、一旦、パックケースを設置場所から取り出して、作業を行う必要がある。

[0008] また、電池パックを設置した状態でも、メンテナンス等の作業ができるようにするためには、予め、パックケースの開口可能な側面に外部端子が向くように、電池モジュールを配置しなければならず、電池モジュールの配置自由度が制限されてしまうという問題もある。

[0009] 本発明は、かかる課題に鑑みなされたもので、その主な目的は、メンテナンス性が高く、配置自由度の高い電池モジュール、及びそれを積層した電池パックを提供することにある。

課題を解決するための手段

[0010] 上記の課題を解決するために、本発明は、複数の素電池（以下、電池モジュールに使用する電池を、「素電池」と呼ぶ）がケースに収容された電池モジュールにおいて、ケースの一側面に外部端子を配設し、これに隣接する側面に溝部を形成し、Ｌ字型の電極片の一片を外部端子に、他片を溝部に、それぞれ取付可能にした構成を採用する。

[0011] このような構成により、電池モジュールを積層して電池パックを構成したとき、最上段の電池モジュールには、電極片の一片を外部端子に取り付け、他片を溝部に取り付けることによって、電池モジュールの外部端子を、ケースの隣接する２つの側面に配設させることができる。これにより、外部端子を接続するための作業面を、ケースの２つの側面に確保することができるため、メンテナンス性が向上するとともに、電池パックを構成する際の電池モジュールの配置自由度を向上させることができる。

[0012] 本発明に係る電池モジュールは、複数の素電池が配列されてケース内に収容された電池モジュールであって、ケースの第１の側面に、複数の素電池の各電極に接続された正極外部端子及び負極外部端子が、所定の間隔で並列に配設されており、ケースの第１の側面に隣接する第２の側面に、所定の間隔と同じ間隔で一対の溝部が形成されており、Ｌ字型の電極片の第１の片が、正極外部端子又は負極外部端子と、電極片の第２の片が、一対の溝部のいずれか一方と、それぞれ選択的に取付可能になっていることを特徴とする。

[0013] また、本発明に係る電池パックは、上記電池モジュールが複数個、第２の側面に垂直な方向に積層された電池パックであって、最上段の電池モジュールにおいて、電極片の第１の片は、ケースの第１の側面に配設された正極外部端子又は負極外部端子の一方の外部端子に取り付けられ、電極片の第２の片は、ケースの第２の側面に形成された一対の溝部の一方に取り付けられており、電極片の第２の片は、電池パックの一方の極の外部端子を構成していることを特徴とする。

発明の効果

[0014] 本発明によれば、メンテナンス性が高く、配置自由度の高い電池モジュールが実現でき、これを積層した電池パックのメンテナンス性が向上できるとともに、電池パックを構成する際の電池モジュールの配置自由度が向上できる。

図面の簡単な説明

[0015] [図1]（ａ）は、本発明の一実施形態における電池モジュールの構成を模式的

に示した斜視図で、（ｂ）は、Ｌ字型の電極片の構成を示した斜視図である。

[図2]図１の電池モジュールにＬ字型の電極片を取り付けた状態の構成を示した斜視図である。

[図3]電池モジュールを複数個積層された電池パックの構成を模式的に示した斜視図である。

[図4]電池モジュールが電気的に接続された状態の電池パックの構成を示した図で、（ａ）は上面図、は正面図である。

[図5]図１（ａ）に示した電池モジュールを複数個積層した電池パックを配列して構成した電源ユニットの例を示した正面図である。

[図6]図５の電源ユニットに、Ｌ字型の電極片及び第２の電極片を取り付けた状態の電源ユニットの構成を示した図で、（ａ）は平面図、（ｂ）は正面図である。

[図7]電池モジュールを並列に配置して電池パックを構成した例を示した図で、（ａ）は平面図、（ｂ）は正面図である。

発明を実施するための形態

[0016] 以下、本発明の実施形態を図面に基づいて詳細に説明する。なお、本発明は、以下の実施形態に限定されるものではない。また、本発明の効果を奏する範囲を逸脱しない範囲で、適宜変更は可能である。さらに、他の実施形態との組み合わせも可能である。

[0017] 図１（ａ）は、本発明の一実施形態における電池モジュール１００の構成を模式的に示した斜視図である。電池モジュール１００は、複数の素電池（不図示）が配列されてケース１０内に収容されている。なお、本発明の電池モジュールに使用する素電池の種類は、特に制限されないが、例えば、リチウムイオン電池やニッケル水素電池等を用いることができる。また、ノート型パソコン等の携帯用電子機器の電源として単体でも使用できる電池であってもよい。この場合、高性能の汎用電池を、電池モジュールの素電池として使用することができるため、電池モジュールの高性能化、低コスト化をより

容易に図ることができる。

[0018] 図１（ａ）に示すように、ケース１０の第１の側面１１には、複数の素電池の各電極に接続された正極外部端子２０及び負極外部端子２１が、所定の間隔で並列に配設されている。なお、素電池間の電気的な接続は、直列でも並列でもよい。また、素電池間の電気的な接続構造は、特に制限されないが、例えば、並列接続する場合には、素電池の極性を揃えて配置し、素電池の各極性をそれぞれバスバーで接続すればよい。

[0019] ケース１０の第１の側面１１に隣接する第２の側面１２には、外部端子２０、２１と同じ間隔で、一対の溝部３０、３１が形成されている。そして、図１（ｂ）に示すようなＬ字型の電極片５０の第１の片５１が、正極外部端子２０又は負極外部端子２１と、電極片５０の第２の片５２が、一対の溝部３０，３１のいずれか一方と、それぞれ選択的に取付可能になっている。

[0020] すなわち、図２に示すように、Ｌ字型の電極片５０の第１の片５１を、例えば、正極外部端子２０に、第２の片５２を、溝部３０に取り付けた場合、正極外部端子は、ケース１０の互いに隣接する２つの側面１１，１２に配されることになる。

[0021] ここで、Ｌ字型の電極片５０は、必ずしも直角に曲がった形状である必要はなく、外部端子２０、２１、及び溝部３０、３１の形状に合わせて適宜変形されたものであってもよい。また、電極片５０の材料は特に制限されないが、例えば、銅、アルミニウム、ニッケル、または銅とニッケルのクラッド材等を好適に用いることができる。

[0022] なお、図２に示すように、電極片５０の第２の片５２は、溝部３０，３１に埋設して取り付けられるため、溝部３０，３１の深さを、電極片５０の厚みと同じ大きさにしておけば、溝部３０，３１に取り付けられた電極片５０の第２の片５２は、ケース１０の第２の側面１２から突出することはない。従って、電池モジュール１００を、ケース１０の第２の側面１２に垂直な方向に積層した場合、安定して積層することができる。

[0023] また、ケース１０の第１の側面１１にも、電極片５０の第１の片５１を埋

設する一対の第２の溝部２６、２７を形成しておけば、電極片５０の第１の片５１も、溝部２６、２７に埋設して取り付けることができる。

[0024] また、一対の溝部３０、３１及び電極片５０の第２の片５２に、それぞれボルト孔（又はネジ孔）３２、３３及び５４を設けておくことによって、電極片５０の第２の片５２を、ボルト（又はネジ）で、一対の溝部３０、３１に取り付けることができる。なお、電極片５０の取付方法はこれに限定されず、着脱可能な取付方法であれば、他の方法を用いてもよい。

[0025] 同様に、外部端子２０，２１及び電極片５０の第１の片５１にも、それぞれボルト孔（又はネジ孔）２２、２３及び５３を設けておくことによって、電極片５０の第１の片５１を、ボルト（又はネジ）で、外部端子２０，２１に取り付けることができる。

[0026] また、ケース１０に、連結部４０を設けておくことによって、電池モジュール１００を積層したとき、連結部４０で、隣り合う電池モジュール１００同士を連結することができる。

[0027] 図３は、電池モジュール１００が複数個（図では３個）、ケース１０の第２の側面１２に垂直な方向に積層された電池パック２００の構成を模式的に示した斜視図である。

[0028] 図３に示すように、まず、最上段の電池モジュール１００ａにおいては、電極片５０の第１の片５１が、ケース１０の第１の側面１１に配設された正極外部端子２０ａ又は負極外部端子２１ａのいずれか一方（ここでは、正極外部端子２０ａ）に取り付けられ、電極片５０の第２の片５２が、ケース１０の第２の側面１２に形成された一対の溝部３０，３１の一方（ここでは、溝部３０）に取り付けられる。これにより、電極片５０の第２の片５２は、電池パック２００の一方の極（ここでは正極）の外部端子を構成している。

[0029] また、一対の溝部３０，３１の他方（ここでは溝部３１）には、Ｌ字型の第２の電極片６０の第２の片６２が取り付けられており、第２の電極片６０の第１の片６１は、ケース１０の第１の側面１１に形成された一対の第２の溝部２６、２７の一方（ここでは、溝部２７）に取り付けられている。さら

に、第２の電極片６０の第１の片６１は、ケース１０の第１の側面１１側に配設されたバスバー７０ａによって、最下段の電池モジュール１００ｃの負極外部端子２１ｃに接続されている。これにより、第２の電極片６０の第２の片６２は、電池パック２００の他方の極（ここでは負極）の外部端子を構成している。

[0030] ここで、電極片５０と第２の電極片６０とを比較すると、一対の溝部３０、３１に埋設する側の第２の片５２、６２は、ほぼ同じ大きさであるのに対し、第２の電極片６０の片６１の長さは、電極片５０の第１の片５１の長さよりも短い。すなわち、第２の電極片６０は、外部端子２０、２１を、ケース１０の互いに隣接する２つの側面１１、１２に配設するような機能はない。

[0031] なお、第２の電極片６０の第１及び第２の片６１，６２及び一対の第２の溝部２４，２５にも、それぞれボルト孔（又はネジ孔）６３、６４及び２４、２５を設けておくことによって、第２の電極片６０の第１及び第２の片６１、６２を、ボルト（又はネジ）で、一対の溝部３０、３１又は一対の第２の溝部２６、２７に取り付けることができる。

[0032] また、積層された複数の電池モジュール１００ａ、１００ｂ、１００ｃは、ケース１０の第１の側面１１側に配設された複数のバスバー７０ｂ、７０ｃによって、各電池モジュール１００ａ、１００ｂ、１００ｃの正極外部端子２０ａ、２０ｂ、２０ｃ又は負極外部端子２１ａ、２１ｂ、２１ｃと、それぞれ接続されている。

[0033] 例えば、図３に示した例では、最下段の電池モジュール１００ｃの正極外部端子２０ｃは、バスバー７０ｂによって、中段の電池モジュール１００ｂの負極外部端子２１ｂに接続されている。また、中段の電池モジュール１００ｂの正極外部端子２０ｂは、バスバー７０ｃによって、最上段の電池モジュール１００ａの負極外部端子２１ａに接続されている。

[0034] 図４は、このように接続された電池パック２００の構成を示した図で、図４（ａ）は上面図、図４（ｂ）は正面図である。

[0035] 図４（ｂ）に示すように、電池モジュール１００ａ、１００ｂ、１００ｃは、電気的に直列接続されている。そして、最上段の電池モジュール１００ａの正極外部端子２０ａと、最下段の電池モジュール１００ｃの負極外部端子２１ｃとが、それぞれ、電池パック２００の正負の外部端子となる。

[0036] また、図４（ａ）に示すように、ケース１０の第２の側面１２に取り付けられた電極片５０の第２の片５２は、Ｌ字型の電極片５０によって、電池モジュール１００ａの正極外部端子２０ａと接続されている。また、ケース１０の第２の側面１２に取り付けられた第２の電極片６０の第２の片６２は、Ｌ字型の第２の電極片６０及びバスバー７０ａによって、電池モジュール１００ｃの負極外部端子２１ｃと接続されている。従って、ケース１０の第２の側面１２に配設された電極片５０の第２の片５２、及び第２の電極片６０の第２の片６２は、それぞれ、電池パック２００の正負の外部端子となる。

[0037] すなわち、このように構成された電池パック２００は、ケース１０の第１の側面１１側だけでなく、それに隣接する第２の側面１２側にも、正負の外部端子を配設することが可能となる。

[0038] なお、下段の電池モジュール１００ｂ、１００ｃには、電極片５０及び第２の電極片６０は取り付けられていない。このため、電池モジュール１００ｂ、１００ｃを積層する前に、予め、電極片５０及び第２の電極片６０の取付作業は不要となり、電池パック２００の組立工程が複雑になることはない。また、電池モジュール１００ａ、１００ｂ、１００ｃ間には、電極片５０及び第２の電極片６０がないため、安定して積層することができる。

[0039] 図５は、図１（ａ）に示した電池モジュール１００を複数個積層した電池パック２００Ａ、２００Ｂ、２００Ｃを配列して構成した電源ユニット３００の例を示した正面図である。

[0040] 電池パック２００Ａ、２００Ｂは、電池モジュール１００ａ、１００ｂ、１００ｃを積層して、電気的に直列接続したもので、電池パック２００Ｃは、電池モジュール１００ｂ、１００ｃを積層して電気的に直列接続したものである。従って、電池パック２００Ａ、２００Ｂ、２００Ｃの正極外部端子

は、それぞれ、２０Ａａ、２０Ｂａ、２０Ｃａ、負極外部端子は、それぞれ、２１Ａｃ、２１Ｂｃ、２１Ｃｃとなる。

[0041] ここで、電池パック２００Ａ、２００Ｂ、２００Ｃを、電気的に直列接続して電源ユニット３００を構成しようとする場合、図５に示すように、電池パック２００Ａの正極外部端子２０Ａａと、電池パック２００Ｂの負極外部端子２１Ｂｃとを、バスバー８０ａで接続し、電池パック２００Ｂの正極外部端子２０Ｂａと、電池パック２００Ｃの負極外部端子２１Ｃｃとを、バスバー８０ｂで接続すればよい。すなわち、これらの接続は、全て、ケース１０の第１の側面１１側において行うことができる。

[0042] 図６は、図５に示した電源ユニット３００に対して、各電池パック２００Ａ、２００Ｂ、２００Ｃの最上段の電池モジュール１００ａ、１００ａ、１００ｂに、図４（ａ）、（ｂ）に示したような、Ｌ字型の電極片５０、及び第２の電極片６０を取り付けした電源ユニット３００の構成を示した図で、図６（ａ）は平面図、図６（ｂ）は正面図である。

[0043] 例えば、電池パック２００Ａでは、ケース１０の第２の側面１２に取り付けられた電極片５０ａの第２の片５２ａは、第１の片５０ａによって、電池モジュール１００ａの正極外部端子２０Ａａと接続されている。また、ケース１０の第２の側面１２に取り付けられた第２の電極片６０ａの第２の片６２ａは、第１の片６１ａ及びバスバー７０Ａａによって、電池モジュール１００ｃの負極外部端子２１Ａｃと接続されている。従って、ケース１０の第２の側面１２に配設された電極片５０ａの第２の片５２ａ、及び第２の電極片６０ａの第２の片６２ａは、それぞれ、電池パック２００Ａの正負の外部端子となる。

[0044] 同様の接続を行うことによって、ケース１０の第２の側面１２に配設された電極片５０ｂ、５０ｃ及び第２の電極片６０ｂ、６０ｃの第２の片５２ｂ、６２ｂ、並びに、５２ｃ、６２ｃは、それぞれ、電池パック２００Ｂ、並びに電池パック２００Ｃの正負の外部端子となる。

[0045] すなわち、電池パック２００Ａ、２００Ｂ、２００Ｃは、ケース１０の第

１の側面１１側だけでなく、それに隣接する第２の側面１２側にも、正負の外部端子が配設されている。従って、電池パック２００Ａ、２００Ｂ、２００Ｃを、電気的に直列接続して電源ユニット３００を構成しようとする場合、図６（ａ）に示すように、電池モジュール２００Ａの第２の側面１２に配設された電極片５０ａの第２の片５２ａと、電池モジュール２００Ｂの第２の側面１２に配設された第２の電極片６０ｂの第２の片６２ｂとをバスバー８０ａで接続し、さらに、電池モジュール２００Ｂの第２の側面１２に配設された電極片５０ｂの第２の片５２ｂと、電池モジュール２００Ｃの第２の側面１２に配設された第２の電極片６０ｃの第２の片６２ｃとを、バスバー８０ｂで接続すればよい。

[0046] このように、電池パック２００Ａ、２００Ｂ、２００Ｃの外部電極を、ケース１０の隣接する２つの側面１１、１２に配設することができるため、電池パック２００Ａ、２００Ｂ、２００Ｃを配列して電源ユニットを構成する場合、外部端子を接続するための作業面を、ケース１０の２つの側面１１、１２に確保することができる。そのため、電源ユニットをパックケースに収容して、所定の空間に設置した後でも、パックケースの２つ面のいずれか一方を開口することができれば、電源ユニットを設置した状態でも、メンテナンス等の作業を行うことができる。また、外部端子を接続する作業面を、ケース１０の２つの側面１１、１２に確保することができるため、電池パックを構成する際の電池モジュールの配置自由度を向上させることができる。

[0047] 図３及び図４では、電池モジュール１００を積層して電池パック２００を構成した例を説明したが、電池モジュール１００を並列に配置して電池パックを構成した場合でも、本発明の効果を得ることができる。

[0048] 図７は、電池モジュール１００ａ、１００ｂ、１００ｃ、１００ｄを並列に配置して電池パック２１０を構成した例を示した図で、図７（ａ）は平面図、図７（ｂ）は正面図である。

[0049] 図７（ａ）、（ｂ）に示すように、全ての電池モジュール１００ａ、１００ｂ、１００ｃ、１００ｄにおいて、図１（ｂ）に示したＬ字型の電極片５

０ａ、５０ｂ、５０ｃ、５０ｄが、各正負の外部端子２０ａ、２１ａ、２０ｂ、２１ｂ、２０ｃ、２１ｃ、２０ｄ、２１ｄ、及びケース１０の第２の側面１２に形成された一対の溝部（不図示）に、それぞれ取り付けられている。従って、電池モジュール１００ａ、１００ｂ、１００ｃ、１００ｄの第２の側面１２に配設された一対の電極片の第２の片５２ａ、５２ｂ、５２ｃ、５２ｄは、電池モジュール１００ａ、１００ｂ、１００ｃ、１００ｄの正負の外部端子となる。

[0050] 従って、電池モジュール１００ａ、１００ｂ、１００ｃ、１００ｄを電気的に直列接続して電池パック２１０を構成しようとする場合、図７（ｂ）に示すように、第２の側面１２側において、隣接する電池モジュールの第２の片５２ａ、５２ｂ間、５２ｂ、５２ｃ間、及び５２ｃ、５２ｄ間を、それぞれバスバー８０ａ、８０ｂ、８０ｃで接続すればよい。もちろん、第１の側面１１側においても、隣接する電池モジュールの正負の外部端子２０ａ、２１ｂ間、２０ｂ、２１ｃ間、及び２０ｃ、２１ｄ間を、バスバー（不図示）で接続することは可能である。

[0051] 以上、本発明を好適な実施形態により説明してきたが、こうした記述は限定事項ではなく、もちろん、種々の改変が可能である。例えば、上記実施形態においては、電池パック２００間を電気的に直列接続する例を説明したが、電気的に並列接続する場合にも、本発明を適用し得る。また、電気的な接続を、第１の側面１１側、又は第２の側面１２側でそれぞれ行った例を説明したが、第１の側面１１側及び第２の側面１２側の両方で、電気的な接続を行うことも、もちろん可能である。

産業上の利用可能性

[0052] 本発明は、自動車、電動バイク又は電動遊具等の駆動用電源として有用である。

符号の説明

[0053] １０ ケース

１１ 第１の側面

１２　　第２の側面

２０　　正極外部端子

２１　　負極外部端子

２４、２５　　ボルト孔（又はネジ孔）

２６、２７　　一対の溝部（第１の側面側）

３０、３１　　一対の溝部（第２の側面側）

３２、３３　　ボルト孔（又はネジ孔）

４０　　連結部

５０　　Ｌ字型の電極片

５１　　第１の片

５２　　第２の片

５３、５４　　ボルト孔（又はネジ孔）

６０　　第２の電極片

６１　　第１の片

６２　　第２の片

６３、６４　　ボルト孔（又はネジ孔）

７０ａ、７０ｂ、７０ｃ　　バスバー

８０ａ、８０ｂ、８０ｃ　　バスバー

１００　　電池モジュール

２００、２１０　　電池パック

３００　　電源ユニット

請求の範囲

[請求項1] 複数の素電池が配列されてケース内に収容された電池モジュールであって、

前記ケースの第１の側面に、前記複数の素電池の各電極に接続された正極外部端子及び負極外部端子が、所定の間隔で並列に配設されており、

前記ケースの第１の側面に隣接する第２の側面に、前記所定の間隔と同じ間隔で一対の溝部が形成されており、

Ｌ字型の電極片の第１の片が、前記正極外部端子又は前記負極外部端子と、前記電極片の第２の片が、前記一対の溝部のいずれか一方と、それぞれ選択的に取付可能になっている、電池モジュール。

[請求項2] 前記電極片の第２の片は、前記溝部に埋設して取り付けられる、請求項１に記載の電池モジュール。

[請求項3] 前記一対の溝部には、前記電極片の第２の片をボルト又はネジで固定するボルト孔又はネジ孔が設けられている、請求項１に記載の電池モジュール。

[請求項4] 前記ケースの第１の側面にも、前記電極片の第１の片を埋設する一対の第２の溝部が形成されている、請求項１に記載の電池モジュール。

[請求項5] 前記一対の第２の溝部にも、前記電極片の第１の片をボルト又はネジで固定するボルト孔又はネジ孔が設けられている、請求項４に記載の電池モジュール。

[請求項6] 請求項１に記載の電池モジュールが複数個、前記第２の側面に垂直な方向に積層された電池パックであって、

最上段の前記電池モジュールにおいて、

前記電極片の第１の片は、前記ケースの第１の側面に配設された前記正極外部端子又は前記負極外部端子の一方の外部端子に取り付けられ、

前記電極片の第２の片は、前記ケースの第２の側面に形成された前記一対の溝部の一方に取り付けられており、

前記電極片の第２の片は、前記電池パックの一方の極の外部端子を構成している、電池パック。

[請求項7] 前記一対の溝部の他方には、Ｌ字型の第２の電極片の第２の片が取り付けられており、

前記第２の電極片の第１の片は、下段の前記電池モジュールのいずれかの外部端子に、前記ケースの第１の側面側に配設されたバスバーで接続されており、

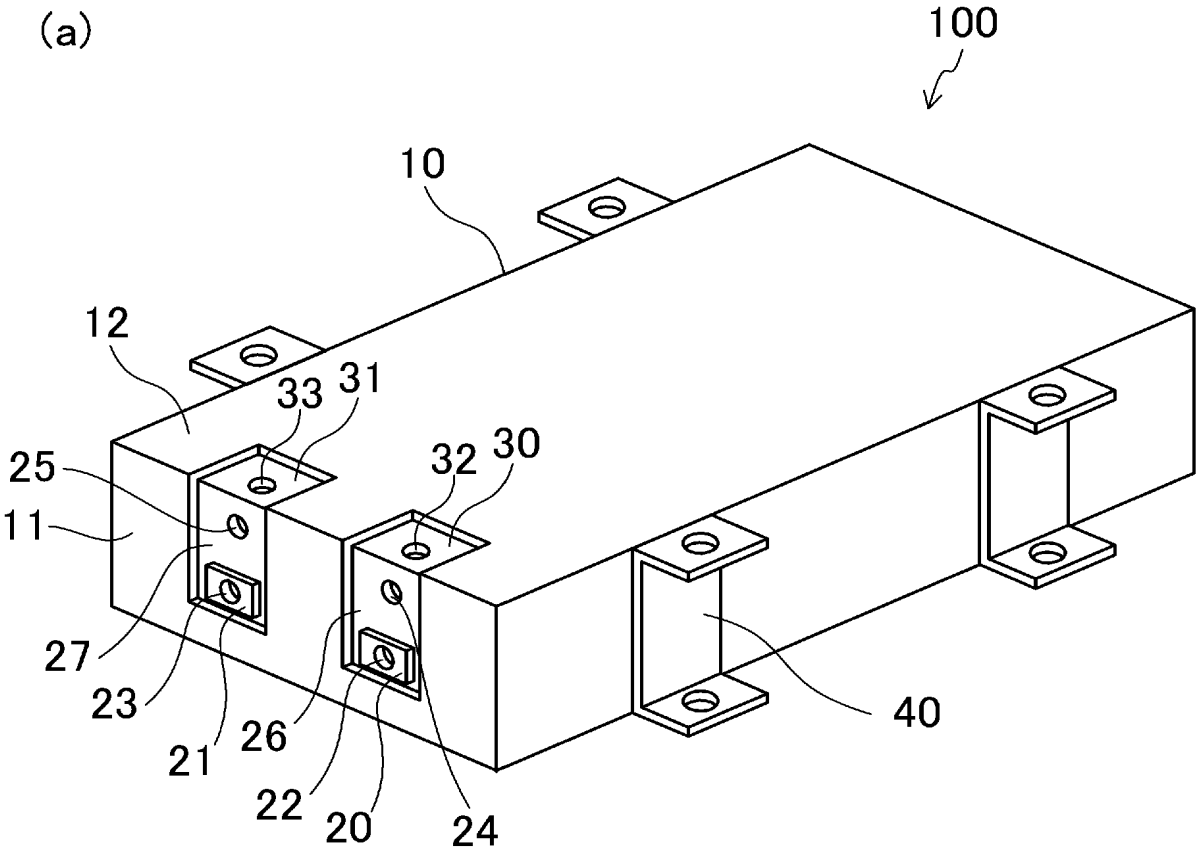
前記第２の電極片の第２の片は、前記電池パックの他方の極の外部端子を構成している、請求項６に記載の電池パック。

[請求項8] 前記積層された複数の電池モジュールは、前記ケースの第１の側面側に配設された複数のバスバーによって、各電池モジュールの前記正極外部端子又は前記負極外部端子と、それぞれ接続されている、請求項６に記載の電池パック。

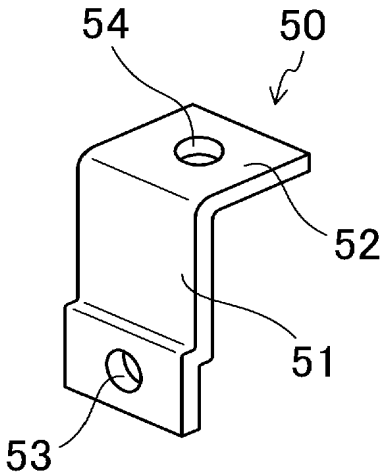
[請求項9] 下段の前記電池モジュールには、前記電極片及び第２の電極片は取り付けられていない、請求項６に記載の電池パック。

[図1]

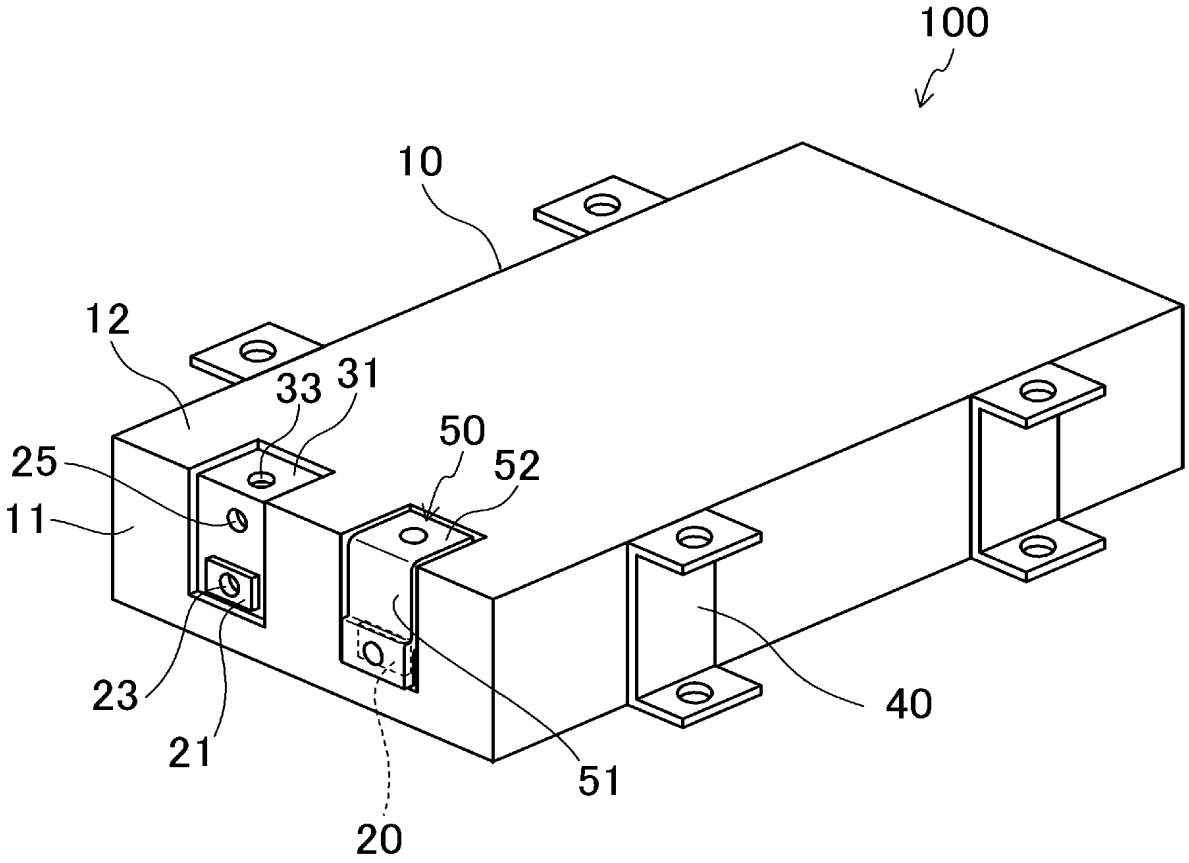
(a)



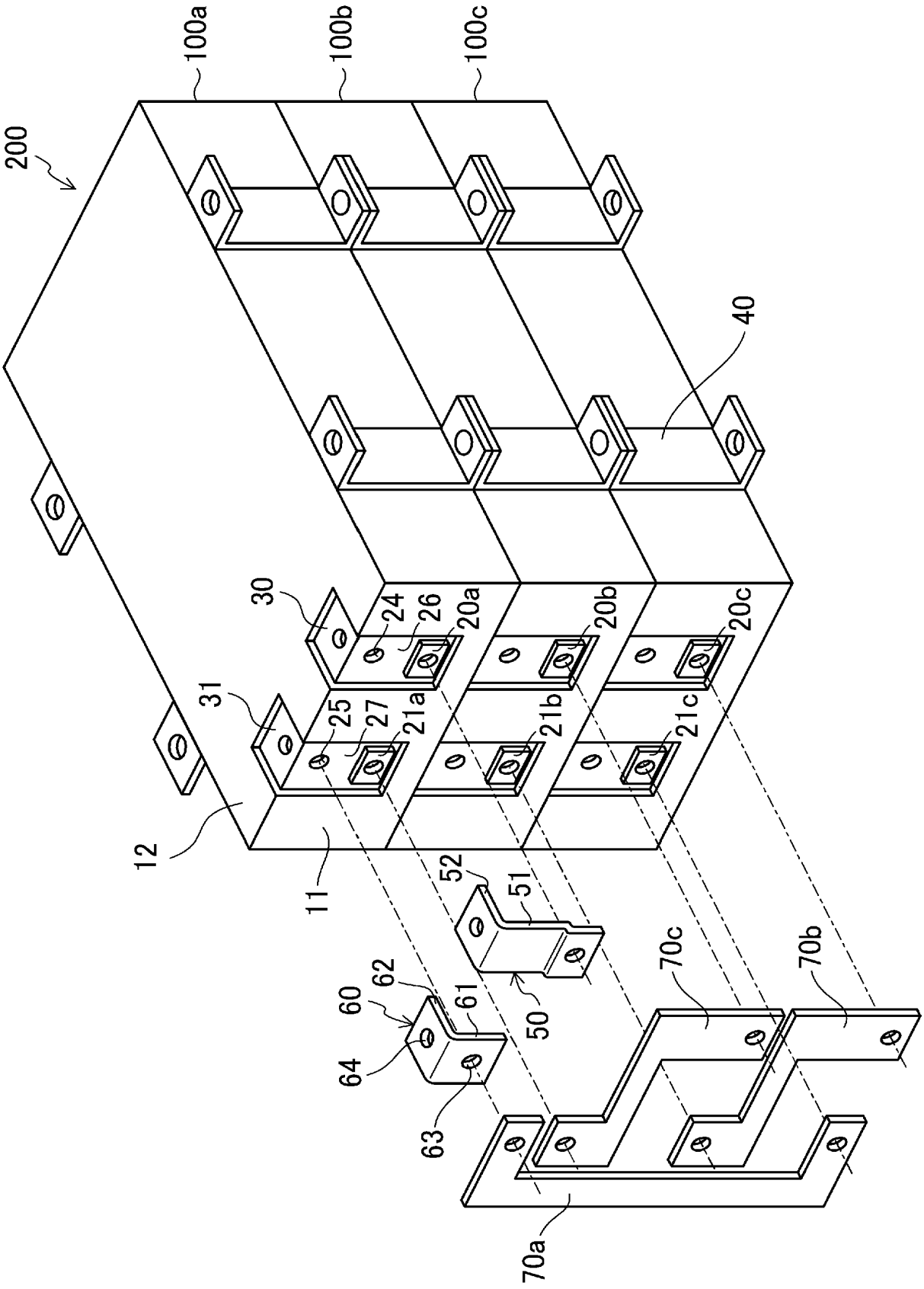
(b)



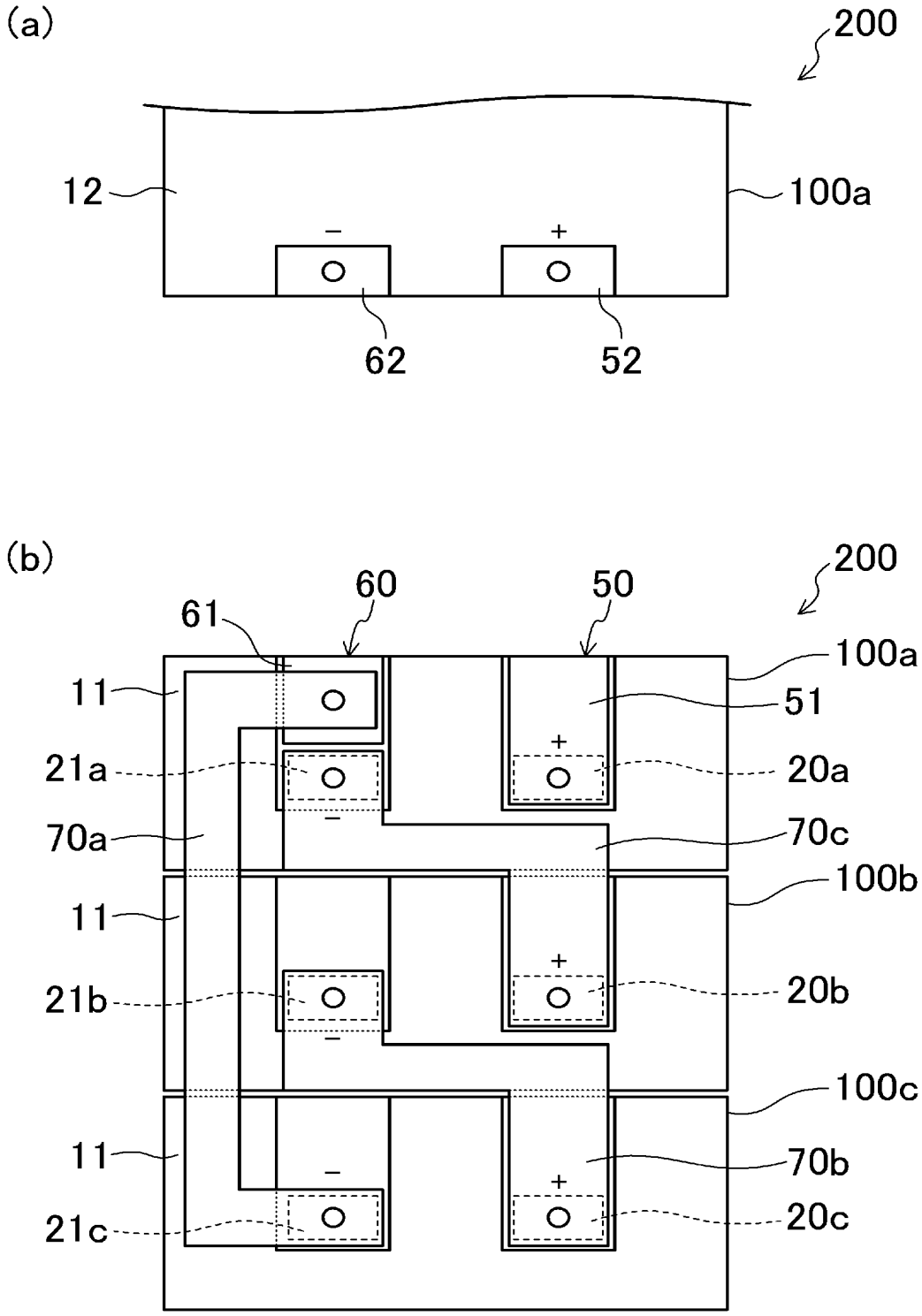
[図2]



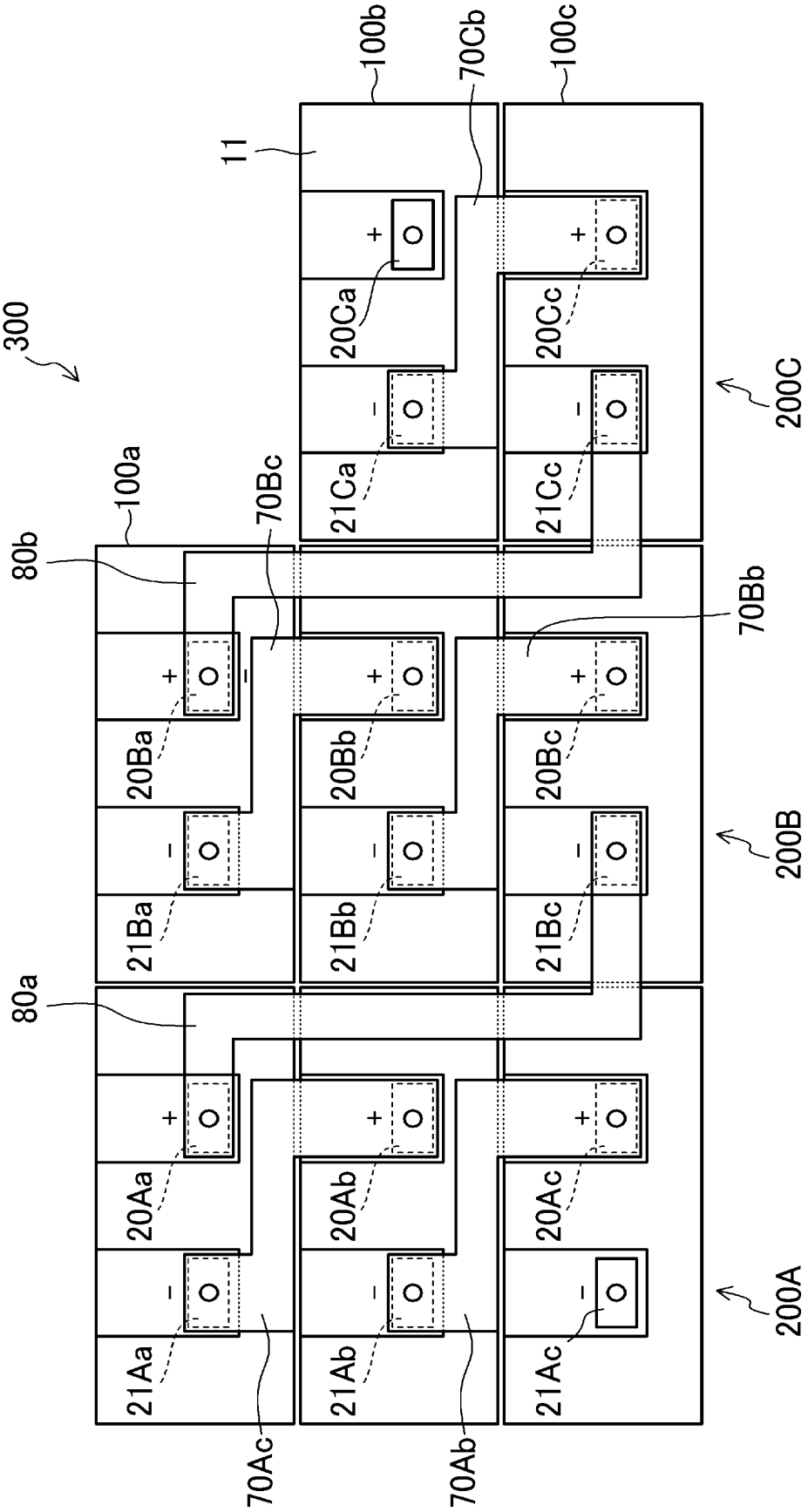
[図3]


100a
100b
100c
200
40
30
24
26
20a
20b
20c
31
25
27
21a
21b
21c
12
11
52
51
50
62
61
60
64
63
70c
70b
70a

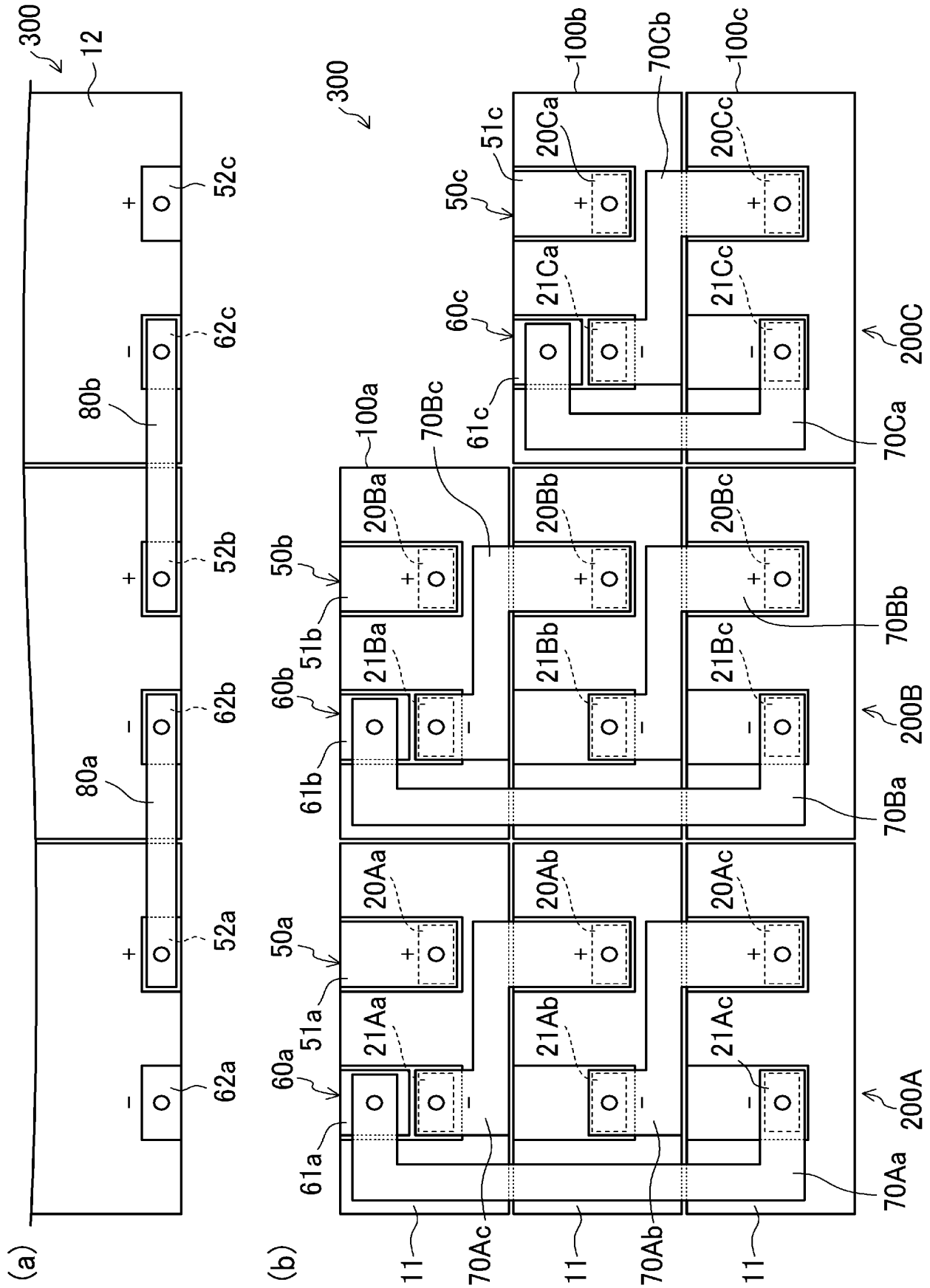
[図4]


(a)
200
12
100a
62
52
(b)
200
60
50
61
100a
11
51
21a
20a
70a
70c
100b
11
21b
20b
100c
11
70b
21c
20c

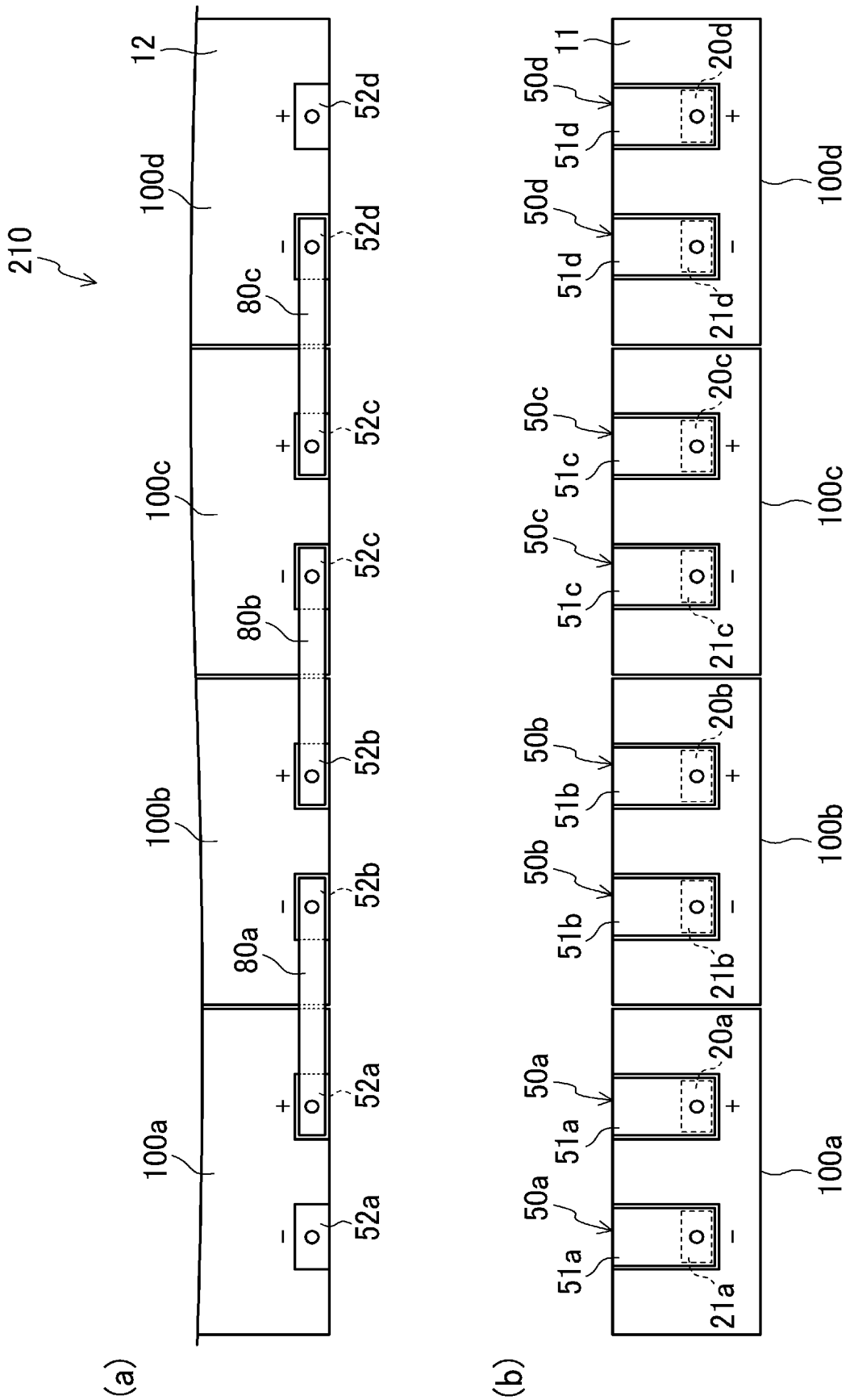
[図5]


300
11
100a
100b
100c
70Ac
70Ab
70Bc
70Cb
70Bb
80a
80b
200A
200B
200C
20Aa
20Ab
20Ac
20Ba
20Bb
20Bc
20Ca
20Cc
21Aa
21Ab
21Ac
21Ba
21Bb
21Bc
21Ca
21Cc

[図6]


(a)
300
12
52a
52b
52c
62a
62b
62c
80a
80b
(b)
300
100a
100b
100c
200A
200B
200C
50a
50b
50c
51a
51b
51c
60a
60b
60c
61a
61b
61c
20Aa
20Ab
20Ac
20Ba
20Bb
20Bc
20Ca
20Cc
21Aa
21Ab
21Ac
21Ba
21Bb
21Bc
21Ca
21Cc
70Aa
70Ab
70Ac
70Ba
70Bb
70Bc
70Ca
70Cb
11

[図7]


(a)
210
12
100d
100c
100b
100a
80c
80b
80a
52d
52c
52b
52a
(b)
11
50d
51d
21d
20d
50c
51c
21c
20c
50b
51b
21b
20b
50a
51a
21a
20a

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/004202

A. CLASSIFICATION OF SUBJECT MATTER
H01M2/10(2006.01)i, *H01M2/20*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01M2/10, H01M2/20-2/34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-021048 A (Panasonic Corp.), 29 January 2009 (29.01.2009), claims; fig. 1 to 4 & US 2009/0017367 A1	1-9
A	JP 2008-300083 A (Sanyo Electric Co., Ltd.), 11 December 2008 (11.12.2008), claims; fig. 1 to 20 (Family: none)	1-9
A	JP 2007-26894 A (Nissan Motor Co., Ltd.), 01 February 2007 (01.02.2007), claims; fig. 1 to 8 (Family: none)	1-9

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 August, 2011 (12.08.11)	30 August, 2011 (30.08.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

ADC EX1002
IPR2025-00885

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/004202

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-313733 A (Nissan Motor Co., Ltd.), 16 November 2006 (16.11.2006), claims; fig. 1, 4 & US 2006/0246350 A1 & EP 1710859 A1	1-9
A	JP 2006-120489 A (Yazaki Corp.), 11 May 2006 (11.05.2006), claims; fig. 1 to 7 (Family: none)	1-9

ADC EX1002
IPR2025-00885

国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１１／００４２０２

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　H01M2/10(2006.01)i, H01M2/20(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　H01M2/10, H01M2/20～2/34

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２０１１年
日本国実用新案登録公報	１９９６－２０１１年
日本国登録実用新案公報	１９９４－２０１１年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
A	JP 2009-021048 A（パナソニック株式会社）2009.01.29, 特許請求の範囲、図１～４ & US 2009/0017367 A1	1-9
A	JP 2008-300083 A（三洋電機株式会社）2008.12.11, 特許請求の範囲、図１～２０（ファミリーなし）	1-9
A	JP 2007-26894 A（日産自動車株式会社）2007.02.01, 特許請求の範囲、図１～８（ファミリーなし）	1-9

☑　Ｃ欄の続きにも文献が列挙されている。

☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「Ａ」特に関連のある文献ではなく、一般的技術水準を示すもの
「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「Ｌ」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「Ｏ」口頭による開示、使用、展示等に言及する文献
「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Ｙ」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「＆」同一パテントファミリー文献

国際調査を完了した日 １２．０８．２０１１	国際調査報告の発送日 ３０．０８．２０１１
国際調査機関の名称及びあて先 日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	特許庁審査官（権限のある職員）　４Ｘ　３１２２ 井上　能宏 電話番号　０３－３５８１－１１０１　内線　３４７７

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国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１１／００４２０２

Ｃ（続き）．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
A	JP 2006-313733 A（日産自動車株式会社）2006.11.16，特許請求の範囲、図１、４ & US 2006/0246350 A1 & EP 1710859 A1	1-9
A	JP 2006-120489 A（矢崎総業株式会社）2006.05.11，特許請求の範囲、図１～７（ファミリーなし）	1-9

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IN THE HIGH COURT OF JUSTICE **HP-2020-000022**
BUSINESS AND PROPERTY COURTS OF ENGLAND AND WALES
INTELLECTUAL PROPERTY LIST (ChD)
PATENTS COURT

B E T W E E N :

THE NOCO COMPANY
(a company incorporated under the laws of Ohio, United States of America)
Claimant

and

RING AUTOMOTIVE LIMITED
Defendant

GROUNDS OF INVALIDITY

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1. The following are the Grounds of Invalidity referred to in the Defence and Counterclaim upon which the Defendant relies.

2. The alleged inventions claimed in UK Patent No. GB 2 527 858 (the '**Patent**') are not new and/or do not involve an inventive step, being obvious to a person skilled in the art, having regard to the matters comprising the state of the art before the priority date of the Patent and in particular:

   (1) the making available to the public by supply, description and/or use of the HP2200 jump starter described in the manual dated August 2013 at **Annex A** before 3 July 2014 including in and after August 2013 ('**HP2200**');

   (2) the publication prior to the earliest claimed priority date of the Patent of International Patent Application WO 2004/0 36 714 on or after about 29 April 2004 ('**Krieger April 2004**');

   (3) the making available to the public prior to the earliest claimed priority date of the Patent (as alleged in the Grounds of Invalidity in the Earlier Proceedings referred to in the Defence and Counterclaim) of:

      (a) Chinese Patent Application CN 103 066 662 A on or after about 24 April 2013 ('**Carku CN**'),

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(b) US Patent Application US 2004/0 130 298 on or after about 8 July 2004 (**'Krieger July 2004'**),

(c) US Patent Application US 2013/0 154 543 on or after about 20 June 2013 (**'Richardson'**),

(d) the Carku E-Power 21 device in so far as it is established to have been made available to the public in the Earlier Proceedings (**'Carku E-Power 21'**);

(e) US Patent No. 6 424 158 (**'Klang'**), and

(f) US Patent No. 8 172 603 (**'Richardet'**).

(4) common general knowledge.

JAMES ST.VILLE

STATEMENT OF TRUTH

The Defendant believes that the facts stated in these Grounds of Invalidity are true. I understand that proceedings for contempt of court may be brought against anyone who makes, or causes to be made, a false statement in a document verified by a statement of truth without an honest belief in its truth. I am duly authorised to sign this Statement of Truth on the Defendant's behalf.

Signed 

Name: Theresa Spencer

Date: August 3, 2020

Position: Director

Served: August 3, 2020

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Espacenet

JP2014232666A NONAQUEOUS ELECTROLYTE SECONDARY BATTERY

Applicants: KANEKA CORP

Inventors: IMAMURA YUICHI,NIWA YUKIMASA,SAWADA YUKI

Classifications:

IPC ***H01M10/052; H01M10/0585; H01M10/0587; H01M10/52; H01M2/02; H01M2/06; H01M2/08; H01M2/30; H01M2/34; H01M4/13; H01M4/131; H01M4/48; H01M4/485; H01M4/505;***

CPC Y02E60/10 (EP);

Priorities: JP2013113362A 2013-05-29

Application: JP2014232666A·2013-05-29

Publication: JP2014232666A·2014-12-11

Published as: JP2014232666A

NONAQUEOUS ELECTROLYTE SECONDARY BATTERY

Abstract

PROBLEM TO BE SOLVED: To provide a nonaqueous electrolyte secondary battery arranged so that gas generated when charge and discharge is repeated can be absorbed, and an outer sheath can be prevented from being swelled.SOLUTION: A nonaqueous electrolyte secondary battery comprises: an internal power-generation body 8 including a positive electrode including a positive electrode active material, a negative electrode including a negative electrode active material, and a separator interposed between the positive and negative electrodes; at least two metal tab leads 14 connected to the positive and negative electrodes respectively; and a film-like outer sheath 10 which houses the internal power-generation body 8 together with an electrolytic solution 20 of nonaqueous electrolyte in a hermetic condition. The nonaqueous electrolyte secondary battery further comprises a resin part 26 used to prevent the short circuit inside the battery and provided between the outer sheath 10 and the internal power-generation body 8. The resin part 26 has a gas-absorbing material such as a hydrogen-absorbable alloy mixed therein.

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2014-232666
(P2014-232666A)
(43)公開日　平成26年12月11日(2014.12.11)

(51)Int.Cl.		F I			テーマコード（参考）
H01M 10/52	***(2006.01)***	H01M	10/52		5H011
H01M 2/34	***(2006.01)***	H01M	2/34	B	5H029
H01M 2/08	***(2006.01)***	H01M	2/08	K	5H031
H01M 2/06	***(2006.01)***	H01M	2/06	K	5H043
H01M 2/30	***(2006.01)***	H01M	2/30	D	5H050

審査請求 未請求　請求項の数 10　ＯＬ　（全 21 頁）　最終頁に続く

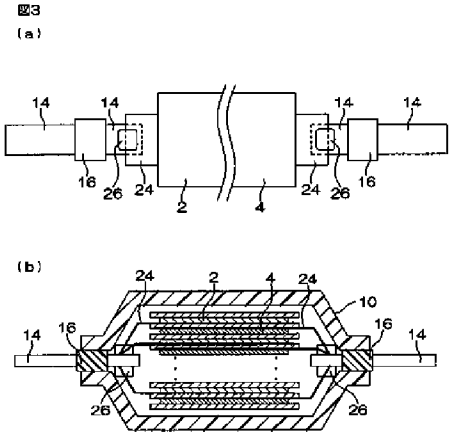
(21)出願番号　特願2013-113362 (P2013-113362)
(22)出願日　平成25年5月29日 (2013.5.29)

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最終頁に続く

(54)【発明の名称】非水電解質二次電池

(57)【要約】
【課題】充放電を繰り返すときに発生するガスを吸収し、外装体の膨れを防止できる非水電解質二次電池を提供する。
【解決手段】正極活物質を含む正電極と、負極活物質を含む負電極と、前記正電極と負電極との間に介在するセパレータとで構成される内部発電体８と、正電極と負電極とにそれぞれ接合された少なくとも２本の金属タブリード１４と、内部発電体８を非水電解質の電解液２０と共に密封状態に収容するフィルム状の外装体１０とを備え、前記外装体１０と前記内部発電体８との間に、電池内部の短絡防止のために使用されている樹脂部品２６を有し、前記樹脂部品２６に水素吸蔵合金などのガス吸着材を混入させている。
【選択図】図３



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【特許請求の範囲】
【請求項１】
正極活物質を集電箔に塗工した正電極と、負極活物質を集電箔に塗工した負電極と、前記正電極と前記負電極との間に介在するセパレータとで構成される内部発電体と、前記正電極と前記負電極とにそれぞれ接合された少なくとも２本の金属タブリードと、前記内部発電体を非水電解質の電解液と共に密封状態に収容するための少なくとも一層の金属膜を積層したフィルム状の外装体と、前記外装体と前記内部発電体との間に、電池内部の短絡防止のために使用されている樹脂部品とを有し、前記樹脂部品にガス吸着材が混入していることを特徴とする、非水電解質二次電池。
【請求項２】
前記短絡防止のために使用されている樹脂部品が、
（ａ）前記内部発電体の絶縁固定のために使用される樹脂テープ、
（ｂ）前記金属タブリードと前記集電箔とが接合される部分に形成される樹脂材、又は
（ｃ）前記正極活物質の前記金属タブリード側の端部若しくは前記負極活物質の前記金属タブリード側の端部に形成される樹脂材、
のいずれかである、請求項１に記載の非水電解質二次電池。
【請求項３】
前記負極活物質が、前記リチウムイオンの脱離及び挿入が０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上２．０Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以下で進行する負極活物質である、請求項１又は請求項２に記載の非水電解質二次電池。
【請求項４】
前記負極活物質が、チタン酸リチウムあるいはチタン酸化物である、請求項３に記載の非水電解質二次電池。
【請求項５】
前記正極活物質が、前記リチウムイオンの脱離及び挿入の電位が４．５Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上４．９Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）未満の正極活物質である、請求項１～請求項４のいずれか１項に記載の非水電解質二次電池。
【請求項６】
前記正極活物質が、リチウムマンガン化合物である、請求項５に記載の非水電解質二次電池。
【請求項７】
前記外装体の金属膜の材質はアルミニウムである、請求項１～請求項６のいずれか１項に記載の非水電解質二次電池。
【請求項８】
前記内部発電体は、前記正電極と前記負電極と前記セパレータとの積層体で構成される、請求項１～請求項７のいずれか１項に記載の非水電解質二次電池。
【請求項９】
前記内部発電体は、前記正電極と前記負電極と前記セパレータとの積層体を倦回したものである、請求項１～請求項７のいずれか１項に記載の非水電解質二次電池。
【請求項１０】
請求項１～請求項９のいずれか１項に記載の非水電解質二次電池を複数個接続してなる組電池。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明はリチウムイオン二次電池等の非水電解質二次電池に関するものである。
【背景技術】
【０００２】
近年、携帯機器などの電子機器、ハイブリット自動車、電気自動車、家庭用蓄電用途に、リチウムイオン二次電池等の非水電解質二次電池の研究開発が盛んにおこなわれている

。これらの分野に用いられる非水電解質二次電池は、長期間、充放電サイクルが繰り返されて使用される。

非水電解質二次電池の構造は、正極活物質を集電箔に塗工したシート状正電極と、負極活物質を集電箔に塗工したシート状負電極とをセパレータを介して交互に積層又は倦回した内部発電体と、当該内部発電体を電解液と共に密封状態に収容したフィルム状の外装体とを有している。フィルムは、ガスバリア性を向上させるため、アルミニウムなどの金属膜を内部に配置している。

【０００３】

内部発電体から電流を引き出すための金属タブリードは、密封された外装体の、融着されたフィルム同士の隙間から外に露出している。

非水電解質二次電池は、電解液として有機溶媒を含んでいて、これが電極活物質と作用しあって、充放電時に水素ガスなどのガスが発生することがある。外装体の内部は完全に密封された状態になっているので、このことが原因で、非水電解質二次電池が膨れてしまい、この電池が組み込まれている電子機器内部のプリント基板や端子部等に異常な圧力を加えて、変形を生じさせるおそれがあり、機器の信頼性を損なう原因となる。

【０００４】

特に、従来のカーボン系負極活物質を用いた非水電解質二次電池では、通常の使用条件ではガスの発生は少ないものの、過充電時や高温保存時に急激に大量のガスが発生することがあり、非水二次電池の膨れによる影響を十分に抑制するため、相当な量のガス吸着材を、電池の内部に配置することが必要となる。

特許文献１は、電池上部の空き空間、電池底部、正電極と負電極とセパレータを巻回して作成した発電要素の中心部、または電池ケースの内側などに水素吸蔵合金を配置して、発生した水素を吸収する構造を示している（実施例２）。特許文献２では、ラミネート型非水電解質二次電池において、ラミネートフィルムの内面のうち、封止した部分以外の内面に水素吸蔵合金からなるガス吸着層を貼り付ける技術が開示されており、特許文献３では、ラミネートフィルムに、電極群を収容する収納部を形成し、この収納部におけるコーナー部の少なくとも一箇所以上の内面に水素吸蔵合金からなるガス吸着材を配置する技術が開示されている。特許文献４は、外装体と内部発電体との間にガス吸着材を配置する技術を示している。

【先行技術文献】

【特許文献】

【０００５】

【特許文献１】特開平１１－３１２５４０号公報
【特許文献２】特開２０１１－２４９２６９号公報
【特許文献３】特開２０１２－５９４８９号公報
【特許文献４】特開２００１－１５５７９０号公報
【特許文献５】特開２００８－１４６９６３号公報
【特許文献６】特開平１１－１９１４００号公報

【発明の概要】

【発明が解決しようとする課題】

【０００６】

しかし何れの技術も、電極、セパレータなどの二次電池の本来の構成部品とは別に、ガス吸収剤を用意し、外装体の内部に設置する技術である。二次電池の構成部品とは別のガス吸着材を配置するための余分なスペースが必要になり、またそれを設置する工程若しくは貼り付ける工程が必要になる。このため電池の体積が増え、エネルギー密度が低下するといった問題がある。

【０００７】

ガス吸着材を二次電池の本来の構成部品に、ガス吸着材を混合する技術もある。特許文献５は、ガス吸収剤をセパレータ基材に混ぜ込む例を示し、特許文献６は、フィルム状の外装体の一層に、ガス吸収剤を練り込む技術を開示している。

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しかし、ガス吸着材は直径の大きなザラザラした粒子であり、内部発電体の構成部品にガス吸着材を混合すると、構成部品の物性を変えてしまい、充放電性能を劣化させるおそれがある。フィルム状の外装体自体にガス吸着材の粒子を混ぜる場合も、外装体のガスバリア性能を低下させるおそれがある。

【０００８】

一方、カーボン系負極活物質に変わる材料として、高安全性、高耐久性であることから、リチウムの脱離及び挿入の平均電位が金属リチウム基準で０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上２．０Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）未満である負極活物質（チタン酸リチウムあるいはチタン酸化物）を用いた非水電解質二次電池が開発されている。

このような非水電解質二次電池は、従来のカーボン系負極活物質では見られない、２５℃～４５℃といった通常の使用温度域で少量のガスが徐々に発生するという傾向がある。このため、通常の使用温度域での充放電時における長期に渡る微量のガス発生に対応するには、特許文献１～４のように特別の場所に大量のガス吸着材を配置しなくてもよいと考えられる。

【０００９】

そこで、本発明者は、外装体の内部の特別の場所に大量のガス吸着材を配置しないで済み、かつ二次電池の本来の構成部品であって、電池の性能に影響を与えない部品にガス吸着材を含ませることを想定した。

本発明は、小スペースであるが非水二次電池に使用されている短絡防止樹脂にガス吸着材を含ませることで、エネルギー密度を低下させることなく非水二次電池の外装体の膨れを防止することを目的とする。

【課題を解決するための手段】

【００１０】

本発明の非水電解質二次電池は、正極活物質を集電箔に塗工した正電極と、負極活物質を集電箔に塗工した負電極と、正電極と負電極との間に介在するセパレータとで構成される内部発電体と、正電極と負電極とにそれぞれ接合された少なくとも２本の金属タブリードと、内部発電体を非水電解質の電解液と共に密封状態に収容するための少なくとも一層の金属膜を積層したフィルム状の外装体と、フィルム状の外装体と内部発電体との間に、電池内部の短絡防止のために使用されている樹脂部品とを有し、樹脂部品にガス吸着材を混入させていることを特徴とする。

【００１１】

この構成であれば、二次電池に従来から用いられる小さな構成部品であって、電池の性能に影響を与えない部品にガス吸着材を含ませて、内部発電体から発生するガスを吸収するので、電池の性能に悪い影響を与えることはない。また外装体の内部の特別の場所を占める物ではないので、電池が大型化することもない。

短絡防止のために使用されている樹脂部品の具体例は、（ａ）内部発電体の固定のために使用される樹脂テープ、（ｂ）金属タブリードと集電箔とが接合される部分に形成される樹脂材、又は（ｃ）正極活物質の金属タブリード側の端部又は負極活物質の金属タブリード側の端部に形成される樹脂材、のいずれかであってもよい。

【００１２】

負極活物質が、リチウムイオンの脱離及び挿入が０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上２．０Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以下で進行する負極活物質（例えばチタン酸リチウムあるいはチタン酸化物）である場合は、通常の使用温度域で長期にわたって発生する少量のガスを吸着すればよいので、本発明のようにフィルム状の外装体と内部発電体との間に、電池内部の短絡防止のために使用されている樹脂部品にガス吸着材を混入させておけば、非水二次電池の外装体の膨れを防止するのに十分である。

【００１３】

正極活物質が、リチウムイオンの脱離及び挿入の電位が４．５Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上４．９Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）未満の正極活物質（例えばリチウムマンガン化合物）である場合は、通常の使用温度域でも電解液の酸化分解によりガスが発生するといった問題

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があったが、本発明の構造を採用することにより、ガスを吸収することができる。

【発明の効果】

【００１４】

本発明によれば、フィルム状の外装体と内部発電体との間に、電池内部の短絡防止のために使用されている樹脂部品にガス吸着材を混入させることにより、電池性能の低下を回避し、電池容積の無駄な増大を回避しながら、非水二次電池の外装体の膨れを防止することができる。特に、チタン酸リチウムを負電極に用いた非水二次電池特有の問題である、通常の使用温度域での充放電時における長期に渡る微量のガスの発生に対応することができる。

【図面の簡単な説明】

【００１５】

【図１】非水電解質二次電池の内部発電体の構造を示す断面図である。

【図２】本発明の実施の形態に係る非水電解質二次電池の全体構造を示す平面図（ａ）及び側断面図（ｂ）である。

【図３】本発明の他の実施の形態に係る非水電解質二次電池の全体構造を示す平面図（ａ）及び側断面図（ｂ）である。

【図４】本発明のさらに他の実施の形態に係る非水電解質二次電池の内部発電体を示す平面図である。

【図５】図５の変形例に係る内部発電体を示す平面図である。

【発明を実施するための形態】

【００１６】

以下、本発明の実施の形態を添付図面を参照して説明する。本発明の範囲は特許請求の範囲によって示され、特許請求の範囲と均等の意味及び範囲内でのすべての変更が含まれることが意図されている。

＜非水電解質二次電池＞

図１は、非水電解質二次電池の内部発電体８の構造を示す断面図である。内部発電体８は、正電極２と、負電極４と、正電極２と負電極４との間に介在するセパレータ６とで構成される。正電極２は、正極活物質をシート状の集電箔２４に塗工したものであり、負電極４は、負極活物質をシート状の集電箔２４に塗工したものである。

【００１７】

非水電解質二次電池の集電箔２４は、セパレータ６を挟んで両側に配置されており、そのうち片側の集電箔２４は正極活物質を塗工したものであり、他側の集電箔２４は負極活物質を塗工したものである。正極活物質の集電箔２４が形成されていない方の面と負極活物質の集電箔２４が形成されていない方の面とは、他のセパレータ６を挟んで向かい合っている。このようにして、正電極２と負電極４とセパレータ６とで１つの発電単位を構成する。発電単位が１層又は複数層積層されて内部発電体８を構成している。積層数は、所望の電池容量を発現する数までとすることができる。

【００１８】

内部発電体８は、リチウムイオンの伝導を担う非水電解質の電解液に浸されている。集電箔２４の材質と電解液の成分については後述する。

なお、本発明の非水電解質二次電池の内部発電体の構造は図１の構造に限定されることはない。例えば、集電箔の片面に正電極、他面に負電極を形成させた形態、すなわち、バイポーラ電極を用いて内部発電体を構成してもよい。この場合は、隣り合うバイポーラ電極の正電極側と負電極側との間にセパレータを配置する。１枚の集電箔を挟んで正電極側と負電極側とが対向している層には、液絡を防止するため周辺部に絶縁材料を配置する必要がある。

【００１９】

図２は、本発明の実施の形態に係る非水電解質二次電池の全体構造を示す平面図（ａ）と側断面図（ｂ）である。非水電解質二次電池は、内部発電体８と、内部発電体８の正電極側の集電箔２４と負電極側の集電箔２４とにそれぞれ接合された金属タブリード１４を

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有している。さらにこの内部発電体８を、２枚のフィルム状の外装体１０の間に収容し、非水電解質の電解液２０と共に密封状態に収容している。

【００２０】

フィルム状の外装体１０の内壁と内部発電体８との空間に満たされている非水電解質の電解液２０は、あらかじめ正電極２、負電極４及びセパレータ６に含ませておいてもよいし、正電極側と負電極側との間にセパレータ６を配置したものを巻回あるいは積層し、フィルム状の外装体１０の中に収容した後に添加してもよい。電解液２０の量は、特に限定されないが、正極合剤、負極合剤及びセパレータの総空隙体積以上であることが好ましく、前記総空隙体積の１２０％以上が更に好ましい。正極合剤、負極合剤及びセパレータの総空隙体積未満であると充放電に寄与する部分への電解液の未充填部位が発生し、充放電に寄与できなくなってしまう。

【００２１】

フィルム状の外装体１０は、一般的に少なくとも３層を有しており、最外層は物理的保護を目的にポリエチレンなどの合成樹脂フィルムが用いられ、中間層にはガスバリア性を向上させるため、アルミニウム金属箔などが用いられ、最内層には、ラミネート接着性、ガスバリア性及び耐電解液性を目的に変性ポリプロピレンなどの合成樹脂フィルムが用いられる。合成樹脂層は複数の機能を持たせるため多層構造となる場合もある。

【００２２】

２本の金属タブリード１４は薄い板状であり、そのうち１本の金属タブリード１４は、内部発電体８の正電極２の集電箔２４に接合され、他の１本の金属タブリード１４は、内部発電体８の負電極４の集電箔２４に接合されている。図示するように、内部発電体８が積層したものであれば、積層された複数の正電極２の各集電箔２４が１本の金属タブリード１４に接合され、積層された複数の負電極４の各集電箔２４が他の１本の金属タブリード１４に接合される。

【００２３】

金属タブリード１４の材質は、導電性に優れた金属であればよく、例えばアルミニウム、銅、ニッケルなどがあげられる。集電箔２４の金属タブリード１４への接合法には、超音波溶接、半田付け、抵抗溶接などがあげられる。

金属タブリード１４の一部には、ポリプロピレンなどの熱融着樹脂１６が金属タブリード１４の上面から下面にわたって塗布されている。この熱融着樹脂１６は、金属タブリード１４を上下の外装体１０どうしの間に挟んで熱処理するときに融解して、外装体１０と金属タブリード１４とを接着するのに役立つように、予め形成されたものである。

【００２４】

本発明の非水電解質二次電池では、正電極２と負電極４とセパレータ６とが離れないように、積層された内部発電体８を固定する電極固定テープ２２を用いる。

この電極固定テープ２２は、フィルム状の外装体１０の中にラミネートされている金属層を通した電気的な短絡を防止するために絶縁性を有している。この絶縁性は内部発電体８を構成する正電極２と負電極４との間の電気的な短絡を防止するのにも役立つ。この電極固定テープ２２が、「電池内部の短絡防止のために使用されている樹脂部品」に該当する。

【００２５】

電極固定テープ２２は、テープの強度を保つための基材層と接着層とで構成されるが、本発明では、基材層、接着層のいずれか又は両方にガス吸着材が混入されている。

ガス吸着材としては、特に限定しないがシリカゲル、ゼオライト、活性炭、ステアリン酸金属塩、ハイドロタルサイト、水素吸蔵合金、活性アルミナ、遷移金属酸化物、ソーダ石灰、酸化カルシウム、酸化マグネシウム、アスカライトなどから、発生ガス種に応じて選ばれる少なくとも一種以上であることが好ましい。

【００２６】

ガス吸着材は粒子状のものを用いることが好ましい。その粒子径は、特に限定しないが、作業性、表面積、混入後の凹凸から1～50μm程度が好ましい。

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ガス吸着材の混入量は、テープとして接着性が維持される限り、特に限定されない。ただしガス吸着材の混入量が多すぎると、粒子同士が接触して導電性が発現することがあるが、テープによってセパレータ上を固定するので、極板や端子等には触れない限り、差し支えない。

【００２７】

ガス吸着材のテープ基材層への混入の場合は、基材フィルムの製膜時に混入させる。また接着樹脂層に混入する場合は、テープ基材へ塗工する際の塗工液に混入する。

テープ基材層の材質は、特に限定しないが、耐熱性（熱収縮）、強度、耐久性、耐電解液性からポリイミド等が好ましい。

電極固定テープ２２にガス吸着材が混入されていることにより、内部発電体８から発生し外装体１０の中に閉じ込められた水素ガスなどのガスを吸収することができる。

【００２８】

図３は、本発明の他の実施の形態に係る非水電解質二次電池の全体構造を示す平面図（ａ）と側断面図（ｂ）である。平面図（ａ）では右側に負極活物質の層を示し、左側に正極活物質の層を示している。積層された内部発電体８を固定する電極固定テープは図示していない。

図２から追加された点を説明すると、外装体１０の中であって、薄い板状の金属タブリード１４の、正電極２の集電箔２４に接合されている部分が短絡防止樹脂２６で覆われ、他の１本の金属タブリード１４の、負電極４の集電箔２４に接合されている部分が短絡防止樹脂２６で覆われていることである。

【００２９】

短絡防止樹脂２６の材質として、一般的には、ポリイミドが用いられるが、ポリイミドに限定されず、強度、耐熱性（熱収縮）、耐久性、耐電解液性があれば他の種類の樹脂でも良い。

正電極２又は負電極４の集電箔２４を、超音波溶接法などで金属タブリード１４に接合するときに、集電箔２４や金属タブリード１４上に鋭利な金属切片が生じる可能性があり、この短絡防止樹脂２６は、その金属切片がラミネートフィルム内の金属膜に接触するのを防止するために形成されるものである。

【００３０】

短絡防止樹脂２６の形成方法は限定されないが、例えば、正電極２の集電箔２４を金属タブリード１４に超音波溶接した後、小さくカットした短絡防止樹脂２６片を、金属タブリード１４の両面の溶接された部分に置き、負電極側の短絡防止樹脂２６も他方の金属タブリード１４の両面の溶接された部分に置き、前述した熱融着樹脂１６とともに、上下の外装体１０どうしの間に挟んで熱融解させると、短絡防止樹脂２６が金属タブリード１４上に、かつ集電箔２４を覆った状態で形成される。またこれ以外に、ポリイミドテープを金属タブリード１４に貼り付ける方法もある。この短絡防止樹脂２６が、「電池内部の短絡防止のために使用されている樹脂部品」に該当する。

【００３１】

本発明では、短絡防止樹脂２６の中にガス吸着材が混入されている。

ガス吸着材としては、特に限定しないがシリカゲル、ゼオライト、活性炭、ステアリン酸金属塩、ハイドロタルサイト、水素吸蔵合金、活性アルミナ、遷移金属酸化物、ソーダ石灰、酸化カルシウム、酸化マグネシウム、アスカライトなどから、発生ガス種に応じて選ばれる少なくとも一種以上であることが好ましい。

【００３２】

ガス吸着材は粒子状のものを用いることが好ましい。その粒子径は、特に限定しないが、作業性、表面積、混入後の凹凸から１～５０μｍ程度が好ましい。

ガス吸着材の混入量が多すぎると粒子同士が接触して導電性が発現することがあるので、ガス吸着材の混入量の上限は、短絡防止樹脂２６の絶縁性が維持されるかどうかに応じて決められる。このような導電性が発現するような混入量の上限は、実際に短絡防止樹脂２６にガス吸着材を混入させてみて抵抗率を測定して、定めるとよい。

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【００３３】
短絡防止樹脂２６にガス吸着材が混入されていることにより、内部発電体８から発生し外装体１０の中に閉じ込められる水素ガスなどのガスを吸収することができる。
図４は、本発明のさらに他の実施の形態に係る非水電解質二次電池の内部発電体８を示す平面図（ａ）及び断面図（ｂ）である。
この図（ａ）は、図１に示した構造の内部発電体８を負電極側から見た平面図になる。負電極４の一端部において、負極活物質が塗工されていない部分があり、集電箔２４が露出している。ここに負電極側の金属タブリード１４を溶接している。なお図示しないが、正電極側（図の紙面裏側）においても、正電極２の一端部において、正極活物質が塗工されていないで集電箔２４が露出していて、ここに正電極側の金属タブリード１４が溶接されている。
【００３４】
この内部発電体８を巻回して、フィルム状の外装体１０の中に入れて、電解液２０で満たしながら、金属タブリード１４を残してフィルム状の外装体１０を密閉することにより、非水電解質二次電池を製造することができる。
巻回する前、集電箔２４が露出している部分において、超音波溶接法などで金属タブリード１４を接合するときに、集電箔２４や金属タブリード１４上に鋭利な金属切片が生じる可能性がある。その金属切片が、巻回された内部発電体８の正電極２と電気的に接触するのを防止するために、短絡防止樹脂２８を、図４に示すように、集電箔２４上に金属タブリード１４を覆う状態で形成している。また短絡防止樹脂３０を、集電箔２４と活物質４の端部との境界上にも形成している。
【００３５】
短絡防止樹脂２８，３０の形成方法は限定されないが、例えば金属タブリード１４を集電箔２４の片面に超音波溶接した後、小さくカットした短絡防止樹脂片を、金属タブリード１４の溶接された部分上に置き、上下から熱と圧力を加えながら熱融解させるとよい。また短絡防止樹脂片を集電箔２４と活物質の端部との境界上に置き、同時に熱融解させる。この短絡防止樹脂２８，３０が、「電池内部の短絡防止のために使用されている樹脂部品」に該当する。
【００３６】
この実施形態においても、短絡防止樹脂２８，３０の中にガス吸着材が混入されている。ガス吸着材の混入量、混入方法などは図３に関連して前述した実施形態と同様である。短絡防止樹脂２８，３０にガス吸着材が混入されていることにより、巻回された内部発電体８から発生するガスをガス吸着材に吸収することができる。
以上に説明した本発明の非水電解質二次電池は、内部発電体が外装体に包まれ、金属タブリードが外装体から露出した形状のものであり、このまま二次電池として、電子機器内部に組み込んで使用する。
【００３７】
本発明の非水電解質二次電池は、複数接続することによって組電池とすることができる。本発明の組電池は、所望の大きさ、容量、電圧によって適宜直列、並列に接続することによって作製することができる。また、各電池の充電状態の確認、安全性向上のため、前記組電池に制御回路が付属されていることが好ましい。
以下、本発明の非水電解質二次電池の各構成部分である、負電極、正電極、セパレータ、非水電解質の材質、製造方法などを説明する。
【００３８】
＜負電極＞
本発明の非水電解質二次電池に用いる負電極は、特に、リチウムイオンの挿入・脱離反応が０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上２．０Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以下で進行する負極活物質を含む。
リチウムイオンの挿入反応が０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上２．０Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以下で進行するとは、負極活物質へのリチウムイオン挿入が２．０Ｖ（ｖｓ

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．Ｌｉ$^{+}$／Ｌｉ）以下で開始し、０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上で終了することである。一方、リチウムイオンの脱離反応が０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上２．０Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以下で進行するとは、負極活物質からのリチウムイオン脱離が０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上で開始し、２．０Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以下で終了することである。

【００３９】

リチウムイオン挿入・脱離反応の電圧値（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）は、例えば、負極活物質を用いた動作極、リチウム金属を対極とした半電池の充放電特性を測定し、プラトー開始時、及び終了時の電圧値を読み取ることによって求めることができる。プラトーが２箇所以上あった場合は、もっとも低い電圧値のプラトーが０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上であればよく、もっとも高い電圧値のプラトーが２．０Ｖ（ｖｓ．Ｌｉ+／Ｌｉ）以下であればよい。前記半電池に用いる動作極、電解液、セパレータは後述のものと同様のものを用いることができる。

【００４０】

リチウムイオンの挿入・脱離反応が０．３Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以上２．０Ｖ（ｖｓ．Ｌｉ$^{+}$／Ｌｉ）以下で進行する負極活物質は、チタン酸リチウム、二酸化チタン、五酸化ニオブ及び二酸化モリブデンなどが好ましく、負極活物質の安定性が高い点から、チタン酸リチウム、二酸化チタンがより好ましく、チタン酸リチウムがさらに好ましい。これら負極活物質は１種類でもよいし、２種類以上用いてもよい。

【００４１】

チタン酸リチウムは、スピネル構造であることが好ましく、分子式として$Li_4Ti_5O_{12}$で表されるものが好ましい。スピネル構造の場合、リチウムイオンの挿入・脱離の反応における活物質の膨張収縮が小さい。チタン酸リチウムには、たとえばＮｂなどのリチウム、チタン以外の元素が微量含まれていてもよい。

チタン酸リチウムは、ＣｕＫαによる粉末Ｘ線回折の（４００）面の半値幅が０．５°以下であることが好ましい。０．５°より大きいと、チタン酸リチウムの結晶性が低いため、電極の安定性が低下する場合がある。

【００４２】

チタン酸リチウムは、Ｘ線回折によるリートベルト解析法による８ａサイトに占めるリチウム含有率が９０％以上であることが好ましい。９０％未満であると、チタン酸リチウムの結晶中の欠陥が多いため、電極の安定性が低下する場合がある。

チタン酸リチウムは、リチウム化合物、チタン化合物を５００℃以上１５００℃以下で加熱処理することによって得ることができる。５００℃未満、又は１５００℃より高いと、所望の構造をしたチタン酸リチウムを得ることができにくい傾向がある。チタン酸リチウムの結晶性を向上させるため、加熱処理後、再び５００℃以上１５００℃以下で再加熱処理してもよい。再加熱処理の温度は、最初におこなった温度と同じでもよいし、違っていてもよい。加熱処理は、空気存在下でもよいし、窒素あるいはアルゴンなどの不活性ガスの存在下でおこなってもよい。加熱処理には、特に限定されないが、例えば、箱型炉、管状炉、トンネル炉、ロータリーキルン等を用いることができる。

【００４３】

前記リチウム化合物としては、例えば、水酸化リチウム、炭酸リチウム、硝酸リチウム、酢酸リチウム、シュウ酸リチウム、ハロゲン化リチウムなどを用いることができる。これらリチウム化合物は、１種類でもよいし、２種類以上用いてもよい。

前記チタン化合物としては、特に限定されないが、例えば、二酸化チタン、一酸化チタンなどのチタン酸化物を用いることができる。

【００４４】

リチウム化合物、及びチタン化合物の配合比は、原料の性状や加熱条件によってリチウム、及びチタンの原子比、Ｔｉ／Ｌｉ＝１．２５前後で多少の幅をもたせてもよい。

チタン酸リチウムの表面には、導電性向上、あるいは安定性向上のため、炭素材料、金属酸化物、あるいは高分子等で覆われてもよい。

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チタン酸リチウムの粒子径は、０．５μｍ以上５０μｍ以下であることが好ましく、１μｍ以上３０μｍ以下であることは取り扱いの観点からさらに好ましい。前記粒子径はＳＥＭ、ＴＥＭ像から各粒子の大きさを測定し、平均粒子径を算出した値である。

【００４５】

チタン酸リチウムの比表面積は、０．１m^2／ｇ以上５０m^2／ｇ以下であることは所望の出力密度を得やすいことから好ましい。前記比表面積は、水銀ポロシメータ、ＢＥＴ法での測定により算出するのがよい。

チタン酸リチウムの嵩密度は、０．２ｇ／ｃm^3以上１．５ｇ／ｃm^3以下であることが好ましい。０．２ｇ／ｃm^3未満の場合では後述のスラリー作製時に多量の溶媒が必要となるため経済的に不利となる傾向があり、１．５ｇ／ｃm^3より大きいと後述の導電助材、バインダーとの混合が困難となる傾向がある。

【００４６】

本発明の負電極は炭素材料を含む導電助材を含有している。導電助材を構成する炭素材料としては、例えば、天然黒鉛、人造黒鉛、気相成長炭素繊維、カーボンナノチューブ、アセチレンブラック、ケッチェンブラック、又はファーネスブラックなどが挙げられる。これら炭素材料は１種類でもよいし、２種類以上用いてもよい。

本発明において、負電極に含まれる導電助材の量は、負極活物質１００重量部に対して、好ましくは０重量部以上１０重量部以下、より好ましくは０重量部以上８重量部以下である。前記範囲であれば、バインダーとの接着性が維持され、集電箔との接着性が十分に得ることができる。

【００４７】

本発明の負電極にはバインダーを使用してよい。バインダーとしては、特に限定されないが、例えば、ポリフッ化ビニリデン（ＰＶｄＦ）、ポリテトラフルオロエチレン（ＰＴＦＥ）、スチレン－ブタジエンゴム、ポリイミド及びそれらの誘導体からなる群からえらばれる少なくとも１種を用いることができる。バインダーは負電極の作製しやすさから、非水溶媒又は水に、溶解又は分散されていることが好ましい。非水溶媒は、特に限定されないが、Ｎ－メチル－２－ピロリドン（ＮＭＰ）、ジメチルホルムアミド、ジメチルアセトアミド、メチルエチルケトン、酢酸メチル、酢酸エチル、及びテトラヒドロフランなどを挙げることができる。これらに分散剤、増粘剤を加えてもよい。

【００４８】

本発明において、負電極に含まれるバインダーの量は、負極活物質１００重量部に対して、好ましくは１重量部以上２０重量部以下、より好ましくは２重量部以上１５重量部以下である。前記範囲であれば、負極活物質と導電助材との接着性が維持され、集電箔との接着性が十分に得ることができる。

本発明において好ましい負電極の一形態としては、負極活物質、導電助材、及びバインダーの混合物を集電箔上に形成することによって作製されるが、作製方法の容易さから、前記混合物及び溶媒でスラリーを作製し、得られたスラリーを集電箔上に塗工した後に、溶媒を除去することによって負電極を作製する方法が好ましい。

【００４９】

本発明の負電極に用いることのできる集電箔は、０．３Ｖ（ｖｓ．Li^+／Ｌｉ）以上２．０Ｖ（ｖｓ．Li^+／Ｌｉ）以下で安定な金属、例えば、銅、ＳＵＳ、ニッケル、チタン、アルミニウム又はそれらの合金が好ましく、安定性が高いことからアルミニウムであることが特に好ましい。アルミニウムは、正電極及び負電極の電極反応雰囲気下で安定であることから、その組成は特に限定されないが、ＪＩＳ規格１０３０、１０５０、１０８５、１Ｎ９０、１Ｎ９９等に代表される高純度アルミニウムであることが好ましい。

【００５０】

集電箔の表面粗度Ｒａは、０．０５μｍ以上０．５μｍ以下であることが好ましい。０．０５μｍ未満であると、負電極との接着性が低下する場合があり、０．５μｍより大きいと、負電極を均一に形成することが困難となる場合がある。なお、表面粗度Ｒａは、光波干渉式表面粗さ測定器などを用いて測定できる。

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集電箔の電気抵抗は、５μΩ・ｃｍ以下であることが好ましい。５μΩ・ｃｍより高い場合は、電池の性能が低下する恐れがある。電気抵抗は、四端子法で測定することができる。

【００５１】

集電箔の厚みは、特に限定されないが、１０μｍ以上１００μｍ以下であることが好ましい。１０μｍ未満では作製の観点から取り扱いが困難となり、１００μｍより厚い場合は経済的観点から不利になる。

なお、集電箔は、アルミニウム以外の金属材料（銅、ＳＵＳ、ニッケル、チタン、及びそれらの合金）の表面にアルミニウムを被覆したものも用いることもできる。

【００５２】

前記スラリーの作製方法は、特に限定されないが、負極活物質、導電助材、バインダー、及び溶媒を均一に混合できることから、ボールミル、プラネタリミキサ、ジェットミル、薄膜旋回型ミキサーを用いることが好ましい。スラリーの作製は、特に限定されないが、負極活物質、導電助材、及びバインダーを混合した後に溶媒を加えて作製してもよいし、負極活物質、導電助材、バインダー、及び溶媒を一緒に混合して作製してもよい。

【００５３】

スラリーの固形分濃度は、３０ｗｔ％以上８０ｗｔ％以下であることが好ましい。３０ｗｔ％未満の場合、スラリーの粘度が低すぎる傾向があり、一方、８０ｗｔ％より高い場合は、スラリーの粘度が高すぎる傾向があるため、後述の電極の形成が困難となる場合がある。

スラリーに用いる溶媒は、非水溶媒、あるいは水であることが好ましい。非水溶媒は、特に限定されないが、例えば、Ｎ－メチル－２－ピロリドン（ＮＭＰ）、ジメチルホルムアミド、ジメチルアセトアミド、メチルエチルケトン、酢酸メチル、酢酸エチル、及びテトラヒドロフランなどを挙げることができる。また、これらに分散剤、増粘剤を加えてもよい。

【００５４】

集電箔上への負電極の形成方法は、特に限定されないが、例えば前記スラリーをドクターブレード、ダイコータ、コンマコータ等により塗布した後に、溶剤を除去する方法、あるいはスプレーにより塗布した後に溶剤を除去する方法が好ましい。溶媒を除去する方法は、オーブンや真空オーブンを用いた乾燥が簡単であり好ましい。雰囲気としては室温、あるいは高温とした空気、不活性ガス、真空状態などが挙げられる。また、溶媒を除去する温度は特に限定されないが、６０℃以上２００℃以下であることが好ましい。６０℃未満では溶媒の除去に時間を要する場合があり、２００℃より高いとバインダーが劣化する場合がある。負電極の形成は、前述の正電極を形成する前でも、後でもよい。また、負電極作製後、ロールプレス機などを用いて負電極を圧縮させてもよい。前記電極の圧縮は、前述の正電極を形成する前でも、後でもよい。

【００５５】

本発明において、負電極の厚みは、１０μｍ以上２００μｍ以下であることが好ましい。１０μｍ以下では、所望の容量を得ることが難しい場合があり、２００μｍより厚い場合は、所望の出力密度を得ることが難しい場合がある。

本発明において、負電極の重量密度は、１．０ｇ／ｃｍ^{3}以上３．０ｇ／ｃｍ^{3}以下であることが好ましい。１．０ｇ／ｃｍ^{3}未満であれば、負極活物質、導電助材との接触が不十分となり電子伝導性が低下する場合がある。３．０ｇ／ｃｍ^{3}より大きい場合は、後述の電解液が負電極内に浸透しにくくなり、リチウム伝導性が低下する場合がある。負電極は、所望の厚み、密度まで圧縮させてもよい。圧縮は、特に限定されないが、例えば、ロールプレス、油圧プレス等を用いておこなうことができる。電極の圧縮は、前述の正電極を形成する前でも、後でもよい。

【００５６】

本発明において、負電極の面積１ｃｍ^{2}あたりの電気容量は、０．５ｍＡｈ以上３．６ｍＡｈ以下であることが好ましい。０．５ｍＡｈ未満である場合は所望する容量の電池の

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大きさが大きくなる場合があり、一方、３．６ｍＡｈより多い場合は所望の出力密度を得ることが難しい場合がある。負電極の１ｃｍ^{2}あたりの電気容量の算出は、負電極作製後、リチウム金属を対極とした半電池を作製した後に、充放電特性を測定することによって算出できる。負電極の面積１ｃｍ^{2}あたりの電気容量は、特に限定されないが、集電箔単位面積あたりに形成させる負電極の重量で制御する方法、例えば、前述の負電極塗工時の塗工厚みで制御することができる。

【００５７】

＜正電極＞

本発明の非水電解質二次電池に用いる正電極は、特に、リチウムイオンの挿入・脱離反応が４．５Ｖ（ｖｓ．Ｌｉ$^+$／Ｌｉ）以上４．９Ｖ（ｖｓ．Ｌｉ$^+$／Ｌｉ）以下で進行する正極活物質を含む。このように４．５Ｖ（ｖｓ．Ｌｉ$^+$／Ｌｉ）以上４．９Ｖ（ｖｓ．Ｌｉ$^+$／Ｌｉ）以下である場合、前述した負極活物質と組み合わせて高い電池電圧を発現できる。

【００５８】

リチウムイオン挿入・脱離反応の電圧値（ｖｓ．Ｌｉ$^+$／Ｌｉ）は、例えば、正極活物質を用いた動作極、リチウム金属を対極とした半電池の充放電特性を測定し、プラトー開始時、及び終了時の電圧値を読み取ることによって求めることができる。プラトーが２箇所以上あった場合は、もっとも低い電圧値のプラトーが４．５Ｖ（ｖｓ．Ｌｉ$^+$／Ｌｉ）以上であればよく、もっとも高い電圧値のプラトーが４．９Ｖ（ｖｓ．Ｌｉ$^+$Ｌｉ）以下であればよい。前記半電池に用いる動作極、電解液、セパレータは後述のものと同様のものを用いることができる。

【００５９】

リチウムイオンの挿入・脱離反応が４．５Ｖ（ｖｓ．Ｌｉ$^+$／Ｌｉ）以上４．９Ｖ（ｖｓ．Ｌｉ$^+$／Ｌｉ）以下で進行する正極活物質は、特に限定されないが、充放電サイクルの安定性効果が高いことから、リチウムマンガン化合物であることが好ましい。

リチウムマンガン化合物としては、例えば、Li_2MnO_3、$Li_aM_bMn_{1-b}N_cO_4$（０＜ａ≦２、０≦ｂ≦０．５、１≦ｃ≦２、Ｍは２～１３族でかつ第３、４周期に属する元素、Ｎは１４～１６族でかつ第３周期に属する元素）、$Li_{1+x}M_yMn_{2-x-y}O_4$（０≦ｘ≦０．２、０＜ｙ≦０．６、Ｍは２～１３族でかつ第３～４周期に属する元素からなる群から選ばれる少なくとも１種）で表されるリチウムマンガン化合物が挙げられる。ここでの”Ｍ”は、２～１３族でかつ第３～４周期に属する元素から選ばれる少なくとも１種であるが、安定性向上の効果が大きい点から、Ａｌ、Ｍｇ、Ｚｎ、Ｎｉ、Ｃｏ、Ｆｅ、Ｔｉ、Ｃｕ及びＣｒが好ましく、Ａｌ、Ｍｇ、Ｚｎ、Ｎｉ、Ｔｉ、Ｃｕ及びＣｒがより好ましく、Ａｌ、Ｍｇ、Ｚｎ、Ｔｉ、Ｃｕ及びＮｉがさらに好ましい。また、ここでの”Ｎ”は安定性向上の効果が大きい点から、Ｓｉ、Ｐ及びＳが好ましい。

【００６０】

中でも、正極活物質の安定性が高いことから、$Li_{1+x}M_yMn_{2-x-y}O_4$（０≦ｘ≦０．２、０＜ｙ≦０．６、Ｍは２～１３族でかつ第３～４周期に属する元素からなる群から選ばれる少なくとも１種）で表されるリチウムマンガン化合物であることが特に好ましい。ｘ＜０の場合は、正極活物質の容量が減少する傾向がある。また、ｘ＞０．２の場合は炭酸リチウムなどの不純物が多く含まれるようになる傾向がある。ｙ＝０の場合は、正極活物質の安定性が低くなる傾向がある。また、ｙ＞０．６の場合はＭの酸化物などの不純物が多く含まれるようになる傾向がある。例えば、Ｍ＝Ｎｉ，ｘ＝０，ｙ＝０．４の場合、化合物は$LiNi_{0.4}Mn_{1.6}O_4$であり、ｘ＝０，ｙ＝０．５の場合、化合物は$LiNi_{0.5}Mn_{1.5}O_4$である。

【００６１】

前記$Li_{1+x}M_yMn_{2-x-y}O_4$は、スピネル構造であることが好ましい。スピネル構造の場合、リチウムイオンの挿入・脱離の反応における活物質の膨張収縮が小さいので好ましい。

前記$Li_{1+x}M_yMn_{2-x-y}O_4$は、ＣｕＫαによる粉末Ｘ線回折の（４００）面

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の半値幅が０．５°以下であることが好ましい。０．５°より大きいと、正極活物質の結晶性が低いため、電極の安定性が低下する場合がある。

【００６２】

前記$Li_{1+x}M_yMn_{2-x-y}O_4$は、Ｘ線回折によるリートベルト解析法による８ａサイトに占めるリチウム含有率は、９０％以上であることが好ましい。９０％未満であると、正極活物質の結晶中の欠陥が多いため、電極の安定性が低下する場合がある。

前記$Li_{1+x}M_yMn_{2-x-y}O_4$の粒子径は、０．５μｍ以上５０μｍ以下であることが好ましく、１μｍ以上３０μｍ以下であることは取り扱いの観点からさらに好ましい。ここでの粒子径はＳＥＭ、ＴＥＭ像から各粒子の大きさを測定し、平均粒子径を算出した値である。

【００６３】

前記$Li_{1+x}M_yMn_{2-x-y}O_4$の比表面積は、０．１m^2／ｇ以上５０m^2／ｇ以下であることは所望の出力密度を得やすいことから好ましい。比表面積はＢＥＴ法での測定により算出できる。

前記$Li_{1+x}M_yMn_{2-x-y}O_4$の嵩密度は、０．２ｇ／cm^3以上２．５ｇ／cm^3以下であることが好ましい。０．２ｇ／cm^3未満の場合では後述のスラリー作製時に多量の溶媒が必要となるため経済的に不利となり、２．５ｇ／cm^3より大きい場合では後述の導電助剤、バインダーとの混合が困難となる傾向がある。

【００６４】

前記$Li_{1+x}M_yMn_{2-x-y}O_4$は、リチウム化合物、マンガン化合物、Ｍの化合物を５００℃以上、１５００℃以下で加熱処理することによって製造することができる。５００℃未満、又は１５００℃より高いと、所望の構造をした正極活物質を得ることができない場合がある。加熱処理は、リチウム化合物、マンガン化合物、及びＭの化合物を混合して加熱処理もよいし、マンガン化合物とＭの化合物とを加熱処理した後に、リチウム化合物と加熱処理してもよい。正極活物質の結晶性を向上させるため、加熱処理後、再び５００℃以上、１５００℃以下で再加熱処理してもよい。再加熱処理の温度は、最初におこなった温度と同じでもよいし、違っていてもよい。加熱処理は、空気存在下でもよいし、窒素あるいはアルゴンなどの不活性ガスの存在下でおこなってもよい。加熱処理には、特に限定されないが、例えば、箱型炉、管状炉、トンネル炉、ロータリーキルン等を用いることができる。

【００６５】

前記リチウム化合物としては、例えば、水酸化リチウム、炭酸リチウム、硝酸リチウム、酢酸リチウム、シュウ酸リチウム、ハロゲン化リチウムなどを用いることができる。これらリチウム化合物は、１種類でもよいし、２種類以上用いてもよい。

前記マンガン化合物としては、例えば、二酸化マンガン等のマンガン酸化物、炭酸マンガン、硝酸マンガン、マンガン水酸化物などを用いることができる。これらマンガン化合物は、１種類でもよいし、２種類以上用いてもよい。

【００６６】

前記Ｍの化合物としては、例えば、炭酸化物、酸化物、硝酸化物、水酸化物、硫酸化物などを用いることができる。$Li_{1+x}M_yMn_{2-x-y}O_4$に含まれるＭの量は、加熱処理時におけるＭの化合物の量で制御することができる。Ｍの化合物は、１種類でもよいし、２種類以上用いてもよい。

リチウム化合物、マンガン化合物及びＭの化合物の配合比は、リチウム、マンガン及びＭの原子比をそれぞれ１＋ｘ（リチウム）、２－ｘ－ｙ（マンガン）、及びｙ（Ｍ）、但し、０≦ｘ≦０．２、０＜ｙ≦０．６を満たす範囲で選択される。例えば、Ｍｎ／Ｌｉの原子比１．５の正極活物質を作製する場合、原料の性状や加熱条件によって前記配合比１．５前後で多少の幅をもたせてもよい。

【００６７】

本発明の正極活物質の表面は、導電性向上、あるいは安定性向上のため、炭素材料、金属酸化物、あるいは高分子等で覆われてもよい。

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本発明の正電極は、好ましくは導電助材を含有している。導電助材としては、特に限定されないが、炭素材料が好ましい。例えば、天然黒鉛、人造黒鉛、気相成長炭素繊維、カーボンナノチューブ、アセチレンブラック、ケッチェンブラック、及びファーネスブラックなどが挙げられる。これら炭素材料は１種類でもよいし、２種類以上用いてもよい。

【００６８】

本発明の正電極に含まれる導電助材の量は、正極活物質１００重量部に対して、好ましくは１重量部以上２０重量部以下、より好ましくは２重量部以上１５重量部以下である。前記範囲であれば、正電極の導電性が確保される。また、後述のバインダーとの接着性が維持され、集電箔との接着性が十分に得ることができる。

本発明の正電極にはバインダーを含有させてよい。バインダーは、特に限定されないが、例えば、ポリフッ化ビニリデン（ＰＶｄＦ）、ポリテトラフルオロエチレン（ＰＴＦＥ）、スチレンーブタジエンゴム、ポリイミド、及びそれらの誘導体からなる群からえらばれる少なくとも１種を用いることができる。バインダーは正電極の作製しやすさから、非水溶媒又は水に溶解又は分散されていることが好ましい。非水溶媒は、特に限定されないが、例えば、Ｎ－メチル－２－ピロリドン（ＮＭＰ）、ジメチルホルムアミド、ジメチルアセトアミド、メチルエチルケトン、酢酸メチル、酢酸エチル、及びテトラヒドロフランなどを挙げることができる。これらに分散剤、増粘剤を加えてもよい。

【００６９】

本発明の正電極に含まれるバインダーの量は、正極活物質１００重量部に対して、好ましくは１重量部以上２０重量部以下、より好ましくは２重量部以上１５重量部以下である。前記範囲であれば、正極活物質と導電助材との接着性が維持され、集電箔との接着性が十分に得ることができる。

本発明の正電極の作製方法としては、正極活物質、導電助材、及びバインダーの混合物を集電箔上に塗工することによって作製する方法が挙げられるが、作製方法の容易さから、前記混合物及び溶媒でスラリーを作製し、得られたスラリーを集電箔上に塗工した後に、溶媒を除去することによって正電極を作製する方法が好ましい。

【００７０】

本発明の正電極に用いる集電箔は、アルミニウム及びその合金であることが好ましい。前記アルミニウムは、正電極反応雰囲気下で安定であることから、特に限定されないが、ＪＩＳ規格１０３０、１０５０、１０８５、１Ｎ９０、１Ｎ９９等に代表される高純度アルミニウムであることが好ましい。

集電箔の表面粗度Ｒａは、０．０５μｍ以上０．５μｍ以下であることが好ましい。０．０５μｍ未満であると、正電極との接着性が低下する場合があり、０．５μｍより大きいと、正電極を均一に形成することが困難となる場合がある。なお、表面粗度Ｒａは、光波干渉式表面粗さ測定器などを用いて測定できる。

【００７１】

集電箔の電気抵抗は、５μΩ・ｃｍ以下であることが好ましい。５μΩ・ｃｍより高い場合は、電池の性能が低下する恐れがある。電気抵抗は、四端子法で測定することができる。

集電箔の厚みは、特に限定されないが、１０μｍ以上１００μｍ以下であることが好ましい。１０μｍ未満では作製の観点から取り扱いが困難となり、１００μｍより厚い場合は経済的観点から不利になる。

【００７２】

なお、集電箔は、アルミニウム以外の金属（銅、ＳＵＳ、ニッケル、チタン、及びそれらの合金）の表面にアルミニウムを被覆したものも用いることもできる。

スラリーの作製方法は、特に限定されないが、正極活物質、導電助材、バインダー、及び溶媒を均一に混合できることから、ボールミル、プラネタリミキサ、ジェットミル、薄膜旋回型ミキサーを用いることが好ましい。スラリーの作製は、特に限定されないが、正極活物質、導電助材、及びバインダーを混合した後に溶媒を加えて作製してもよいし、正極活物質、導電助材、バインダー、及び溶媒を一緒に混合して作製してもよい。

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【００７３】
スラリーの固形分濃度は、３０ｗｔ％以上８０ｗｔ％以下であることが好ましい。３０ｗｔ％未満の場合スラリーの粘度が低すぎる傾向があるため、一方、８０ｗｔ％より高い場合はスラリーの粘度が高すぎる傾向があるため、後述の電極の形成が困難となる場合がある。
スラリーに用いる溶媒は、非水溶媒、あるいは水であることが好ましい。非水溶媒は、特に限定されないが、例えば、Ｎ－メチル－２－ピロリドン（ＮＭＰ）、ジメチルホルムアミド、ジメチルアセトアミド、メチルエチルケトン、酢酸メチル、酢酸エチル、及びテトラヒドロフランなどを挙げることができる。また、これらに分散剤、増粘剤を加えてもよい。
【００７４】
集電箔上への正電極の形成方法は、特に限定されないが、例えば前記スラリーをドクターブレード、ダイコータ、コンマコータ等により塗布した後に、溶剤を除去する方法、あるいはスプレーにより塗布した後に溶剤を除去する方法が好ましい。溶媒を除去する方法は、オーブンや真空オーブンを用いた乾燥が簡単であり好ましい。溶媒を除去する雰囲気としては、空気、不活性ガス、真空状態などが挙げられる。また、溶媒を除去する温度は、特に限定されないが、６０℃以上２００℃以下であることが好ましい。６０℃未満では溶媒の除去に時間を要する場合があり、２００℃より高いと、バインダーが劣化する場合がある。なお、正電極の形成は、後述の負電極を形成する前でも、後でもよい。
【００７５】
本発明の正電極の厚みは、１０μｍ以上２００μｍ以下であることが好ましい。１０μｍ未満では所望の容量を得ることが難しい場合があり、一方、２００μｍより厚い場合は所望の出力密度を得ることが難しい場合がある。
本発明の正電極の重量密度は、１．０ｇ／ｃｍ^{3}以上４．０ｇ／ｃｍ^{3}以下であることが好ましい。１．０ｇ／ｃｍ^{3}未満であると、正極活物質、導電助材との接触が不十分となり電子伝導性が低下する場合がある。一方、４．０ｇ／ｃｍ^{3}より大きいと、電解液が正電極内に浸透しにくくなり、リチウム伝導性が低下する場合がある。
【００７６】
本発明の正電極は、所望の厚み、密度まで圧縮させてもよい。圧縮は、特に限定されないが、例えば、ロールプレス、油圧プレス等を用いておこなうことができる。電極の圧縮は、前述の負電極を形成する前でも、後でもよい。
本発明の正電極は、面積１ｃｍ^{2}あたりの電気容量が０．５ｍＡｈ以上３．６ｍＡｈ以下であることが好ましい。０．５ｍＡｈ未満である場合は所望する容量の電池の大きさが大きくなる傾向があり、３．６ｍＡｈより多い場合は所望の出力密度を得ることが難しくなる傾向がある。面積１ｃｍ^{2}あたりの電気容量の算出は、正電極作製後、リチウム金属を対極とした半電池を作製した後に、充放電特性を測定することによって算出してもよい。
【００７７】
前記正電極の面積１ｃｍ^{2}あたりの電気容量は、特に限定されないが、集電箔単位面積あたりに形成させる正電極の重量で制御する方法、例えば、前述のスラリー塗工時の塗工厚みで制御することができる。
＜セパレータ＞
本発明の非水電解質二次電池に用いるセパレータは、前述の正電極と負電極との間に設置され、電子伝導性がなくかつリチウムイオン伝導性を有する物質であればよく、例えば、ナイロン、セルロース、ポリスルホン、ポリエチレン、ポリポロピレン、ポリブテン、ポリアクリロニトリル、ポリイミド、ポリアミド、及びそれらを２種類以上複合したものの織布、不織布、微多孔膜などが挙げられる。セパレータには、各種可塑剤、酸化防止剤、難燃剤が含まれてもよいし、金属酸化物等が被覆されていてもよい。
【００７８】
セパレータの厚みは、１０μｍ以上１００μｍ以下であることが好ましい。１０μｍ未

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満の場合、正電極と負電極との接触する場合があり、１００μｍより厚い場合は電池の抵抗が高くなる場合がある。経済性、取り扱いの観点から、１５μｍ以上５０μｍ以下であることがさらに好ましい。

＜非水電解質＞

本発明の非水電解質二次電池に用いる非水電解質は、特に限定されないが、非水溶媒に溶質を溶解させた電解液、非水溶媒に溶質を溶解させた電解液を高分子に含浸させたゲル電解質などを用いることができる。

【００７９】

非水溶媒としては、環状の非プロトン性溶媒及び／又は鎖状の非プロトン性溶媒を含むことが好ましい。環状の非プロトン性溶媒としては、環状カーボネート、環状エステル、環状スルホン及び環状エーテルなどが例示される。鎖状の非プロトン性溶媒としては、鎖状カーボネート、鎖状カルボン酸エステル及び鎖状エーテルなどが例示される。また、前記に加えアセトニトリルなどの一般的に非水電解質の溶媒として用いられる溶媒を用いても良い。より具体的には、ジメチルカーボネート、メチルエチルカーボネート、ジメチルカーボネート、ジプロピルカーボネート、メチルプロピルカーボネート、エチレンカーボネート、プロピレンカーボネート、ブチレンカーボネート、γ－ブチルラクトン、１，２－ジメトキシエタン、スルホラン、ジオキソラン、プロピオン酸メチルなどを用いることができる。これら溶媒は１種類で用いてもよいし、２種類以上混合しても用いてもよいが、後述の溶質を溶解させやすさ、リチウムイオンの伝導性の高さから、２種類以上混合した溶媒を用いることが好ましい。また、高分子に電解液をしみこませたゲル状電解質も用いることができる。

【００８０】

前記溶質は、特に限定されないが、例えば、ＬｉＣｌＯ４、ＬｉＢＦ４、ＬｉＰＦ６、ＬｉＡｓＦ６、ＬｉＣＦ３ＳＯ３、ＬｉＢＯＢ（Ｌｉｔｈｉｕｍ　Ｂｉｓ　（Ｏｘａｌａｔｏ）　Ｂｏｒａｔｅ）、ＬｉＮ（ＳＯ２ＣＦ３）２などは溶媒に溶解しやすいことから好ましい。電解液に含まれる溶質の濃度は、０．５ｍｏｌ／Ｌ以上２．０ｍｏｌ／Ｌ以下であることが好ましい。０．５ｍｏｌ／Ｌ未満では所望のリチウムイオン伝導性が発現しない場合があり、一方、２．０ｍｏｌ／Ｌより高いと、溶質がそれ以上溶解しない場合がある。

【００８１】

＜負電極と正電極の好ましい容量比及び面積比＞

本発明の電極活物質混合物より製造された非水電解質二次電池用電極を用いて作製した二次電池における正電極と負電極の電気容量の比は、下記式（ａ）を満たすことが望ましい。

０．７≦Ｂ／Ａ≦１．３　　（ａ）

但し、上記式（ａ）中、Ａは正電極１ｃｍ^{2}あたりの電気容量を示し、Ｂは負電極１ｃｍ^{2}あたりの電気容量を示す。

【００８２】

Ｂ／Ａが０．７未満である場合は、過充電時に負電極の電位が負電極集電体とリチウムが反応する電位又はリチウムの析出電位になる場合があり、一方、Ｂ／Ａが１．３より大きい場合は電池反応に関与しない負極活物質多いために副反応が起こる場合がある。

本発明の非水電解質二次電池における正電極と負電極との面積比は、特に限定されないが、下記式（ｂ）を満たすことが好ましい。

【００８３】

１≦Ｄ／Ｃ≦１．２　　（ｂ）

但し、Ｃは正電極の面積、Ｄは負電極の面積を示す。Ｄ／Ｃが１未満である場合は、例えば前述のＢ／Ａ＝１の場合、負電極の容量が正電極よりも小さくなるため、過充電時に負電極の電位がリチウムの析出電位になる恐れがある。一方、Ｄ／Ｃが１．２より大きい場合は、正電極と接していない部分の負電極が大きいため、電池反応に関与しない負極活物質が副反応を起こす場合がある。正電極及び負電極の面積の制御は特に限定されないが、

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例えば、電極作製の際、塗工幅を制御することによって行うことができる。

【００８４】

本発明の非水電解質二次電池に用いるセパレータと負電極との面積比は特に限定されないが、下記式（ｃ）を満たすことが好ましい。

$$1 \leqq F/E \leqq 1.5 \qquad (c)$$

但し、Ｅは負電極の面積、Ｆはセパレータの面積を示す。Ｆ／Ｅが１未満である場合は、正電極と負電極とが接触し、１．５より大きい場合は外装に要する体積が大きくなり、電池の容量密度及び出力密度が低下する場合がある。

【実施例】

【００８５】

以下、実施例により本発明をさらに具体的に説明するが、本発明はこれらの実施例によって限定されるものではなく、その要旨を変更しない範囲において適宜変更実施が可能である。

（正電極の製造）

正電極用活物質の$Li_{1.1}Al_{0.1}Mn_{1.8}O_4$を、文献（"Lithium Aluminum Manganese Oxide Having Spinel-Framework Structure for Long-Life Lithium-Ion Batteries" Electrochemical and Solid-State Letters Volume9, Issue12, Pages A557 (2006)）に記載されている方法で作製した。

【００８６】

すなわち二酸化マンガン、炭酸リチウム、水酸化アルミニウム、及びホウ酸の水分散液を調製し、スプレードライ法で混合粉末を作製した。このとき、二酸化マンガン、炭酸リチウム及び水酸化アルミニウムの量は、リチウム、アルミニウム及びマンガンのモル比が１．１：０．１：１．８となるように調製した。次に、この混合粉末を空気雰囲気下９００℃で１２時間加熱した後、再度６５０℃で２４時間加熱した。最後に、この粉末を９５℃の水で洗浄後、乾燥させることによって正極活物質を作製した。

この正極活物質を、導電助材（アセチレンブラック）、及びバインダー（固形分濃度１２ｗｔ％、ＮＭＰ溶液）を８８／６／６の重量比で混合して、スラリーを作製した。このスラリーをアルミニウム箔（厚さ２０μｍ）に塗工し、１２０℃でＮＭＰを除去した後に、１５０℃で真空乾燥することによって正電極（面積５０cm^2）を作製した。

正電極の容量を、次の充放電試験で測定した。前述と同様にアルミニウム箔の片面に塗工した電極を１６ｍｍΦに打ち抜き動作極、Ｌｉ金属を１６ｍｍΦに打ち抜き対極とした。これらの電極を用いて、動作極（片面塗工）／セパレータ／Ｌｉ金属の順に試験セル（ＨＳセル、宝泉社製）内に積層し、非水電解質（プロピレンカーボネート／エチルメチルカーボネート＝３０／７０ｖｏｌ％、ＬｉＰＦ６　１ｍｏｌ／Ｌ）を０．１５ｍＬ入れ、半電池を作製した。この半電池を２５℃で一日放置した後、充放電試験装置（ＨＪ１００５ＳＤ８、北斗電工社製）に接続した。この半電池を２５℃、０．４ｍＡで定電流充電（終止電圧：５．０Ｖ）及び定電流放電（終止電圧：２．０Ｖ）を行い、初回の充電容量を正電極の容量とした。その結果、正電極の容量は、１．０ｍＡｈ／ｃｍ２であった。この半電池は、４．７V付近にプラトー領域を示した。この電圧４．７Ｖが、従来のコバルト酸リチウム等の４Ｖ（ｖｓ．Li^+／Ｌｉ）以下の領域で動作する物質を用いた正極活物質に比べて、高い電位（ｖｓ．Li^+／Ｌｉ）を有する正極活物質であることを裏付けている。

【００８７】

（負電極の製造）

負極活物質の$Li_4Ti_5O_{12}$を、文献（"Zero-Strain Insertion Material of Li[Li1/3Ti5/3] O4 for Rechargeable Lithium Cells" J. Electrochem. Soc., Volume 142, Issue 5, pp. 1431-1435 (1995)）に記載されている方法で作製した。

すなわち、まず二酸化チタンと水酸化リチウムを、チタンとリチウムとのモル比を５：４となるように混合し、次にこの混合物を窒素雰囲気下８００℃で１２時間加熱することによって負極活物質を作製した。

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【００８８】
この負極活物質を、導電助材（アセチレンブラック）、及びバインダー（固形分濃度１２ｗｔ％、ＮＭＰ溶液）を８８／６／６の重量比で混合してスラリーを作製した。このスラリーをアルミニウム集電体（厚さ２０μｍ）に塗工し、１２０℃でＮＭＰを除去した後に、１５０℃で真空乾燥することによって負電極（面積６６ｃｍ^2）を作製した。
負電極の容量は次の充放電試験で測定した。前述と同様の条件でアルミニウム箔の片面に電極を塗工し、１６ｍｍΦに打ち抜き動作極を作製した。Ｌｉ金属を１６ｍｍΦに打ち抜き対極とした。これらの電極を用いて、動作極（片面塗工）／セパレータ／Ｌｉ金属の順に試験セル（ＨＳセル、宝泉社製）内に積層し、非水電解質（プロピレンカーボネート／エチルメチルカーボネート＝３０／７０ｖｏｌ％、ＬｉＰＦ６　１ｍｏｌ／Ｌ）を０．１５ｍＬ入れ、半電池を作製した。この半電池を２５℃で一日放置した後、充放電試験装置（ＨＪ１００５ＳＤ８、北斗電工社製）に接続した。この半電池を２５℃、０．４ｍＡで定電流放電（終止電圧：１．０Ｖ）及び定電流充電（終止電圧：２．０Ｖ）を行い、初回の充電容量を負電極の容量とした。その結果、負電極の容量は、１．１ｍＡｈ／ｃｍ２であった。
【００８９】
（非水電解質二次電池の製造）
非水電解質二次電池を次のとおりに作製した。
＜実施例１＞
前記作製した正電極（片面塗工）、負電極（片面塗工）、およびセパレータを、正電極（片面塗工）／セパレータ／負電極（片面塗工）の順に積層し、水素吸蔵合金を含む固定テープにより電極群を固定した。セパレータには、セルロース不織布（２５μｍ）を用いた。
【００９０】
水素吸蔵合金を含む固定テープは、ポリイミドテープの接着樹脂に平均粒子径30μｍのLaMgNi合金系水素吸蔵合金を5wt%混入して作製した。固定テープのサイズは3cmｘ4cmで、これにより極板群を二箇所固定した。
次に、両端の正電極および負電極にアルミニウムタブを振動溶着させた後に、袋状のアルミラミネートフィルムに入れた。非水電解質（プロピレンカーボネート／エチルメチルカーボネート＝３０／７０ｖｏｌ％、ＬｉＰＦ$_6$　１ｍｏｌ／Ｌ）を２ｍＬ入れた後に、減圧しながら封止することによって非水電解質二次電池を作製した。
【００９１】
＜実施例２＞
前記作製した正電極（片面塗工）、負電極（片面塗工）、およびセパレータを、正電極（片面塗工）／セパレータ／負電極（片面塗工）の順に積層し、固定テープにより電極群を固定した。セパレータには、セルロース不織布（２５μｍ）を用いた。次に、正電極及び負電極の集電箔とアルミニウムタブとを振動溶着させた後に、正電極の集電箔とアルミニウムタブとの接合部、及び負電極の集電箔とアルミニウムタブとの接合部に、水素吸蔵合金を含む短絡防止用樹脂を形成した。
【００９２】
短絡防止樹脂にはポリイミドテープを用いた。このポリイミドテープの接着樹脂に平均粒子径30μｍのLaMgNi合金系水素吸蔵合金を5wt％混入させた。このポリイミドテープ（サイズ1.5cmｘ4cm）を用いて、正負極タブリード溶接部の上下に計4枚貼り付けた。
袋状のアルミラミネートフィルムに入れて、非水電解質（プロピレンカーボネート／エチルメチルカーボネート＝３０／７０ｖｏｌ％、ＬｉＰＦ$_6$　１ｍｏｌ／Ｌ）を２ｍＬ入れた後に、減圧しながら封止することによって非水電解質二次電池を作製した。
【００９３】
＜比較例１＞
水素吸蔵合金を用いない以外は実施例１と同様に非水電解質二次電池を作製した。
（ガス量の測定）

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実施例１，２及び比較例１で作製された非水電解質二次電池を、充放電装置（ＨＪ１００５ＳＤ８、北斗電工社製）に接続し、５０ｍＡ定電流充電、５０ｍＡ定電流放電を６０℃で１００回繰り返し、サイクル直後、一ヶ月間室温で静置後、六ヶ月間室温で静置後に前後の体積変化からガス量を測定した。このときの充電終止電圧および放電終止電圧は３．４Ｖおよび２．５Ｖとした。充放電サイクルの前後の体積変化から測定したガス発生量を表１に示す。

【００９４】

【表１】

表1

	水素吸蔵合金	配置場所	100サイクル後のガス量（cc/Ah）	静置一ヶ月後のガス量（cc/Ah）	静置六ヶ月後のガス量（cc/Ah）
実施例1	有	電極群の固定テープ	18.2	16.5	4.1
実施例2	有	合剤端部の短絡防止樹脂	17.9	16.2	3.7
比較例1	無	-	18.9	18.5	18.3

【００９５】

表１から明らかなとおり、本発明の実施例１，２の非水電解質二次電池は、同じ条件で測定した比較例１の非水電解質二次電池よりも残留ガス量が減少している 。例えば、実施例１の残留ガス量は４．１ｃｃ／Ａｈ、実施例２の残留ガス量は３．７ｃｃ／Ａｈであるのに対して、比較例１の残留ガス量は１８．３ｃｃ／Ａｈである。一ヶ月放置する間に、実施例１では、１６．５－４．１＝１２．４ｃｃ／Ａｈのガスが水素吸蔵合金に吸収されたものと考えられる。実施例２では、１６．２－３．７＝１２．５ｃｃ／Ａｈのガスが水素吸蔵合金に吸収されたものと考えられる。

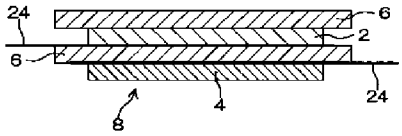
【符号の説明】

【００９６】

２…正電極、４…負電極、６…セパレータ、８…内部発電体、１０…外装体、１４…金属タブリード、１６…熱融着樹脂、２０…電解液、２２…電極固定テープ、２４…集電箔、２６，２８，３０…短絡防止樹脂

【図１】

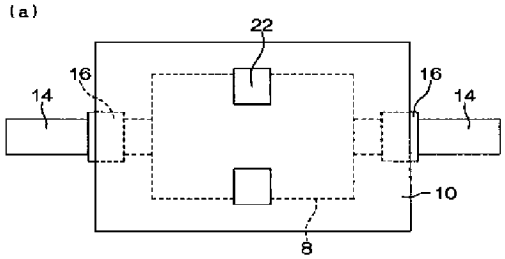
図1



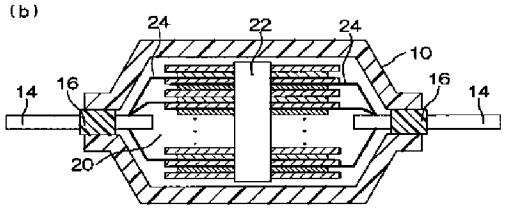
【図２】

図2

(a)



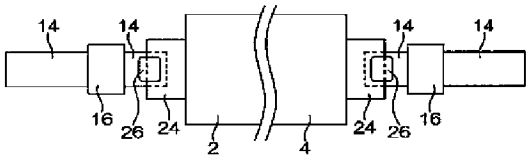
(b)



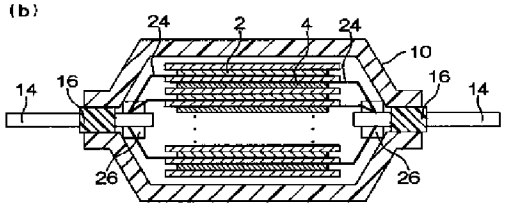
【図３】

図3

(a)



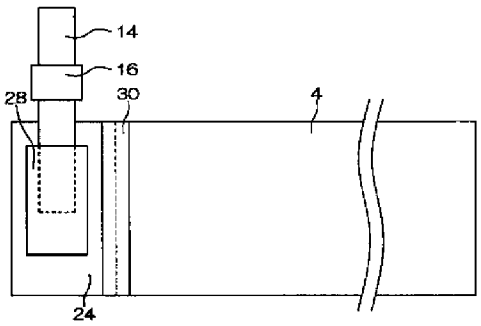
(b)



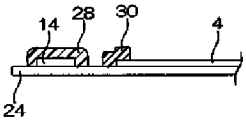
【図４】

図4

(a)

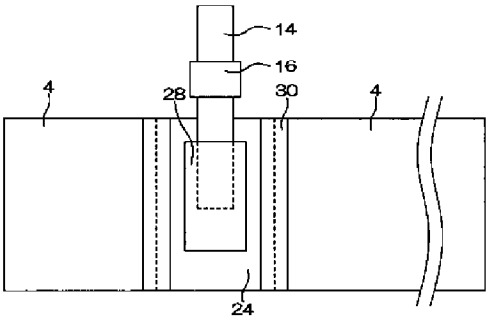


(b)



【図５】

図5



フロントページの続き

(51)Int.Cl.			F I			テーマコード（参考）
H01M	***10/052***	***(2010.01)***	H01M	10/052		
H01M	***10/0585***	***(2010.01)***	H01M	10/0585		
H01M	***4/13***	***(2010.01)***	H01M	4/13		
H01M	***4/131***	***(2010.01)***	H01M	4/131		
H01M	***4/485***	***(2010.01)***	H01M	4/485		
H01M	***4/48***	***(2010.01)***	H01M	4/48		
H01M	***4/505***	***(2010.01)***	H01M	4/505		
H01M	***2/02***	***(2006.01)***	H01M	2/02	K	
H01M	***10/0587***	***(2010.01)***	H01M	10/0587		

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Ｆターム(参考) 5H011 AA13 BB03 CC02 CC06 CC10 DD13 EE04 FF04 GG09 HH02
JJ12 KK00
5H029 AJ05 AJ12 AK03 AL02 AL03 AM03 AM04 AM05 AM07 BJ04
BJ06 BJ12 BJ14 CJ05 CJ22 DJ02 DJ03 DJ04 DJ05 DJ10
EJ01 EJ03 EJ05 EJ12 HJ18
5H031 AA00 AA08 BB03 EE03 EE04 EE08 HH01
5H043 AA04 AA19 BA19 CA08 CA12 CA13 CA21 DA02 DA10 DA13
FA22 FA23 GA22 GA26 GA27 HA13D HA16D HA17D HA22 HA22D
HA32 HA32D JA13D JA15 JA15D JA21 KA07D KA08D KA09 KA09D
KA11 KA13 KA22 KA22D KA24 KA27 KA38 KA38D KA45 KA45D
LA31
5H050 AA07 AA15 BA17 CA07 CA09 CB02 CB03 DA19 DA20 EA02
EA23 FA02 FA05 GA02 GA22 HA18

ADC EX1002
IPR2025-00885

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 June 2012 (07.06.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/074548 A1

(51) International Patent Classification:
H02J 7/00 (2006.01)

(21) International Application Number:
PCT/US2011/001937

(22) International Filing Date:
28 November 2011 (28.11.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/458,657 29 November 2010 (29.11.2010) US
61/463,736 22 February 2011 (22.02.2011) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) **Title**: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

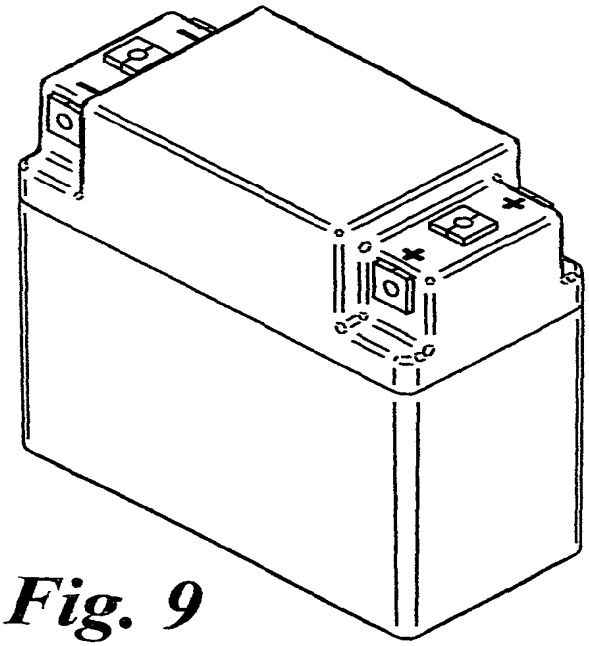


Fig. 9

(57) **Abstract**: Apparatus for increasing the efficiency of a starter battery for a starter motor of an internal combustion engine in a battery pack arrangement with one or more lithium based cells. The invention includes a solid state switching configuration for high powered battery systems for protecting against over-charging, over- discharging and short circuiting of batteries, especially starter batteries for internal combustion engines.

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LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for starting an internal combustion (IC) engine. More particularly, the invention is a lithium-based cell for starting such engines. The invention includes a solid state switching configuration for high powered battery systems for protecting against over-charging, over- discharging and short circuiting of batteries, especially starter batteries for internal combustion engines (ICE).

BACKGROUND OF THE INVENTION

Presently, internal combustion engines use a starter battery comprised of lead-acid to turn over an electric motor to start an IC engine. Lead-acid batteries are heavy, bulky, and have short cycle life, short calendar life, and low turn around efficiency. Lead-acid batteries also have a high internal impedance (resistance) that is greater in cold weather making it more difficult to start an IC engine in cold weather with less current available. To overcome these variables, lead-acid starter batteries are provided with oversized battery capacity in order to produce the necessary current needed for an electric starter to start an IC engine. The oversized lead-acid battery increases the weight, space requirement, and cost needed to start an IC engine.

In order to turn off power terminals in presently known starter batteries, expensive electronic/electrical components are required to handle the high current loads that a starter motor needs to turn over an IC engine. These embody electronic protection circuitry for upper voltage cut-off (overcharging), lower level voltage cut-off (over discharging) and temperature measurements. These circuits also induce heat losses and electrical losses that can be large, as well as taking up additional space. (Noise) spikes can trigger false voltage, temperature or current readings that can terminate the battery system's operation, when in fact all the cells are working within safe specifications. Some of these protection circuits are temperamental and difficult to reactivate once they have been triggered. For example, if an under-voltage condition happens and the cells are still in under-voltage condition with a relay approach, current can not be provided to the cells since a path has been broken thus another button needs to be pressed to activate the system for a short duration in order to allow the cells to charge. Also, in some cases such as a military application or racing application, every last bit of

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energy needs to be extracted, even if it damages the battery.

With any type of rechargeable (secondary) battery used, the battery does not operate well in a low state of charge (SOC), which in most cases is a low battery voltage. Whenever a battery is at a low voltage level, the battery can suffer internal damage permanently or the battery life can be drastically reduced. With battery chemistries such as lithium, over-charging a battery can be even more dangerous, potentially leading to an exothermal runaway reaction, which can create a fire. With a solid state switch placed in-line with the battery output power terminals, the solid state switch can be electronically controlled to open or close the current pathway leaving or entering the battery. This can prevent battery damage from happening if the battery voltage is brought too low or too high. This can be applied to any type of battery chemistry at any voltage. An example is to apply the solid state switch to a 12V car battery that starts a vehicle. A vehicle might have a voltage drain source left on, in which case the solid state switch would automatically turn off the current flow from the battery before the battery is damaged.

A relay or contactor could be used as well, but has the following disadvantages:

1) A relay or contactor continuously needs current to keep the contactor open or closed. That requires energy to do so.

2) A relay or contactor having a closed pathway allows current to flow in both directions and can not be controlled for a single direction.

3) A relay or contactor can only be ON or OFF. During a switching process for large currents large arcing can occur inside the relay or contactor, and that can cause the relay or contactor to "weld" shut. Once a relay or contactor is welded shut, no switching can occur at that point, which can be a safety issue, i.e., by not allowing switching to occur when needed.

4) Relays and contactors are large and bulky for larger current applications.

A better approach is to use a solid state switch either a FET, a MOSFET (metal–oxide–semiconductor field-effect transistor), or IGBT (insulated gate bipolar transistor) format, but not limited to these, in a unique configuration. The unique configuration involves connecting two solid state devices such as MOSFET or IGBT with the "Sources" or "Drains" tied together electrically. These solid state devices can be either N or P type. A doped semiconductor containing excess holes is called "p-type", and when it contains excess free electrons it is known as "n-type", where p (positive for holes) or n (negative for electrons) is the sign of the charge of the majority mobile charge carriers. This arrangement simplifies the control electronics needed and also allows current to flow in one direction but not the other with the internal diode. An FET (field-effect transistor) is a

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majority-charge-carrier device having an active channel through which majority charge carriers, electrons or holes, flow from the source to the drain. Source and drain terminal conductors are connected to semiconductor through ohmic contacts. The majority charge carriers enter the channel through the source and leave the channel through the drain. Figure 15 shows the "Drain" of each terminal being connected, and Figure 16 shows the "Source" of each terminal being connected.

The advantages of a solid state switch are:

1) A solid state switch needs very little energy to activate an allowed pathway to be open or close.

2) A solid state device can gradually increase current, controlling inrush current that might occur switching ON large power applications or providing instant short circuit protection if the current is too high.

3) A solid state switch can be very compact and light for higher power applications.

DESCRIPTION OF THE PRIOR ART

Applicant is aware of the following U. S. Patent concerning battery packs for starting engines:

US Patent No.	Issue Date	Inventor	Title
7,525,287	April 28, 2009	Miyashi	BATTERY PACK FOR DRIVING ELECTRIC MOTOR OF COMPACT ENGINE STARTING DEVICE, ENGINE STARTING DEVICE DRIVEN BY THE BATTERY PACK, AND MANUAL WORKING MACHINE HAVING THE ENGINE STARTING DEVICE

SUMMARY OF THE INVENTION

The invention provides means for increasing the efficiency of a starter battery for a starter motor of an internal combustion engine. By replacing a lead-acid starter battery with a lithium base or lithium-iron-phosphate ($LiFePO_4$ or LiFePO) or $LiFeMgPO_4$ or $LiFeYPO_4$ cell, the needed capacity, weight and size is drastically reduced while increasing the cycle life, calendar life and turn around efficiency for a starter battery. The lithium iron phosphate ($LiFePO_4$) cell is a type of rechargeable cell, specifically a lithium ion cell, which uses $LiFePO_4$ as a cathode material. It may also include magnesium or yttrium in the lithium iron compound. Connecting four cylindrical cells in series, each of which has a standard industry

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cell format size of both 18650 (less than 3Ah) or 26650 (less than 4Ah), or prismatic flat or other type cells, enough current is available to penetrate to a starter motor rated for 12V system to start large IC engines that use 1, 2, 3, 4, 5, 6, 8, or 12 cylinders. Larger cells may be utilized in the invention, from 1 Ah to 5000 Ah, common sizes being 5Ah, 10Ah, 20 Ah, 50Ah, 100Ah, 400Ah, and 500 Ah.

With a configuration of 4 cells in series, no protection circuit board is needed to protect the individual cells from over-voltage or undervoltage, unlike larger system using more cells which require a protection circuit board in them for safety protection. Individual cell balancing is also not needed for such a small starter battery but may be included to increase the product life. A smaller and lighter starter battery increases the performance of mobile systems that use starter batteries. The resulting increase of cycle life and calendar life reduces user costs.

No separate nor special charging system is needed with the invented system

The invention also comprises a housing for the lithium-based cells, with upper and lower mating casings, a contoured pad within the lower casing for receiving at least one lithium-based cell, and electrical connections from the at least one lithium-based batter to the exterior of the housing. Optionally, an upper battery pad may be placed in the upper casing, and, if desired, a protection circuit board, such as a balancing board or a cut-off circuit, may be placed within the upper casing for safety protection.

The invented solid state switch apparatus allows current to flow in one direction and not the other. A minimum of two solid state switches are arranged in a unique configuration, which allows current to flow in a controlled manner bidirectionally when needed. This is particularly useful for preventing overcharging or over- discharging an entire battery pack. A separate cell balancing circuit is used to balance out the individual cells. The solid state switch can be used on each individual cell, if desired, to prevent overcharging or over-discharging of the individual cell. It can be used with any battery application in which charging and discharging is required, and is particularly useful with lithium-based batteries. It can also be used with lead-acid batteries, nickel-cadmium (NiCd) batteries, and low self-discharge nickel metal hydride (NiMH) batteries. More sophisticated items of equipment to which a battery may be attached have programmable shut-off settings, but less sophisticated equipment does not have shut-off parameters in place. Using a battery in a starter applications (for instance, to start an IC engine) will prevent the battery from overcharging, as well as prevent the battery from being discharged to too low a level if a current drain (leakage) is present in the system, even though everything is turned off.

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By connecting the "Sources" or the "Drains" together using a minimum of two solid state devices allows for automation and simplification to fully and partially switch the batteries power terminals ON and OFF. The two solid state devices can either be N or P type and connected either on the Positive or Negative side of the battery terminal and controlled by simple electronic circuit to control the drivers of the solid state devices.

This invented switch configuration also allows for short circuit protection across the battery power terminals, along with allowing the maximum current control when charging.

OBJECTS OF THE INVENTION

The principal object of the present invention is to provide means for increasing the performance of a starter battery for a starter motor of an internal combustion engine.

Another object of the invention is to provide a starter battery for an internal combustion engine that is lighter, more reliable, has less bulk, longer cycle life, longer calendar life, and higher turn around efficiency than lead-acid batteries.

A further object of this invention is to provide a starter battery system for an internal combustion engine that is easy to assemble, waterproof, and maintenance free.

Another object of the invention is to provide a starter battery for an internal combustion engine that can be used in existing vehicles.

Another object of the invention is to provide a starter battery for an internal combustion engine that has a wide operating temperature range with exceptional cold-weather cranking performance.

Another object of the invention is to provide an improved apparatus for protecting a single cell or battery from being overcharged or over-discharged.

Another object of the invention is to provide apparatus for charging a cell having a very low charge.

Another object of the invention is to provide apparatus for short circuit protection for one or more cells or batteries.

Another object of the invention is to provide apparatus for discharging a cell having too high a charge.

A further object of the invention is to provide an apparatus for short circuit protection in case a metal object causes a short circuit across the terminals.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects will become more readily apparent by referring to the

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following detailed description and the appended drawings in which:

Figure 1 is an exploded isometric view of one embodiment of the invention, in which 4 cells are arranged into a starter battery pack.

Figure 2 is an exploded isometric view of another embodiment of the invention, in which 8 cells are arranged into a starter battery pack.

Figure 3 is an exploded isometric view of another embodiment of the invention, in which a prismatic cell is arranged into a starter battery pack.

Figure 4 is a front view of the assembled battery pack of Figure 3, the rear view being identical.

Figure 5 is a top view of the assembled battery pack of Figure 3.

Figure 6 is a right end view of the assembled battery pack of Figure 3, the left end view being a mirror image thereof.

Figure 7 is a schematic diagram of a block of 4 lithium prismatic cells in series connected to a balancing circuit board.

Figure 8 is a schematic diagram of a block of 4 lithium prismatic cells in series connected to a balancing and cutoff circuit board

Figure 9 is an isometric view of an alternative embodiment of a housing showing contacts for switches.

Figure 10 is a top view of the housing of Figure 9 showing the contact locations.

Figure 11 is a front view of the housing of Figure 9, the rear view being identical.

Figure 12 is an end view of the housing of Figure 9, the opposite end being identical.

Figure 13 is an exploded isometric view of an alternative embodiment of the invention of Figure 3, in which 2 blocks of prismatic cells and a control board of cutoff switch are arranged into the housing of Figure 9.

Figure 14 is a schematic diagram of a Solid State Switch with "Drain" connection.

Figure 15 is a schematic diagram of a Solid State Switch with "Source" connection.

Figure 16 is a schematic diagram showing a preferred embodiment of the invention in which the "Drain" of each gate is connected together using N type MOSFET or IGBT with the cells being above the solid state switches.

Figure 17 is a schematic diagram example of connecting the "Drain" of each gate together using N type FET, MOSFET, or IGBT with the cells being below the solid state switches.

Figure 18 is a schematic diagram illustrating connecting the "Source" of each gate together using N type FET, MOSFET or IGBT with the cells being above the solid state

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switches.

Figure 19 is a schematic diagram illustrating connecting the "Source" of each gate together using N type FET, MOSFET or IGBT with the cells being below the solid state switches.

Figure 20 is a schematic diagram illustrating connecting the "Drain" of each gate together using P type FET, MOSFET or IGBT with the cells being above the solid state switches.

Figure 21 is a schematic diagram illustrating connecting the "Drain" together using P type FET, MOSFET or IGBT with the cells being below the solid state switches.

Figure 22 is a schematic diagram illustrating connecting the "Source" together using P type FET, MOSFET or IGBT with the cells being above the solid state switches.

Figure 23 is a schematic diagram illustrating connecting the "Source" together using P type FET, MOSFET or IGBT with the cells being below the solid state switches.

Figure 24 is a schematic diagram illustrating the invention utilized in engine restarting.

Figure 25 is a schematic diagram illustrating short circuit protection of a battery.

DETAILED DESCRIPTION

Lithium containing LiFePO, $LiFePO_4$, $LiFeMgPO_4$, and $LiFeYPO_4$ cells have a low nominal cell voltage (3.2V-3.3V) that match directly with existing 12V lead-acid equivalent systems. Four LiFePO cells in series have a nominal voltage of 13.2V. Thus they can directly replace existing 12V lead-acid equivalent systems without requiring any electrical modification.

Other lithium chemistries have a higher nominal voltage, such as: lithium-cobalt (3.6V), lithium-manganese (3.7V-3.8V), lithium-nickel-cobalt-manganese (3.7V). Each of these thus have a higher system voltage when 4 cells are used in series. With the higher cell voltages, most existing 12V direct replacement systems will not be able to charge other lithium cell chemistries above 60% of their capacity. Other lithium-based cells that can be utilized in this invention are lithium-cobalt-oxide ($LiCoO_2$), lithium-manganese-oxide ($LiMn_2O_4$), lithium-nickel-cobalt-manganese-oxide ($LiNiCoAlO_2$), lithium-nickel-manganese-cobalt-oxide ($LiNiMnCoO_2$), and lithium-titanate ($Li_4Ti_5O_{12}$).

LiFePO, $LiFePO_4$, $LiFeMgPO_4$, and $LiFeYPO_4$ cells also have a higher thermal runaway condition than lead-acid cells. For a thermal runaway to occur, the cell temperature must be extremely hot (over 200°C). When a cell reaches a certain temperature, mostly caused by overcharging, then the cell will start producing more heat by an internal reaction

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that fuels itself in most cases with a fire, which phenomenon is known as "thermal runaway". All other Lithium cell chemistries have a lower thermal runaway temperature making those cells more prone to catch on fire.

A thermal venting cap is usually placed inside each individual cylindrical cell casing to minimize the chances of explosion. The venting cap allows the electrolyte of a cell to leak out before an internal fire can occur.

Although it is advantageous to use protective circuitry, it is possible to operate the present invention without protective circuitry, which simplifies the system to allow charging or discharging. Omitting all of the electronic protection circuitry for upper voltage cut-off (overcharging), lower level voltage cut-off (over discharging) and temperature measurements reduces the overall manufacturing cost of the starter battery. This also simplifies the system to allow charging or discharging in all conditions and not be restricted by any suggested or specified operating range.

By using lithium cells, a battery housing structure is both smaller and lighter than with lead-acid cells. Any time less internal mass is involved the housing structure size can be reduced, which also results in reducing cost.

The housing structure of the embodiment of Figures 1 and 2 may vary in depth to accommodate varying numbers of cells which provides for different capacity. The lid structure of the housing (or casing) for cylindrical cells is the same for most battery packs, as shown. Such cells can be stacked in parallel to allow for larger capacity for different battery packs to be assembled. The lid of the housing also incorporates a threaded bushing made from aluminum to minimize weight, but that has similar electrical properties to aluminum, copper or brass, or an internally threaded hole to receive an electrical connector screw.

Referring now to the drawings, and particularly to Figure 1, the invented battery pack 10 comprises a housing12, having a lower receptacle 14 and a mating top 16, at least one lithium-based rechargeable battery 18, or cell, within the housing, with appropriate electrical connections. The total discharging amount of each lithium-based cell in the battery pack is one (1) to 5000 Ah, and charging voltage per one cell is 3.0 to 4.2 V.

The lower portion of the housing 16 can be provided with bottom padding 20 which fits therein, receives the cell or cells, and mates with the lower receptacle 14. A top pad 22 can be provided in the top 16 of the housing, as desired.

Electrical connections 24 are provided between the cells, as shown, positive to negative, with screws 26 connecting the cells through holes 28 the bottom of the housing to electrical leads, not shown, but which leads connect to bottom screws 30. Alternatively, a

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welded connection can be used instead of screws.

Optionally, a protection circuit board 32 may be placed within the upper casing or top 14 for safety protection. Such a protection circuit board may be a cutoff board or a cell-balancing circuit board. A cell-balancing circuit board may include a cutoff function. A lithium iron battery having two or more cells in series has a battery voltage equal to the sum of the individual cell voltages. Over the life of the battery, it may be charged and discharged for hundreds or thousands of cycles. The individual cells may age differently. Some cells may become mismatched with respect to the others. This phenomenon is corrected, by balancing. Balancing is the process of forcing all of the cells to have identical voltages. This is accomplished by a balancing circuit.

Starter battery systems can utilize a greater number of lithium cells as desired for greater capacity.

Lithium cells have substantially less weight than a lead-acid cell, and are 80% smaller. A lithium cell will last about 3 times as long as a lead-acid cell with 100% full discharge cycles. Lithium cells are maintenance free, whereas lead-acid cells need to be refilled with distilled water to maintain the acid level above the plates. Lithium cells do not freeze. They have a discharge power 8 times that of lead-acid. Their charging time is less than 2 hours.

Lithium cell self discharge rate is less than 2% monthly, whereas the self discharge rate for a lead-acid cell is 10% monthly.

Lithium cells can operate at very high temperature, up to 70°C without major degradation. They can also operate at very low temperature, down to -30°C with slight capacity degrade at that temperature, but power is available.

Lithium cells are 98% energy efficient (energy going in and out of the cell), whereas lead-acid cells are only 90% energy efficient.

For each 12 volt increment, four $LiFePO_4$ cells are required in series, and some cases fewer cells with other lithium chemistries. The following Table I compares lead-acid battery voltages to the $LiFePO_4$ cell requirements and for other lithium-based battery cells:

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TABLE I

Nominal Lead-Acid Voltage	$LiFePO_4$ (3.3V nominal)	$(LiCoO_2)$, $(LiMn_2O_4)$, $(LiNiCoAlO_2)$, $(LiNiMnCoO_2)$, or $(Li_4Ti_5O_{12})$ (3.7V nominal)
12V	3 to 4 cells in series	2 to 4 cells in series
24V	5 to 9 cells in series	5 to 8 cells in series
36V	8 to 13 cells in series	7 to 12 cells in series
48V	11 to 17 cells in series	10 to 16 cells in series
60V	14 to 22 cells in series	12 to 19 cells in series
72V	16 to 26 cells in series	15 to 23 cells in series
84V	19 to 31 cells in series	17 to 27 cells in series
96V	22 to 35 cells in series	19 to 31 cells in series
108V	25 to 39 cells in series	22 to 35 cells in series
120V	27 to 44 cells in series	24 to 39 cells in series

As shown in Figures 3 through 6, a block 40 formed of one or more flat prismatic cells connected in series is fitted into a housing 12, each block of cells having a common set of electrical connections 42A and 42B. A protection circuit board 30 is provided within the housing, and is electrically connected to the block. Figures 4 through 6 show the assembled housing with the electrical connections 24A and 24B in the top thereof.

Figure 7 shows a block of 4 flat lithium based prismatic cells connected to a balancing circuit board 46, which has a balancing controller or microprocessor 60. Figure 8 shows a block of 4 flat prismatic cells connected to a balancing and cutoff circuit board 48, which includes a controller 60 and a solid state cutoff switch 62, such as an FET. Figures 9 through 12 show the housing 12 for the battery pack 10 with positive terminal 34 and negative terminal 36.

Figure 13 shows multiple blocks 40 of flat cells along with bottom padding, packing, or spacers 50, flat packing 52, and large packing blocks 54, all of which packing is optional. The upper portion or top section 56 of the housing is advantageously provided with three contacts on each end thereof, as shown.

An auto-detect restart feature is especially useful for a motorcycle: "IQ Restart technology" protects the battery from a deep cycle discharge by monitoring battery voltage level and shutting the battery power off prior to a full discharge, such as in the case of leaving

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a headlight or electrical component on for an extended period of time while the engine is off. Enough reserve power is left in the battery, to automatically detect (by measuring a change in resistivity) a starting effort and allow the user to start the engine again. This avoids the cyclist being stranded or the headache of replacing a battery. The auto-detect apparatus has at least one lithium-based cell, a voltage detector, an associated switch such as a cutoff board, or a micro-controller in a balancing circuit connected to a solid state switch, such as an FET. One function turns off an FET in the circuit when the voltage drops to a preselected level, leaving sufficient reserve capacity for starting the engine. A second function detects a "keying cycle" or the resistance change upon attempting to start the engine, which turns on the FET. This resistance change is a reaction to a key turn, push button, or remote activator.

To control the solid state switches, electronic controls are needed for the different voltages, currents and/or temperature with specified parameters in which cells work to prevent damage. The control electronics used in battery systems are often referred to a Battery Management System (BMS) or Battery Management Unit (BMU). The BMS or BMU can individual monitor all the cell or battery voltages, and/or temperatures. To protect a single cell or battery from being over charged, that might lead to an exothermal runaway reaction creating a fire and/or to prevent the cell from damaging when discharging them too low, the solid state switch would close or open the current pathway to prevent cell damage from occurring.

The arrangement of devices shown in Figures 15 and 16 are examples of how solid state switches can be configured to connect the "Drains" or "Sources" together which is an unconventional approach. The solid state switches in parallel are examples to increase the current capabilities.

Referring particularly to Figure 17, under normal operations both T1 and T2 are ON allowing power pathway to go in both directions: discharge and charge. Should a cell be outside of its specified working specification (cell voltage), both D1 and D2 can be turned off but current can still flow through the internal diode to allow for added functionality.

In the event that the cell voltage drops too low, below the set voltage configuration, from a drain on the battery, T1 will turn off, preventing further discharge from occurring. However, with the internal diode in place of T1, and T2 still on, the circuit will allow charging to occur.

If the cell voltage goes too high, above the set voltage configuration, T2 will turn off, preventing further over charging from occurring. However, with the internal diode in place of T2, and T1 still on, the circuit will allow discharging to occur.

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Using solid state switching in the configuration shown in Figure 17 allows for user friendly reactivation of the circuit without any pushbuttons or reset buttons. Both Charge and Discharge current can go through the internal MOSFET or IGBT diode to bring the cell back to the specified operating voltage.

Alternative switch and gate arrangements are set forth in Figures 18 through 23. Each such arrangement works in a similar manner as that describing the Figure 17 operation.

The invention's restart function is illustrated by Figure 24. Controller 60 is connected to a battery pack having a block of cells 64 and to MOSFETs Q1 and Q2. After a low voltage cutoff, the controller periodically tests the load to detect a change in the load impedance. When an abrupt change in the load impedance is detected, for example connecting or disconnecting a load such as the headlight(s), the ignition switch, or the starter switch, the controller 60 turns on power MOSFETs Q1 and Q2, which reconnects the battery to the vehicle and allows the vehicle to be restarted.

When the controller drives the base of Q3 high through R1, Q3 and Q4 turn on. When Q4 turns on, it connects the battery to the load through R4 and D1. R4 and the load impedance form a voltage divider, and the resulting voltage at node A will depend on the load impedance. D2 steers the node A voltage to the R5/R6 voltage divider which scales down the voltage at node B to a level that the controller can read using an analog-to-digital converter (ADC). The ADC may be of the type commonly included as a built-in peripheral in a micro-controller or a digital signal processor; alternatively the ADC may be a standalone device. After turning on Q4, the controller may make one or more ADC readings after one or more fixed or variable delay periods. By reading the ADC at different times after turn-on, the controller can infer not only the resistive, but also the inductive and/or capacitive components of the load impedance. By tracking the periodic ADC readings and applying the appropriate digital filtering, abrupt changes in the load impedance can be determined. Gradual changes in the ADC readings, which may be caused for example by temperature changes or battery charge depletion, are disregarded (i.e., filtered out). Immediately after making the required ADC reading(s) the Controller turns off Q3 and Q4 to minimize battery drain. It should be noted that while Q3 and Q4 are shown here as bipolar junction transistors, a number of other types of electronic devices could be used to accomplish the switching function of Q4, including but not limited to one or more MOSFETs or a relay.

In order to conserve battery charge as long as possible in low voltage cutoff mode, the controller tests the load impedance only as often as necessary. The testing period is determined by the application, and is approximately 1 to 5 seconds. In a vehicle application,

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this period represents the maximum time that a user would have to hold a starter switch in the start position in order to effect a restart after a low voltage cutoff. To further reduce drain on the battery, the testing period may be extended if the battery remains in low voltage shutdown mode for a long time, or if the battery voltage (in one or more cells) continues to drop.

The invention is useful for short circuit protection as shown in Figure 25. Cross-coupled NAND gates E and F form a set-reset (SR) latch that controls the gate drive of power MOSFET Q2. The latch is set when the controller 60 drives Q2 ENABLE low. When Q2 ENABLE is driven high again, the output of NAND gate G is low and NAND gate H turns on Q3, which turns on Q4, which supplies the boosted gate drive voltage to turn on Q2. C3 and C4 help ensure fast turn-on of Q2 even with the relatively high value resistors for R4, R5, and R8 required to satisfy the application's low power requirements.

Current monitor A monitors the voltage drop across the drain-source ON resistance ($R_{DS(on)}$) of power MOSFET Q1 and sources a current into node B that is proportional to the MOSFET current. R1 converts this current to a voltage that is compared to VREF at comparator D. When a short circuit occurs, the voltage at node B will exceed VREF (at least momentarily) and cause the output of D to go low, resetting the S-R latch. When the S-R latch is reset the output of G will go high, and C2 will differentiate a positive going pulse into the base of Q5, causing Q5 to turn on for a few microseconds and rapidly discharge the gate of Q2. Rapid turn-off of Q2 is essential to limiting the energy associated with a short circuit event. By monitoring the status of the S-R latch, the controller 60 can determine when a short circuit cut-off event has occurred. C1 low pass filters the signal at node B so that extremely short duration overcurrent conditions can be tolerated if desired. The controller 60 may adjust VREF to compensate for Q2's $R_{DS(on)}$ variation with temperature if desired, or to adjust the over current trip threshold.

The solid state switches can be transistors, FET (field-effect transistors), JFET or JUGFET (junction gate field-effect transistors), BJT bipolar junction transistors, CMOS (complementary metal–oxide–semiconductors), VMOS (Vertical Metal Oxide Silicon), TMOS transistors, vertical DMOS (Double-Diffused MOS), or HEXFET.(hexagonal shape MOSFET).

It should be noted that the invented solid state switch apparatus can also be used in any battery system that requires charging and discharging in order to extend the battery life, and for safety. This is extremely useful and is a first for starter batteries.

The solid state devices all must be the same (N) or (P) type used in the same circuit, as illustrated.

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SUMMARY OF THE ACHIEVEMENT OF THE OBJECTS OF THE INVENTION

From the foregoing, it is readily apparent that I have invented an improved means for increasing the performance of a starter battery for a starter motor of an internal combustion engine, and a starter battery for an internal combustion engine that is lighter, more reliable, has less bulk, longer cycle life, longer calendar life, and higher turn around efficiency than lead-acid batteries. The starter battery system for an internal combustion engine is easy to assemble, waterproof, and maintenance free, can be used in existing vehicles, and has a wide operating temperature range with exceptional cold-weather cranking performance. The invention also apparatus for protecting a single cell or battery from being over charged, as well as providing apparatus for charging a cell having a very low charge, more effectively, and more economically than heretofore has been possible.

It is to be understood that the foregoing description and specific embodiments are merely illustrative of the best mode of the invention and the principles thereof, and that various modifications and additions may be made to the apparatus by those skilled in the art, without departing from the spirit and scope of this invention, which is therefore understood to be limited only by the scope of the appended claims.

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What is claimed is:

1. A battery pack for driving an electrical device, said battery pack comprising:
a housing; and
at least one lithium-based rechargeable cell within said housing;
wherein a total discharging amount of each lithium-based cell in the battery pack is from one (1) Ah to 5000 Ah, and charging voltage per one cell is 3.0 to 4.2 V.

2. A battery pack according to claim 1 wherein the lithium-based cell is a lithium iron phosphate cell.

3. A battery pack according to claim 2, wherein the lithium iron phosphate cell is selected from the group consisting of LiFePO, $LiFePO_4$, $LiFeMgPO_4$, and $LiFeYPO_4$ cells.

4. A battery pack according to claim 1 wherein the lithium-based cell is selected from the group consisting of $LiCoO_2$, $LiMn_2O_4$, $LiNiCoAlO_2$, $LiNiMnCoO_2$, and $Li_4Ti_5O_{12}$ cells.

5. A battery pack according to claim 1, wherein said battery pack comprises four lithium-based rechargeable cells in series in said housing.

6. A battery pack according to claim 1, wherein said battery pack comprises an even number of lithium-based rechargeable cells in said housing.

7. A battery pack according to claim 1 wherein said electrical device is an internal combustion engine starting device connected to an internal combustion engine.

8. A battery pack according to claim 1, further comprising a protection circuit board within said housing.

9. A battery pack according to claim 8, wherein said protection circuit board is a cut-off board or a cell balancing circuit board.

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10. A battery pack according to claim 9, wherein said protection circuit board is a cut-off board comprising a controller, said controller having associated means for periodically measuring a load to detect a change in load impedance, further comprising a switch between said battery pack and said device, and means for turning on said switch to provide power to the electrical device to restart the device.

11. A battery pack according to claim 9 wherein said protection circuit board is a cut-off board comprising a controller, said battery pack being connected to a current monitor, said current monitor being connected to a current comparator and a set-reset latch,

whereby upon the occurrence of a short circuit, the set-reset latch will turn off an associated switch.

12. Solid state switching apparatus for one or more cells in a battery pack having a positive terminal and a negative terminal, each of said cells having a positive pole and a negative pole, said apparatus comprising:

at least a pair of solid state switches, each switch having a source and a drain, with drains connected;

said solid state switches being connected to the positive pole of said one or more cells in series, and to said positive terminal, the negative pole of said one or more cells being connected to said negative terminal.

13. Apparatus according to claim 12, wherein the solid state switches are MOSFETs or IGBTs.

14. Apparatus according to claim 13, wherein the solid state switches are transistors, FET, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET.

15. Apparatus according to claim 12, wherein the solid state switches are either n-type or p-type.

16. Apparatus according to claim 12, wherein said one or more cells are selected from the group consisting of LiFePO, $LiFePO_4$, $LiFeMgPO_4$, $LiFeYPO_4$, $LiCoO_2$, $LiMn_2O_4$, $LiNiCoAlO_2$, $LiNiMnCoO_2$, $Li_4Ti_5O_{12}$, lead-acid, NiCd, and nickel metal hydride (NiMH) batteries.

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17. Apparatus according to claim 12, further comprising a housing for said one or more cells, batteries, wherein said solid state switches are within said housing.

18. Solid state switching apparatus for one or more cells in a battery pack having a positive terminal and a negative terminal, each of said cells having a positive pole and a negative pole, said apparatus comprising:

at least a pair of solid state switches, each switch having a source and a drain, with sources connected;

said solid state switches being connected to the negative pole of said one or more cells in series, and to said negative terminal, the positive pole of said one or more cells being connected to said positive terminal.

19. Apparatus according to claim 18, wherein the solid state switches are transistors, FET, MOSFET, IGBT, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET.

20. Apparatus according to claim 18, wherein said one or more cells are selected from the group consisting of LiFePO, $LiFePO_4$, $LiFeMgPO_4$, $LiFeYPO_4$, $LiCoO_2$, $LiMn_2O_4$, $LiNiCoAlO_2$, $LiNiMnCoO_2$, $Li_4Ti_5O_{12}$, lead-acid, NiCd, and nickel metal hydride (NiMH) batteries.

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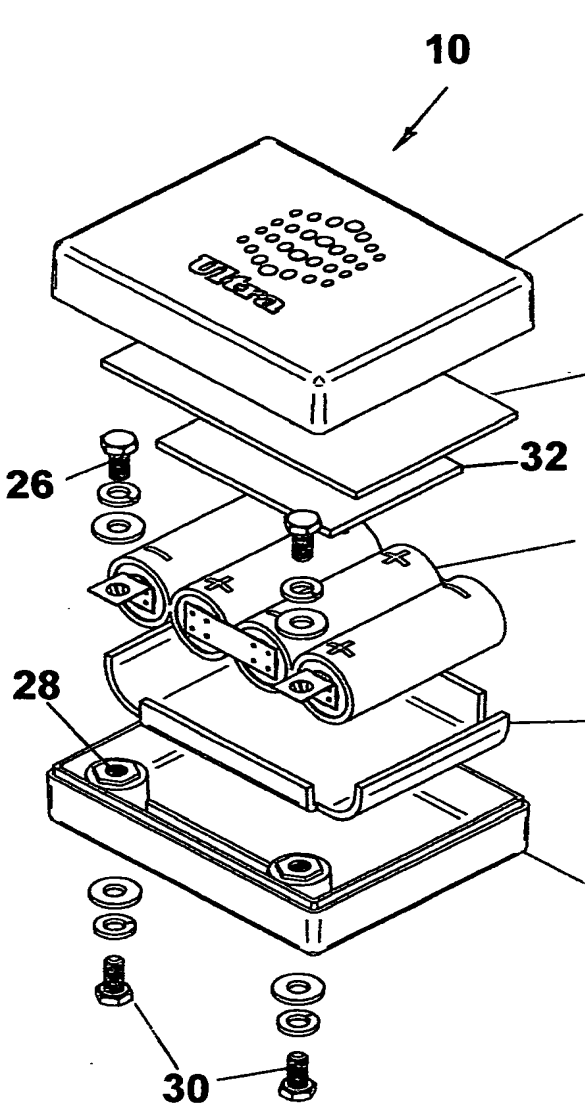


Fig. 1

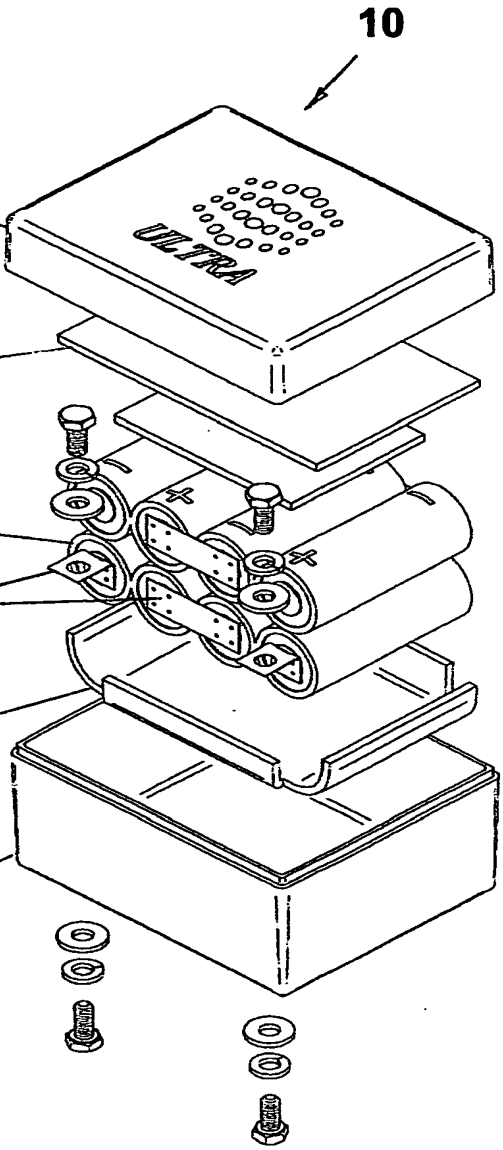


Fig. 2

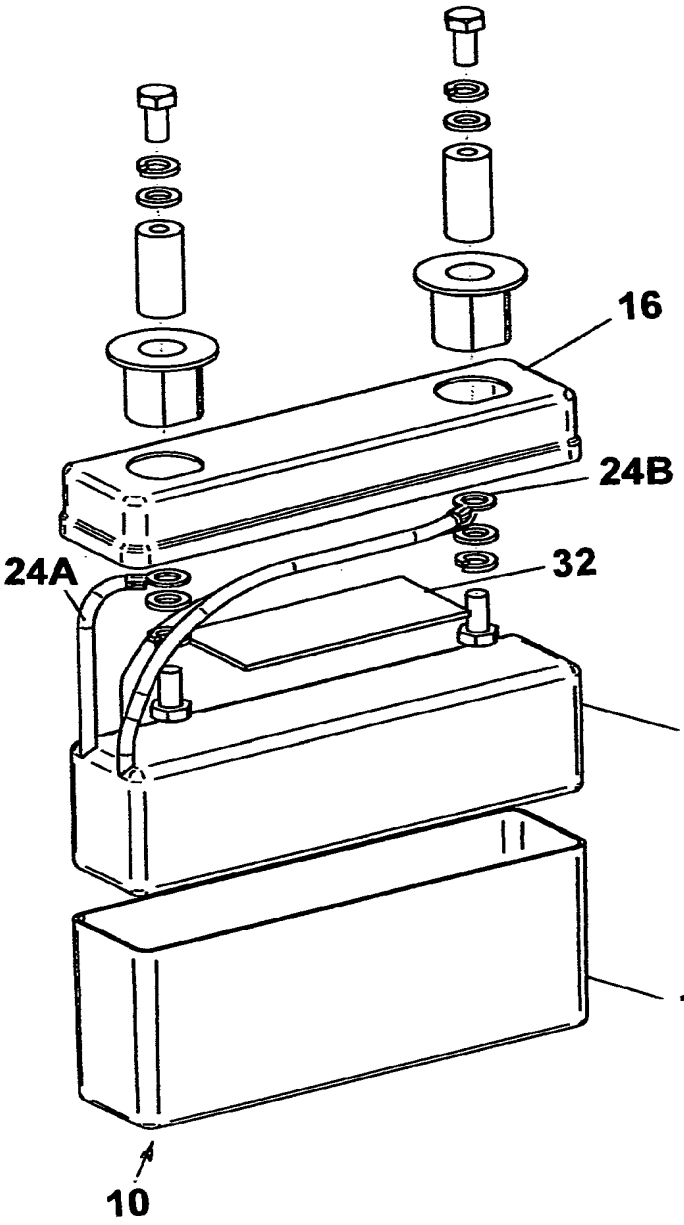


Fig. 3

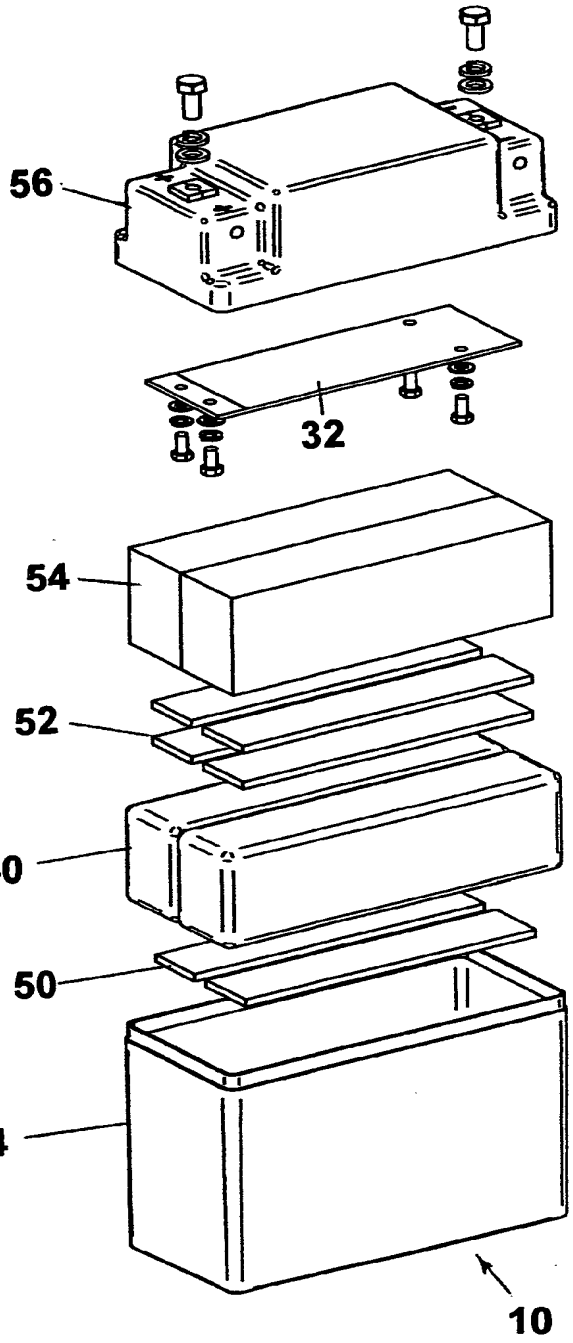


Fig. 13

Fig. 5

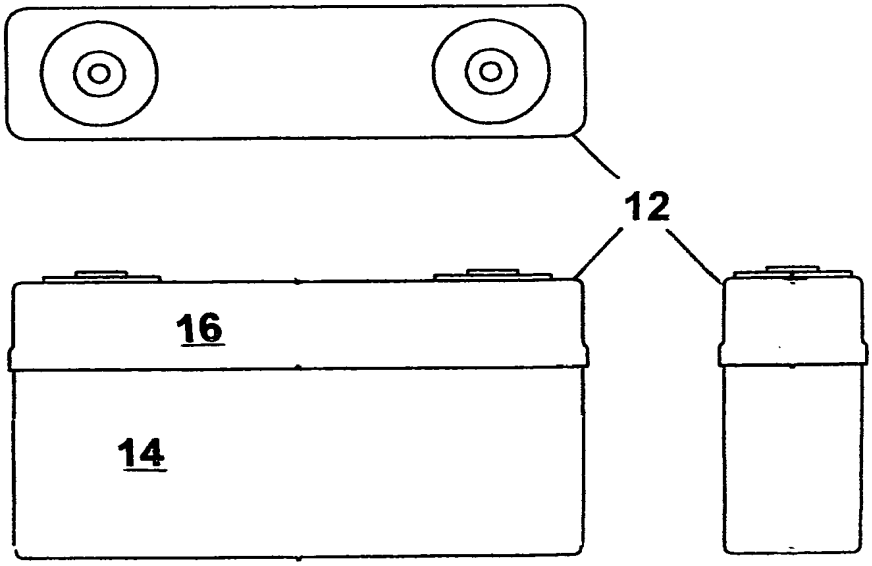


Fig. 4

Fig. 6

Fig. 7

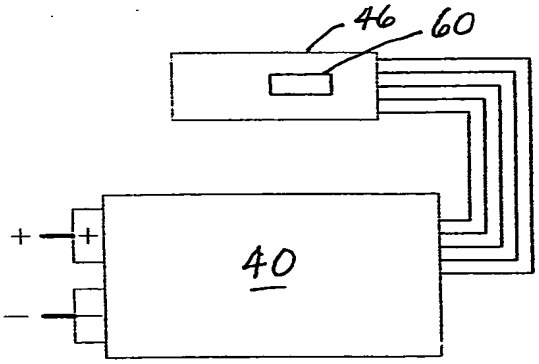
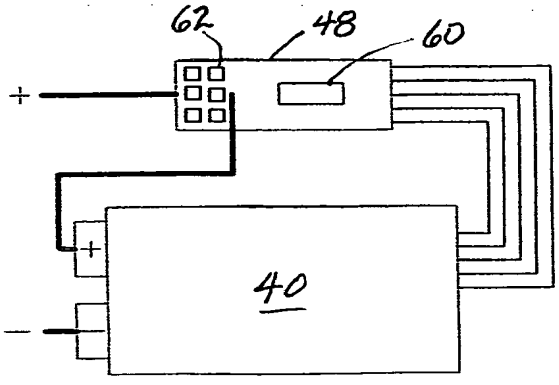


Fig. 8



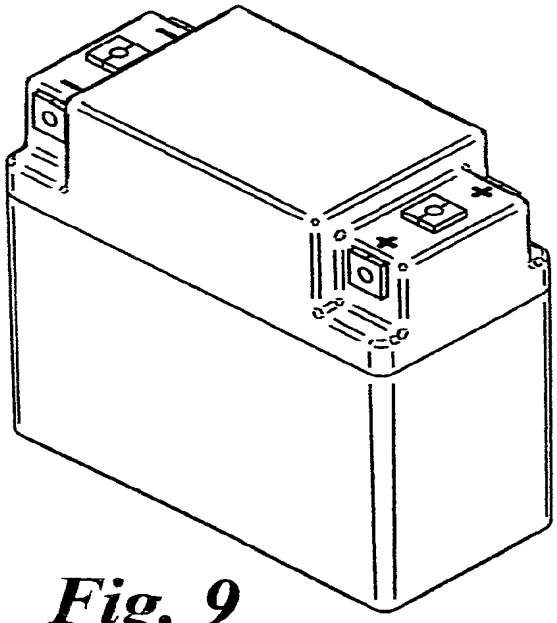


Fig. 9

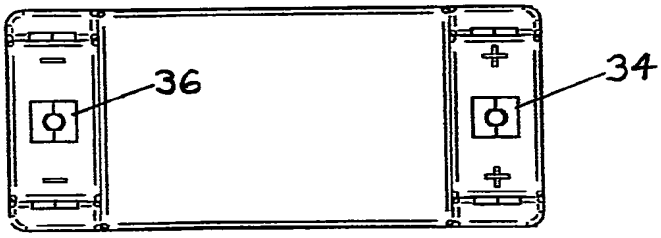


Fig. 10

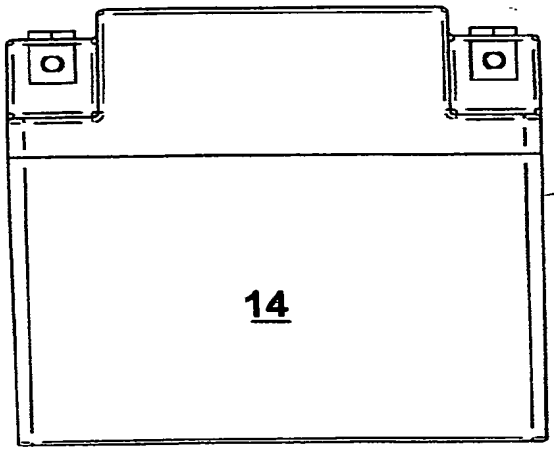


Fig. 11

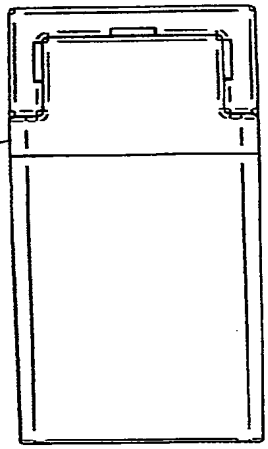


Fig. 12

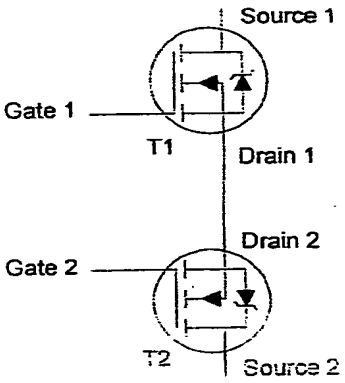


Fig. 14

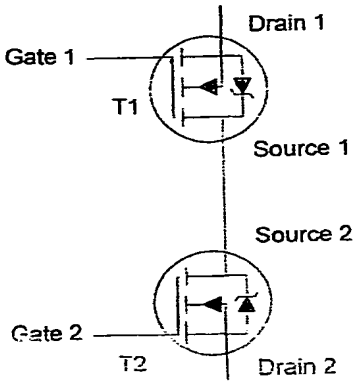


Fig. 15

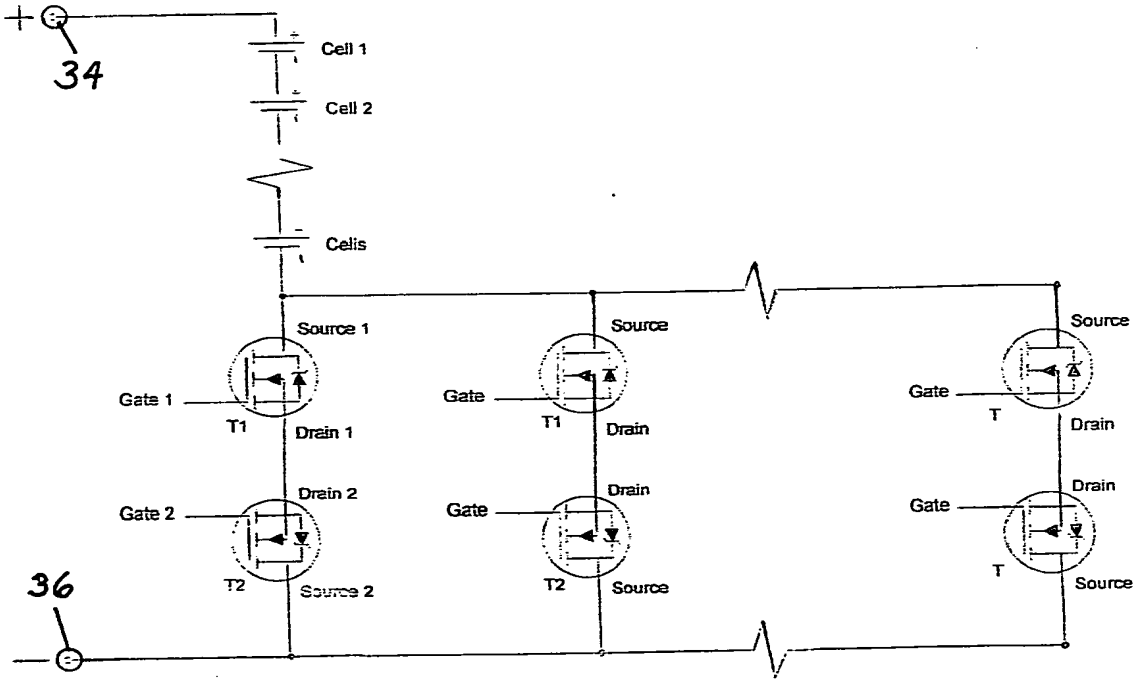


Fig. 16

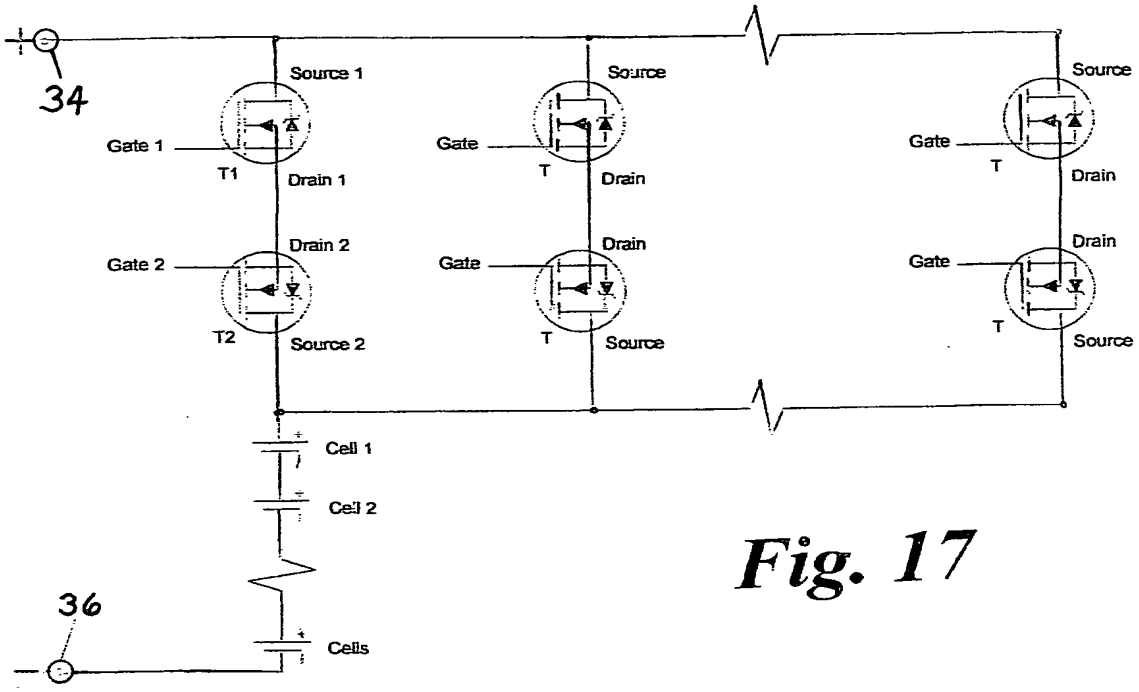

34
Source 1
Gate 1
T1
Drain 1
Drain 2
Gate 2
T2
Source 2
Source
Gate
T
Drain
Drain
Gate
T
Source
Source
Gate
T
Drain
Drain
Gate
T
Source
Cell 1
Cell 2
Cells
36

Fig. 17

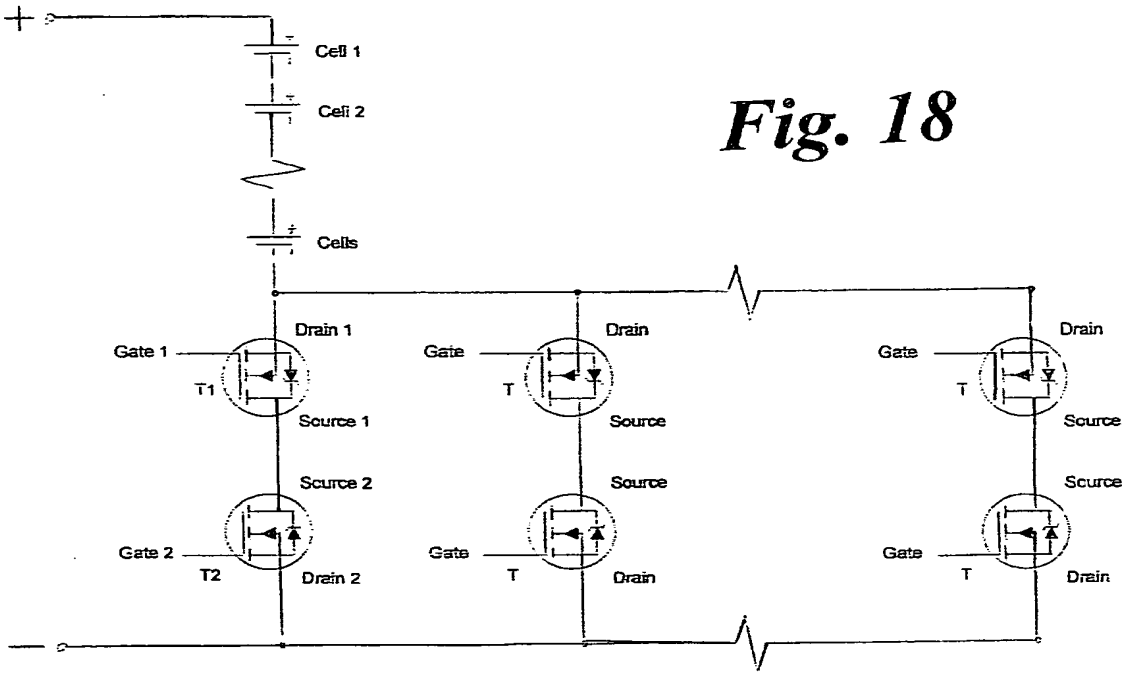

Cell 1
Cell 2
Cells
Drain 1
Gate 1
T1
Source 1
Source 2
Gate 2
T2
Drain 2
Drain
Gate
T
Source
Source
Gate
T
Drain
Drain
Gate
T
Source

Fig. 18

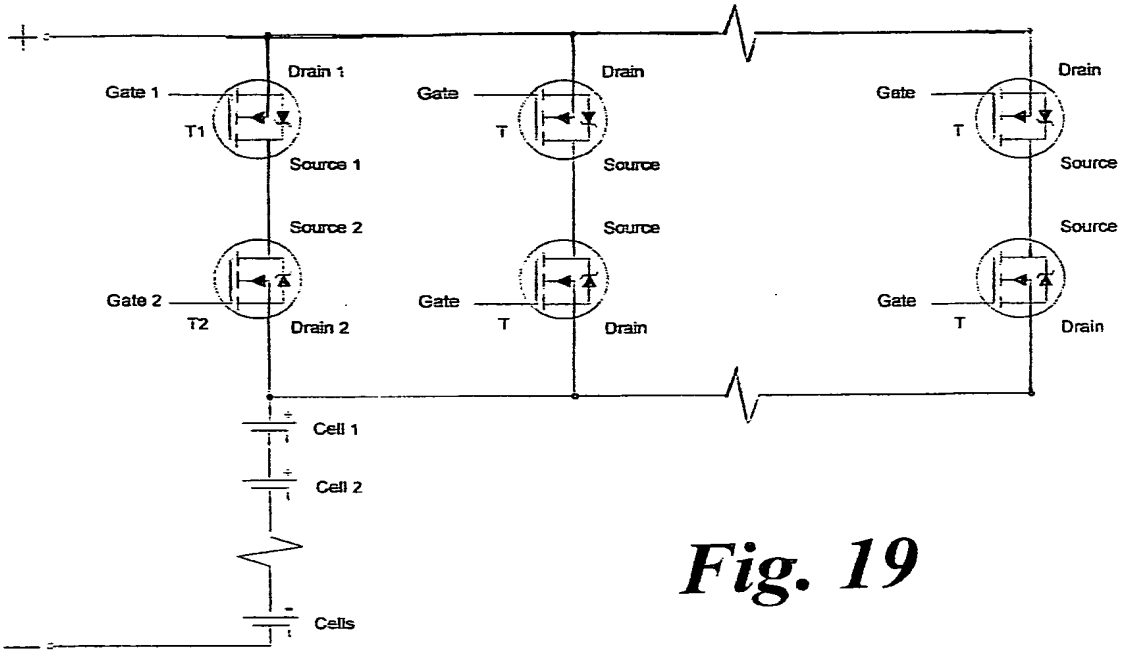

Drain 1
Gate 1
T1
Source 1
Source 2
Gate 2
T2
Drain 2
Gate
T
Drain
Source
Source
Gate
T
Drain
Gate
T
Source
Source
Gate
T
Drain
Cell 1
Cell 2
Cells

Fig. 19

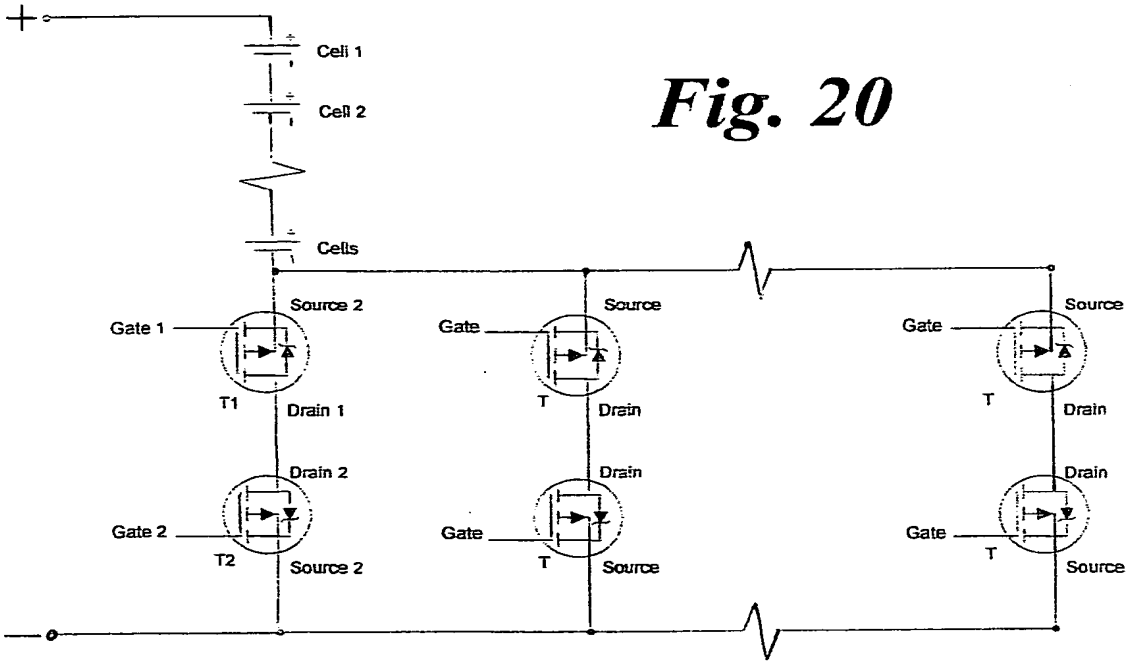

Cell 1
Cell 2
Cells
Source 2
Gate 1
T1
Drain 1
Drain 2
Gate 2
T2
Source 2
Source
Gate
T
Drain
Drain
Gate
T
Source
Source
Gate
T
Drain
Drain
Gate
T
Source

Fig. 20

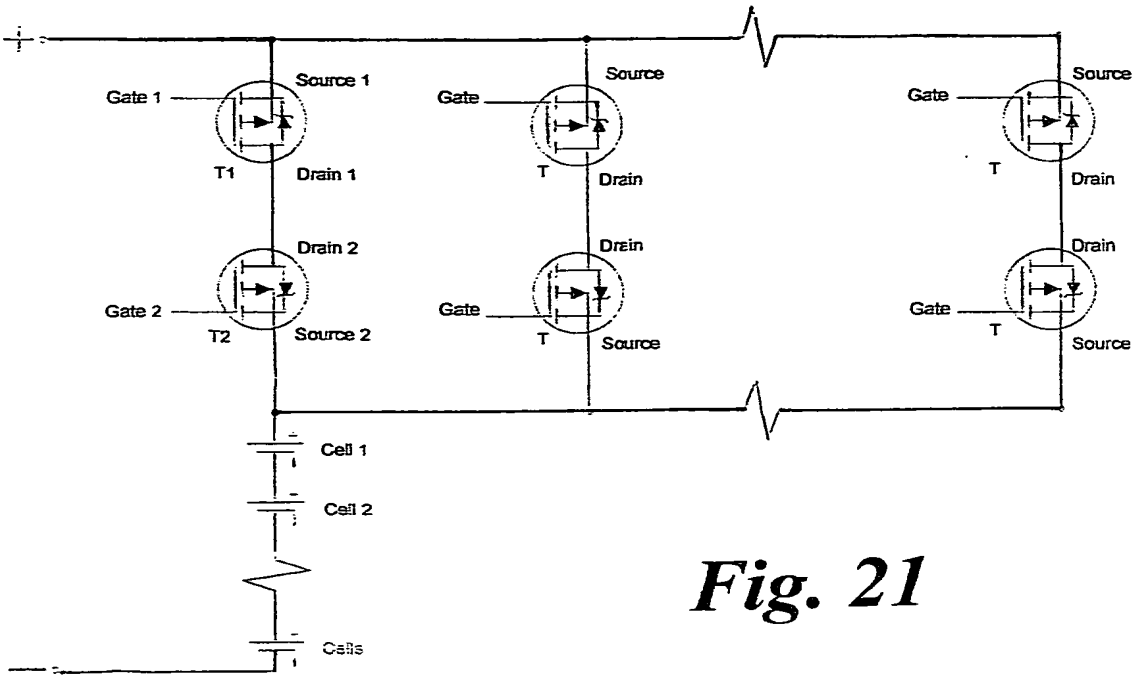

Gate 1
Source 1
T1
Drain 1
Drain 2
Gate 2
T2
Source 2
Gate
Source
T
Drain
Drain
Gate
T
Source
Gate
Source
T
Drain
Drain
Gate
T
Source
Cell 1
Cell 2
Cells

Fig. 21

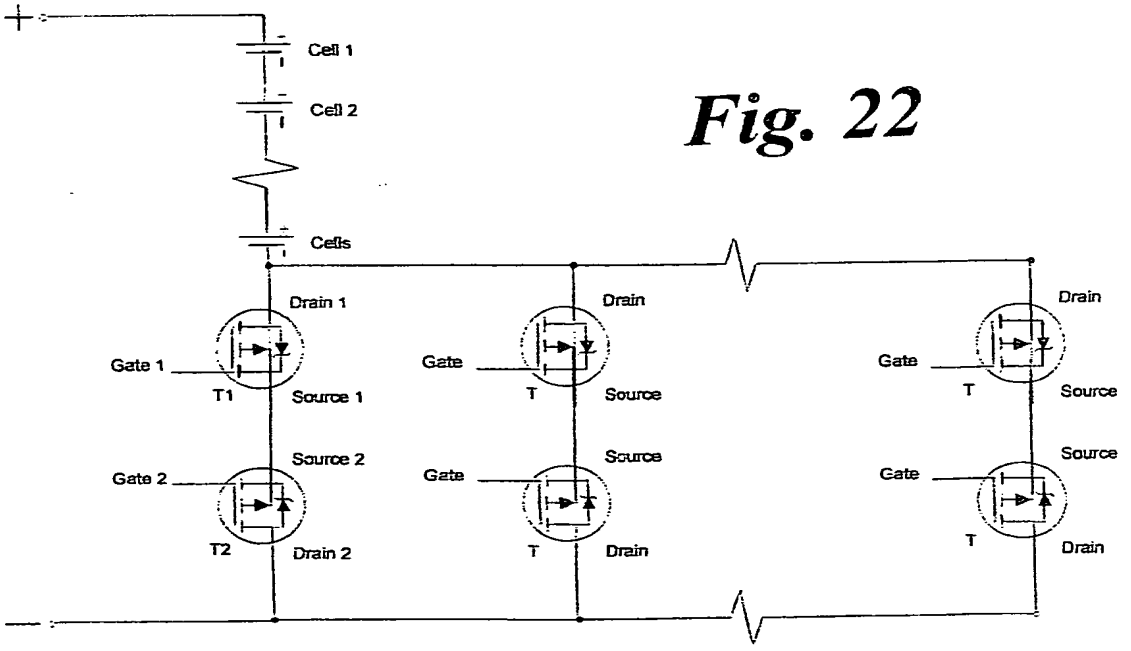

Cell 1
Cell 2
Cells
Drain 1
Gate 1
T1
Source 1
Source 2
Gate 2
T2
Drain 2
Drain
Gate
T
Source
Source
Gate
T
Drain
Drain
Gate
T
Source
Source
Gate
T
Drain

Fig. 22

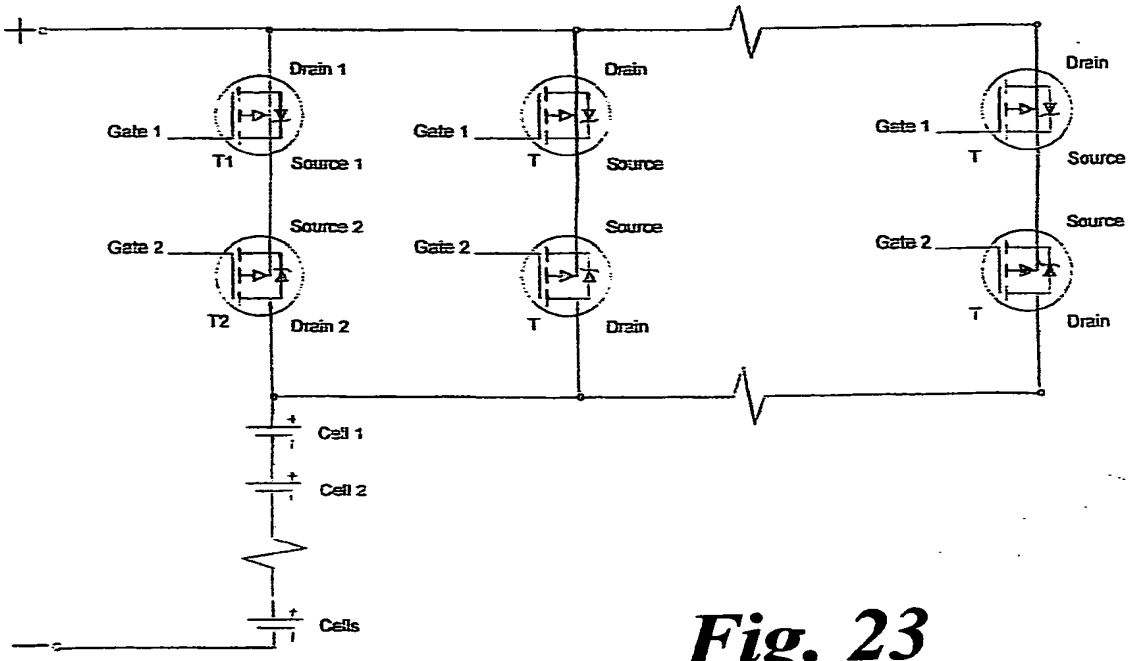

Drain 1
Gate 1
T1
Source 1
Source 2
Gate 2
T2
Drain 2
Drain
Gate 1
T
Source
Source
Gate 2
T
Drain
Drain
Gate 1
T
Source
Source
Gate 2
T
Drain
Cell 1
Cell 2
Cells

Fig. 23

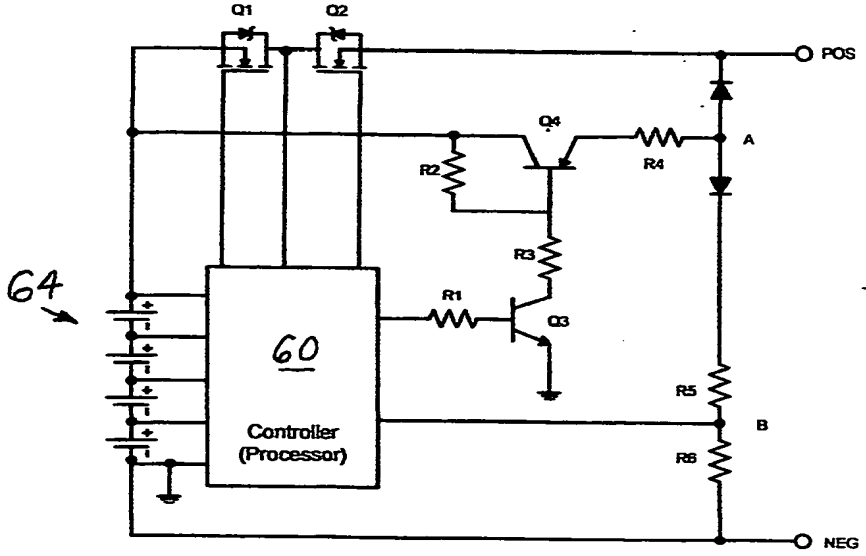

Q1
Q2
POS
Q4
R2
R4
A
R3
R1
Q3
64
60
Controller
(Processor)
R5
B
R6
NEG

Fig. 24

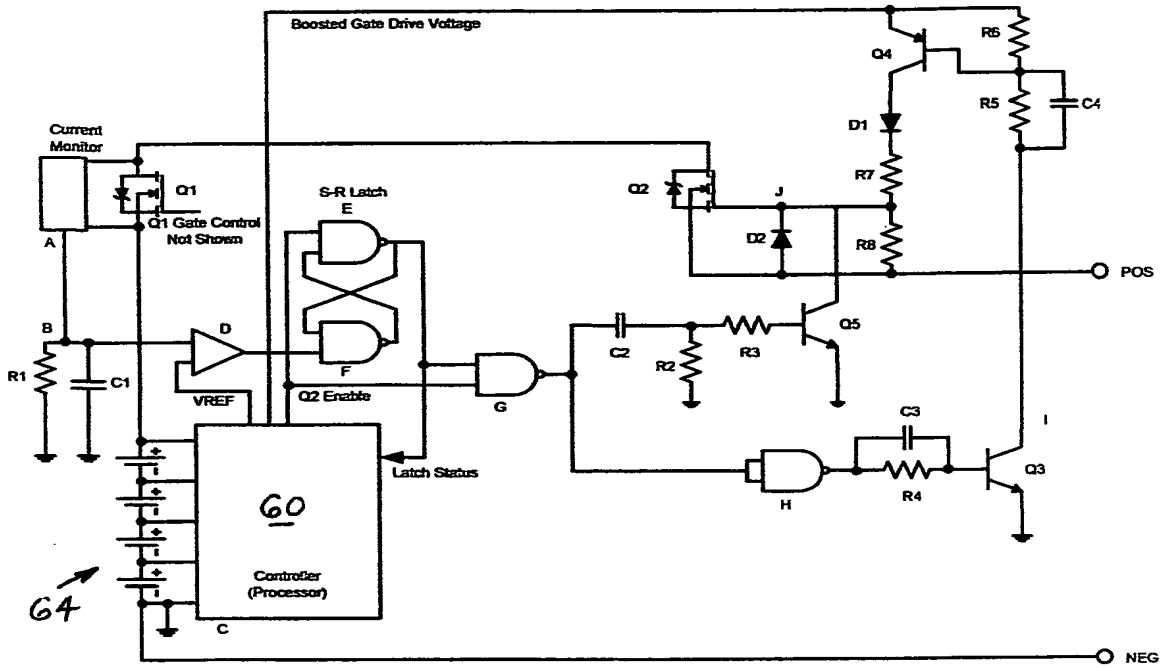

Boosted Gate Drive Voltage
Current Monitor
Q1
Q1 Gate Control Not Shown
A
S-R Latch
E
Q2
J
D2
R7
R8
POS
B
D
F
R1
C1
VREF
Q2 Enable
G
C2
R2
R3
Q5
C3
I
Q3
R4
H
Latch Status
60
Controller (Processor)
64
C
R6
Q4
R5
C4
D1
NEG

Fig. 25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/001937

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H02J 7/00 (2012.01)
USPC - 320/121
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - H01M 10/42, 10/44; H02J 7/00 (2012.01)
USPC - 320/104, 110, 112, 116, 118, 121; 429/50, 122, 149, 150, 153, 322

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/0087280 A1 (MIYASHITA et al) 27 April 2006 (27.04.2006) entire document	1, 6-9
---		---
Y		2-5, 10-20
Y	US 2009/0123813 A1 (CHIANG et al) 14 May 2009 (14.05.2009) entire document	2-4, 16, 20
Y	US 5,635,821 A (SMITH) 03 June 1997 (03.06.1997) entire document	5, 11-20
Y	US 2007/0080662 A1 (WU) 12 April 2007 (12.04.2007) entire document	10

☐ Further documents are listed in the continuation of Box C. ☐

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 March 2012	26 MAR 2012
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

USB Battery Charging 1.2 Compliance Plan

Revision 1.0

October 12, 2011

ADC EX1002
IPR2025-00885
GAR-RPA-ITC-05076

Revision History

Revision	Issue Date	Author	Comment
1.0	Oct 26, 2011	Pat Crowe	First release

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Wen-Hwa Chou	Terminus Technology
Ivo Huber	Texas Instruments
Jean Picard	Texas Instruments
Pasi Palojarvi	Texas Instruments
Steven Tom	Texas Instruments
Ed Beeman	USB-IF
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1 Introduction

1.1 General

This compliance plan enables test and certification of USB Portable Devices, Chargers and Charging Ports, Micro-ACAs, Standard-ACAs and ACA-Docks to USB 2.0 specification and to Battery Charging specification revision 1.2.

Charging Ports include Dedicated Charging Ports and Charging Downstream Ports as defined in the Battery Charging Specification revision 1.2. A USB Charger is a device with a Dedicated Charging Port, such as a wall adapter or car power adapter. Herein, USB Chargers are referred to as Dedicated Charging Ports as functionally they are identical.

Previously a USB Portable Device with a battery and charging capability simply took power from a USB port without any control. With BC 1.2, a Portable Device can get more power and the battery can be charged faster. It is important to verify that a Portable Device complies with the BC 1.2 specification while communicating with a Charging Downstream Port and identifying a Dedicated Charger, and ensuring that it continues to operate as a functional USB device.

Many existing dedicated chargers have offered a USB compliant physical connection but lacked a USB compliance program. This led to many chargers having characteristics incompatible with USB specifications.

As well, even though PC host ports go through an extensive certification process, future PCs that claim a USB compliant Charging Port in their feature list will be required to pass compliance checks described in this document. These checks are in addition to those required for a USB compliant Standard Downstream Port.

1.2 Objective of the Compliance Program

The overall objective of the USB Charger and Charging Port compliance program is to mirror the effectiveness of the USB-IF compliance program. The benefits of a compliance program have been proven by the USB initiative: the proliferation of knowledge, more stringent testing, and a higher standard of quality.

1.3 Scope of the Document

This document provides a compliance plan applicable to Portable Devices, USB Chargers and Charging Ports, Micro-ACAs, Standard-ACAs and ACA-Docks, as defined in the BC 1.2 specification.

1.4 Intended Audience

This plan is intended for compliance test labs and workshops. In addition, the document is intended for device manufacturers for pre-certification activities before applying for official compliance certification.

1.5 Reference Document(s)

- Battery Charging 1.2 Specification and Adopters Agreement
  http://www.usb.org/developers/devclass_docs/

- Universal Serial Bus Specification Revision 2.0 Specification
  http://www.usb.org/developers/docs/

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2 Acronyms and Terms

This chapter lists and defines terms and abbreviations used throughout this document.

ACA	Accessory Charger Adapter
BC 1.2	USB-IF Battery Charging Specification version 1.2
CDP	Charging Downstream Port
CMO	Common Mode Offset
CMV	Common Mode Voltage
DBP	Dead Battery Provision
DC	Direct Current
DCD	Data Contact Detect
DCP	Dedicated Charging Port
ETB	Electrical Test Board
FS	Full-speed
HS	High-speed
ID	Identification
LS	Low-speed
MRP	Multiple Role Port (CDP/DCP/SDP)
OTG	On-The-Go
PC	Personal Computer
PD	Portable Device
PET	Protocol and Electrical Tester
PHY	Physical Layer Interface for High Speed USB
PS2	Personal System 2
SDP	Standard Downstream Port
SIE	Serial Interface Engine
SRP	Session Request Protocol
TID	Test Identification Number
TPL	Targeted Peripheral List
USB	Universal Serial Bus
USBCV	USB Command Verifier
USB-IF	USB Implementers Forum
UUT	Unit Under Test
VBUS	Voltage line of the USB interface

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3 Scope of Tests

This document describes suites of tests for a number of product types. These tests only cover the additional requirements for these products, relating to the functionality of battery charging. Most of the product types will require further compliance testing to ensure their functionality in other areas, and it is beyond the scope of this document to define those tests.

For example, a Portable Device (PD) may be an OTG device and as such, require to be tested according to the appropriate OTG Supplement Compliance Plan.

The document is divided into suites of tests, each of which represents all or part of the Battery Charging test requirements for a particular product. A given product shall be tested against all the appropriate test suites. The following examples, which are not exhaustive, illustrate this principle.

PD

Test against both:

- 'PD, except Dead Battery Provision' tests and
- 'PD, Dead Battery Provision' tests.

Simple Charger

Test against:

- DCP tests

Charging Port on Host

Test against:

- CDP tests

Hub

Test against:

- CDP tests
- DCP tests
- SDP tests
- MRP tests

ACA or ACA-Dock

Test against the one appropriate category from:

- Micro-ACA, Separate Charger
- Micro-ACA, Combined Charger
- Standard-ACA, Separate Charger
- Standard-ACA, Combined Charger
- ACA-Dock

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4 PET – Protocol and Electrical Tester

The PET is a unit, designed to perform compliance testing or assist with development work leading towards compliance testing on On-the-Go, Battery Charging and other general USB applications. It is described in detail in the document:

- Protocol and Electrical Tester Specification

A brief breakdown of its functional blocks follows.

4.1 Serial Interface Engine (SIE)

A fully functional SIE, with both host and peripheral capabilities, connected via a PHY to the UUT micro-AB receptacle on the front panel. This is under the control of the Script Processor.

4.2 Electrical Test Board (ETB)

This contains circuitry to allow control and measurement of the electrical parameters for USB, OTG and BC specifications. It includes VBUS Generator, ID pin circuitry, data line test mode circuitry, VBUS current and voltage loads, and a variety of voltage and current measuring blocks. Extra connections are provided to enable the testing of Accessory Charger Adapters (ACAs). The ETB functionality required is shown in Figure 4-1.

4.3 Script Processor

Scripts are downloaded to this processor to control the sequence of operations required for a particular test. The processor controls the SIE and ETB as required by the operator. Scripts for all the OTG and BC compliance tests would be provided by the application accompanying the PET.

4.4 USB Analyzer

The PET could also provide full USB analyzer functionality. By designing the analyzer into the PET circuitry the analyzer could be designed to have zero impact on the data line transmission quality.

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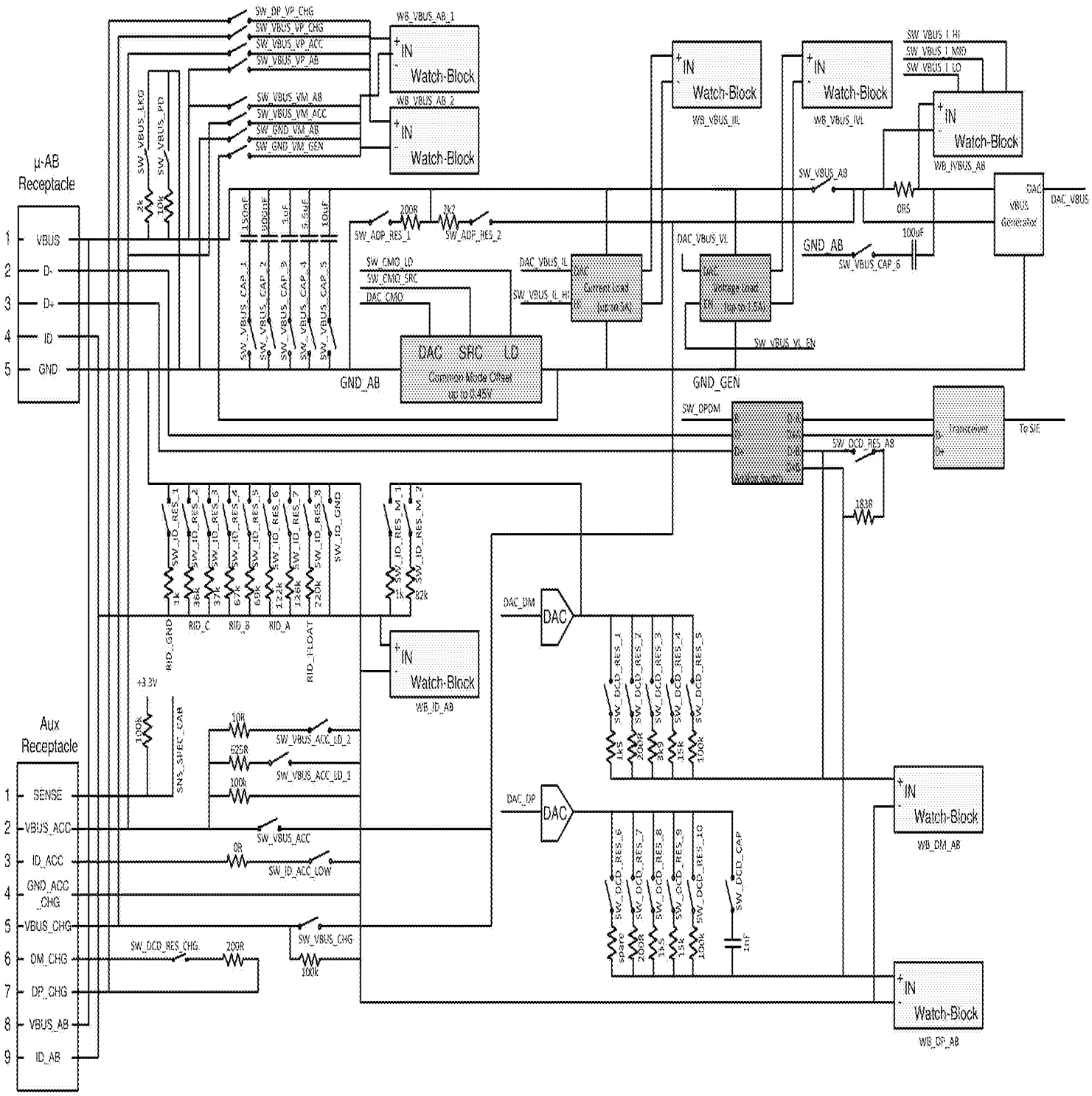


Figure 4-1 ETB Block Diagram

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5 Test Cables Required

The cables required by the PET tester are described below.

Each cable should be labeled, and specify the lead loop resistance value, required to be entered into the test dialog, if the lead is replaced. The tester application contains a check box to specify whether the UUT has a captive lead, as in this case the captive test cable is deemed to be part of the unit under test.

5.1 Special Test Cable A

Table 5-1 Special Test Cable A

Micro-B plug to Micro-B plug		
Micro-B plug (PET)	**Micro-B plug (UUT)**	**Purpose**
1	1	VBUS
2	2	D-
3	3	D+
4	4	ID
5	5	GND

This cable has been specified to allow control of the ID pin of the unit-under-test. It is important to use this cable when the test specifies it. The particular resistance of the cable has also been allowed for in the test suite.

5.2 Special Test Cable B

Table 5-2 Special Test Cable B

Micro-B plug to Standard-A plug		
Micro-B plug (PET)	**Standard-A plug (UUT)**	**Purpose**
1	1	VBUS
2	2	D-
3	3	D+
nc		
5	4	GND

Although this is a standard cable configuration, it is important to use the specified cable, as its particular resistance has been allowed for in the test suite.

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5.3 Special Test Cable C

Table 5-3 Special Test Cable C

9-pin D-type Assembly			
D-type (PET)	**Standard-A Receptacle (ACA Charger Port)**	**Micro-B Plug (ACA Accessory Port)**	**Purpose**
1 (linked to 4)			Cable Sense
2		1	Accessory VBUS
3		4	Accessory ID
4	4	5	GND
5	1		Charger VBUS
6	2		Charger D-
7	3		Charger D+
8			OTG VBUS
9			OTG ID

This cable is used when testing a Micro-ACA. This is correct for a Micro-ACA with a captive charger port cable. For a Micro-ACA with a Micro-B receptacle as the charger port, connect Special Cable B to the Standard-A receptacle of Special cable C, and plug the other end into the charger port of the ACA.

5.4 Special Test Cable D

Table 5-4 Special Test Cable D

9-pin D-type Assembly			
D-type (PET)	**Standard-A Receptacle (ACA Charger Port)**	**Standard-A Plug (ACA Accessory Port)**	**Purpose**
1 (linked to 4)			Cable Sense
2		1	Accessory VBUS
3			Accessory ID
4	4	4	GND
5	1		Charger VBUS
6	2		Charger D-
7	3		Charger D+
8			OTG VBUS
9			OTG ID

This cable is used when testing a Standard-ACA. This is correct for a Standard-ACA with a captive charger port cable. For a Standard-ACA with a Micro-B receptacle as the charger port, connect Special Cable B to the Standard-A receptacle of Special cable C, and plug the other end into the charger port of the ACA.

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5.5 Special Test Cable E

Table 5-5 Special Test Cable E

Micro-A plug to Standard-A receptacle		
Micro-A plug (PET)	**Standard-A receptacle (UUT)**	**Purpose**
1	1	VBUS
2	2	D-
3	3	D+
4 - Connected to pin 5		
5	4	GND

This is a short adapter cable, which may be used to connect a PD with a standard-A plug to the PET.

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6 Test Setups

6.1 OTG Device as Unit-Under-Test (Setup no. 1)

When running a test-suite relating to an OTG device, the first test will prompt you to connect it to the PET using 'Special Cable A'. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reasons:

It has 5 cores, instead of the usual 4. This allows the PET to control the ID pin of the UUT.

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

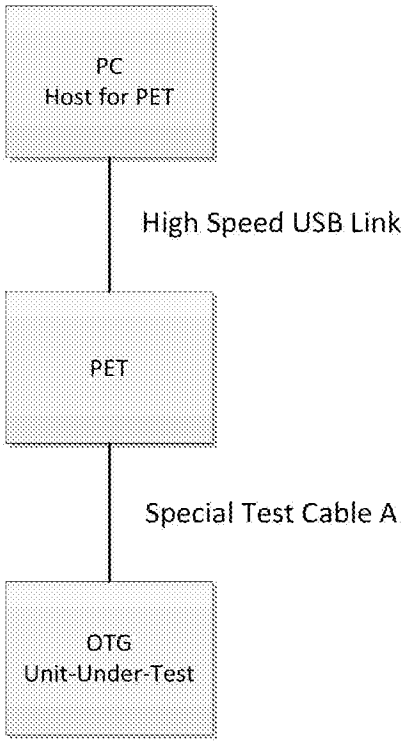


Figure 6-1 Setup No 1 – OTG Device

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6.2 Embedded Host as Unit-Under-Test (Setup no. 2)

When running a test-suite relating to an Embedded Host, the first test will prompt you to connect it to the PET using 'Special Cable B'. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

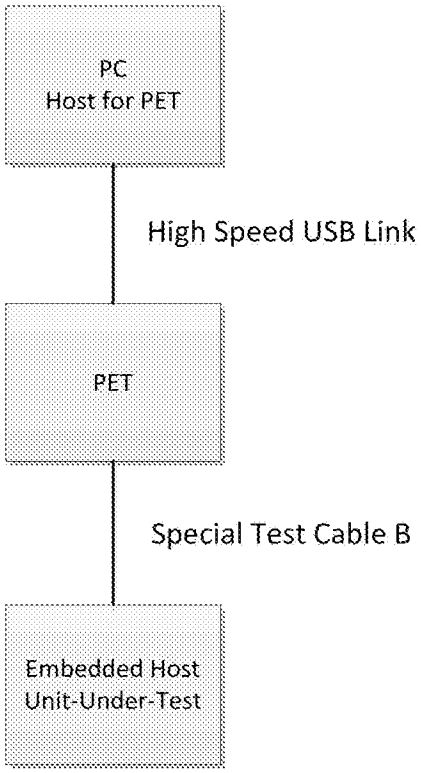


Figure 6-2 Setup No 2 – Embedded Host

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6.3 Peripheral Only as Unit-Under-Test (Setup no. 3)

When running a test-suite relating to a Peripheral-Only OTG device with a ***Micro-B receptacle***, the first test will prompt you to connect it to the PET using 'Special Cable A'. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

Another possibility is that the device has a captive cable with a ***Micro-A plug***. In this case use this, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

Finally, the device may have a captive cable with a ***Standard-A plug***. In this case, use 'Special Cable E' to connect the ***Standard-A plug*** to the ***Micro-AB receptacle*** of the PET, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

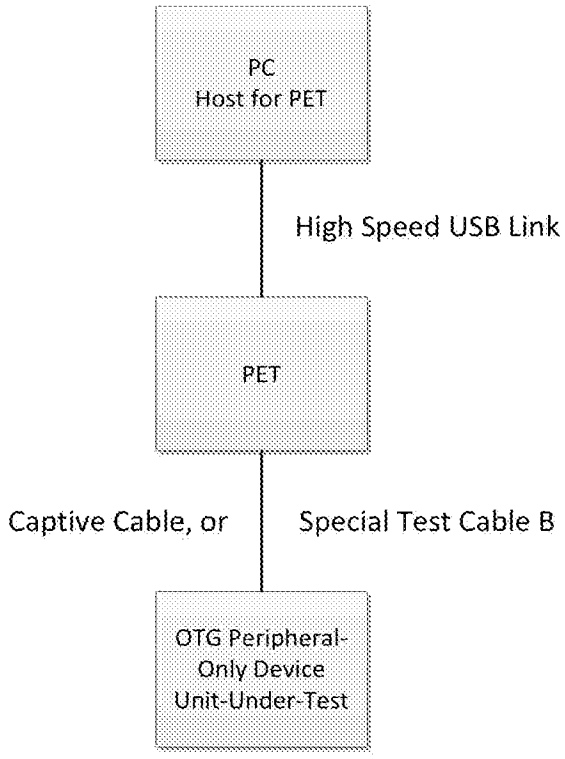


Figure 6-3 Setup No 3 – Peripheral Only

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6.4 PD as Unit-Under-Test (Setup no. 4)

A Portable Device (PD) is assumed to have a ***Micro-B receptacle*** or a ***Micro-AB receptacle***. A PD that mates with an ACA-Dock or ACA is required to have a ***Micro-AB receptacle***. The PD may alternatively have a captive cable.

When running a test-suite relating to a PD having a ***Micro-B receptacle*** or a ***Micro-AB receptacle***, the first test will prompt you to connect it to the PET using 'Special Cable A'. This ***Micro-B plug*** to ***Micro-B plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

The other possibility is that the device has a captive cable with a ***micro-A plug***. In this case use this, and check the 'Captive Cable' check box, in the 'PET Test Suites' Dialog.

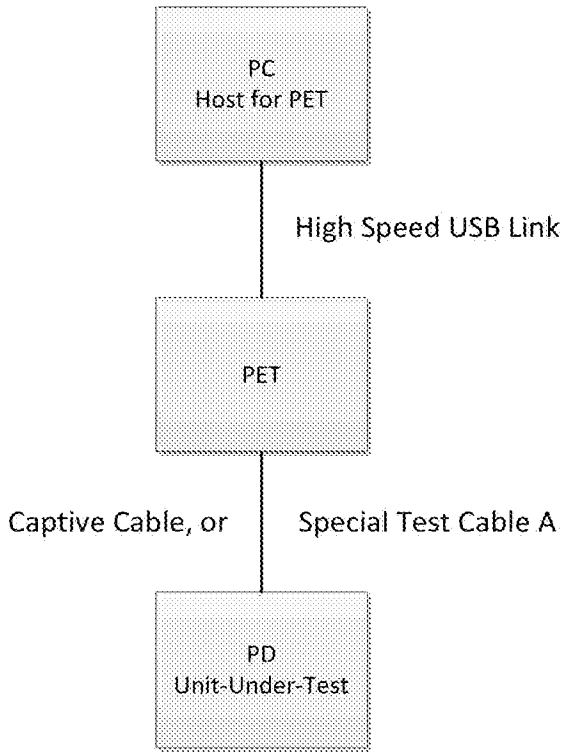


Figure 6-4 Setup No 4 – Portable Device

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6.5 CDP (or SDP) as Unit-Under-Test (Setup no. 5)

A Charging Downstream Port (CDP) must be equipped with a Standard-A receptacle.

When running a test-suite relating to a CDP, the first test will prompt you to connect it to the PET using 'Special Cable B'. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

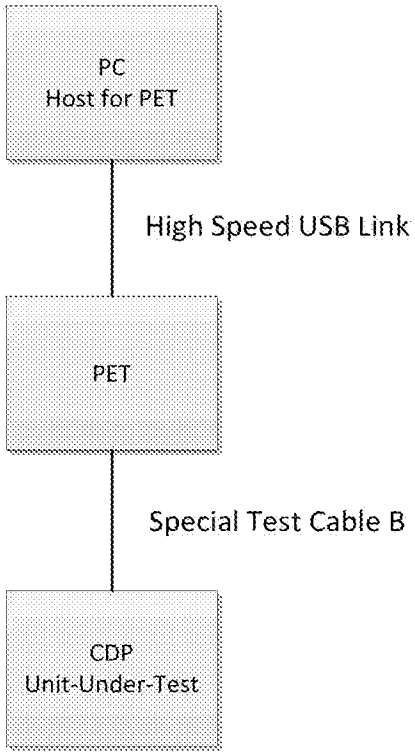


Figure 6-5 Setup No 5 – CDP

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6.6 DCP as Unit-Under-Test (Setup no. 6)

A Dedicated Charging Port (DCP) must be equipped with a ***Standard-A receptacle***, or a captive cable terminated with a ***Micro-B plug***.

When running a test-suite relating to a DCP with a ***Standard-A receptacle***, the first test will prompt you to connect it to the PET using 'Special Cable B'. This ***Micro-B plug*** to ***Standard-A plug*** cable is provided with the PET unit and it is essential that this particular cable be used, for the following reason:

The resistance of this cable has been allowed for in tests involving large VBUS currents with measurements on VBUS current and voltage.

The other possibility is that the device has a captive cable with a ***micro-B plug***. In this case use this, and check the 'Captive Cable' check box, in the 'USB-PET Test Suites' Dialog.

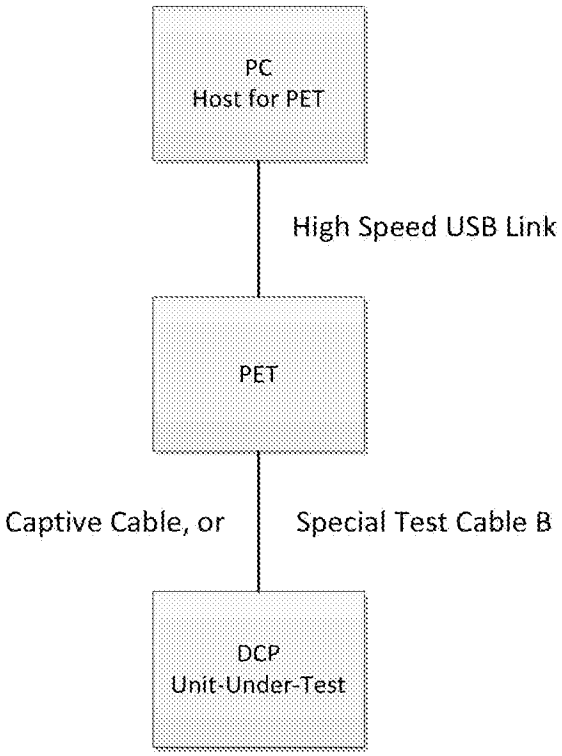


Figure 6-6 Setup No 6 – DCP

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6.7 Micro-ACA (Separate Charger) as Unit-Under-Test (Setup no. 7)

An Accessory Charger Adapter having a Micro-AB receptacle for its accessory port (Micro-ACA) must be equipped with:

- a captive cable terminated with a Micro-A plug for its OTG port
- a Micro-B receptacle, or a captive cable with Standard-A plug for its charger port, and of course
- a Micro-AB receptacle for its accessory port

When running a test-suite relating to a Micro-ACA, the first test will prompt you to connect it to the PET using 'Special Cable C'.

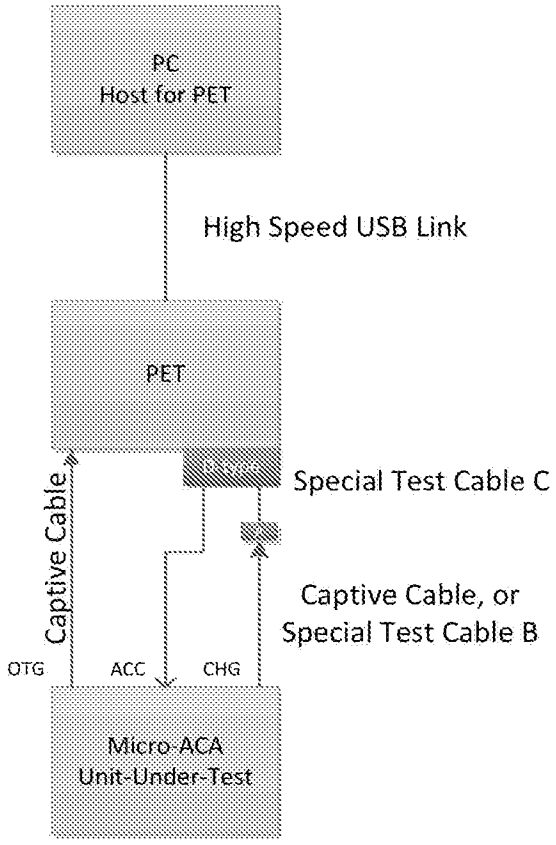


Figure 6-7 Setup No 7 – Micro-ACA

6.8 Micro-ACA (Combined Charger) as Unit-Under-Test (Setup no. 7b)

This is the same as Setup 7 except that there is no charger cable coming from the UUT.

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6.9 Standard-ACA (Separate Charger) as Unit-Under-Test (Setup no. 8)

An Accessory Charger Adapter having a Standard-A receptacle for its accessory port (Standard-ACA), must be equipped with:

- a captive cable terminated with a Micro-A plug for its OTG port
- a Micro-B receptacle, or a captive cable with Standard-A plug for its charger port, and of course
- a Standard-A receptacle for its accessory port

When running a test-suite relating to a Standard-ACA, the first test will prompt you to connect it to the PET using 'Special Cable D'.

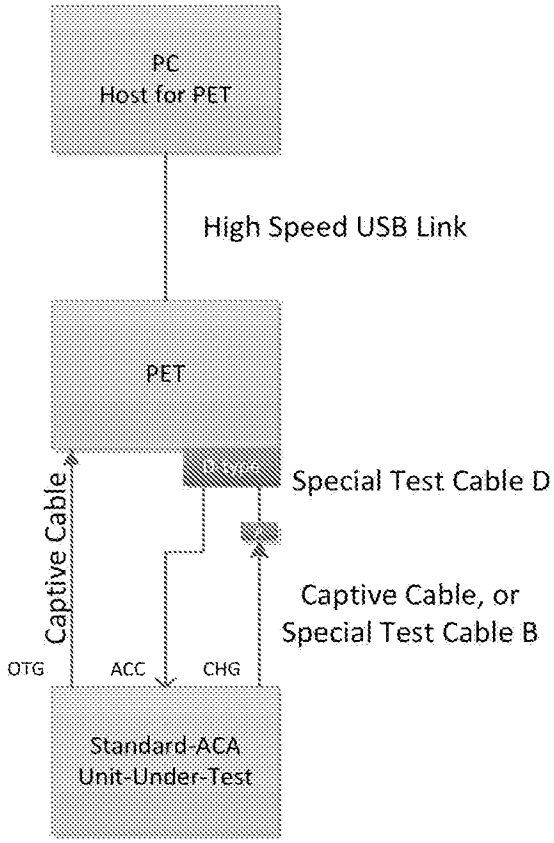


Figure 6-8 Setup No 8 – Standard-ACA

6.10 Standard-ACA (Combined Charger) as Unit-Under-Test (Setup no. 8b)

This is the same as Setup 8 except that there is no charger cable coming from the UUT.

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6.11 ACA-Dock as Unit-Under-Test (Setup no. 9)

An ACA-Dock must be equipped with a Micro-A plug, for connecting to the Micro-AB receptacle of a PD. It is represented here as a captive cable. In practice it may comprise part of a fixture, which may be difficult to connect to the PET front panel. In this case it is the responsibility of the vendor to provide a suitable means to connect the ACA-Dock to the Micro-AB receptacle of the PET.

When running a test-suite relating to an ACA-Dock, the first test will prompt you to connect it to the PET using its captive cable.

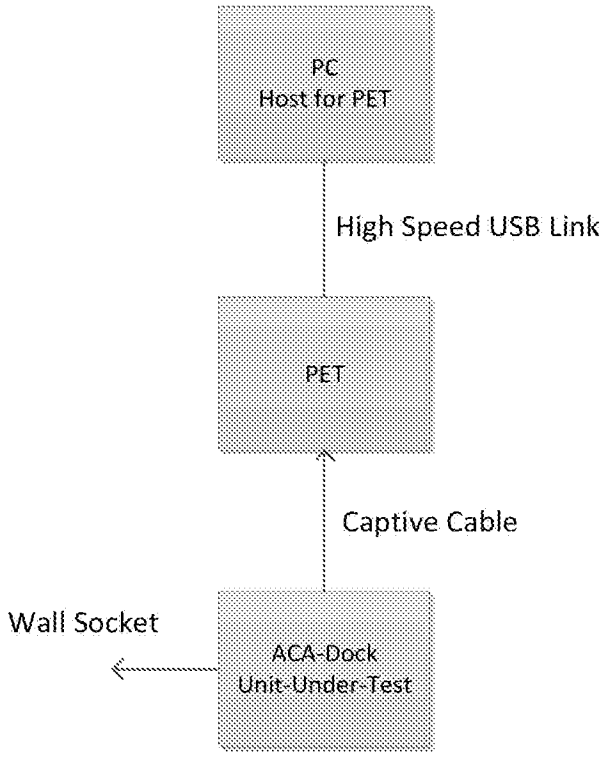


Figure 6-9 Setup No 9 – ACA-Dock

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7 Portable Device Compliance

7.1 Submission Materials

7.1.1 Device Specific Information and Materials

Table 7-1 Device Specific Information and Materials for PDs

Item	Function	Value/ Support
1	Captive Cable	Yes ☐ No ☐
2	Apply Dead Battery Provision	Yes ☐ No ☐
3	Weak Battery Threshold	V
4	Maximum Charging Current with Dedicated Charger	_____mA
5	Maximum Charging Current with Charging Downstream Port operating at LS or FS	_____mA
6	Maximum charging current with Charging Downstream Port operating at HS	_____mA
7	Typical and maximum times that UUT with a dead battery will take to connect after being attached to a Standard Downstream Port	Typ. _____m _____s Max. _____m _____s
8	Typical and maximum times that UUT with a dead battery will take to connect after being attached to a Charging Downstream Port	Typ. _____m _____s Max. _____m _____s
9	Maximum current that the UUT can draw from a CDP	_____mA
10	The USB-IF TID for the UUT USB receptacle or captive plug intended to connect the UUT to a host or OTG device.	
11	Supply 2 batteries in a dead state for the Dead Battery Provision test.	
12	Supply 2 batteries in a state just above the weak battery threshold.	
13	Supply 1 good battery.	

7.1.2 Checklist

Table 7-2 Checklist for PDs

ID - Question		Response	Test Number	BC 1.2 Reference
PD1	Can the PD detect when V_{BUS} is greater than a threshold in the range $V_{OTG\_SESS\_VLD}$?	Yes ☐ No ☐	Vendor Declaration	3.2.2 3.3.1
PD2	Can the PD detect when D+ is greater than a threshold in the range V_{DAT_REF} ?	Yes ☐ No ☐	Vendor Declaration	3.3.1
PD3	Can the PD detect when D- is greater than a threshold in the range V_{DAT_REF} ?	Yes ☐ No ☐	Vendor Declaration	3.3.1

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PD4	Can the PD detect when D- is greater than a threshold in the range V_{LGC} ?	Yes ☐ No ☐	Vendor Declaration	3.3.1
PD5	[**Optional**] Does PD use a current source I_{DP_SRC} and pull-down resistor R_{DM_DWN} to detect when the data pins have made contact during an attach event?	Yes ☐ No ☐	7.3	3.2.3.1 3.4.1 4.6.2
PD6	If yes, does PD commence Primary Detection within $T_{DCD\_TIMEOUT}$ max after V_{BUS} rises above $V_{OTG\_SESS\_VLD}$, if pin contact has not been detected on D+ or ID pins?	Yes ☐ No ☐	7.3	3.2.3.1 3.3.2 4.6.2
PD7	If no, does PD wait a time of $T_{DCD\_TIMEOUT}$ after the attach event before starting Primary Detection?	Yes ☐ No ☐	7.4	3.2.3.1 3.3.2 4.6.2
PD8	Does PD connect within $T_{SVLD\_CON\_PWD}$ of the attach event?	Yes ☐ No ☐	7.6, 7.7, 7.10, 7.11	3.2.3.1
PD9	Does PD wait for D+ to stay below V_{LGC_LOW} for T_{DCD_DBNC} min before disconnecting I_{DP_SRC} and R_{DM_DWN}?	Yes ☐ No ☐	7.3	3.3.2 3.4.1
PD10	Does PD turn on V_{DP_SRC} and I_{DM_SINK} and maintain them for T_{VDPSRC_ON} during Primary Detection?	Yes ☐ No ☐	7.6, 7.7	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 3.4.2
PD11	Is the design of V_{DP_SRC} such that an external device is able to pull D+ to 2.2V through R_{DP_UP}?	Yes ☐ No ☐	7.8	3.2.4.4 5
PD12	Does PD compare D- with V_{DAT_REF} during Primary Detection to distinguish between an SDP and a Charging Port?	Yes ☐ No ☐	7.7	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 4.6.2
PD13	[**Optional**] Does PD compare D- with VLGC during Primary Detection?	Yes ☐ No ☐	Vendor Declaration	3.2.4.1 3.2.4.2 3.2.4.3 3.3.2 4.6.2
PD14	[**Optional**] Does PD implement Secondary Detection?	Yes ☐ No ☐	7.5, 7.6	4.6.2
PD15	If the PD supports Secondary Detection, does the PD turn on V_{DM_SRC} and I_{DP_SINK} and maintain them for T_{VDMSRC_ON} during Secondary Detection?	Yes ☐ No ☐ N/A ☐	7.5, 7.6	3.2.5.1 3.2.5.2 3.3.2 3.4.2
PD16	If the PD supports Secondary Detection, does the PD compare D+ with V_{DAT_REF} during Secondary Detection to distinguish between a DCP and a CDP?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.5.1 3.2.5.2 3.3.2 3.4.2

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PD17	If the PD supports Secondary Detection, and during this detects that it is attached to a DCP, does it disable V_{DM_SRC} and I_{DP_SINK}, and either enable V_{DP_SRC} or pull D+ up to V_{DP_UP} through R_{DP_UP}, within $T_{SVLD\_CON\_PWD}$ of attach, and maintain this for as long as it draws more than I_{SUSP}? If the PD does not support Secondary Detection, and during Primary Detection has detected that it is connected to a DCP or to a CDP, does it pull D+ up to V_{DP_UP} through R_{DP_UP}, within $T_{SVLD\_CON\_PWD}$ of attach, and maintain this for as long as it draws more than I_{SUSP}?	Yes ☐ No ☐	7.5	3.2.5.1 3.3.2
PD18	If the PD supports Secondary Detection, and during this detects that it is attached to a CDP, does it turn off V_{DP_SRC}, V_{DM_SRC} and I_{DP_SINK}, and connect within $T_{SVLD\_CON\_PWD}$ of attach?	Yes ☐ No ☐ N/A ☐	7.6	3.2.5.2 3.3.2 3.4.2
PD19	[**Optional**] Does PD implement ACA Detection?	Yes ☐ No ☐	Vendor Declaration	3.2.6 4.6.2
PD20	If the PD supports ACA detection, does PD have a Micro-AB receptacle?	Yes ☐ No ☐ N/A ☐	Inspection	3.2.6 4.6.4
PD21	If the PD supports ACA detection, is it able to detect being attached to an ACA-Dock when it sees the following conditions: • $V_{BUS} > V_{OTG\_SESS\_VLD}$ • ID at R_{ID_A} • D+ at V_{LGC_HI} • $V_{DAT\_REF} < D- < V_{LGC}$	Yes ☐ No ☐ N/A ☐	7.8	3.2.4.4 3.3.2 3.2.6
PD22	If the PD supports ACA detection, is it able to detect being attached to an ACA with a FS B-device on its accessory port and a charging port attached, when it sees the following conditions: • ID at R_{ID_A} • $D- < V_{DAT\_REF}$	Yes ☐ No ☐ N/A ☐	7.9	3.2.4.5 3.3.2 3.2.6
PD23	If the PD supports ACA detection, is it able to detect being attached to an ACA with a LS B-device on its accessory port and a charging port attached, when it sees the following conditions: • ID at R_{ID_A} • $D- > V_{LGC}$	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.4.5 3.2.6

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PD24	If the PD supports ACA detection, is it able to detect being attached to an ACA having a charging port attached when it sees the following condition: • ID at R_{ID_B}	Yes ☐ No ☐ N/A ☐	7.10	3.2.4.5 3.2.6
PD25	If the PD supports ACA detection, is it able to detect being attached to an ACA with an A-device on its accessory port and a charging port attached, when it sees the following condition: • ID at R_{ID_C}	Yes ☐ No ☐ N/A ☐	7.11	3.2.4.5 3.2.6
PD26	If the PD supports ACA detection, is it able to detect being attached to an ACA with an B-device on its accessory port and no charging port attached, when it sees the following condition: • ID at R_{ID_GND}	Yes ☐ No ☐ N/A ☐	7.12	3.2.6
PD27	If the PD supports ACA detection, does it continue to monitor the ID line after doing Primary detection, and respond correctly to resistance changes?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	3.2.4.5 3.2.6 6.2.7
PD28	Does PD discharge V_{BUS} to less than V_{BUS_LKG} within T_{VLD_VLKG} whenever V_{BUS} is removed?	Yes ☐ No ☐	7.7	4.6.3
PD29	Does PD wait at least $T_{CP\_VDM\_EN}$ after disconnecting, before restarting the charger detection process?	Yes ☐ No ☐	Vendor Declaration	4.6.3
PD30	Does PD draw no more than I_{DEV_CHG} max from a Charging Port? What is the value of I_{MAX_BC}, the actual maximum current drawn? Note: I_{MAX_BC} is the maximum current that the PD can draw from a CDP.	Yes ☐ No ☐ _____mA	7.5, 7.6, 7.8, 7.9, 7.10, 7.11	4.6.1
PD31	Does PD draw no more than I_{CFG_MAX} from a SDP?	Yes ☐ No ☐	7.7	2.1
PD32	Does PD pull output voltage of a Charging Port no lower than V_{DCP_SHTDWN}?	Yes ☐ No ☐	Vendor Declaration	4.6.1
PD33	Does the PD correctly support LS, FS, HS and chirp signaling when the local ground is (I_{MAX_BC} x 0.25Ω + 5mV)* higher than the remote ground, where I_{MAX_BC} is the maximum current that the PD can draw from a CDP? *maximum of 0.375V	Yes ☐ No ☐	7.13, 7.14	3.5

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DBP1	Does PD draw no more than I_{UNIT} when PD is not able to connect?	Yes ☐ No ☐	7.15	2.2
DBP2	Does PD reduce current drawn to I_{SUSP} within $T_{SVLD\_CON\_WKB}$ after attach if it is unable to connect and be enumerated?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP3	Does PD enable V_{DP_SRC} within $T_{DBP\_ATT\_VDPSRC}$ of attach and maintain it if it is unable to connect?	Yes ☐ No ☐	7.15	2.2
DBP4	Does PD connect within $T_{DBP\_VDPSRC\_CON}$ of disabling V_{DP_SRC}?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP5	Does PD prevent the use of DBP current to perform tasks unrelated to battery charging?	Yes ☐ No ☐	Vendor Declaration	2.2
DBP6	If the PD uses the DBP, can the device normally operate stand-alone from internal battery power?	Yes ☐ No ☐ N/A ☐	Vendor Declaration	2.2
DBP7	Can the PD, with a dead battery, pass the inrush test?	Yes ☐ No ☐	Vendor Declaration	2.2

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7.2 B-UUT Initial Power-up Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a downstream port.
Purpose	To prepare the PD for the following tests.
Preconditions	To ensure that the PD has been powered up and is ready for the subsequent tests. All following PD tests assume that this test has been run first. In the case of an ADP capable device, this test also confirms functional startup sequence.
Parameters	TB_SRP_FAIL, TB_ADP_PRB, TPWRUP_RDY
Description	The test operator is then instructed to connect up the PD in preparation for the tests, and to perform any actions required to power it up.

7.2.1 Test Procedure

Part 1 – Common to All B-UUT Types

1. The user enters into the PET:
    - whether the UUT is capable of ADP

The test sequence followed depends on the UUT type

- PD capable of ADP
- PD not capable of ADP

Part 2 – For PD UUT capable of ADP

2. Operator: Ensure UUT connected using special cable A or, where the device does not have a micro-AB or micro-B receptacle, a suitable alternative.
3. UUT is either powered or is not powered. PET is not applying VBUS, and not applying capacitance between VBUS and ground, ID pin is not connected to ground.
4. Operator: Turn UUT off, if not already off.
5. Operator: Turn UUT on.
6. Check that UUT performs an ADP probe within TPWRUP_RDY (30 sec or as specified by vendor).
7. To check probe, check that VBUS goes below 0.3V and then rises above 0.5V within 10ms.
8. After the first probe check that either a further probe (or probes) is performed, or that D+ goes high. Wait here till D+ goes high or TPWRUP_RDY times out.
9. Check that D+ stays high for at least 5ms.
10. Check that D+ goes low within 10ms of start of pulse.

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11. Check ADP probe is not performed for TB_SRP_FAIL min (5 sec) after start of D+ (SRP) pulse.

12. Check that ADP probe is performed within TB_SRP_FAIL max plus TB_ADP_PRB max (6.0 + 2.6 = 8.6 sec) after start of D+ (SRP) pulse.

13. Now ready for any other B_UUT test.

Part 2 – For PD UUT not capable of ADP

2. Operator: Ensure UUT connected using special cable A or, where the device does not have a micro-AB or micro-B receptacle, a suitable alternative

3. UUT is either powered or is not powered. PET is not applying V_{BUS}, and not applying capacitance between V_{BUS} and ground, ID pin is not connected to ground.

4. Operator: Turn UUT on, if not already on.

5. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10kΩ) to V_{BUS} and turns on V_{BUS}.

6. Check that D+ goes high within T_{PWRUP_RDY} (30 sec).

7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

8. Wait 5 seconds to allow disconnection to be detected.

9. Now ready for any other B_UUT test.

Following Tests

From now on all test sequences must start and finish with the PET holding V_{BUS} off, and no capacitance or pull-down resistance connected to V_{BUS}. This allows the tests to be performed in any sequence. In between tests, the ID pin is not connected to ground.

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7.3 Data Contact Detect Test – With Current Source

Test Setup	Test Setup 4. UUT is a PD, PET simulates a downstream port.
Pre-conditions	Only required if UUT supports DCD using I_{DP_SRC}. The charge state of the battery is not critical in this test, provided it is above the Weak Battery Threshold.
Purpose	To validate a correct data contact detection procedure when the UUT supports DCD using I_{DP_SRC}.
Description	Check that I_{DP_SRC} is maintained for T_{DCD_DBNC} after D+ is pulled low and that $T_{DCD\_TIMEOUT}$ is complied with.
Parameters	R_{DM_DWN} or I_{DM_SINK}, T_{DCD_DBNC}, I_{DP_SRC}
Checklist	PD5, PD6, PD9
Pass Criteria	Step 3: D+ to rises above 2V Step 6: D- does not exceed 0.498V Step 10: D+ is less than 0.375V.

7.3.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD using I_{DP_SRC}

1. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.
2. Start timer when V_{BUS} reaches 0.8V.
3. Wait for D+ to rise above 2V. (If it doesn't within 0.9 second – test fails.) This proves that I_{DP_SRC} is sufficiently large to overcome the UUT's own leakage current. [PD5]
4. Measure and report time till it does.
5. After 1ms of D+ exceeding 2V, measure and report voltage on D+.
6. Connect 0.8V via 15kΩ to D-. Check voltage at D- is in correct range for a pull-down value meeting the specification (i.e. that voltage is not greater than 0.498V and not less than 0.390V). [PD5]

Note: For worst case max R_{DM_DWN} of 24.8K we need a max voltage at D- of 0.498V. For worst case min R_{DM_DWN} of 14.25K we need a min voltage at D- of 0.390V.

7. Disconnect components in previous step.
8. Connect 15kΩ from D+ to 0V.
9. Wait just less than T_{DCD_DBNC} min (<10ms = 9.5ms). [PD9]
10. Check voltage on D+ is less than 0.375V. This proves that I_{DP_SRC} and leakage, together, are low enough to provide a low logic level on D+, even after nearly

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T_{DCD_DBNC} min (10ms). (Voltage to be adjusted in actual test script to allow for small tester leakage.)

Note: Highest current sourced by UUT should be I_{DP_SRC} max (13µA) plus V_{DAT_LKG} max (3.6V) across R_{DAT_LKG} min (300K), equals 13 + 12 µA = 25µA. 25µA x 15K = 0.375V.

11. Disconnect everything from V_{BUS}, and switch V_{BUS} off.

12. Wait 2 seconds for disconnect to be detected.

DCD using Timeout

13. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.

14. Start timer when V_{BUS} reaches 0.8V.

15. Wait for D+ to rise above 2V. (If it doesn't within 0.9 second – test fails.).

16. Check that D+ goes down to voltage in the range V_{DP_SRC} (0.5 to 0.7V) within $T_{DCD\_TIMEOUT}$ (0.3 to 0.9 sec) of D+ going high and within 1 second of V_{BUS} reaching 0.8V. [PD6]

17. Turn off V_{BUS}.

18. Wait 8 seconds, ignoring SRP pulse, for disconnect to be detected.

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7.4 Data Contact Detect Test – No Current Source

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Only required if UUT does not support DCD using I_{DP_SRC}. The charge state of the battery is not critical in this test, provided it is above the Weak Battery Threshold.
Purpose	To validate a correct data contact detection procedure when the UUT does not support DCD using I_{DP_SRC}.
Description	Check that Primary Detection commences within $T_{DCD\_TIMEOUT}$ max of VBUS turning on.
Parameters	R_{DM_DWN} or I_{DM_SINK}, T_{DCD_DBNC}, I_{DP_SRC}
Checklist	PD5, PD7
Pass Criteria	Step 3: Time for D+ to go to V_{DP_SRC} is 0.3 to 0.9 sec.

7.4.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD using Timeout

1. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.
2. Start timer when V_{BUS} reaches 0.8V.
3. Connect 15k resistors from 0V to D+, and from 0V to D-.
4. Check that D+ goes up to voltage in the range V_{DP_SRC} (0.5 to 0.7V) within $T_{DCD\_TIMEOUT}$ (0.3 to 0.9 sec) of V_{BUS} going on. [PD7]
5. Disconnect 15k pull-down resistors from D+ and D-.
6. Disconnect capacitance and pull-down resistor from V_{BUS} and switch V_{BUS} off.
7. Wait 8 seconds, ignoring SRP pulse, for disconnect to be detected.

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7.5 DCP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a DCP.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a DCP.
Description	PET simulates a DCP and monitors activity on D+ and D-, and current drawn.
Parameters	V_{DP_SRC}, V_{DM_SRC}, T_{VDPSRC_ON}, T_{VDMSRC_ON},
Checklist	PD14, PD15, PD17, PD30
Pass Criteria	See below

7.5.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD

1. PET connects 200R between D+ and D-.
2. PET connects voltage source of 0V via 100k to D-, to prevent false detection of voltage on D+ etc.
3. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to V_{B_BUS} nom (5V). ID pin is left floating.

Primary Detection

4. Wait for D+ to rise above 0.5V
5. Wait 1ms for D+ to settle.
6. Measure D+ and check voltage is V_{DP_SRC} (0.5 to 0.7V).
7. Wait for slightly less than T_{VDPSRC_ON} min (38ms).
8. Check that D+ voltage is still V_{DP_SRC} (0.5 to 0.7V)
9. Wait for D+ to go below 0.5V, or above 0.8V, or for $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} going on to expire.

$T_{SVLD\_CON\_PWD}$ expires:

Implication is that change between driving V_{DP_SRC}, then driving V_{DM_SRC} and then driving V_{DP_SRC} was not seen by the tester, as no gaps were inserted. We can only assume that this is not a failure. Skip to 'Checking Current Draw'.

D+ goes below 0.5V:

If secondary detection is declared not to be implemented, skip to 'Checking Current Draw'.

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If secondary detection is declared to be implemented, proceed with 'Secondary Detection'.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a 'device connect'.

If secondary detection is declared not to be implemented, this is a valid procedure, and the tester will report that this sequence has occurred, and skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, and less than 80ms has passed since D+ first rose above 0.5V, this constitutes a failure because the specified periods T_{VDPSRC_ON} plus T_{VDMSRC_ON} have not been completed. [PD14]

If secondary detection is declared to be implemented, and more than 80ms has passed since D+ first rose above 0.5V, this implies that the change between driving V_{DP_SRC} and then driving V_{DM_SRC} was not seen by the tester. The only possible conclusion here is to assume a pass at this stage, and to skip to 'Checking Current Draw'.

Secondary Detection

10. Wait for D- to rise above 0.5V, or above 0.8V, or for expiration of $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} going on.

$T_{SVLD\_CON\_PWD}$ expires:
This constitutes a failure because neither V_{DP_SRC} nor a pullup to V_{DP_UP} through R_{DP_UP} occurred.

D- goes above 0.5V:
First check if it goes between 0.7V and 0.8V within 1ms. If so this is an error.

Also check if it goes above 0.8V within 1ms. If so go to 'D- goes above 0.8V'.

If voltage stays within V_{DM_SRC} (0.5 to 0.7V), assume this is secondary detection and go to Step 11.

D- goes above 0.8V:
This will be regarded as a 'device connect'. (D+ and D- are connected via 200R.)

If less than 80ms has passed since D+ first rose above 0.5V, this constitutes a failure because the specified periods T_{VDPSRC_ON} plus T_{VDMSRC_ON} have not been completed. [PD14]

Otherwise, proceed to 'Checking Current Draw'.

(In practice we may have missed gap between V_{DP_SRC} and V_{DM_SRC}, and be seeing a gap between V_{DM_SRC} and connect. However this will not invalidate the next steps.)

11. Wait for slightly less than T_{VDMSRC_ON} min (38ms).

12. Check that D- voltage is still V_{DM_SRC} (0.5 to 0.7V). [PD14], [PD15]

13. Wait for D- to go below 0.5V, or above 0.8V, or for $T_{SVLD\_CON\_PWD}$ max (1 sec) from V_{BUS} going on to expire.

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Checking Current Draw

14. If secondary detection is declared to be implemented, display message to test operator 'PD under test should now have detected DCP'.
    If secondary detection is declared not to be implemented, display message to test operator 'PD under test should now have detected DCP or CDP'.
    (This is a development aid.)

15. Check current drawn does not exceed 1.5A from now on. [PD30]

16. Check D+ is held at or above V_{DP_SRC} min (0.5V) for the entire period, starting $T_{SVLD\_CON\_PWD}$ max (1 sec) after V_{BUS} was applied, that current drawn exceeds I_{SUSP} max (2.5mA). *Note that the voltage drop in the cable ground will raise the apparent voltage on D+.* [PD17]

17. Maintain session for 30 seconds from step 14.

18. Disconnect 200R resistor between D+ and D-.

19. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

20. Disconnect voltage source and 100k resistor from D-.

21. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.6 CDP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test must be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a CDP. Also to check correct renegotiation behavior.
Description	PET simulates a CDP and monitors activity on D+ and D- , and current drawn.
Parameters	VDP_SRC, TVDPSRC_ON, TSVLD_CON_PWD, IMAX_BC
Checklist	PD8, PD10, PD14, PD15, PD18, PD28, PD30
Pass Criteria	See below

7.6.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No VBUS voltage applied. PD is switched on.

DCD

1. Switch data lines to PET test circuit. PET applies a pull-down resistor of ROTG_VBUS min (10k) to VBUS and turns on VBUS to 5V. ID pin is left floating.

2. Connect 0V via 15k resistor to D+. Connect 0V via15k resistor to D-.

Primary Detection

3. Wait for D+ to rise above 0.5V

4. Wait 1ms for D+ to settle.

5. Measure D+ and check voltage is VDP_SRC (0.5 to 0.7V). [PD10]

6. Check value of IDM_SINK, as follows: Change voltage on 15k resistor to D- to 0.6V. Wait 1ms, then check voltage at D- is in correct range for a worst case IDM_SINK of 25µA (i.e. that voltage is not greater than 0.225V). [PD10]

7. Change voltage on 15k resistor to D- to 0V.

8. Wait for 17ms (together with 2ms delay above, this is less than TVDMSRC_EN max).

9. Disconnect 15K resistor from D- and replace with 1K5 from 0.7V.

10. Wait 1ms for D- to settle.

11. Measure voltage on D-. This must be above 0.4V, to prove that IDM_SINK max (175µA) is not exceeded.

12. Wait 19ms (together with 20ms delay above, this is less than TVDPSRC_ON min).

13. Check that D+ voltage is still VDP_SRC (0.5 to 0.7V). [PD10]

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14. Wait for D+ to go below 0.5V, or above 0.8V, or for TSVLD_CON_PWD (1 sec) from VBUS going on to expire.

TSVLD_CON_PWD expires:

This is a failure, as the UUT failed to connect within TSVLD_CON_PWD (1 sec). [PD8]

D+ goes below 0.5V:

End of primary detection, proceed from step 15.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a 'device connect'. [PD8]

If secondary detection is declared not to be implemented, this is a valid procedure, and the tester will report that this sequence has occurred, perform steps 13 and 14, and then skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, this is a failure, secondary detection was not attempted. [PD14]

15. Disconnect 1K5 resistor from D- and replace with 15K from 0V.

16. Wait 100us (for D- to fall).

If secondary detection is declared not to be implemented, skip to Checking Current Draw.

Secondary Detection

17. Wait for D- to rise above 0.5V

18. Wait 1ms for D- to settle.

19. Measure D- and check voltage is VDM_SRC (0.5 to 0.7V). [PD15]

20. Check value of IDP_SINK, as follows: Change voltage on 15k resistor to D+ to 0.6V. Wait 20ms, then check voltage at D+ is in correct range for a worst case IDP_SINK of 25µA (i.e. that voltage is not greater than 0.225V). [PD15]

21. Change voltage on 15k resistor to D+ to 0V.

22. Wait for 18ms (together with 21ms delays above, this is less than TVDMSRC_ON min).

23. Check that D- voltage is still VDM_SRC (0.5 to 0.7V). [PD14] [PD15]

24. DO NOT Connect 0.6V to D+.

25. Wait for D- to go below 0.5V.

Checking Current Draw

26. If secondary detection is declared to be implemented, display message to test operator 'PD under test should now have detected CDP'.
If secondary detection is declared not to be implemented, display message to test

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operator 'PD under test should now have detected DCP or CDP'.
(This is a development aid.)

27. Switch data lines to transceiver.

28. Check current drawn does not exceed I_{MAX_BC} from now on until end of step 31. [PD30]

29. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on. [PD8] [If secondary detection supported: PD18]

30. Enumerate UUT (at HS if possible), and Set Configuration 1.

31. Maintain session for 30 seconds from configuration.

Checking Renegotiation

32. Switch data lines to PET test circuit. Turn off V_{BUS} and disconnect pull-down resistance from VBUS.

33. Check that the PD discharges V_{BUS} to less than V_{BUS_LKG} max (0.7V) within T_{VLD_VLKG} max (500ms). [PD28]

34. Wait for T_{VBUS_REAPP} min (100ms).

35. Apply a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turn on V_{BUS} to 5V.

36. Connect 0V via 15k resistor to D+. Connect 0V via15k resistor to D-.

Note: We will emulate an SDP this time to demonstrate that renegotiation was successful.

Renegotiation - Primary Detection

37. Wait for D+ to rise above 0.5V.

38. Wait 1ms for D+ to settle.

39. Measure D+ and check voltage is V_{DP_SRC} (0.5 to 0.7V). [PD10]

Renegotiation - Checking Current Draw

40. Switch data lines to transceiver.

41. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on.

42. Display message to test operator 'PD under test should now have detected SDP'.

43. Wait for 150ms (D+ debounce time plus 50ms).

44. Check that current drawn from V_{BUS} does not exceed I_{UNIT} (100mA).

45. Turn off V_{BUS} and disconnect pull-down resistance from V_{BUS}.

46. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.7 SDP Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	Vendor has declared whether secondary detection is implemented. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the best check on the maximum current drawn.
Purpose	To validate a correct detection procedure when the UUT encounters a SDP.
Description	PET simulates a SDP and monitors activity on D+, and current drawn.
Parameters	V_{DP_SRC}, T_{VDPSRC_ON}, $T_{SVLD\_CON\_PWD}$
Checklist	PD8, PD10, PD12, PD28, PD31
Pass Criteria	See below

7.7.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

DCD

1. PET applies a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V. ID pin is left floating.

2. Connect 0V via15k resistor to D+. Connect 0V via15k resistor to D-.

Primary Detection

3. Wait for D+ to rise above 0.5V

4. Wait 1ms for D+ to settle.

5. Measure D+ and check voltage is V_{DP_SRC} (0.5 to 0.7V). [PD10]

6. Check value of I_{DM_SINK}, as follows: Change voltage on 15k resistor to D- to 0.6V. Wait 20ms, then check voltage at D- is in correct range for a worst case I_{DM_SINK} of 25µA (i.e. that voltage is not greater than 0.225V). [PD10]

7. Change voltage on 15k resistor to D- to 0V.

8. Wait for 18ms (together with 21ms delay above, this is less than T_{VDPSRC_ON} min).

9. Check that D+ voltage is still V_{DP_SRC} (0.5 to 0.7V) [PD10]

10. **Do not** connect 0.6V to D-.

11. Wait for D+ to go below 0.5V, or above 0.8V, or for $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} going on to expire.

$T_{SVLD\_CON\_PWD}$ expires:

This is a failure, as the UUT failed to connect within $T_{SVLD\_CON\_PWD}$ (1 sec). [PD8]

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D+ goes below 0.5V:

If secondary detection is declared not to be implemented, skip to 'Checking Current Draw'.

If secondary detection is declared to be implemented, proceed with 'Secondary Detection'.

D+ rises above 0.8V:

If D+ rises instead above 0.8V, it will be regarded as a legitimate 'device connect'. Skip to 'Checking Current Draw'. [PD8]

Secondary Detection

12. Note: If the primary detection identifies an SDP, then Secondary Detection may not occur. In this case there is no purpose in looking for Secondary Detection, even if it does occur. So we will go straight to 'Checking Current Draw'.

Checking Current Draw

13. Display message to test operator 'PD under test should now have detected SDP. (This is a development aid.)

14. Check current drawn does not exceed I_{CFG_MAX} (500mA) from now on. [PD12], [PD31]

15. Check D+ goes high within $T_{SVLD\_CON\_PWD}$ (1 sec) from V_{BUS} turning on. [PD8]

16. Enumerate UUT (at HS if possible), and Set Configuration 1.

17. Maintain session for 30 seconds from configuration.

18. Turn off V_{BUS} and disconnect pull-down resistance from V_{BUS}.

19. Check that V_{BUS} falls below V_{BUS_LKG} max (0.7V) within T_{VLD_VLKG} max (500ms). [PD28]

20. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.8 ACA-Dock Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates ACA-Dock.
Pre-conditions	Only required if UUT supports ACA detection. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of R_{ID_A}, owing to the current flowing in the cable ground.
Purpose	Demonstrate that PD UUT responds to R_{ID_A} on ID pin. i.e. The PD is attached to an ACA-Dock that is driving V_{BUS}.
Description	Connect R_{ID_A} to ID pin and check that PD behaves correctly.
Parameters	R_{ID_A}
Checklist	PD11, PD21, PD30
Pass Criteria	Step 9: UUT enumerates the PET.

7.8.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

1. Switch data lines to PET test circuit. Set up transceiver (now not connected) to peripheral mode with 1k5 pull-up to 3.3V on D+, and 15k pull-down on D-.
2. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.
3. Wait 10ms.
4. Simultaneously
    - Connect ID pin to ground via R_{ID_A} min (122k).
    - Connect 0.6V via 200R to D-.
    - Connect 3.3V via 1K5 to D+.
5. Check that D+ remains above V_{LGC_HI} min (2.0V) for $T_{DCD\_TIMEOUT}$ min (0.3 sec). [PD11]

Note: DCD using current source is not available in this case.

6. Display message to test operator 'PD under test should now have detected ACA-Dock'. (This is a development aid, and may appear up to 0.4sec before actual detection.)
7. Check that SE0 occurs within $T_{A\_BCON\_ARST}$ max (30 sec).
8. On detecting SE0, switch data lines to transceiver. This has the effect of disconnecting the 0.6V from D-, and replaces the test circuit pull-up with the transceiver pull-up.
9. Check that UUT enumerates the PET within 30 seconds. PET responds as test device 0x1A0A/0x0200. [PD21]

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10. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]

11. Wait 10 seconds.

12. Simulate a detach as follows:

    - Switch off transceiver D+ pullup
    - Switch off transceiver pull-down from D-.
    - Disconnect R_{ID_A} from ID pin
    - Disconnect 0.6V via 200R from D-.
    - Disconnect data line test circuit 3.3V via 1K5 from D+
    - Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

13. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

14. Repeat steps 1-13 using R_{ID_A} max (126k).

End of Test

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7.9 ACA-A Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	Demonstrate that PD UUT responds to R_{ID_A} on ID pin (i.e. the PD is attached to an ACA that has a charger on its Charger Port, and a B-device on its Accessory Port). This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of R_{ID_A}, owing to the current flowing in the cable ground.
Description	Connect R_{ID_A} to ID pin and check that PD behaves correctly.
Parameters	R_{ID_A}
Checklist	PD22, PD30
Pass Criteria	Step 6: UUT enumerates the PET.

7.9.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on. ID pin not connected.

1. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V
2. Wait 10ms to simulate plug insertion.
3. Connect ID pin to ground via R_{ID_A} min (122k).
4. Display message to test operator 'PD under test should now have detected ACA-A'. (This is a development aid, and may appear slightly before actual detection.)
5. Connect using D+.
6. Check that UUT resets and enumerates the PET within 30 seconds. PET responds as test device 0x1A0A/0x0200. [PD22]
7. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]
8. Wait 10 seconds.
9. Disconnect using D+.
10. Disconnect resistor from ID pin.
11. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.
12. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.
13. Repeat steps 1-12 using R_{ID_A} max (126k).

End of Test

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7.10 ACA-B Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates ACA-B.
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	To validate a correct detection procedure when the UUT encounters an ACA-B (i.e. the PD is attached to an ACA that has a charger on its Charger Port, and does not have an accessory on its Accessory Port).
Description	PET simulates an ACA-B and monitors activity on D+, and current drawn.
Parameters	R_{ID_B}
Checklist	PD8, PD24, PD30
Pass Criteria	Step 97: UUT does not connect

7.10.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on. ID pin not connected.

DCD

1. Switch data lines to PET test circuit.
2. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V.
3. Wait 10ms to simulate plug insertion.
4. Connect ID pin to ground via R_{ID_B} min (67k).
5. Connect 0V via 15k resistor to D+. Connect 0V via 15k resistor to D-.
6. Start timer of $T_{SVLD\_CON\_PWD}$ (1 sec).
7. Wait for D+ to exceed V_{LGC} min, or timer to expire.

Timer $T_{SVLD\_CON\_PWD}$ expires:

Proceed to ' Checking Current Draw'

D+ rises above 0.8V:

Check that D+ goes below 0.8V within no more than $T_{B\_DATA\_PLS}$ max (10ms). This represents a valid SRP pulse, which we will ignore. Proceed to ' Checking Current Draw'

Else UUT has attempted to connect – FAIL. [PD8]

Primary Detection

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Primary detection is optional, and its parameters are measured elsewhere, so we will ignore it during this test.

Checking Current Draw

8. Display message to test operator 'PD under test should now have detected R_{ID_B}'. (This is a development aid.)

9. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]

10. Check D+ is held below V_{DAT_REF} min (0.25V) from now on. It is possible that SRP pulses are attempted, these should be ignored if they do not exceed $T_{B\_DATA\_PLS}$ max (10ms). [PD24]

11. Maintain session for 15 seconds from step 6.

12. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

13. Disconnect 15k pulldown resistor from D+ and D-.

14. Disconnect ID pin resistor.

15. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

16. Repeat steps 1-15 using R_{ID_B} max (69K).

17. Disconnect data lines from PET test circuit.

End of Test

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7.11 ACA-C Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates ACA-C.
Pre-conditions	Only required if UUT supports ACA detection.
Purpose	To validate a correct detection procedure when the UUT encounters an ACA-C. i.e. The PD is attached to an ACA that has a charger on its Charger Port, and an A-device on its Accessory Port. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of R_{ID_C}, owing to the current flowing in the cable ground.
Description	PET simulates an ACA-C and monitors activity on D+, enumerates the PD UUT and monitors current drawn.
Parameters	R_{ID_C}
Checklist	PD8, PD25, PD30
Pass Criteria	Step 8: UUT does connect

7.11.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on. ID pin not connected.

DCD

1. Switch data lines to PET test circuit.
2. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V
3. Wait 10ms to simulate plug insertion.
4. Connect ID pin to ground via R_{ID_C} min (36k).
5. Connect 0V via15k resistor to D+. Connect 0V via15k resistor to D-.
6. Start timer of $T_{SVLD\_CON\_PWD}$ (1 sec).
7. Wait for D+ to exceed V_{LGC} min, or timer to expire.

Timer $T_{SVLD\_CON\_PWD}$ expires:

UUT failed to connect – FAIL [PD8] [PD25]

D+ rises above 0.8V:

Check that D+ is high for more than 10ms. If not this is a failure (SRP not allowed). [PD25]

Else UUT has connected – proceed to ' Checking Current Draw'.

Primary Detection

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Primary detection is optional, and its parameters are measured elsewhere, so we will ignore it during this test.

Checking Current Draw

8. Switch data lines back to transceiver.

9. Display message to test operator 'PD under test should now have detected R_{ID_C}'. (This is a development aid.)

10. From now on check current drawn and report. Check that this current does not exceed I_{MAX_BC}. (If current exceeds 1.5A test will terminate to protect tester connectors.) [PD30]

11. Enumerate UUT and Set Configuration 1. [PD25]

12. Maintain session for 10 seconds from step 8.

13. Disconnect 15k pulldown resistor from D+ and D-.

14. Disconnect ID pin resistor.

15. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

16. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

17. Repeat steps 1-15 using R_{ID_C} max (37K)

End of Test

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7.12 ACA-GND Detection Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates.
Pre-conditions	Only required if UUT supports ACA detection. This test should be performed with a battery just above the Weak Battery Threshold, as this provides the greatest stress on the measurement of R_{ID_GND}, owing to the current flowing in the cable ground.
Purpose	Demonstrate that PD UUT responds to R_{ID_GND} max on ID pin. i.e. the PD is attached to a B-device, or to an ACA that has a B-device on its Accessory Port, but no charger.
Description	Connect R_{ID_GND} max to ID pin and check that PD behaves as A-device.
Parameters	R_{ID_GND}
Checklist	PD26
Pass Criteria	Step 6: V_{BUS} turns on in response to SRP.

7.12.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. PD is switched on.

1. Connect 6.5µF from V_{BUS} to ground.
2. Connect ID pin to ground via R_{ID_GND} max (1k).
3. Wait 3 seconds.
4. If V_{BUS} is on, wait for it to go off, and stay off for 5 seconds.

This deals with ADP and any initial test for a peripheral.

5. Perform SRP for 7.5ms pulse.
6. Check that V_{BUS} rises above $V_{OTG\_SESS\_VLD}$ within $T_{A\_SRP\_RSPNS}$ of rising edge of SRP pulse. [PD26]
7. Disconnect R_{ID_GND}, and capacitance and resistance from V_{BUS}.
8. Wait for V_{BUS} to go off, and stay off for 5 seconds.

End of Test

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7.13 Common Mode Test - Full Speed

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	This test should be performed with a good battery in order to minimize extra current flowing in the cable ground, as the PET provides the ground offset itself.
Purpose	This test verifies that a UUT is able to communicate with a charging downstream port at full-speed when cable ground is dropping I_{MAX_BC} x 0.25Ω + 5mV.
Description	This test will apply a maximum of 375mV offset to UUT ground, and then verify UUT will enumerate and work successfully. PET simulates an SDP to reduce the risk that the UUT itself draws a significant current.
Parameters	
Checklist	PD33
Pass Criteria	Step 5: UUT enumerates successfully Step 6: UUT functions as expected

7.13.1 Test procedure

Initial State. Special Test Cable A is connected to PD. V_{BUS} is off, capacitance of 6.5µF is connected to V_{BUS}, data lines switched to PET transceiver.

1. Apply a common mode offset of I_{MAX_BC} x 0.25 Ω + 5mV (a maximum of V_{GND_OFFSET} [0.375V] if I_{MAX_BC} is declared as 1500mA) with PET test socket higher than PET transceiver ground.
2. Turn V_{BUS} on to 5V.
3. Wait for UUT to connect
4. Wait 100ms.
5. Reset and enumerate at Full Speed. Check that enumeration was successful.
6. Continue for 10 seconds, without configuring, to perform a number of standard requests, (e.g. Get Device Descriptor) checking again for failure to respond to transactions. This is achieved by counting the number of failures to respond to transactions, and comparing this to an arbitrary ceiling. (A good device would never fail to respond in practice.) [PD33]
7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.
8. Remove common mode offset.
9. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.14 Common Mode Test - High Speed

Test Setup	Test Setup 4. UUT is a PD, PET simulates a SDP.
Pre-conditions	This test should be performed with a good battery in order to minimize extra current flowing in the cable ground, as the PET provides the ground offset itself.
Purpose	This test verifies that a UUT is able to communicate with a charging downstream port at high-speed when cable ground is dropping I_{MAX_BC} x 0.25Ω + 5mV.
Description	This test will apply a maximum of 375mV offset to UUT ground, and then verify UUT will enumerate and work successfully. PET simulates an SDP to reduce the risk that the UUT itself draws a significant current.
Parameters	
Checklist	PD33
Pass Criteria	Step 5: UUT enumerates successfully Step 6: UUT functions as expected

7.14.1 Test procedure

Initial State. Special Test Cable A is connected to PD. V_{BUS} is off, capacitance of 6.5µF is connected to V_{BUS}, data lines switched to PET transceiver.

1. Apply a common mode offset of I_{MAX_BC} x 0.25 Ω + 5mV (a maximum of V_{GND_OFFSET} [0.375V] if I_{MAX_BC} is declared as 1500mA) with PET test socket higher than PET transceiver ground.
2. Turn V_{BUS} on to 5V.
3. Wait for UUT to connect
4. Wait 100ms.
5. Reset and enumerate at High Speed. Check that enumeration was successful.
6. Continue for 10 seconds, without configuring, to perform a number of standard requests, (e.g. Get Device Descriptor) checking again for failure to respond to transactions. This is achieved by counting the number of failures to respond to transactions, and comparing this to an arbitrary ceiling. (A good device would never fail to respond in practice.) [PD33
7. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.
8. Remove common mode offset.
9. Wait 8 seconds, ignoring SRP pulse, for detachment to be detected.

End of Test

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7.15 Dead Battery Provision Test

Test Setup	Test Setup 4. UUT is a PD, PET simulates an SDP.
Pre-conditions	UUT has been fitted with a 'Dead Battery'. Assumption is that this remains dead for 30 second duration of test.
Purpose	To verify that the UUT complies with requirements of the 'Dead Battery Provision – Unconfigured Clause'
Description	This test is performed separately from the other PD tests, as it requires a dead battery to be fitted. V_{BUS} is applied to the device, and the current drawn and D+ voltage are monitored.
Parameters	I_{UNIT}, V_{DP_SRC}
Checklist	DBP1, DBP3
Pass Criteria	Step 4: D+ is below V_{LGC} min Step 9: D+ is at V_{DP_SRC} Step 10: Watch-block has not been triggered.

7.15.1 Test procedure

Initial State: Special Test Cable A is connected to PD. No V_{BUS} voltage applied. Any mechanical switches on the PD required for it to be able to power up have been operated.

1. PET applies C_{ADP_VBUS} max (6.5µF) and a pull-down resistor of R_{OTG_VBUS} min (10k) to V_{BUS} and turns on V_{BUS} to 5V. ID pin is left floating.
2. Connect 0V via 15k resistor to D+. Connect 0V via 15k resistor to D-.
3. Wait $T_{SVLD\_CON\_PWD}$ max plus a margin (1 sec + .5 sec = 1.5 sec).
4. Set up a watch-block to monitor the current drawn from V_{BUS}, and be triggered if this current exceeds I_{UNIT} (100mA).
5. Check that D+ is below V_{LGC} min (0.8v). If UUT connects at any time during the remainder of the test, skip to Step15. We must assume that the dead battery provision is no longer required by the UUT.
6. Display message to test operator 'PD under test should now have detected SDP'. (This is a development aid.)
7. For the next 30 seconds, follow the procedure in steps 8-10
8. Measure the average current drawn from V_{BUS}, sampling every 1ms for a period of 1 second. Record whether this value exceeds I_{SUSP} (2.5mA).
9. If the value does exceed I_{SUSP} for two consecutive averages, then check that D+ is at V_{DP_SRC} (0.5V-0.7V).
10. Check that the watch-block has not been triggered.
11. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

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12. Disconnect 15k pull-down resistors.

13. Wait 5 seconds for detachment to be recognized.

14. Skip to End of Test

Enumerating

15. Wait $T_{A\_BCON\_LDB}$ min (100ms) then issue a bus reset to the B-UUT.

16. Check that PET can enumerate UUT (at HS if possible), and Set Configuration 1.

17. For the next 30 seconds, check current drawn does not exceed bMaxPower.

18. Turn off V_{BUS} and disconnect capacitance and pull-down resistance from V_{BUS}.

19. Disconnect 15k pull-down resistors.

20. Wait 5 seconds for detachment to be recognized.

End of Test

Note: Parameters and behavior such as $T_{SVLD\_CON\_WKB}$, $T_{DBP\_VDPSRC\_CON}$ are verified by vendor declaration.

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8 Dedicated Charging Port (DCP) Compliance

8.1 Submission Materials

8.1.1 Device Specific Information

The following items are required to be submitted along with the UUT:

Table 8-1 Device Specific Information for DCPs

Item	Function	Value/ Support
1	Evidence the UUT contains on its nameplate and/or end-user documentation, the continuous current rating at which output voltage of 4.75V to 5.25V is provided	
2	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
3	The USB-IF TID for the UUT standard-A receptacle(s) or micro-B plug(s) (via captive cable)	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on VBUS to exceed V_{CHG_FAIL}?	
5	UUT Charging Port identification label drawing (If additional Charging or non Charging Ports are included in UUT)	
6	Description of UUT output or Charging Port operation and availability when multiple outputs or Charging Ports are present (if applicable)	
7	Description of UUT output or Charging Port operation and availability during Device power states (if applicable)	

8.1.2 Checklist

Table 8-2 Checklist for DCPs

Question		Response	Test Number	BC 1.2 Reference
DCP1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on of off?	Yes ☐ No ☐	8.2	4.1.1
DCP2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition?	Yes ☐ No ☐	Vendor Declaration	4.1.2
DCP3	If the UUT switches roles among SDP, CDP and DCP, does it allow V_{BUS} to drop to less than V_{BUS_LKG} and wait for a time T_{VBUS_REAPP} before driving V_{BUS} again?	Yes ☐ No ☐	Vendor Declaration	4.1.3
DCP4	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on V_{BUS} will not exceed V_{CHG_FAIL}?	Yes ☐ No ☐	Vendor Declaration	4.1.5

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DCP5	As per provided UUT description: if the UUT provides multiple USB Charging Ports, the active UUT USB Charging Port does not affect operation of any other Charging Port.	Yes ☐ No ☐	Vendor Declaration	4.1.6
DCP6	Does the UUT output a voltage of V_{CHG} (averaged over T_{VBUS_AVG}) for all currents less than I_{DCP} min?	Yes ☐ No ☐	8.5	4.4.1
DCP7	Does the UUT output a voltage less than V_{CHG} max (averaged over T_{VBUS_AVG}) for all currents between I_{DCP} min and I_{DEV_CHG} max?	Yes ☐ No ☐	8.5	4.4.1
DCP8	Is the output voltage of the UUT greater than V_{CHG_UNDSHT} min for any step change in load current from I_{DCP_LOW} to I_{DCP_MID}?	Yes ☐ No ☐	8.2	4.4.2
DCP9	Is the output voltage of the UUT greater than V_{CHG_UNDSHT} min for any step change in load current from I_{DCP_MID} to I_{DCP_HI}, including steps that occur $T_{DCP\_LD\_STP}$ after a transition from I_{DCP_LOW} to I_{DCP_MID}?	Yes ☐ No ☐	8.2	4.4.2
DCP10	Is the duration of any undershoot less than T_{DCP_UNDSHT} ?	Yes ☐ No ☐	8.2	4.4.2
DCP11	Does the output voltage of the UUT drop below V_{CHG} min for less than T_{DCP_UNDSHT}, any step change in load current from I_{DCP_LOW} to I_{DCP_HI} provided the load current is less than I_{DCP} min ?	Yes ☐ No ☐	8.2	4.4.2
DCP12	Does the UUT have a resistance between D+ and D- of R_{DCP_DAT} ?	Yes ☐ No ☐	8.3	4.4.3
DCP13	Does the UUT have a leakage current from D+/D- less than or equal to R_{DAT_LKG} tied to a voltage of V_{DAT_LKG} ?	Yes ☐ No ☐	8.3	4.4.3
DCP14	Does the UUT have a capacitance from D+/D- of C_{DCP_PWR} ?	Yes ☐ No ☐	8.3	4.4.3
DCP15	Does the UUT have a Standard-A receptacle, or a captive cable terminated with a Micro-B plug?	Standard-A ☐ Captive ☐ No ☐	Inspection	4.4.4
DCP16	Does the UUT provide V_{BUS} discharge functionality?	Yes ☐ No ☐	Vendor Declaration	4.1.3

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8.2 DCP Overshoot and Undershoot Voltage Test

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	This test must be run before any of the other DCP tests.
Purpose	To verify the DCP meets overshoot and undershoot voltage specifications, for any specified step change in load.
Description	This test changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels. Note: The DCP can have a Standard-A receptacle or a captive cable. In the case of a captive cable, the BC specification requires voltage measurements to be taken at the Micro-B plug of the captive cable.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT, TDCP_UNDSHT
Checklist	DCP1, DCP6, DCP8, DCP9, DCP10, DCP11, DCP12
Pass Criteria	Step 7 – Maximum voltage during overshoot is less than 6.0V. Step 19 – VBUS is in range 4.75V to 5.25V Step 20 – Minimum voltage during undershoot is above 4.1V. Step 20 – Maximum voltage during overshoot is less than 6.0V. Step 24 – VBUS is in range 4.75V to 5.25V Step 25 – Minimum voltage during undershoot is above 4.1V. Step 25 – Maximum voltage during overshoot is less than 6.0V. Step 28 – Minimum voltage during undershoot is above 4.1V. Step 28 – Maximum voltage during overshoot is less than 6.0V. Step 31 – VBUS is in range 4.75V to 5.25V Step 32 – VBUS is in range 4.75V to 5.25V

8.2.1 Test procedure

Initial State: No load applied. If captive cable equipped, check the 'Captive Cable' box in the test dialog.

1. Ensure that UUT is connected via Special Test Cable B, or its captive cable, to the PET.
2. Ensure that DCP is in an unpowered state.
3. Wait for DCP voltage to fall below 0.5V, in case it has just been switched off. (Speed up fall using current load.)
4. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on VBUS.
5. Instruct test operator to plug DCP into 'wall-socket', or to perform steps required to bring the DCP from an un-powered state to a powered one.
6. Wait for operator to click 'OK'.

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7. Check watch-block overshoot detector latch was not triggered. [DCP1]

8. Set up voltage watch-block ready to capture undershoot of V_{CHG_UNDSHT} (4.1V), or overshoot of V_{CHG_OVRSHT} (6.0V) on V_{BUS}.

9. With an applied current load of I_{DCP_LOW} min (0mA), check that V_{BUS} average is within appropriate range V_{CHG} (4.75V to 5.25V) over the next T_{VBUS_AVG} max (0.25 sec). [DCP6]

10. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1][DCP8]

11. Re-program watch-block to allow for voltage drop in cable.

Emulate attaching PD

12. Apply V_{DP_SRC} nom. (0.6V) to D+.

13. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)

14. Check D- > V_{DAT_REF} min (0.25V). [DCP12]

15. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).

16. Take D+ back to 0V.

Load Testing

17. Apply load of I_{DCP_MID} max (100mA) to V_{BUS}.

18. Wait T_{DCP_UNDSHT} max (10ms).

19. Check V_{BUS}, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable (spot check voltage). [DCP6][DCP10]

20. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1][DCP8]

21. Re-program watch-block to allow for voltage drop in cable.

22. Increase load on V_{BUS} to I_{DCP} min (500mA), 20ms after rise to I_{DCP} mid.

23. Wait T_{DCP_UNDSHT} max (10ms).

24. Check V_{BUS} average, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), over the next T_{VBUS_AVG} max (0.25 sec), making due allowance for voltage drop in cable. [DCP6]

25. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1] [DCP9]

26. Remove Current Load.

27. Wait 100ms

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28. Check watch-block overshoot and undershoot detector latches were not triggered.

29. Apply load of I_{DCP} min (500mA) to V_{BUS}.

30. Wait T_{DCP_UNDSHT} max (10ms).

31. Check V_{BUS}, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable (spot check voltage). [DCP1] [DCP9] [DCP11]

32. Check V_{BUS} average, at DCP connector, is in range V_{CHG} (4.75V to 5.25V), over the next T_{VBUS_AVG} max (0.25 sec), making due allowance for voltage drop in cable. [DCP6]

33. Remove Current Load.

34. Wait 100ms

35. Check watch-block overshoot and undershoot detector latches were not triggered. [DCP1] [DCP9]

End of Test

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8.3 DCP Handshaking Test

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	DCP Overshoot and Undershoot Voltage Test has been run, and DCP is now switched on.
Purpose	To verify the parameters of detection handshake. This test is particularly designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP, and may therefore have more complex circuitry on D+ and D- than a simple resistive connection.
Description	Test confirms correct handshake behavior.
Parameters	
Checklist	DCP6
Pass Criteria	Step 5 – Voltage is in range Step 10 - Voltage is in range

8.3.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on. Data lines switched to data measurement circuit.

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V). [DCP6]
2. Wait 200ms

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check D- voltage is in range V_{DM_SRC} (0.5V - 0.7V). [DCP12, DCP13]
6. Wait 20ms to complete T_{VDPSRC_ON}.
7. Disconnect voltage source via 200R resistor from D+.

Secondary Detection

8. Connect voltage source (0.6V) via 200R resistor to D-.
9. Wait 21ms.
10. Check D+ voltage is in range V_{DM_SRC} (0.5V - 0.7V). [DCP12, DCP13]
11. Wait 20ms to complete T_{VDMSRC_ON}.
12. Disconnect voltage source via 200R resistor from D-.
13. Wait 5 seconds for UUT to recover.

End of Test

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8.4 DCP Resistance and Capacitance Tests

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	
Purpose	To verify that the resistance between D+/D- and data line resistance and capacitance to V_{BUS}/GND is in valid range.
Description	This test measures the resistance of data lines (D+/D-) and then the resistance/capacitance from D+/D- to VBUS and to GND. Also, ID pin resistance is checked for sanity.
Parameters	R_{DCP_DAT}, C_{DCP_PWR}, R_{DAT_LKG}
Checklist	DCP12, DCP13, DCP14
Pass Criteria	Step 6 - Resistance between D+ and D- is less than 200Ω. Step 12 - Resistances between D+/- and GND/V_{OH} are greater than 150kΩ. (R_{DAT_LKG} / 2). Step 15 - Capacitances between D+/- and GND are less than 1nF.

8.4.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on. Data lines switched to data measurement circuit.

Emulate attaching PD

1. Apply V_{DP_SRC} nom. (0.6V) to D+.
2. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)
3. Check D- > V_{DAT_REF} min (0.25V).
4. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).
5. Take D+ back to 0V.

Checking Resistance between D+ and D-

6. Check that resistance from D+ to D- is less than R_{DCP_DAT} max (200R). i.e. Connect 3.0V via 200R resistor to D+, connect 0V via 200R resistor to D-. Measure voltages at D+ and D-. The difference must be less than 1.05V. [DCP12]

Checking leakage from D+ or D-

7. Connect D+ via 100k to 0V
8. Wait 2 seconds to eliminate capacitive effects.
9. Check that voltage at D+ is below 1.44V (Two R_{DAT_LKG} (300k) in parallel, V_{DAT_LKG} = 3.6V).
10. Connect D+ via 100K to 3.3V
11. Wait 2 seconds
12. Check that D+ is greater than 1.98V (Two R_{DAT_LKG} (300k) in parallel, V_{DAT_LKG} = 0V).

This shows that leakage resistance is greater than R_{DAT_LKG} / 2. [DCP13]

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Checking Capacitance of D+ or D-

13. Discharge Standard 1nF capacitor and Capacitance under Test
    Connect 0V to D+ via 1nF test capacitor. Connect 0V to D- via 200R resistor. There is a tested, <200R, resistor between D- and D+. This will discharge the standard 1nF capacitor and the capacitance under test to 0V. Wait 10ms.

14. Isolate Capacitances
    Disconnect 0V from test capacitor to isolate it. Disconnect 0V from 200R resistor.

Note: We will now use the D+ voltage watch-block to determine whether, during the charge-sharing process, D+ rises above 1.65V. The watch-block amplifier has a limited band-width by design, so that the watch-block voltage set is lower than 1.65V. The actual value can be found in the test script.

15. Share Charge Between Capacitances
    Set D+ watch-block to be testing for voltage less than the value required. Connect 3.3V to D+ via 1nF test capacitor. Wait 1ms. This allows for charge sharing between standard 1nF capacitor and capacitance under test.

16. Read watch-block to see if voltage on D+ went above 1.65V. If it did, then the capacitance under test is less than 1nF and therefore in specification. [DCP14]

End of Test

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8.5 DCP Voltage and Current

Test Setup	Test Setup 6. UUT is a DCP, PET simulates a PD.
Pre-conditions	
Purpose	To verify that the V_{BUS} voltage / current load characteristic meets the specified requirements. These are steady-state tests, hence the 1 second delay in step 3. The test may result in shutdown of the DCP, so this test is placed last in the test sequence, as no recovery time is specified by the Battery Charging 1.2 Specification.
Description	This test measures the voltage at various current loads, in order to confirm correct behavior.
Parameters	V_{CHG}, V_{DCP_SHTDWN}
Checklist	DCP6, DCP7
Pass Criteria	Step 1 - V_{BUS} voltage is in correct range. Step 9 - V_{BUS} voltage is in correct range. Step 12 - V_{BUS} voltage is in correct range.

8.5.1 Test procedure

Initial State: UUT is connected via Special Test Cable B, or its captive cable, to the PET. No load applied. DCP is switched on.

1. I_{DCP} is initially 0mA. Check that V_{BUS} voltage, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), from DCP is within V_{CHG} (4.75 – 5.25V). [DCP6]

Emulate attaching PD

2. Apply V_{DP_SRC} nom. (0.6V) to D+.
3. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)
4. Check D- > V_{DAT_REF} min (0.25V).
5. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).
6. Take D+ back to 0V.
7. Apply load of I_{DCP} min (500 mA) to V_{BUS}.
8. Wait 1 sec to avoid possible transient period (overshoot and undershoot are measured separately).
9. Check that V_{BUS} voltage from DCP, at DCP connector, with samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within V_{CHG} (4.75 – 5.25V), making due allowance for voltage drop in cable. [DCP6]
10. Increase load to I_{DEV_CHG} max (1.5A).
11. Wait 1 sec to avoid possible overshoot.

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12. Check that V_{BUS} voltage from DCP, at DCP connector, with samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is below V_{CHG} max (5.25V), making due allowance for voltage drop in cable. The PET reports the voltage measured. [DCP7]

13. Disconnect the current load.

End of Test

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9 Charging Downstream Port (CDP) Compliance

9.1 Submission Materials

The following items are required to be submitted along with the UUT:

9.1.1 Device Specific Information

Table 9-1 Device Specific Information for CDPs

Item	Function	Value/ Support
1	Evidence the UUT contains on its nameplate and/or end-user documentation, the continuous current rating at which output voltage of 4.75V to 5.25V is provided	
2	Schematics or other proof that UUT output current cannot exceed 5.0 amperes	
3	The USB-IF TID for the UUT standard-A receptacle(s) or micro-B plug(s) (via captive cable)	
4	Schematics or other proof that a single UUT failure will not cause the output voltage on VBUS to exceed V_{CHG_FAIL}?	
5	UUT Charging Port identification label drawing (If additional Charging or non Charging Ports are included in UUT)	
6	Description of UUT output or Charging Port operation and availability when multiple outputs or Charging Ports are present (if applicable)	
7	Description of UUT output or Charging Port operation and availability during Device power states (if applicable)	

9.1.2 Checklist

Table 9-2 Checklist for CDPs

ID	Question	Response	Test Number	BC 1.2 Section Number
CDP1	Is the output voltage of the UUT less than V_{CHG_OVRSHT} max for any step change in load current, and also when powering on of off?	Yes ☐ No ☐	9.2	4.1.1
CDP2	Is the output current of the UUT prevented from exceeding I_{CDP} max under any condition?	Yes ☐ No ☐	Vendor Declaration	4.1.2
CDP3	If the UUT switches roles among SDP, CDP and DCP, does it allow V_{BUS} to drop to less than V_{BUS_LKG} and wait for a time T_{VBUS_REAPP} before driving V_{BUS} again?	Yes ☐ No ☐	Vendor Declaration	4.1.3
CDP4	Has it has been shown, using schematics or by some other explanation, that in the case of a single failure in the UUT, the output voltage on V_{BUS} will not exceed V_{CHG_FAIL}?	Yes ☐ No ☐	Vendor Declaration	4.1.5

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CDP5	As per provided UUT description: if the UUT provides multiple USB Charging Ports, the active UUT USB Charging Port does not affect operation of any other Charging Port.	Yes ☐ No ☐	Vendor Declaration	4.1.6
CDP6	Does the UUT output a voltage of V_{CHG} (averaged over T_{VBUS_AVG}) for all currents less than I_{CDP} min?	Yes ☐ No ☐	9.3	4.2.1
CDP7	Is the output voltage of the UUT greater than V_{CHG_UNDSHT} min for any step change in load current where current is less than I_{CDP} min?	Yes ☐ No ☐	9.2	4.2.3
CDP8	Does the CDP either: A.) Enable V_{DM_SRC} within $T_{CP\_VDM\_EN}$ of a disconnect and disable V_{DM_SRC} within $T_{CP\_VDM\_DIS}$ of a connect, or B.) Enable V_{DM_SRC}, whenever D+ is greater than V_{DAT_REF} and less than V_{LGC}, and disable V_{DM_SRC}, whenever D+ is less than V_{DAT_REF} or greater than V_{LGC}?	Yes ☐ (A ☐ B ☐) No ☐	9.4	3.4.2 4.2.4
CDP9	If the first option of CDP8 is implemented, is the design of V_{DM_SRC} such that an external device is able to pull D- to 2.2V through R_{DM_UP} ?	Yes ☐ No ☐ N/A ☐	9.4	5.
CDP10	If before connecting, a device applies V_{DM_SRC} to D-, does the CDP maintain a voltage of less than V_{DAT_REF} min on D+?	Yes ☐ No ☐	8.4	3.2.5.2
CDP11	If a PD draws more than I_{CFG_MAX} from the CDP, does the CDP correctly support LS, FS, HS and chirp signaling when the local ground is V_{GND_OFFSET} max lower than the remote ground.	Yes ☐ No ☐	9.5, 9.6	3.5
CDP12	Does the UUT have a Standard-A receptacle?	Yes ☐ No ☐	Inspection	4.2.5
CDP13	If the CDP goes into shutdown during a current overload condition, does it recover and output a voltage of V_{CHG} within a time of T_{SHTDWN_REC} when the current overload condition has been removed.	Yes ☐ No ☐	Vendor Declaration	4.2.2

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CDP14	Does the UUT provide VBUS discharge functionality?	Yes ☐ No ☐	Vendor Declaration	4.1.3

9.2 CDP Overshoot and Undershoot Voltage Test

Test Setup	Test Setup 5. UUT is a CDP, PET simulates a PD.
Pre-conditions	This must be performed as the first test in the CDP suite.
Purpose	To verify the CDP meets overshoot and undershoot voltage specifications, for any specified step change in load.
Description	This test changes the VBUS current abruptly, and measures the resulting voltage overshoot and undershoot levels.
Parameters	VCHG_OVERSHT, VCHG_UNDSHT
Checklist	CDP1, CDP7
Pass Criteria	Step 8 – Maximum voltage during overshoot is less than 6.0V. Step 10 – VBUS is in range 4.75V to 5.25V Step 18 – VBUS is in range 4.75V to 5.25V Step 19 – Minimum voltage during undershoot is above 4.1V. Step 19 – Maximum voltage during overshoot is less than 6.0V. Step 22 – Minimum voltage during undershoot is above 4.1V. Step 22 – Maximum voltage during overshoot is less than 6.0V.

9.2.1 Test procedure

Initial State: No load applied.

1. Ensure that UUT is connected via Special Test Cable B to the PET.
2. Ensure that CDP is in an un-powered state.
3. Wait for CDP voltage to fall below VBUS_LKG max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
4. Set up voltage watch-block ready to capture overshoot of VCHG_OVRSHT (6.0V) on VBUS.
5. Instruct test operator to perform steps required to bring the CDP from an un-powered state to a powered one.
6. Wait for operator to click 'OK'.
7. Wait for VBUS to rise above VCHG min (4.75V).
8. Check watch-block overshoot detector latch was not triggered. [CDP1]
9. Set up voltage watch-block ready to capture undershoot of VCHG_UNDSHT (4.1V), or overshoot of VCHG_OVRSHT (6.0V) on VBUS, allowing for voltage drop in cable.

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10. With no current load applied, check that V_{BUS} is within appropriate range V_{CHG} (4.75V to 5.25V). [CDP6]

Emulate attaching PD

11. Apply V_{DP_SRC} nom. (0.6V) to D+.

12. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)

13. Check D- > V_{DAT_REF} min (0.25V).

14. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).

15. Take D+ back to 0V.

Load Testing

16. Apply load of I_{CDP} min (1.5A) to V_{BUS}.

17. Wait 10ms.

18. Check that V_{BUS} voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable.

19. Check watch-block overshoot and undershoot detector latches were not triggered. [CDP1] [CDP7]

20. Remove Current Load.

21. Wait 10ms

22. Check that V_{BUS} voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V).[CDP6]

23. Check watch-block overshoot and undershoot detector latches were not triggered. [CDP1] [CDP7]

End of Test

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9.3 CDP Voltage and Current Test

Test Setup	Test Setup 5. UUT is a CDP, PET simulates a PD.
Pre-conditions	CDP Overshoot and Undershoot Voltage Test has been run, and CDP is now switched on.
Purpose	To verify that the V_{BUS} voltage / current load characteristic meets the specified requirements.
Description	This test measures the voltage at various current loads, in order to confirm correct behavior.
Parameters	V_{CHG}
Checklist	CDP6
Pass Criteria	Step 1 - V_{BUS} voltage is in correct range. Step 9 - V_{BUS} voltage is in correct range.

9.3.1 Test procedure

Initial State: Special Cable B is connected to CDP. CDP is switched on.

1. Check that V_{BUS} voltage, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), from CDP is within V_{CHG} (4.75 – 5.25V). [CDP6]

Emulate attaching PD

2. Apply V_{DP_SRC} nom. (0.6V) to D+.
3. Wait T_{VDMSRC_EN} max + 1 ms (= 21ms)
4. Check D- > V_{DAT_REF} min (0.25V).
5. Wait for 1ms more than the remainder of T_{VDPSRC_ON} (40ms – 20ms = 20ms).
6. Take D+ back to 0V.

Load Testing

7. Apply load of I_{CDP} min (1.5A) to V_{BUS}.
8. Wait 1 sec to avoid possible transient period (overshoot and undershoot are measured separately).
9. Check that V_{BUS} voltage from CDP, at CDP connector, samples taken every 1 ms and averaged over T_{VBUS_AVG} max (250ms), is within appropriate range V_{CHG} (4.75V to 5.25V), making due allowance for voltage drop in cable. [CDP6]
10. Disconnect the current load.

Note: In order that the test should not damage the tester connectors, no recovery time test is performed. A special test configuration is detailed elsewhere to provide a means of performing this test safely, if required.

End of Test

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9.4 CDP Handshaking Test

Test Setup	Test Setup 5. UUT is an CDP, PET simulates a PD.
Pre-conditions	CDP Overshoot and Undershoot Voltage Test has been run, and CDP is now switched on.
Purpose	To verify the parameters of detection handshake.
Description	Test determines which of the two permissible behaviors is implemented, and confirms correct behavior.
Parameters	RDP_DWN, RDM_DWN, VDM_SRC, VDAT_REF, TVDMSRC_DIS, TVDMSRC_EN, TCP_VDM_DIS, TCP_VDM_EN, TVDMSRC_ON, RDAT_LKG, VDAT_LKG
Checklist	CDP8, CDP9, CDP10
Pass Criteria	Step 8: D- voltage is still in range VDM_SRC min (0.5V – 0.7V). Step 15: Voltage on D- is greater than 2V. Step 28: Voltage on D- is below VDAT_REF min (0.25V). or Step 35. D- voltage is still in range VDM_SRC min (0.5V – 0.7V). Step 43. Voltage on D- is below VDAT_REF min (0.25V).

9.4.1 Test procedure

Initial State: Special Cable B is connected to CDP. CDP is switched on.

1. Check VBUS is above VOTG_SESS_VLD max (4V). [CDP6]
2. Wait 200ms
3. Examine voltage on D-. If this is less than VDAT_REF min (0.25V), skip to step 31.

Behavior 1 – CDP maintains VDM_SRC while device not connected.

Primary Detection

4. Connect voltage source (0.6V) via 200R resistor to D+.
5. Wait slightly more than TVDMSRC_EN max (20ms +1 ms = 21ms).

Check VDM_SRC Gets Connected

6. Connect voltage source (0.5V) via 200R resistor to D-.
7. While voltage across 200R is less than 50mV, decrement the D- voltage source in steps of 2mV. Stop if D- voltage falls below VDM_SRC min (0.5V) - FAIL. Else we will now be drawing the required 250µA from VDM_SRC.
8. Check D- voltage is still in range VDM_SRC (0.5V – 0.7V). [CDP8]
9. Disconnect voltage source and 200R from D-.
10. Wait 20ms to complete TVDPSRC_ON

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11. Disconnect voltage source (0.6V) via 200R resistor from D+.
12. Wait 100ms.
13. Check if D- is still at V_{DM_SRC} (0.5V - 0.7V). If not – FAIL owing to inconsistent behavior.

D- Pull-up Test

14. Connect 3.3V via 1K5 to D-.
15. Check that D- is greater than 2.2V. [CDP9]
16. Disconnect 3.3V via 1K5 from D-.
17. Wait 5 seconds for UUT to recognize disconnect.

Primary Detection

18. Connect voltage source (0.6V) via 200R resistor to D+.
19. Wait T_{VDPSRC_ON} min (40ms)
20. Disconnect voltage source via 200R resistor from D+.

Secondary Detection

21. Connect voltage source (0.6V) via 200R resistor to D-.
22. Wait 21ms.
23. Check that D+ is below V_{DAT_REF} min (0.25V)
24. Wait 20ms to complete T_{VDMSRC_ON}.
25. Disconnect voltage source via 200R resistor from D-.

Check V_{DM_SRC} Gets Disconnected

26. Connect 3.3V via 1k5 resistor to D+.
27. Wait slightly more than T_{VDMSRC_DIS} max (20ms +1 ms = 21ms)
28. Check that D- voltage is below V_{DAT_REF} min (0.25V). [CDP8]
29. Disconnect 3.3V via 1k5 resistor from D+
30. Wait 5 seconds for UUT to recognize disconnect.

End of Test – Behavior 1

Behavior 2 – CDP only connects V_{DM_SRC} in response to Primary detection.

Primary Detection

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31. Connect voltage source (0.6V) via 200R resistor to D+.
32. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).

Check V_{DM_SRC} Gets Connected

33. Connect voltage source (0.5V) via 200R resistor to D-.
34. While voltage across 200R is less than 50mV, decrement the D- voltage source in steps of 2mV. Stop if D- voltage falls below V_{DM_SRC} min (0.5V) - FAIL. Else we will now be drawing the required 250µA from V_{DM_SRC}.
35. Check D- voltage is still in range V_{DM_SRC} (0.5V – 0.7V). [CDP8]
36. Disconnect voltage source and 200R from D-.
37. Wait 20ms to complete T_{VDPSRC_ON}
38. Disconnect voltage source (0.6V) via 200R resistor from D+.
39. Wait 100ms.
40. Check if D- is still at V_{DM_SRC} (0.5V - 0.7V). If so – FAIL owing to inconsistent behavior.

Secondary Detection

41. Connect voltage source (0.6V) via 200R resistor to D-.
42. Wait 21ms.
43. Check that D+ is below V_{DAT_REF} min (0.25V). [CDP10]
44. Wait 20ms to complete T_{VDMSRC_ON}.
45. Disconnect voltage source via 200R resistor from D-.
46. Wait 5 seconds for UUT to recover.

End of Test – Behavior 2

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9.5 CDP Ground Offset Test – Full Speed

Test Setup	Test Setup 5. UUT is an CDP, PET simulates a PD.
Pre-conditions	When running this test, ensure that an isolated computer is used for the tester host (e.g. Laptop).
Purpose	To verify that charging downstream port fulfills USB2.0 specification common mode voltage requirements at full speed.
Description	Insert specified command voltage offset and check UUT can enumerate reference device and operate well.
Parameters	
Checklist	CDP11
Pass Criteria	Step 9: Enumeration is successful.

9.5.1 Test procedure

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V).
2. Wait 200ms.

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check D- voltage is in range V_{DM_SRC} (0.5V-0.7V).
6. Switch data lines to transceiver.

CMO Test

7. Apply common mode offset of V_{GND_OFFSET} (0.375 V) with test socket lower than PET transceiver ground.
8. Connect using D+.
9. Allow PET to be reset and enumerated, responding as a Full Speed device. Check that communication is reliable. [CDP11] This is achieved as follows:

    - If we do not receive a Get Device Descriptor request within 30 seconds communication is deemed to have failed.
    - After the Get Device Descriptor setup transaction we NAK the IN transactions for 250 frames duration (mid-frame to mid-frame).
    - During this period we count the successfully received SOF packets; less than 100% success is considered a failure.
    - Assuming success, we now allow enumeration to continue, in whatever form the CDP chooses (we have no way to control the CDP).

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Note: we are now confident that we can receive IN packets, and need to check whether the CDP reliably receives packets we send to it.

- We monitor whether any IN transactions timeout when expecting ACK. This would indicate a failure of the CDP to have received our Data0/1 packet. Continue this monitoring until we get suspended, or for a chosen maximum period. A 'pass' requires 100% success in receiving ACKs to IN transactions.

10. Disconnect using D+

11. Remove common mode offset.

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9.6 CDP Ground Offset Test – High Speed

Test Setup	Test Setup 5. UUT is an CDP, PET simulates a PD.
Pre-conditions	When running this test, ensure that an isolated computer is used for the tester host (e.g. Laptop).
Purpose	To verify that charging downstream port fulfills USB2.0 specification common mode voltage requirements at high speed.
Description	Insert specified command voltage offset and check UUT can enumerate reference device and operate well.
Parameters	
Checklist	CDP11
Pass Criteria	Step 9: Enumeration is successful.

9.6.1 Test procedure

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V).
2. Wait 200ms.

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check D- voltage is in range V_{DM_SRC} (0.5V-0.7V).
6. Switch data lines to transceiver.

CMO Test

7. Apply common mode offset of V_{GND_OFFSET} (0.375 V) with test socket lower than PET transceiver ground.
8. Connect using D+.
9. Allow PET to be reset and enumerated, responding as a High Speed device. Check that communication is reliable. [CDP11] This is achieved as follows:
    - If we do not receive a Get Device Descriptor request within 30 seconds communication is deemed to have failed.
    - After the Get Device Descriptor setup transaction we NAK the IN transactions for 250 frames duration (mid-frame to mid-frame).
    - During this period we count the successfully received SOF packets; less than 100% success is considered a failure.
    - Assuming success, we now allow enumeration to continue, in whatever form the CDP chooses (we have no way to control the CDP).

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Note: we are now confident that we can receive IN packets, and need to check whether the CDP reliably receives packets we send to it.

- We monitor whether any IN transactions timeout when expecting ACK. This would indicate a failure of the CDP to have received our Data0/1 packet. Continue this monitoring until we get suspended, or for a chosen maximum period. A 'pass' requires 100% success in receiving ACKs to IN transactions.

10. Disconnect using D+

11. Remove common mode offset.

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10 Standard Downstream Port (SDP) Compliance

This section is included in order to allow the testing of a Multiple Role Port, which may behave as a CDP, a DCP or an SDP, depending on circumstances. Its purpose is to check the additional BC requirement placed on an MRP acting as an SDP, namely to take part in detection handshaking correctly.

10.1 Submission Materials

10.1.1 Device Specific Information

The following items are required to be submitted along with the UUT:

Table 10-1 Device Specific Information for SDPs

Item	Function	Value/ Support
1	The USB-IF TID for the UUT standard-A receptacle(s).	

10.1.2 Checklist

Table 10-2 Checklist for DCPs

Question		Response	Test Number	BC 1.2 Reference
SDP1	If before connecting, a device applies V_{DP_SRC} to D+, does the SDP maintain a voltage of less than V_{DAT_REF} min on D-?	Yes ☐ No ☐	10.2	3.2.4.3
SDP2	If before connecting, a device applies V_{DM_SRC} to D-, does the SDP maintain a voltage of less than V_{DAT_REF} min on D+?	Yes ☐ No ☐	10.2	3.2.4.3
SDP3	Does the UUT provide VBUS discharge functionality?	Yes ☐ No ☐	Vendor Declaration	4.1.3

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10.2 SDP Handshaking Test

Test Setup	Test Setup 5. UUT is a SDP, PET simulates a PD.
Pre-conditions	SDP is switched on.
Purpose	To verify the parameters of detection handshake. This test is particularly designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP, and may therefore have more complex circuitry on D+ and D- than a standard downstream port.
Description	Test confirms correct handshake behavior.
Parameters	-
Checklist	SDP1, SDP2
Pass Criteria	Step 5. D- is below 0.25V. Step 10. D+ is below 0.25V.

10.2.1 Test procedure

Initial State: UUT is connected via Special Test Cable B to the PET. No load applied. SDP is switched on. Data lines switched to data measurement circuit.

1. Check V_{BUS} is above $V_{OTG\_SESS\_VLD}$ max (4V).
2. Wait 200ms

Primary Detection

3. Connect voltage source (0.6V) via 200R resistor to D+.
4. Wait slightly more than T_{VDMSRC_EN} max (20ms +1 ms = 21ms).
5. Check that D- is below V_{DAT_REF} min (0.25V). [SDP1]
6. Wait 20ms to complete T_{VDPSRC_ON}.
7. Disconnect voltage source via 200R resistor from D+.

Secondary Detection

8. Connect voltage source (0.6V) via 200R resistor to D-.
9. Wait 21ms.
10. Check that D+ is below V_{DAT_REF} min (0.25V). [SDP2]
11. Wait 20ms to complete T_{VDMSRC_ON}.
12. Disconnect voltage source via 200R resistor from D-.
13. Wait 5 seconds for UUT to recover.

End of Test

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11 Multiple Role Port (MRP) Compliance

This section is included in order to allow the testing of a Multiple Role Port, which may behave as a CDP, a DCP or an SDP, depending on circumstances. Its purpose is to check that the MRP port behaves correctly when switching between its roles.

11.1 Submission Materials

11.1.1 Device Specific Information

Table 11-1 Device Specific Information for SDPs

Item	Function	Value/ Support
1	Description of how to bring the UUT from an un-powered state to a state where it is acting as a CDP.	
2	Description of how to bring the UUT from a state where it is acting as a CDP, to a state where it is acting as an SDP, if applicable.	
3	Description of how to bring the UUT from a state where it is acting as an SDP, to a state where it is acting as a CDP, if applicable.	
4	Description of how to bring the UUT from a state where it is acting as a CDP, to a state where it is acting as a DCP, if applicable.	
5	Description of how to bring the UUT from a state where it is acting as a DCP, to a state where it is acting as a CDP, if applicable.	

11.1.2 Checklists

Table 11-2 Checklist for MRPs

Question		Response	BC 1.2 Section Number
Information			
MRPI1	Can the MRP act as a CDP? *	Yes ☐ No ☐	4.1.3
MRPI2	Can the MRP act as a SDP?	Yes ☐ No ☐	4.1.3
MRPI3	Can the MRP act as a DCP?	Yes ☐ No ☐	4.1.3
MRPI4	Does the MRP force detection renegotiation when changing from a CDP to an SDP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI5	Does the MRP force detection renegotiation when changing from an SDP to a CDP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI6	Does the MRP force detection renegotiation when changing from a CDP to a DCP role?	Yes ☐ No ☐ N/A ☐	4.1.3
MRPI7	Does the MRP force detection renegotiation when changing from a DCP to a CDP role?	Yes ☐ No ☐ N/A ☐	4.1.3

* The Multiple Role Port compliance test assumes that the MRP can act as a CDP.

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Question		Response	Test Number	BC 1.2 Section Number
Requirements				
MRP1	If the MRP forces detection renegotiation when changing from an CDP to a SDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP2	If the MRP forces detection renegotiation when changing from an SDP to a CDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP3	If the MRP forces detection renegotiation when changing from an CDP to a DCP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3
MRP4	If the MRP forces detection renegotiation when changing from an DCP to a CDP role, does it stop driving VBUS, allow VBUS to drop to less than VBUS_LKG, wait for a time of TVBUS_REAPP and then start driving VBUS?	Yes ☐ No ☐ N/A ☐		4.1.3

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11.2 MRP Functional Test

Test Setup	Test Setup 5. UUT is an MRP, PET simulates a PD.
Pre-conditions	MRP is switched on.
Purpose	To verify the parameters of detection renegotiation. This test is designed to verify the behavior of UUTs which switch roles among DCP, CDP and SDP.
Description	Test confirms correct detection renegotiation behavior, where implemented.
Parameters	V_{BUS_LKG}, T_{VBUS_REAPP}
Checklist	MRP1, MRP2, MRP3, MRP4
Pass Criteria	Step 19. If implemented, VBUS goes below 0.7V for at least 100ms. Step 22. If implemented, VBUS goes below 0.7V for at least 100ms. Step 25. If implemented, VBUS goes below 0.7V for at least 100ms. Step 27. If implemented, VBUS goes below 0.7V for at least 100ms.

11.2.1 Test procedure

Initial State: No load applied.

1. Ensure that UUT is connected via Special Test Cable B to the PET.
2. Ensure that UUT is in an un-powered state.
3. Wait for UUT voltage to fall below V_{BUS_LKG} max (0.7V), in case it has just been switched off. (Speed up fall using 100mA current load.)
4. Ask the test operator whether the MRP can act as a CDP. Record the answer. [MRPI1] If answer is 'No', then abandon test.
5. Ask the test operator whether the MRP can act as a SDP. Record the answer. [MRPI2]
6. Ask the test operator whether the MRP can act as a DCP. Record the answer. [MRPI3]
7. If neither MRPI2 nor MRPI3 were answered 'Yes', then abandon test.
8. If MRPI2 was answered 'No', skip to step 11.
9. Ask the test operator whether the MRP forces detection renegotiation when changing from a CDP to an SDP role. Record the answer. [MRPI4]
10. Ask the test operator whether the MRP forces detection renegotiation when changing from an SDP to a CDP role. Record the answer. [MRPI5]
11. If MRPI3 was answered 'No', skip to step 14.
12. Ask the test operator whether the MRP forces detection renegotiation when changing from a CDP to a DCP role. Record the answer. [MRPI6]
13. Ask the test operator whether the MRP forces detection renegotiation when changing from a DCP to a CDP role. Record the answer. [MRPI7]

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14. If none of MRPI4, MRPI5, MRPI6, MRPI7 were answered 'Yes', then abandon test.

15. Instruct test operator to perform steps required to bring the UUT from an un-powered state to a powered one, such that it will be acting in a CDP role, and then to indicate that this has occurred.

16. Wait for operator to click 'OK'.

17. Wait for V_{BUS} to rise above V_{CHG} min (4.75V).

18. If the answer to MRPI2 is 'No', skip to Step 24.

19. Instruct test operator to perform steps required to change the role of the UUT from a CDP to an SDP, and then to click 'OK' to indicate that this has been done.

20. If the answer to MRPI4 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked 'OK' in the previous step. [MRP1]

21. Instruct test operator to perform steps required to change the role of the UUT from an SDP to an CDP, and then to click 'OK' to indicate that this has been done.

22. If the answer to MRPI5 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked 'OK' in the previous step.. [MRP2]

23. If the answer to MRPI3 is 'No', skip to 'End of Test'.

24. Instruct test operator to perform steps required to change the role of the UUT from a CDP to a DCP, and then to click 'OK' to indicate that this has been done.

25. If the answer to MRPI6 was 'No' skip to next step; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked 'OK' in the previous step. [MRP3]

26. Instruct test operator to perform steps required to change the role of the UUT from an DCP to an CDP, and then to click 'OK' to indicate that this has been done.

27. If the answer to MRPI7 was 'No' skip to 'End of Test'; else monitor V_{BUS} to check whether it went below V_{BUS_LKG} max (0.7V) for T_{VBUS_REAPP} min (100ms), before the operator clicked 'OK' in the previous step. [MRP4]

End of Test

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12 Micro-ACA Compliance, Separate Charger

Note: There are some discrepancies in the BC 1.2 Specification with regard to the Micro-ACA. Essentially, these relate to the requirement in Table 6-2 of that document that the Accessory switch be closed, in rows 1-3 (i.e. have a resistance of less than 200mΩ) at a time when there is no power available to the Micro-ACA. The presence and/or required value of C_{MACA_VBUS} capacitor(s) is also related to this. As some further work will be required to resolve this issue, it was decided to release this Compliance Plan with the appropriate parts of the Micro-ACA tests left out, with the intention of adding them as soon as a resolution is found.

This situation has no effect on the Standard-ACA tests.

12.1 Submission Materials

12.1.1 Device Specific Information

Table 12-1 Device Specific Information for Micro-ACAs with Separate Charger

Item	Function	Value/ Support
1	The USB-IF TID for the UUT micro-AB receptacle used for the accessory port	
2	The USB-IF TID for the UUT micro-A plug used for the OTG port captive cable	
3	The USB-IF TID for the UUT standard-A plug or micro-B receptacle used for the charger port	

12.1.2 Checklists

Table 12-2 Checklist for Micro-ACAs

Question		Response	Test Number	BC 1.2 Section Number
Questions relating to all Micro-ACAs				
MACA1	Does the UUT have a capacitance from V_{BUS} to ground of C_{MACA_VBUS} on its OTG port?	Yes ☐ No ☐	12.12	6.2.6
MACA2	Does the UUT have a capacitance from V_{BUS} to ground of C_{MACA_VBUS} on its accessory port?	Yes ☐ No ☐	12.12	6.2.6
MACA3	Does the ACA have an indicator showing when the charger port is able to supply power to the other ports?	Yes ☐ No ☐	12.3 - 012.11	6.1
MACA4	Is the Charger Port on the UUT clearly labeled 'Charger Only'? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	Inspection	6.1

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MACA5	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when nothing is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_GND} when the unit is not connected to a power source and a B-device is connected to its accessory port?	Yes ☐ No ☐	012.11	4.5.3
MACA6	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_GND} when an SDP is connected to its charger port, and a B-device is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.5	4.5.3
MACA7	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_A} when a DCP or a CDP is connected to its charger port, and a B-device is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_A} when the unit is connected to a power source, and a B-device is connected to its accessory port?	Yes ☐ No ☐	12.8	4.5.3
MACA8	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_B} when a DCP or a CDP is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_B} when the unit is connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.6	4.5.3

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MACA9	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_B} when a DCP or a CDP is connected to its charger port, and an A-device not providing V_{BUS} is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_B} when the unit is connected to a power source, and an A-device not providing V_{BUS} is connected to its accessory port?	Yes ☐ No ☐	12.7	4.5.3
MACA10	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_C} when a DCP or a CDP is connected to its charger port, and an A-device providing V_{BUS} is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_C} when the unit is connected to a power source, and an A-device providing V_{BUS} is connected to its accessory port?	Yes ☐ No ☐	12.7	4.5.3
MACA11	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when nothing is connected to its charger port, and nothing is connected to its accessory port? If the UUT has a combined charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when the unit is not connected to a power source, and nothing is connected to its accessory port?	Yes ☐ No ☐	12.9	4.5.3
MACA12	If the UUT uses a separate charger, does the UUT pull the ID pin to ground through R_{ID_FLOAT} when an SDP is connected to its charger port, and nothing is connected to its accessory port? This does not apply to a UUT with a combined charger.	Yes ☐ No ☐ N/A ☐	12.3	4.5.3

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Espacenet

CN202058834U Automobile emergency start power supply suitable for low temperature environment

Applicants: HAIRISHENG ELECTRICAL APPLIANCE PRODUCTS SHENZHEN CO LTD

Inventors: LINGTAO SHEN

Classifications:
IPC ***H01M10/42; H01M10/44;***

CPC Y02E60/10 (EP);

Priorities: CN201120105578U 2011-04-12

Application: CN201120105578U·2011-04-12

Publication: CN202058834U·2011-11-30

Published as: CN202058834U

Automobile emergency start power supply suitable for low temperature environment

Abstract

An embodiment of the utility model discloses an automobile emergency start power supply suitable for a low temperature environment. The start power supply comprises a charging control circuit which is used for charging a storage battery of an automobile with low current before the automobile starts for emergency; releasing heat in a charging process to increase the temperature of the start power supply and recover battery capacity; connecting a built-in battery of the start power supply with the storage battery of the automobile to control the built-in battery of the start power supply to charge the storage battery of the automobile with low current before the automobile starts for emergency; and controlling the built-in battery of the start power supply to stop charging the storage battery of the automobile with small current when the temperature of the built-in battery of the start power supply reaches a preset temperature threshold. The automobile emergency start power supply suitable for the low temperature environment is capable of realizing emergency start of the automobile through small-capacity batteries and simultaneously solving the start problem of the automobile in the low temperature environment. The energy of the built-in battery of the start power supply is fully utilized.

(19)中华人民共和国国家知识产权局

(12)实用新型专利

(10)授权公告号 CN 202058834 U
(45)授权公告日 2011.11.30

(21)申请号 201120105578.5

(22)申请日 2011.04.12

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(51)Int.Cl.
H01M 10/42(2006.01)
H01M 10/44(2006.01)

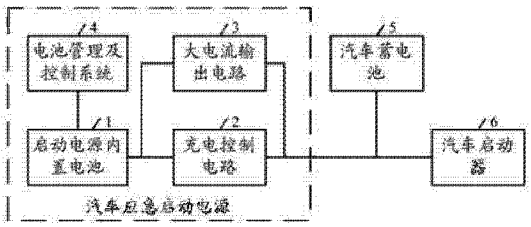
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(54)实用新型名称

一种适用低温环境的汽车应急启动电源

(57)摘要

本实用新型实施例公开了一种适用低温环境的汽车应急启动电源，包括：用于在汽车应急启动前，对汽车蓄电池进行小电流充电；并在充电过程中放热，使自身温度升高，电池容量恢复；连接启动电源内置电池与汽车蓄电池，用于在汽车应急启动前，控制启动电源内置电池对汽车蓄电池进行小电流充电；并在启动电源内置电池的温度达到预设的温度阈值时，控制启动电源内置电池停止对汽车蓄电池的小电流充电的充电控制电路。本实用新型实施例所提供的适用低温环境的汽车应急启动电源，利用小容量电池即可实现汽车的应急启动，使其能兼顾低温环境下的汽车启动问题，同时启动电源内置电池的能量得到充分利用。



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1. 一种适用低温环境的汽车应急启动电源，其特征在于，包括：

用于在汽车应急启动前，对汽车蓄电池进行小电流充电；并在充电过程中放热，使自身温度升高，电池容量恢复；在汽车应急启动时，所述启动电源内置电池与所述汽车蓄电池配合，通过大电流输出电路向汽车启动器提供启动电流的启动电源内置电池；

连接所述启动电源内置电池与汽车蓄电池，用于在汽车应急启动前，控制所述启动电源内置电池对汽车蓄电池进行小电流充电；并在所述启动电源内置电池的温度达到预设的温度阈值时，控制所述启动电源内置电池停止对所述汽车蓄电池的小电流充电的充电控制电路；

连接所述启动电源内置电池与汽车启动器，用于在汽车应急启动时，为所述启动电源内置电池提供向所述汽车启动器的电流通路的大电流输出电路。

2. 如权利要求 1 所述的适用低温环境的汽车应急启动电源，其特征在于，所述温度阈值为，所述启动电源内置电池在该温度下的电池容量足以使汽车启动的温度值。

3. 如权利要求 1 所述的适用低温环境的汽车应急启动电源，其特征在于，所述启动电源内置电池在自身温度升高的过程中，其内阻减小。

4. 如权利要求 1 至 3 中任一项所述的适用低温环境的汽车应急启动电源，其特征在于，所述启动电源内置电池为锂离子电池。

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一种适用低温环境的汽车应急启动电源

技术领域

[0001] 本实用新型涉及汽车应急启动电源领域，尤其涉及一种适用低温环境的汽车应急启动电源。

背景技术

[0002] 汽车应急启动电源是在汽车蓄电池因电量电力不足或耗尽而无法使汽车启动的情况下，可以利用内置电池应急启动汽车。目前市场上汽车应急启动电源的内置电池普遍使用的是价格便宜的大容量铅酸蓄电池，在汽车蓄电池电量不足时，由启动电源内置电池提供汽车的启动电流。

[0003] 而在启动电源内置电池的选用中，因为锂离子电池（锂电池）具有比能量高、使用寿命长、充放电能力高、自放电率低、绿色环保等特点，在汽车领域应用得越来越多，逐渐成为启动电源内置电池的理想选择。值得注意的是，锂离子电池因其固有的化学反应特性，最佳使用环境温度在 10℃ ~30℃之间。在低温环境下，电池的放电容量会降低。在 -10℃时，电池容量只有初始容量的 70%。

[0004] 在汽车实际使用过程中，汽车应急启动电源所处的工作环境显然是多变的，为使启动电源内置电池在低温环境、电池容量下降的情况下，依然能够为汽车提供足够大的启动电流，目前有两种常用的方法：一种方法是使启动电源内置电池温度升高，尽可能恢复至初始容量，但升温过程中会消耗额外的能量；另一种方法是增加启动电源内置电池的初始容量，保证其在低温环境下的正常使用，但这必然会增加汽车应急启动电源的成本。

实用新型内容

[0005] 本实用新型实施例所要解决的技术问题在于，提供一种适用低温环境的汽车应急启动电源，利用小容量的启动电源内置电池即可实现汽车的应急启动，并能兼顾低温环境下的汽车启动问题，使汽车应急启动电源的内置电池能量得到充分的利用。

[0006] 为了解决上述技术问题，本实用新型实施例提供了一种适用低温环境的汽车应急启动电源，包括：

[0007] 用于在汽车应急启动前，对汽车蓄电池进行小电流充电；并在充电过程中放热，使自身温度升高，电池容量恢复；在汽车应急启动时，所述启动电源内置电池与所述汽车蓄电池配合，通过大电流输出电路向汽车启动器提供启动电流的启动电源内置电池；

[0008] 连接所述启动电源内置电池与汽车蓄电池，用于在汽车应急启动前，控制所述启动电源内置电池对汽车蓄电池进行小电流充电；并在所述启动电源内置电池的温度达到预设的温度阈值时，控制所述启动电源内置电池停止对所述汽车蓄电池的小电流充电的充电控制电路；

[0009] 连接所述启动电源内置电池与汽车启动器，用于在汽车应急启动时，为所述启动电源内置电池提供向所述汽车启动器的电流通路的大电流输出电路。

[0010] 其中，所述温度阈值为，所述启动电源内置电池在该温度下的电池容量足以使汽

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车启动的温度值。

[0011] 其中，所述启动电源内置电池在自身温度升高的过程中，其内阻减小。

[0012] 其中，所述启动电源内置电池为锂离子电池。

[0013] 本实用新型实施例提供的适用低温环境的汽车应急启动电源，利用小容量的启动电源内置电池即可实现汽车的应急启动，并能兼顾低温环境下的汽车启动问题，使汽车应急启动电源的内置电池能量得到充分的利用。

附图说明

[0014] 为了更清楚地说明本实用新型实施例或现有技术中的技术方案，下面将对实施例或现有技术描述中所需要使用的附图作简单地介绍，显而易见地，下面描述中的附图仅仅是本实用新型的一些实施例，对于本领域普通技术人员来讲，在不付出创造性劳动性的前提下，还可以根据这些附图获得其他的附图。

[0015] 图 1 为本实用新型提供的适用低温环境的汽车应急启动电源实施例结构示意图；

[0016] 图 2 为本实用新型提供的适用低温环境的汽车应急启动电源工作流程示意图。

具体实施方式

[0017] 本实用新型实施例提供的适用低温环境的汽车应急启动电源，利用小容量的启动电源内置电池即可实现汽车的应急启动，并能兼顾低温环境下的汽车启动问题，使汽车应急启动电源的内置电池能量得到充分的利用。

[0018] 下面将结合本实用新型实施例中的附图，对本实用新型实施例中的技术方案进行清楚、完整地描述，显然，所描述的实施例仅仅是本实用新型一部分实施例，而不是全部的实施例。基于本实用新型中的实施例，本领域普通技术人员在没有作出创造性劳动前提下所获得的所有其他实施例，都属于本实用新型保护的范围。

[0019] 参见图 1，为本实用新型提供的适用低温环境的汽车应急启动电源实施例结构示意图，如图 1 所示，该适用低温环境的汽车应急启动电源包括：启动电源内置电池 1，连接启动电源内置电池 1 与汽车蓄电池 5 的充电控制电路 2，连接启动电源内置电池 1 与汽车启动器 6 的大电流输出电路 3；以及与启动电源内置电池 1 连接的电池管理及控制系统 4。

[0020] 充电控制电路 2，用于在汽车需要应急启动时，控制启动电源内置电池 1 对汽车蓄电池 5 进行小电流充电；使启动电源内置电池 1 在小电流充电过程中放热，温度升高；并在所述启动电源内置电池的温度达到预设的温度阈值时，控制所述启动电源内置电池停止对所述汽车蓄电池的小电流充电。

[0021] 更为具体的，所述温度阈值的设置标准为，所述启动电源内置电池在该温度下的电池容量足以使汽车启动。所以，对于不同的启动电源内置电池，以及在不同的硬件环境中，温度阈值可能不同。

[0022] 进一步的，在实际应用中，温度阈值的设置与启动电源内置电池的类型，以及汽车启动所需电量的大小有关，若启动电源内置电池 1 在某温度下的电池容量足以使汽车启动，则温度阈值的设置可以略高于该温度。在一般情况下，该温度阈值的可以设置在 5℃左右。而启动电源内置电池 1 通过小电流充电转移到汽车蓄电池 5 内的电量大约为该启动电源内置电池 1 自身电量的 1/3。

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[0023] 启动电源内置电池 1，用于在汽车应急启动前，在充电控制电路 2 的控制下，对汽车蓄电池 5 进行小电流充电；并在充电过程中放热，使自身温度升高，电池容量恢复；在汽车应急启动时，启动电源内置电池 1 与汽车蓄电池 5 配合，通过大电流输出电路 3 向汽车启动器 6 提供启动电流。

[0024] 更为具体的，电池因为自身的化学特性，其电量和内阻会随着自身温度的变化而变化，在电池自身温度降低的情况下，电池的容量减小，内阻会增加；与之相反，在电池自身温度升高的情况下，电池的容量会逐渐恢复，内阻会逐渐减小。以锂离子电池为例，因其固有的化学反应特性，最佳使用环境温度在 10℃ ~30℃之间。在低温环境下，锂离子电池的放电容量会降低。在 -10℃时，电池容量只有初始容量的 70%。锂离子电池在放电的过程中，温度会逐渐升高，电池容量逐渐得到恢复。同时，电池在升温的过程中，其内阻会减小，使得启动电源内置电池 1 在后续对汽车启动器放电的时候，放电电流更大。需要说明的是，其它类型电池的容量、内阻也会随温度有类似变化，只是对温度的敏感度没有锂离子电池高。

[0025] 在启动电源内置电池 1 与所述汽车蓄电池 5 配合，向汽车启动器 6 提供启动电流使汽车启动的过程中：启动电源内置电池 1 与汽车蓄电池 5 的配合方式为：由启动电源内置电池 1 与汽车蓄电池 5 中电压较高的一方向汽车启动器 6 提供启动电流。

[0026] 优选的，该汽车应急启动电源还包括：电池管理及控制系统 4，用于控制启动电源内置电池 1 的充放电路切换。

[0027] 在实际应用中，因为锂离子电池具有比能量高、使用寿命长、充放电能力高、自放电率低、绿色环保等特点，所以，本实用新型实施例提供的适用低温环境的汽车应急启动电源使用锂电池作为内置电池的效果会更加明显，且该适用低温环境的汽车应急启动电源可以很好的解决锂电池在低温环境下使用的顾虑。

[0028] 本实用新型实施例提供的适用低温环境的汽车应急启动电源，在应急启动前，利用启动电源内置电池向汽车蓄电池充电，使启动电源内置电池温度升高，电池容量得到恢复，从而使小容量的启动电源内置电池即可实现汽车的应急启动，并能兼顾低温环境下的汽车启动问题，使适用低温环境的汽车应急启动电源的内置电池能量得到充分的利用。

[0029] 参见图 2，为本实用新型提供的适用低温环境的汽车应急启动电源工作流程示意图。如图 2 所示：

[0030] 在步骤 S200，汽车应急启动电源接收到应急启动指令，判断汽车应急启动电源内置电池的当前温度是否低于温度阈值，若判断为是，则执行步骤 S201；若判断为否，则执行步骤 S204。

[0031] 更为具体的，该应急启动指令是汽车驾驶者直接触发的，汽车应急启动电源接收后，首先判断汽车应急启动电源内置电池的当前温度是否低于温度阈值。该温度阈值的设置标准是，启动电源内置电池在该温度下的电池容量足以使汽车启动。故，若汽车应急启动电源当前温度高于温度阈值时，其电量足以使汽车直接启动，则执行步骤 S204 即可；在汽车应急启动电源当前温度低于温度阈值时，其电量不能使汽车直接启动，才需要执行步骤 S201 及后续步骤。

[0032] 在实际应用中，温度阈值的设置与启动电源内置电池的类型，以及汽车启动所需电量的大小有关，若启动电源内置电池在某温度下的电池容量足以使汽车启动，则温度阈值的设置可以略高于该温度。在一般情况下，该温度阈值的可以设置在 5℃左右。

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[0033] 在步骤 S201，控制启动电源内置电池对汽车蓄电池进行小电流充电。

[0034] 更为具体的，汽车应急启动电源接收到应急启动指令后，其充电控制电路控制启动电源内置电池对汽车蓄电池进行小电流充电。在启动电源内置电池放电的过程中，会产生热量，使启动电源内置电池自身的温度升高。

[0035] 在步骤 S202，启动电源内置电池随着自身温度升高，电池容量恢复。需要说明的是，电池因为自身的特性，其电量和内阻会随着自身温度的变化而变化，在电池自身温度降低的情况下，电池的容量减小，内阻会增加；与之相反，在电池自身温度升高的情况下，电池的容量会逐渐恢复，内阻会逐渐减小。

[0036] 以锂离子电池为例，因其固有的化学反应特性，最佳使用环境温度在 10℃ ~30℃之间。在低温环境下，锂离子电池的放电容量会降低。在 -10℃时，电池容量只有初始容量的 70%。锂离子电池在放电的过程中，温度会逐渐升高，电池容量逐渐得到恢复。同时，电池在升温的过程中，其内阻会减小，使得启动电源内置电池在后续对汽车启动器放电的时候，放电电流更大。

[0037] 在步骤 S203，在启动电源内置电池的温度达到预设的温度阈值时，停止对所述汽车蓄电池的小电流充电。在启动电源内置电池通过小电流向汽车蓄电池充电的过程中，充电转移到汽车蓄电池内的电量大约为该启动电源内置电池自身电量的 1/3。

[0038] 在步骤 S204，所述启动电源内置电池与所述汽车蓄电池配合，向汽车启动器提供启动电流使汽车启动。启动电源内置电池与汽车蓄电池配合的方式为：由所述启动电源内置电池与所述汽车蓄电池中电压较高的一方向所述汽车启动器提供启动电流。

[0039] 在步骤 S205，汽车利用启动电源内置电池与汽车蓄电池输出的电流启动，汽车应急启动流程结束。

[0040] 在实际应用中，因为锂离子电池具有比能量高、使用寿命长、充放电能力高、自放电率低、绿色环保等特点，所以，本实用新型实施例提供的适用低温环境的汽车应急启动方法对使用锂电池作为内置电池的效果会更加明显，且该方法可以很好的解决锂电池在低温环境下使用的顾虑。

[0041] 本实用新型实施例提供的适用低温环境的汽车应急启动电源，在应急启动前，利用启动电源内置电池向汽车蓄电池充电，使启动电源内置电池温度升高，电池容量得到恢复。从而使小容量的启动电源内置电池即可实现汽车的应急启动，并能兼顾低温环境下的汽车启动问题，使适用低温环境的汽车应急启动电源的内置电池能量得到充分的利用。

[0042] 本领域普通技术人员可以理解实现上述实施例方法中的全部或部分流程，是可以通过计算机程序来指令相关的硬件来完成，所述的程序可存储于一计算机可读取存储介质中，该程序在执行时，可包括如上述各方法的实施例的流程。其中，所述的存储介质可为磁碟、光盘、只读存储记忆体（Read-Only Memory，ROM）或随机存储记忆体（Random Access Memory，RAM）等。

[0043] 以上所揭露的仅为本实用新型一种较佳实施例而已，当然不能以此来限定本实用新型之权利范围，因此依本实用新型权利要求所作的等同变化，仍属本实用新型所涵盖的范围。

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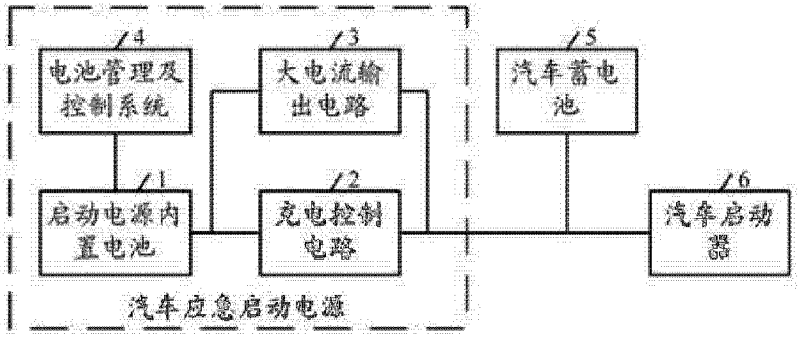


图 1

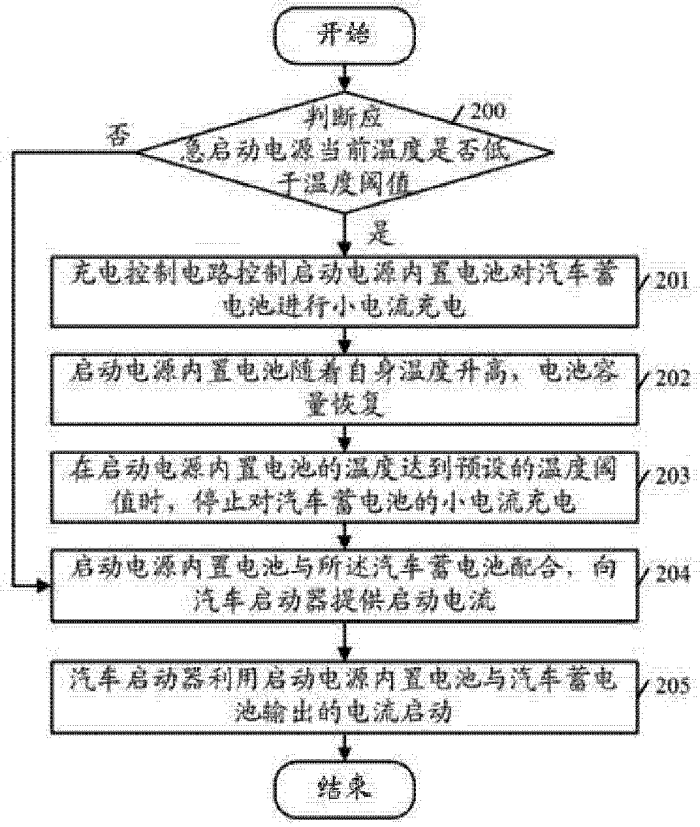


图 2

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Espacenet

CN1440892A Power supply controlling system for vehicle and its controlling method

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Classifications:

IPC ***F02D17/00; F02D29/02; F02N11/08; F02N11/14; H01M10/44;*** *H02J7/14;* (IPC1-7): B60L11/18; H01M10/42;

CPC **B60R16/04 (KR); F02N11/0814 (EP,US); F02N11/0866 (EP,US); F02N11/14 (EP,US);** F02N11/087 (EP,US); F02N2011/0888 (EP,US); F02N2300/2002 (EP,US); H02J7/1423 (EP,US); Y02T10/40 (EP,US);

Priorities: JP2002050450A 2002-02-26

Application: CN03106624A·2003-02-26

Publication: CN1440892A·2003-09-10

Published as: **CN1247396C**; CN1440892A;**DE60300513T2; EP1340908A1; EP1340908B1; JP2003254208A; JP3812459B2; KR100497865B1; KR20030070848A; US2003160510A1; US7042115B2**

Power supply controlling system for vehicle and its controlling method

Abstract

本发明公开了一种用于车辆的供电控制系统，该系统中设置有放电密度较高、但能量密度较低的铅酸蓄电池(12)，并设置有放电密度较低、但能量密度较高的锂离子电池(14)。在伴随车辆驾驶员执行点火操作的发动机起动过程中，由铅酸蓄电池(12)向起动机(18)供电，从而起动发动机。在执行空转停机控制所伴随的发动机重新起动过程中，由锂离子电池(14)向起动机(18)供电，从而使发动机起动。

[19] 中华人民共和国国家知识产权局

[51] Int. Cl[7]
B60L 11/18
H01M 10/42

[12] 发明专利申请公开说明书

[21] 申请号 03106624.0

[43] 公开日 2003 年 9 月 10 日

[11] 公开号 CN 1440892A

[22] 申请日 2003.2.26 [21] 申请号 03106624.0

[30] 优先权

[32] 2002. 2.26 [33] JP [31] 050450/2002

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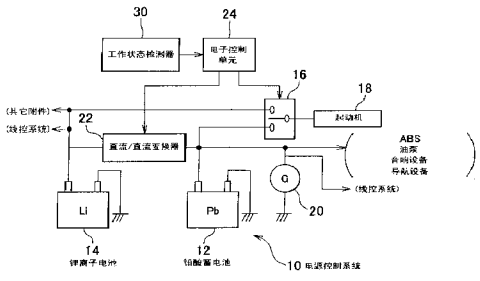
代理人 王 琼

权利要求书 3 页 说明书 14 页 附图 2 页

[54] 发明名称 用于车辆的供电控制系统及其控制方法

[57] 摘要

本发明公开了一种用于车辆的供电控制系统，该系统中设置有放电密度较高、但能量密度较低的铅酸蓄电池(12)，并设置有放电密度较低、但能量密度较高的锂离子电池(14)。 在伴随车辆驾驶员执行点火操作的发动机起动过程中，由铅酸蓄电池(12)向起动机(18)供电，从而起动发动机。 在执行空转停机控制所伴随的发动机重新起动过程中，由锂离子电池(14)向起动机(18)供电，从而使发动机起动。



ISSN1008-4274

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1. 一种用于车辆的供电控制系统，在该车辆中，执行一种空转停机控制，从而能根据车辆的运行状态自动完成对发动机的停机操作和起动操作，所述供电控制系统包括：

第一电池，其与车辆的一起动机相连接；

第二电池，其与车辆的起动机相连接，且该电池的能量密度大于第一电池的能量密度，但其放电密度低于第一电池的放电密度；以及

控制器，该控制器的工作状况是这样的：在第一条件下—即需要起动发动机来使车辆发动的条件下，选择第一电池与起动机接通，从而由第一电池向起动机供电；在第二条件下—即通过空转停机控制来起动发动机的条件下，选择第二电池与起动机接通，从而由第二电池向起动机供电。

2. 根据权利要求 1 所述的供电控制系统，其特征在于：第二电池是锂离子电池和镍氢电池中的一种。

3. 根据权利要求 1 或 2 所述的供电控制系统，其特征在于：第一电池是铅酸蓄电池。

4. 根据权利要求 1 所述的供电控制系统，其特征在于：系统根据车辆操作人员要发动车辆的意愿，而执行在第一条件下的发动机起动。

5. 根据权利要求 1 所述的供电控制系统，其特征在于：系统按照一种无线通讯的识别认证来执行在第一条件下的发动机起动，其中的无线通讯是在车辆上安装的一个装置与车辆操作人员持有的一个便携式装置之间发生的。

6. 根据权利要求 1 所述的供电控制系统，其特征在于：控制器判断第二电池向起动机输送的电力是否能足以起动发动机；如果判断出在第二条件下从第二电池输送给起动机的电力是不充足的，则控制

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器就选择第一电池与起动机相接通，从而由第一电池向起动机供电。

7. 根据权利要求 1 所述的供电控制系统，其特征在于：控制器判断第一电池向起动机输送的电力是否能足以起动发动机；如果判断出在第一条件下从第一电池输送给发动机的电力是不充足的，则控制器就选择第二电池与起动机相接通，从而由第二电池向起动机供电。

8. 根据权利要求 6 所述的供电控制系统，其特征在于：控制器判断第一电池向起动机输送的电力是否能足以起动发动机；如果判断出在第一条件下从第一电池输送给发动机的电力是不充足的，则控制器就选择第二电池与起动机相接通，从而由第二电池向起动机供电。

9. 根据权利要求 8 所述的供电控制系统，其特征在于：控制器是在一个参数的基础上判断第一电池和第二电池输送给起动机的电能是否充足，所述参数包括第一、第二电池的电量、温度、电压、以及电流。

10. 根据权利要求 1 所述的供电控制系统，其特征在于：当第一电池和第二电池的电压和电量中的至少一个参数都小于一预定值时，取消在第二条件下的发动机起动。

11. 一种用于车辆的供电控制方法，在该车辆中，执行一种空转停机控制，从而能根据车辆的运行状态自动完成对发动机的停机操作和起动操作，且将一起动机与一第一电池和一第二电池相连接，其中，第二电池的能量密度大于第一电池的能量密度，但其放电密度低于第一电池的放电密度，该供电控制方法包括：

在第一条件下—即需要起动发动机来使车辆发动的条件下，选择第一电池与起动机接通，从而由第一电池向起动机供电；以及

在第二条件下—即通过空转停机控制来起动发动机的条件下，选择第二电池与起动机接通，从而由第二电池向起动机供电。

12. 根据权利要求 11 所述的供电控制方法，其特征在于：在第一条件下的发动机起动是根据车辆操作人员要发动车辆的意愿而执行

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的。

13. 根据权利要求 11 所述的供电控制方法，其特征在于：在第一条件下的发动机起动是根据一种无线通讯的识别认证来执行的，其中的无线通讯是在车辆上安装的一个装置与车辆操作人员持有的一个便携式装置之间发生的。

14. 根据权利要求 11 所述的供电控制方法，其还包括步骤：判断第二电池向起动机输送的电力是否能足以起动发动机；如果判断出在第二条件下从第二电池输送给起动机的电力是不充足的，则控制器就选择第一电池与起动机相接通，从而由第一电池向起动机供电。

15. 根据权利要求 11 或 14 所述的供电控制方法，其还包括步骤：判断第一电池向起动机输送的电力是否能足以起动发动机；如果判断出在第一条件下从第一电池输送给发动机的电力是不充足的，则控制器就选择第二电池与起动机相接通，从而由第二电池向起动机供电。

16. 根据权利要求 15 所述的供电控制方法，其特征在于：判断第一电池和第二电池输送给起动机的电能是否充足的步骤是在一个参数的基础上进行，所述参数包括第一、第二电池的电量、温度、电压、以及电流。

17. 根据权利要求 11 所述的供电控制方法，其还包括：当第一电池和第二电池的电压和电量中的至少一个参数都小于一预定值时，取消在第二条件下的发动机起动。

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用于车辆的供电控制系统及其控制方法

技术领域

本发明涉及一种用于车辆的供电控制系统。更具体来讲，本发明涉及一种车辆供电控制系统，其可执行一种空转停机控制，这种控制能根据车辆的工作状态而自动地完成发动机的停机和起动。

背景技术

带有铅酸蓄电池和锂离子电池的电源系统在现有技术中是存在的。例如，在第 2001-313082 号日本专利公开文件中就公开了这种系统的一个实例。这种电源系统能将车辆减速时的能量再生回收，并将能量输送向铅酸蓄电池以及锂离子电池，其中，锂离子电池具有更高的再生蓄电能力。因而，该车载电源系统作为一个整体，其能量效率得以提高。另外，对于这种电源系统，当起动发动机时，是由铅酸蓄电池向发动机供电的。

有的车辆上装备有一种系统，该系统可执行这样的控制工作：例如当车辆在等绿灯或由于其它原因而停车时，停止发动机的转动；且当车辆起步时，能再次起动发动机（这种控制在本文中被称为“空转停机控制”）。在这样的情况下：对车辆执行空转停机控制，且如上文讨论的系统那样，车辆上安装有前述的铅酸蓄电池以及锂离子电池，如果无论是在伴随着车辆常规发动的发动机起动过程中、还是在伴随着空转停机控制的发动机起动过程中，都始终是由铅酸蓄电池进行供电，则由于铅酸蓄电池处于始终带载工作的状态下，其性能的恶化将是很迅速的。因而，在这样的设计中，发动机起动的可靠性将会降低，这反过来就会使一种可能性增大：用户拒绝执行空转停机控制。

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发明内容

本发明的一个目的是提供一种用于车辆的供电控制系统，其能可靠地执行车辆发动时的发动机起动工作、以及伴随着空转停机控制的发动机起动工作，同时还不会加速电池的性能劣化。

本发明提供了一种用于车辆的供电控制系统，在该车辆中，执行一种空转停机控制，从而能根据车辆的运行状态自动完成对发动机的停机操作和起动操作。该供电控制系统包括：第一电池，其与车辆的起动机相连接；第二电池，其也与车辆的起动机相连接，且该电池的能量密度大于第一电池的能量密度，但其放电密度低于第一电池的放电密度；以及一控制器，该控制器的工作状况是这样的：在一种第一条件下—即需要起动发动机来使车辆发动的条件下，选择第一电池与起动机接通，从而由第一电池向起动机供电；在一种第二条件下—即通过空转停机控制来起动发动机的条件下，选择第二电池与起动机接通，从而由第二电池向起动机供电。

一般来讲，对于车辆正常发动时的发动机起动工作（下文将把此类起动称为“常规起动”），由于发动机是冷起动，所以需要电池有较大的负载。在另一方面，对于空转停机控制模式所涉及的发动机起动工作（下文将称为“重新起动”），由于发动机已经被暖机加热了，所以电池的负载相对较小。因而，为了能可靠地保证常规起动时的易起动性，合适的作法是：此时所用电池的放电密度应当大于重新起动时所用电池的放电密度。在车辆的运行过程中，会以一定的时间间隔频繁地执行空转停机控制。因而，为了能可靠地保证在重新起动时发动机的起动性能，合适的作法是：采用一种能量密度较高的电池，其能量密度高于常规起动时所用电池的能量密度。

在本发明中，在常规起动时，由第一电池向起动机供电。另外，在重新起动时，是由相比于第一电池其能量密度较高、但放电密度较

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低的第二电池向起动机供电。因而，无论是在常规起动、还是在重新起动的过程中，都能保证发动机的起动性。此外，在常规起动时，负载相对较大，由于放电密度相对较低的第二电池并不向起动机供电，所以能可靠地保证发动机的起动性能。另外，对于重新起动，由于执行这种起动的频率很高，所以，因为能量密度较低的第一电池并不向起动机供电，因此可避免第一电池出现加速恶化的情况。

第二电池可以是锂离子电池和镍氢电池中的一种。

第一电池可以是铅酸蓄电池。

可根据车辆操作人员要发动车辆的意愿，而执行在第一条件下的发动机起动。

可按照一种无线通讯的识别认证来执行在第一条件下的发动机起动，其中的无线通讯是在车辆上安装的一个装置与车辆操作人员持有的一个便携式装置之间发生的。如上文讨论的那样，无论是车辆发动时的发动机起动工作、还是空转停机控制模式时的发动机起动工作能被可靠地完成，而且不会加速电池的性能劣化。

如果由于电量下降、温度改变等原因，从第一电池或第二电池输送给起动机的电力不足以保证发动机的起动，则采用当前电池很难使发动机起动。

控制器判断第二电池向起动机输送的电力是否能足以起动发动机。如果判断出在第二条件下从第二电池输送给起动机的电力是不充足的，则控制器就选择第一电池与起动机相接通，从而由第一电池向起动机供电。因而，即使发动机不能被第二电池驱动而重新起动，也可以通过第一电池来实现重新起动。这样就可以避免出现这样的情况：由于第二电池向起动机输送的电力不足，发动机无法重新起动。

控制器还判断第一电池向起动机输送的电力是否能足以起动发动机。如果判断出在第一条件下从第一电池输送给发动机的电力是不充足的，则控制器就选择第二电池与起动机相接通，从而由第二电池向

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起动机供电。因而，即使发动机不能被第一电池驱动而完成常规起动，也可以通过第二电池来实现常规起动。这样就可以避免出现这样的情况：由于第一电池向起动机输送的电力不足，发动机无法完成常规起动。

附图说明

图 1 是一个结构示意图，表示了根据本发明一示例性实施方式的车用供电控制系统；以及

图 2 中的流程图表示了一种控制程序，当在空转停机控制模式下进行发动机的重新起动时，执行该控制程序。

具体实施方式

图 1 中的结构示意图表示了一种根据本发明示例性实施方式的车用供电控制系统 10。如图 1 所示，该供电控制系统 10 中设置有两个电池 12 和 14。电池 12 是电压约为 12V 的铅酸蓄电池，电池 14 是电压约为 14.4 伏的锂离子电池。在下文中，电池 12 将被称为铅酸蓄电池 12，电池 14 将被称为锂离子电池 14。相比于锂离子电池 12，铅酸蓄电池 12 每一单位体积的输出电量（放电密度的单位：W/I）较高，但每一单位体积所能蓄储的电量（能量密度的单位：Wh/I）则较少。换言之，锂离子电池 14 的放电密度低于铅酸蓄电池 12，但其能量密度高于铅酸蓄电池 12。

一起动机 18 通过一转换开关 16 既与铅酸蓄电池 12 连接、也与锂离子电池 14 连接。起动机 18 与作为车辆动力源的发动机（图中未示出）相连接。起动机 18 利用经过转换开关 16 从铅酸蓄电池 12 或锂离子电池 14 输送来的电力，来起动处于停机状态的发动机。

发动机上设置有一直流发电机 20，其能利用发动机的转动而发出电能。铅酸蓄电池 12 与直流发电机 12 相连接。当执行再生制动时，

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直流发电机 20 通过将车辆的动能转变为电能，而向铅酸蓄电池 12 供电，从而对铅酸蓄电池 12 进行充电。可通过将直流发电机 20 连接向锂离子电池 14 一侧来提高其再生发电效率。在此情况下，从直流发电机 20 向电池 14 的充电电流要经过一 DC/DC（直流/直流）变换器 22，下文将对此电流变换器进行讨论。

锂离子电池 14 通过一直流对直流的变换器（下文将称作“DC/DC”变换器）22 与铅酸蓄电池 12 相连接。DC/DC 变换器 22 利用其内安装的一功率晶体管的关断—导通操作，而将铅酸蓄电池 12 一侧的电压升高，从而可向锂离子电池 14 一侧送电，或者是将锂离子电池 14 一侧的电压降低，从而可向铅酸蓄电池 12 一侧送电。由于直流发电机 20 是通过 DC/DC 变换器 22 与锂离子电池 14 相连接的，所以直流发电机 20 能向锂离子电池 14 输送其发出的电能，以对其进行充电。

在直流发电机 20、铅酸蓄电池 12 以及锂离子电池 14 上连接了多个利用电能进行工作的附件以及所谓的线控系统（by-wire system），其中的附件例如为空调器、音响设备等等，线控系统例如为加速器、制动器等等。每个线控系统既连接到铅酸蓄电池 12 一侧，也连接到锂离子电池 14 一侧。因而，由于线控系统既能由铅酸蓄电池 12 供电、也能由锂离子电池 14 供电，所以利用当前电源系统就能可靠地保证车辆的工作正常，而无需设置电容等用于提供后备电源的装置。

另外，附件还包括设置在铅酸蓄电池 12 一侧的那些部件（例如：音响设备、汽车导航设备、ABS 系统、油泵等）、以及设置在锂离子电池 14 一侧的那些部件（例如：仪表、除雾器、雨刷器、电动车窗等）。当车辆由发动机驱动时，每一附件以及每一线控系统都由直流发电机 20、铅酸蓄电池 12 以及锂离子电池 14 供电。在另一方面，当发动机停机时，则是由铅酸蓄电池 12 或锂离子电池 14 供电的。当车辆的点火开关处于电器附件工作位置或处于点火接通位置时，诸如音

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响设备、汽车导航设备等的附件是通电的，当点火开关处于点火接通位置时，诸如油泵、ABS 系统、空调器等的附件是通电的。

DC/DC 变换器 22 与一带有微型计算机的电子控制单元 24（下文将称为“ECU”）相连接。ECU24 对 DC/DC 变换器 22 进行操作，以便于合适地控制铅酸蓄电池 12 一侧与锂离子电池 14 一侧之间的电力输送与接收。转换开关 16 也与 ECU24 相连接。转换开关 16 的功能是按照 ECU24 的指令将起动机 18 选择性地连接向铅酸蓄电池 12 或锂离子电池 14。ECU24 能基于一个条件来确定出应当是那一个电池与起动机 18 连接，并控制转换开关 16 来选择所确定的电池，其中，下文将对所述的条件进行讨论。

在 ECU24 上还连接有一个工作状态检测器 30。工作状态检测器判断发动机是否处于暖机状态、发动机起动后车辆的行驶里程或速度是否达到了一个预定值、车辆操作人员是否执行了制动操作、以及变速器的档位，其中，如果车辆上安装的是自动变速箱，则判断制动踏板上的作用力是否达到一预定值，如果车辆上安装的是手动变速箱，则判断是否对离合器踏板进行了操作。ECU24 根据工作状态检测器 30 的检测结果来判断车辆是否处于停车状态（即车速基本为零的状态）。ECU24 还判断执行控制工作的条件是否已被满足，其中的控制工作可将发动机从运转状态转换到停机状态、以及将发动机从停机状态转换为运转状态（这种控制在下文中被称为“空转停机控制”）。

下面，将对根据该示例性实施例的供电控制系统 10 进行介绍。

按照该实施例，如果在发动机处于停机状态的情况下，车辆驾驶员将点火开关从断电位置转动到电器附件工作位置，则那些当点火开关处于电器工作位置时应当工作的附件一旦接收到从铅酸蓄电池 12 输送来的电力，就进入到工作状态。此外，如果点火开关从电器工作位置转到点火接通位置，那些当点火开关处于点火接通位置时应当工作的附件一旦开始由铅酸蓄电池 12 进行供电，就进入到工作状态。

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另外，如果点火开关从点火接通位置转到起动机接通位置，则就断开铅酸蓄电池 12 向各个附件的供电，并经过转换开关 16 将起动机 18 与铅酸蓄电池 12 连通。起动机 18 在由铅酸蓄电池 12 供电后就进入到其工作状态。在此情况下，起动机 18 带动发动机，使其从停机状态开始起动。一旦发动机起动完成、并进入到正常工作状态之后，尽管点火开关从起动机接通位置回到了点火接通位置，发动机也能保持该工作状态。

当发动机处于工作状态时，利用直流发电机 20，可将车辆的再生制动时的动能转换为电能。在此情况下，铅酸蓄电池 12 由直流发电机 20 输出的充电电压进行充电，且每一附件等都处于工作状态。另外，通过 DC/DC 变换器 22 对直流发电机 20 充电电压进行升压，还可对锂离子电池 14 进行充电。并使其它附件等的设备处于工作状态。如果此时锂离子电池已充电饱和，则 DC/DC 变换器 22 的工作能防止对锂离子电池的过充，且切断从铅酸蓄电池 12 一侧向锂离子电池 14 一侧的电能输送。

此外，在车辆发动机已经起动、并进入到工作状态之后，工作状态检测器 30 的工作能根据如下的条件而判断出车辆是否处于停车状态：是否发生了制动操作、以及存在制动踏板力；以及是否对离合器进行了操作、变速箱的档位。工作状态检测器根据车辆的停车状态、车辆的暖机状态、发动机起动后车辆的行驶里程以及速度变化历程等，判断用于执行空转停机控制的条件是否已经满足。如果判断出用于执行空转停机控制的条件已经满足，则无需车辆驾驶员执行将点火开关从点火接通位置转换到点火断开位置的操作，就自动将燃料喷射、点火线圈供电等工作停止。因而，发动机就从工作状态转换到了停机状态。

在发动机于空转停机控制模式下进入到停机状态的情况下，点火开关保持在点火接通位置。因而，空调器、动力转向装置以及仪表等

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的附件、以及加速器和制动器等的线控系统仍保持着工作状态，此状态下，它们仍然由锂离子电池 14 进行供电。需要电压稳定的附件以及线控系统—例如音响设备和汽车导航系统、ABS、油泵保持在工作状态下，在该状态下，由铅酸蓄电池 12 对它们进行供电，或者是通过 DC/DC 变换器 22 由锂离子电池 14 进行供电。

当在空转停机控制模式下将发动机停机时，利用工作状态检测器 30 来判断是否已经满足了取消空转停机控制的条件，工作状态检测器 30 的判断基于如下的条件：如果车辆上安装的是自动变速箱，则变速箱的档位是否从“N”档换到了“D”档（驱动档）或“R”档（倒车档）；制动操作是否已被释放；或者在车辆上安装手动变速箱的情况下，离合器踏板是否已被踩下。结果就是，在判断出取消空转停机控制的条件已满足的条件下，无需车辆驾驶员将点火开关从点火接通位置转到起动机接通位置，起动机 18 就能变为工作状态，从而使发动机起动，重新变为工作状态。下文中，将上述的发动机起动操作称为“重新起动”。与此同时，将安装常规程序、将点火开关转到起动机接通位置的发动机起动操作称为“常规起动”。

按照这样的方式，对于根据本实施例的车辆，在发动机进入到工作状态之后，如果车辆停车时就执行空转停机控制。因而，根据该示例性实施方式，可避免将发动机保持在无用的空转状态，因此，发动机的运行更为高效，并能提高燃油经济性。

对于执行空转停机控制的系统，由于相比于不执行空转停机控制的系统，发动机起动和熄火的次数更为频繁，所以起动机 18 工作的频率（换言之：即从电池向起动机供电的频度）是很高的。在这样的条件下，如果始终是由放电密度较高/能量密度较低的铅酸蓄电池 12 向起动机 18 供电，则铅酸蓄电池始终工作在负载条件下的状况将造成铅酸蓄电池 12 的劣化过程加速。

可通过相对增大铅酸蓄电池 12 的容量来解决上述的问题。但在

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本实施例的结构设计中，这就必须要为铅酸蓄电池 12 留出足够大的安装空间，另外，这样作还会带来成本的增加。

在执行常规起动时，由于发动机通常是冷机，所以电池的负载相对较大。在另一方面，在采用空转停机控制的情况下，当发生发动机重新起动时，发动机处于暖机状态，所以电池的负载相对较小。因而，为了能可靠地保证发动机的起动性能，合适的作法是采用高放电密度的电池，单位质量的这种电池能在单位时间内输出很高的电能。在另一方面，在执行重新起动时，无须高放电密度的电池，采用低放电密度的电池也能足够胜任。在车辆运行过程中，要以一定的时间间隔频繁地执行空转停机控制。因而，为了能可靠地保证发动机在重新起动时的起动性，合适的作法是采用一种能量密度很高的电池，这种电池的单位质量具有很高的蓄电量。

因而，如上文所述，根据该实施例，在按照车辆驾驶员的意愿而起动发动机时（常规起动），起动机 18 由铅酸蓄电池 12 供电而变为工作状态，其中，驾驶员的意愿体现为其所执行的点火操作。当在空转停机控制下起动发动机时（重新起动），转换开关 16 的工作可将与起动机 18 相连接的电池从铅酸蓄电池 12 转换为锂离子电池 14，从而，起动机 18 由锂离子电池 14 供电而变为工作状态，并将发动机起动。

按照这样的设计，由于在常规起动时采用的是高放电密度的铅酸蓄电池 12，所以即使在低温条件下，也能可靠地保证发动机的起动性能，并且由于在重新起动是采用的是高能量密度的锂离子电池 14，所以即使频繁地执行空转停机控制，也能可靠地起动发动机，同时还不会导致铅酸蓄电池 12 的加速老化。因而，根据该示例性实施方式，即使对于这样的两种情况：车辆驾驶员执行点火操作时所涉及的发动机起动、以及执行空转停机控制所涉及的发动机情况，也能始终可靠地起动发动机，且不会导致铅酸蓄电池 12 的老化加速。

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图 2 中的流程图表示了一控制程序的示例，该程序是实现上述功能所必须的，其由根据该实施例的供电控制系统 10 中的 ECU24 来执行。图 2 所示的程序以一定时间周期不断地反复执行。当图 2 所示的程序开始运行时，首先执行步骤 100 中的过程。

在步骤 100 中，在空转停机控制处于有效状态时，工作状态检测器 30 根据空转停机控制的取消条件，检测是否需要重新起动发动机。结果就是，如果判断出不需要重新起动发动机，则程序结束，从而并不执行下面的任何过程。而在另一方面，如果判断出需要重新起动发动机，则逻辑过程就进入到步骤 102。

在步骤 102 中，判断锂离子电池 14 的蓄电量是否降到了一预定水平、或低于该预定水平。如果判断结果是否定的，也就是说，如果锂离子电池 14 的蓄电量并未降低，则就可以断定锂离子电池 14 完全能够驱动起动机 18，并足以将发动机带到其工作状态。然后，过程进入到步骤 104 中。

在步骤 104 中，将锂离子电池 14 转接为与起动机 18 相连接的那个电池，并操作转换开关 16，从而使锂离子电池 14 向起动机 18 供电。在步骤 104 中，随后起动机 18 就接收锂离子电池 14 输送来的电能，进入到工作状态，从而重新起动发动机。当步骤 104 中的过程结束时，程序终止。

如果步骤 102 的判断结果是肯定的，也就是说，锂离子电池 14 的蓄电量已经降到或低于预定的水平，因而，即使接通锂离子电池 18 供电，起动机 18 也将不会工作。因此，不足以使发动机转变到其工作状态。之后，逻辑过程转向步骤 106。

在步骤 106 中，与起动机 18 相连接的电池被换接为铅酸蓄电池 12，并对转换开关 16 进行操作，以使得铅酸蓄电池 12 向起动机 18 供电。在步骤 106 中，而后就由铅酸蓄电池 12 向起动机 18 输送电能，使起动机变为工作状态而重新起动发动机。当步骤 106 中的过程执行

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完毕后，程序终止。

按照图 2 所示的程序，在空转停机控制所涉及的发动机重新起动过程中，如未发生锂离子电池蓄电量降低的情况，则电能是从锂离子电池 14、而非铅酸蓄电池 12 输送给起动机 18 的。因而，根据该实施例的设计，在车辆驾驶员执行点火操作所伴随的常规起动过程中，起动机 18 由铅酸蓄电池 12 供电。与此同时，在伴随着空转停机控制的重新起动过程中，起动机 18 由锂离子电池 14 供电。

按照这样的设计，当发动机为冷机状态时—换言之当电池负载很大时，所执行的常规起动为冷机起动，由于是用放电密度较高的铅酸蓄电池 12 来驱动起动机 18，所以能可靠地保证发动机的起动性。另外，在伴随空转停机控制的重新起动过程中，尽管是用放电密度较低的锂离子电池 14 来驱动起动机 18，但由于空转停机控制所伴随的重新起动是在发动机暖机状态下进行的（也就是说，电池的负载很小），所以仍然能可靠地保证发动机的起动性。另外，在重新起动时，由于是用高能量密度的锂离子电池 14 来驱动起动机 18，所以即使发动机重新起动的次数很频繁，也不会加速铅酸蓄电池 12 的老化，并可靠地保证发动机的起动性。

根据该实施例中的供电控制系统 10，对于执行空转停机控制的车辆，尽管发动机频繁起动，但能减少用铅酸蓄电池 12 来起动发动机的次数。另外，考虑到在发动机常规起动与重新起动时电池负载的差异，可以转换向起动机 18 供电的电池。因而，根据该实施例中的供电控制系统 10，无论是发动机的常规起动、还是重新起动，都能可靠地完成，同时还不会导致铅酸蓄电池 12 的加速老化。因此，可以避免由于电池损坏或老化而造成系统失效。

在根据该实施例的系统中，在空转停机控制所伴随的发动机重新起动过程中，是由锂离子电池 14 向起动机 18 供电的，从而，由于铅酸蓄电池 12 在重新起动时并不与起动机 18 相连接，所以可避免铅酸

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蓄电池 12 的电压出现下降。因而，对于那些连接在铅酸蓄电池 12 一侧的音响设备、导航设备、ABS、以及油泵等电器附件，即使在利用锂离子电池 14 来执行重新起动时，它们仍能接收到电源电压，从而能保持或继续它们的工作。在发动机重新起动时，如果铅酸蓄电池 12 的性能由于电量下降等原因而减弱，则可由锂离子电池 14 经 DC/DC 变换器 22 来向附件供电。因而，根据该实施例的控制系统，在执行发动机重新起动时，可避免那些要求电压恒定的附件出现故障或停止工作（例如，音响设备的中断、导航器屏幕的重设等），从而能可靠地保证附件的工作。

同样，在发动机重新起动过程中，与起动机 18 连接的锂离子电池 14 的电压会出现下降。但是，对于那些连接到锂离子电池 14 一侧的附件（例如除雾器和雨刷器），除了供电电压降低了一些之外，它们的正常工作并不会受到太大影响，或者不会产生一些严重的问题。因而，对于根据该实施例的系统，不必考虑由于发动机重新起动时锂离子电池 14 电压降低而带来的影响。

此外，在该实施例中，如果在空转停机控制所伴随的发动机重新起动的过程中，锂离子电池 14 的电量发生了下降，则由铅酸蓄电池 12 取代锂离子电池 14 向起动机 18 供电。因而，在发动机重新起动时，即使由于锂离子电池 14 的电量降低而不能用锂离子电池 14 来完成发动机的起动，也能用铅酸蓄电池 12 来可靠地起动发动机。因此，根据该实施例的供电控制系统 10，可避免这样的情形出现：由于锂离子电池 14 的电量降低，发动机无法完成重新起动。

在该实施例中，ECU24 的作用在于：通过控制转换开关 16，当常规起动时，使铅酸蓄电池 12 向起动机 18 供电；当重新起动时，使锂离子电池 14 向起动机 18 供电。此外，对电池的换接控制是通过执行图 2 所示程序中的步骤 102、106 来完成的。

在上述的实施例中，如果满足了执行空转停机控制的条件，则就

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将发动机熄火；并且如果在空转停机控制所伴随的发动机重新起动过程中，锂离子电池 14 的电量出现了不足，则就用铅酸蓄电池 12 来起动发动机。如果铅酸蓄电池 12 和锂离子电池 14 的电量都降低了，则停止执行空转停机控制。在这样的条件下停止执行空转停机控制：铅酸蓄电池 12 与锂离子电池 14 的电池电量和电池电压中的至少一项指标出现了不足。

另外，在上述的实施例中，在伴随空转停机控制的发动机重新起动过程中，当锂离子电池 14 的电量不足时，用铅酸蓄电池 12 来起动发动机。但是，在车辆驾驶员执行点火操作所伴随的发动机常规起动过程中，如果铅酸蓄电池 12 的电量降低到、或低于一预定值，则在此情况下将用锂离子电池 14 来起动发动机。在这样的设计中，在发动机的常规起动过程中，即使铅酸蓄电池 12 由于电量降低而不足以使发动机起动，通过采用锂离子电池 14 来起动发动机，也能可靠地避免出现这样的情形：由于蓄电量下降，无法完成发动机的常规起动。在该实施例中，当判断出铅酸蓄电池 12 的电量已经不足时，ECU24 工作而将铅酸蓄电池 12 与锂离子电池 14 换接。从而由锂离子电池 14 向起动机供电。

另外，在上述的实施例中，尽管是基于电池的电量来进行判断的—判断从铅酸蓄电池 12 和锂离子电池 14 向起动机 18 输送的电力是否足够，但这样的判断并不仅限于电池的电量。还可用其它的参数来进行判断，其它的参数例如为电池温度、电池电压或电池电流。

此外，在上述的实施例中，尽管是用锂离子电池 14 作为放电密度较低、但能量密度较高的电池，但也可采用镍氢电池或其它铅酸电池等的电池。

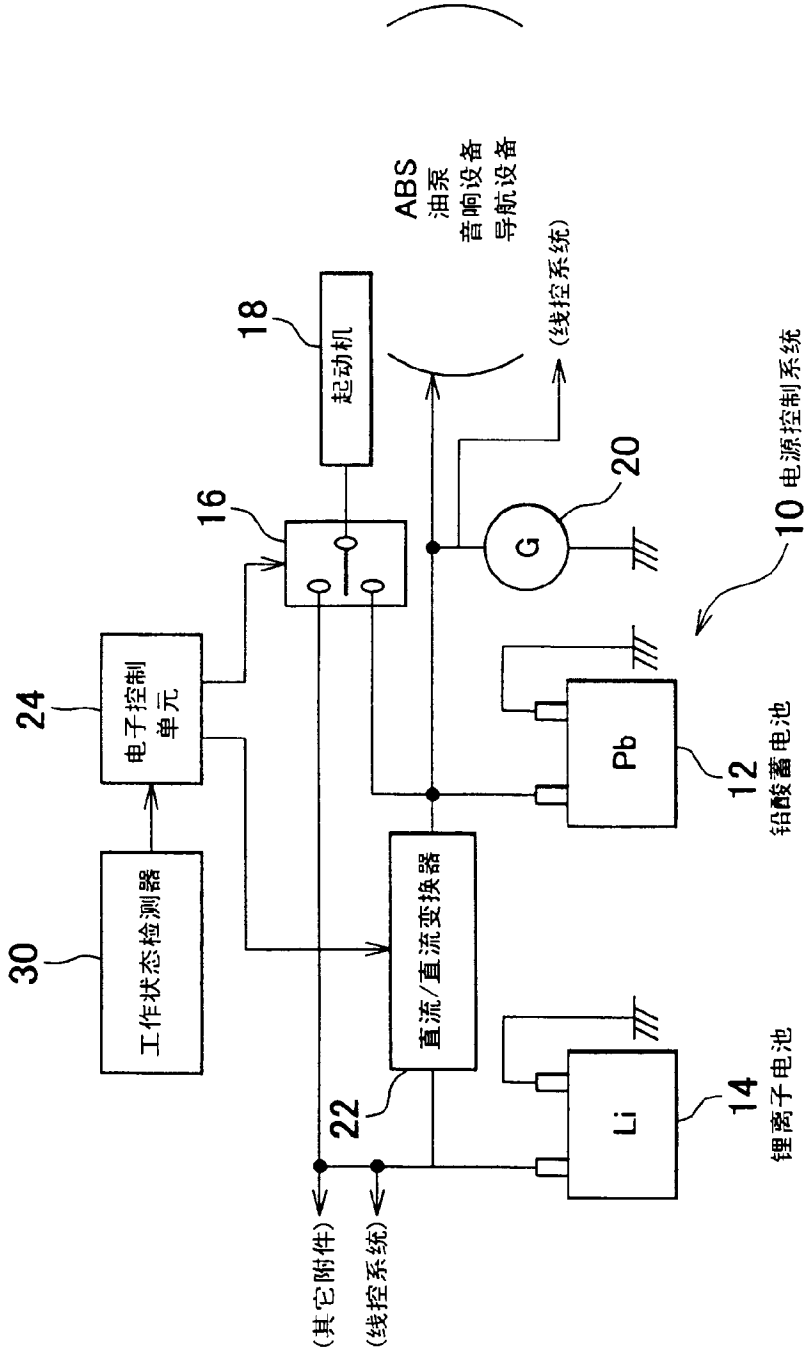
另外，在上述的示例性实施例中，如果车辆驾驶员将点火开关转到了起动机接通位置，则就由铅酸蓄电池 12 向起动机 18 供电，使其进入工作状态而起动发动机。还可应用于这样的设计：无需要由车辆

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驾驶员来进行操作，如果获得了某种认证，就开始从铅酸蓄电池 12 向起动机 18 供电，使其进入到工作系统，进而起动发动机，其中，所述认证是基于一无线通讯来进行的，所述无线通讯是在车辆驾驶员持有的一便携式装置与车辆一侧的一车载单元之间进行的。

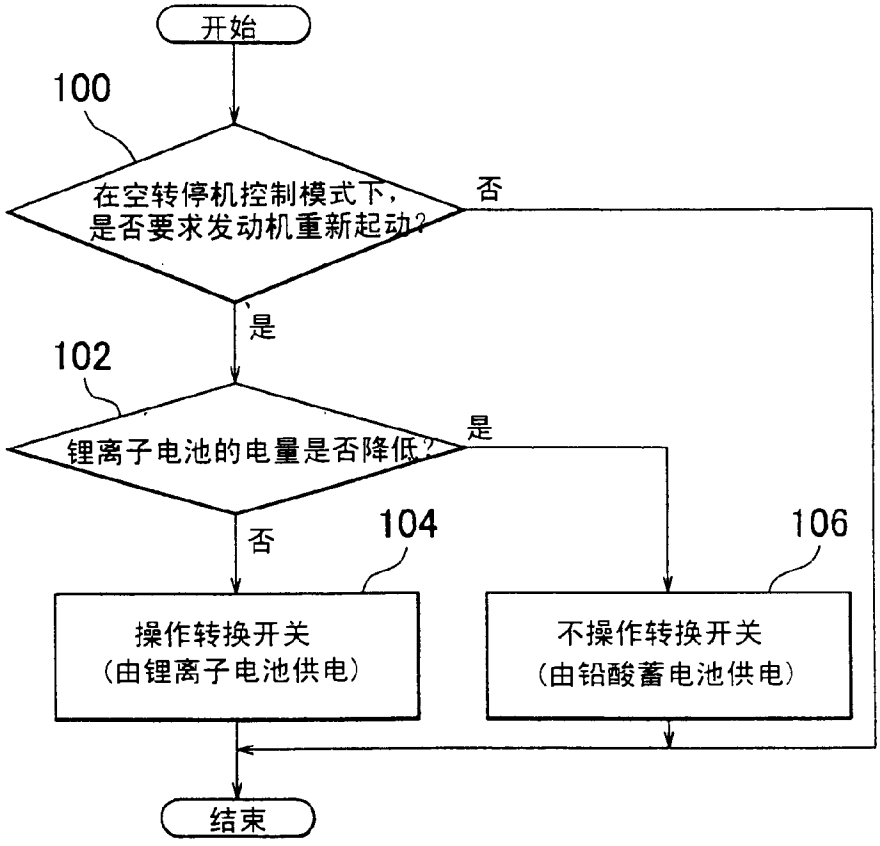
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图1



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图2



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WO2013015539A1 BATTERY MODULE HAVING IMPROVED RELIABILITY AND MID-TO-LARGE BATTERY PACK COMPRISING SAME

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Classifications:

IPC ***H01M2/10; H01M2/26; H01M2/30;***

CPC **H01M50/20 (EP,CN,US); H01M50/258 (EP,US); H01M50/543 (EP,CN,US); H01M50/579 (EP,CN,US); H01M6/46 (EP,CN,US);** H01M2220/20 (EP,CN,US); H01M4/661 (EP,US); H01M4/667 (EP,US); H01M50/10 (EP,CN,US); H01M50/502 (EP,US);

Priorities: KR20110073495A 2011-07-25

Application: KR2012005320W·2012-07-05

Publication: WO2013015539A1·2013-01-31

Published as: **CN103688391A; CN103688391B; EP2738838A1; EP2738838A4; EP2738838B1; JP2014523623A; JP5897121B2; KR101305250B1; KR20130012547A; US2014127550A1; US9496542B2;** WO2013015539A1

BATTERY MODULE HAVING IMPROVED RELIABILITY AND MID-TO-LARGE BATTERY PACK COMPRISING SAME

Abstract

The present invention provides a battery module having a plurality of battery cells in sheet-form which are sequentially laminated, in which the battery module is formed from two or more hexahedral cell units, laminated and connected in series, and the cell unit consists of two or more battery cells connected in series, and adhered to each other. Electrode terminals (outermost electrode terminals) of the outermost battery cells from among the cell units are connected to an external input/output terminal of the battery module, and have wider vertical cross-sectional areas than remaining the electrode terminals of the battery cells so that a break due to an external impact can be prevented.

(19)日本国特許庁(JP)　(12)公表特許公報(A)　(11)特許出願公表番号
特表2014-523623
(P2014-523623A)
(43)公表日　平成26年9月11日(2014.9.11)

(51)Int.Cl.		F I			テーマコード（参考）
H01M 2/30	***(2006.01)***	H01M	2/30	C	5H011
H01M 2/10	***(2006.01)***	H01M	2/10	M	5H040
H01M 2/06	***(2006.01)***	H01M	2/06	K	5H043
H01M 2/20	***(2006.01)***	H01M	2/20	A	
H01M 2/02	***(2006.01)***	H01M	2/02	K	

審査請求 有　予備審査請求 未請求　（全 17 頁）

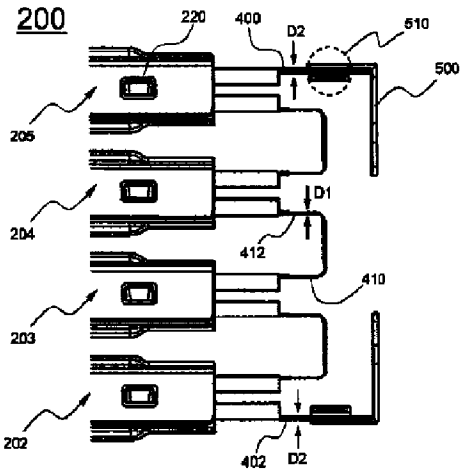
(21)出願番号　特願2014-520116 (P2014-520116)
(86)(22)出願日　平成24年7月5日 (2012.7.5)
(85)翻訳文提出日　平成26年1月14日 (2014.1.14)
(86)国際出願番号　PCT/KR2012/005320
(87)国際公開番号　WO2013/015539
(87)国際公開日　平成25年1月31日 (2013.1.31)
(31)優先権主張番号　10-2011-0073495
(32)優先日　平成23年7月25日 (2011.7.25)
(33)優先権主張国　韓国 (KR)

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最終頁に続く

(54)【発明の名称】信頼性の向上した電池モジュール及びこれを備えた中大型電池パック

(57)【要約】
本発明は、複数の板状型電池セルが順次に積層されている電池モジュールであって、前記電池モジュールは、２つ以上の直方体のセルユニットが積層された状態で直列連結された構造になっており、前記セルユニットは、２つ以上の電池セルが互いに密着した状態で直列連結された構造になっており、前記セルユニットのうち、最外側に配置された電池セルの電極端子（最外側電極端子）は電池モジュールの外部入出力端子と連結されており、外力による破たんを防止するように、残り電池セルの電極端子に比べて垂直断面積が広くなっている電池モジュールを提供する。



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【特許請求の範囲】
【請求項１】
複数の板状型電池セルが順次に積層されている電池モジュールであって、
前記電池モジュールは、２つ以上の直方体のセルユニットが積層された状態で直列連結された構造になっており、
前記セルユニットは、２つ以上の電池セルが互いに密着した状態で直列連結された構造になっており、
前記セルユニットのうち、最外側に配置された電池セルの電極端子（最外側電極端子）は電池モジュールの外部入出力端子と連結されており、外力による破たんを防止するように、残り電池セルの電極端子に比べて垂直断面積が広くなっていることを特徴とする、電池モジュール。
【請求項２】
前記最外側電極端子の垂直断面積は、残り電池セルの電極端子の垂直断面積を基準に１１０％乃至５００％の大きさになっていることを特徴とする、請求項１に記載の電池モジュール。
【請求項３】
前記最外側電極端子は、残り電池セルの電極端子に比べて厚さがより大きいことを特徴とする、請求項１に記載の電池モジュール。
【請求項４】
前記最外側電極端子は、外部入出力端子と連結されるバスバーに結合されていることを特徴とする、請求項１に記載の電池モジュール。
【請求項５】
前記最外側電極端子の厚さは、残り電池セルの電極端子の厚さを基準に１２０％乃至３００％の大きさになっていることを特徴とする、請求項３に記載の電池モジュール。
【請求項６】
前記電池セルの電極端子は、アルミニウムからなる正極端子と、ニッケルメッキ銅からなる負極端子とで構成されることを特徴とする、請求項１に記載の電池モジュール。
【請求項７】
前記正極端子の厚さは前記負極端子の厚さよりも大きいことを特徴とする、請求項５に記載の電池モジュール。
【請求項８】
前記最外側電極端子のうち、正極端子の厚さは負極端子の厚さよりも大きいことを特徴とする、請求項１に記載の電池モジュール。
【請求項９】
前記最外側電極端子のうち、正極端子の厚さは０．３乃至０．５ｍｍであり、負極端子の厚さは、前記正極端子の厚さよりも小さい範囲において０．１乃至０．３ｍｍであることを特徴とする、請求項８に記載の電池モジュール。
【請求項１０】
前記最外側電極端子は、残り電池セルの電極端子に比べて幅（横幅）が大きいことを特徴とする、請求項１に記載の電池モジュール。
【請求項１１】
前記最外側電極端子の幅は、残り電池セルの電極端子の幅を基準に１３０％乃至２００％の大きさであることを特徴とする、請求項１０に記載の電池モジュール。
【請求項１２】
前記バスバーは、ニッケルメッキ銅からなることを特徴とする、請求項４に記載の電池モジュール。
【請求項１３】
前記板状型電池セルは、樹脂層及び金属層を含むラミネートシートの電池ケースに正極／分離膜／負極構造の電極組立体が内蔵されており、前記電池ケース両端に正極端子及び負極端子が突出していることを特徴とする、請求項１に記載の電池モジュール。

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【請求項１４】
前記セルユニットは、電池セルが互いに密着した状態で金属ハウジングに内蔵されていることを特徴とする、請求項１に記載の電池モジュール。
【請求項１５】
金属ハウジングは、２つ以上の電池セル、及び前記正極端子及び負極端子の部位を除いた電池セル積層体の外面全体を覆うように相互結合されていることを特徴とする、請求項１４に記載の電池モジュール。
【請求項１６】
前記金属ハウジングは、電池セル積層体の外面形状に対応する内面構造を有しており、組立締結方式で結合されることを特徴とする、請求項１５に記載の電池モジュール。
【請求項１７】
前記金属ハウジングの断面結合部は、金属ハウジングが互いに対面するように接触させた状態で加圧した時、弾力的な結合により噛み合う雌雄の締結構造になっていることを特徴とする、請求項１５に記載の電池モジュール。
【請求項１８】
前記金属ハウジングは金属板材からなることを特徴とする、請求項１に記載の電池モジュール。
【請求項１９】
前記セルユニットは、２つの電池セルが直列連結されていることを特徴とする、請求項１に記載の電池モジュール。
【請求項２０】
前記セルユニットの直列連結は、第１セルユニットの電極端子端部と第２セルユニットの電極端子端部がそれぞれ断面
【数１】

「┐」

状に折れ曲がり、互いに重なる面が溶接されてなることを特徴とする、請求項１に記載の電池モジュール。
【請求項２１】
出力及び容量に対応して、請求項１に記載の電池モジュールを２つ以上備える、高出力・大容量の中大型電池パック。
【請求項２２】
電気自動車、ハイブリッド電気自動車、又はプラグ－インハイブリッド電気自動車の電源として用いられることを特徴とする、請求項２１に記載の中大型電池パック。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、複数の板状型電池セルが順次に積層されている電池モジュールであって、該電池モジュールは、２つ以上の直方体のセルユニットが積層された状態で直列連結されている構造になっており、当該セルユニットは、２つ以上の電池セルが互いに密着した状態で直列連結されている構造になっており、セルユニットのうち、最外側に配置された電池セルの電極端子（最外側電極端子）は、電池モジュールの外部入出力端子と連結されており、外力による破たんを防止できるように、残りの電池セルの電極端子に比べて垂直断面積がより広いことを特徴とする電池モジュールに関する。
【背景技術】
【０００２】
充放電可能な二次電池は、化石燃料を使用する既存のガソリン車両、ディーゼル車両などにおける大気汚染の問題などを解決するための方案として提示されている電気自動車（ＥＶ）、ハイブリッド電気自動車（ＨＥＶ）、プラグ－インハイブリッド電気自動車（Ｐ

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ｌｕｇ－Ｉｎ　ＨＥＶ）などを含めて、高出力・大容量が要求されるデバイスの動力源として注目されている。

【０００３】

このようなデバイスには、高出力・大容量を提供するべく、複数の電池セルを電気的に連結した中大型電池モジュールが使用されている。

【０００４】

中大型電池モジュールは、可能な限り小さい大きさ及び重量で作製されるのが好ましい。そのため、高い集積度で充積可能であり且つ容量対比重量が小さい角形電池、パウチ形電池などが、中大型電池モジュールの電池セル（単位電池）として主に使用されている。特に、近年、アルミニウムラミネートシートなどを外装部材とするパウチ形電池は、軽量、低コスト、及び形態変形の容易さなどの利点から高い関心を集めている。

【０００５】

一方、現在、車両用電池パックに装着される電池モジュールを構成する各電池セルの電極端子の大きさは、１つの電池パック内においていずれも同一になっている。

【０００６】

また、電極端子としては、一般に、厚さが０．５ｍｍ以下である箔（ｆｏｉｌ）が使用されるため、車両に装着されて振動と衝撃を持続して受ける場合には破たんの可能性が高くなる。

【０００７】

特に、アルミニウム素材からなる正極端子であると、銅素材からなる負極端子に比べて素材自体の特性の上強度が弱いため、外部衝撃と振動に対して素材的に弱いという不具合がある。

【０００８】

また、バスバーは電池モジュールに固定されるため、電池モジュールが振動を受けて電池セルと電池モジュールとの相対運動が発生する場合、バスバーと電池セルとを連結する電極端子が、電池セルと電池セルとを連結する電極端子よりも構造的に弱いという不具合もある。

【０００９】

その上、電極端子と電極端子とを又は電極端子とバスバーとを連結する方法には、レーザー溶接又は超音波溶接が、量産の側面から有利であるため、一般に用いられている。しかし、電極端子の厚さを厚くするほど、溶接に必要なエネルギー消耗が大きくなり、不良率が高くなるという不具合がある。

【００１０】

そのため、高出力・大容量の電力を提供する上で、電池セルの電極端子が外部衝撃により内部短絡及び破たんすることを防止できる電池モジュールが強く要望されている。

【発明の概要】

【発明が解決しようとする課題】

【００１１】

本発明は、上記のような従来技術の問題点、及び過去から要請されてきた技術的課題を解決することを目的とする。

【００１２】

本発明の目的は、セルユニットのうち最外側に配置された電池セルの電極端子を、残り電池セルの電極端子に比べて垂直断面積をより広くすることによって、衝撃又は振動のような外力が電池モジュールに印加されても、電極リード同士の連結信頼性を確保することができる電池モジュールを提供することにある。

【００１３】

本発明の他の目的は、電池セルの低い機械的剛性を効果的に補強しながら、重量と大きさの増加を最小化できるセルユニット及び電池モジュールで構成された高出力・大容量の中大型電池パックを提供することにある。

【課題を解決するための手段】

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【００１４】
上記目的を達成するための本発明に係る電池モジュールは、複数の板状型電池セルが順次に積層されている電池モジュールであって、前記電池モジュールは、２つ以上の直方体のセルユニットが積層された状態で直列連結された構造になっており、前記セルユニットは、２つ以上の電池セルが互いに密着した状態で直列連結された構造になっており、前記セルユニットのうち、最外側に配置された電池セルの電極端子（最外側電極端子）は電池モジュールの外部入出力端子と連結されており、外力による破たんを防止するように、残り電池セルの電極端子に比べて垂直断面積が広くなっている。
【００１５】
したがって、本発明に係る電池モジュールは、電池セルの電極端子のうち、電池モジュールの外部入出力端子と連結されている最外側電極端子を、残り電池セルの電極端子に比べて垂直断面積を広く形成することによって、外部の衝撃や振動により破たんすることを未然に防止し、電池モジュールの信頼性と安全性を大きく向上させることができる。また、最外側電極端子以外の残り電池セルの電極端子は、最外側電極端子に比べて垂直断面積をより小さくすることによって、溶接などの製作容易性を満たすことができる。
【００１６】
前記最外側電極端子の垂直断面積は、例えば、残り電池セルの電極端子の垂直断面積を基準に１１０％乃至５００％の大きさであってよい。
【００１７】
一好適例において、前記最外側電極端子の厚さが残り電池セルの電極端子の厚さよりも大きくなっているとよい。
【００１８】
この場合、最外側電極端子は、残り電極端子に比べて、幅（横幅）が同一で且つ厚さが大きい構造、又は幅（横幅）も厚さも大きい構造を考慮でき、前者の構造の方がより好ましい。
【００１９】
このように、電池セルの電極端子のうち最外側電極端子を残り電池セルの電極端子に比べて厚く形成することによって、向上した信頼性及び安全性を達成でき、且つ電極端子の溶接などの製作容易性が得られる。
【００２０】
一方、前記最外側電極端子は、例えば、外部入出力端子に連結されるバスバーと結合される構造であってもよい。
【００２１】
したがって、バスバーに直接連結される最外側電極端子の厚さを、残り電池セルの電極端子の厚さよりも大きくすることによって、電池モジュールの構造的脆弱性を補強することができる。
【００２２】
前記バスバーは、ニッケルメッキ銅からなり、最外側電極端子との容溶接が容易になっている。
【００２３】
具体例において、前記最外側電極端子の厚さは、残り電池セルの電極端子の厚さを基準に１２０％乃至３００％の大きさであるとよい。具体的に、最外側電極端子の厚さが残り電池セルの電極端子の厚さを基準に１２０％未満であると、所望する最外側電極端子の破たんを防止し難く、最外側電極端子の厚さが残り電池セルの電極端子の厚さを基準に３００％を超えると、バスバーとの溶接性が低下するので、好ましくない。
【００２４】
より好ましくは、最外側電極端子の厚さは、残り電極端子の厚さを基準に１５０％乃至２５０％にするとよい。
【００２５】
前記電池セルの電極端子は、アルミニウムからなる正極端子と、ニッケルメッキ銅から

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なる負極端子とで構成されるとよく、好ましくは、正極端子の厚さは負極端子の厚さよりも大きくなっていればよい。

【００２６】

したがって、アルミニウム正極端子の厚さをニッケルメッキ銅負極端子の厚さよりも大きくすることによって、素材の脆弱性を補強することができる。

【００２７】

具体的な例として、下記の＜表１＞は、正極端子及び負極端子の素材別の機械的特性を示しており、＜表１＞から確認できるように、アルミニウム素材の正極端子の方が銅素材の負極端子に比べて引張強度が低い。

【００２８】

【表１】

＜表１＞電池セルの電極リード素材別の引張強度

	素材	方法	内容
正極端子	材料	JIS H 4170	ALN90H－0アルミニウム
	引張強度	JIS Z 2241	≧40N/mm^2 ≦110N/mm^2
負極端子	材料	JIS H 3100	C1020R-0銅ニッケルメッキ
	引張強度	JIS Z 2241	≧195N/mm^2

【００２９】

これに対し、本発明に係る電池モジュールは、負極端子に比べて強度の低い正極端子の厚さを、負極端子よりも大きく構成することによって、外部の衝撃又は振動による外力が発生しても、正極端子とバスバーとの溶接部位が破たんすることを防止することができる。

【００３０】

すなわち、電池セルの電極端子のうち、銅素材の負極端子に比べて素材上強度の弱い正極端子を厚く構成することによって、正極端子とバスバーとの連結部品が外力により破たんすることを最小化することができる。

【００３１】

一方、前記最外側電極端子のうち、正極端子の厚さは負極端子の厚さよりも大きくなっているのが好ましい。

【００３２】

その具体例として、最外側電極端子のうち、正極端子の厚さは０．３乃至０．５ｍｍであり、負極端子の厚さは、前記正極端子の厚さよりも小さい範囲において０．１乃至０．３ｍｍであってよい。

【００３３】

具体的に、前記正極端子の厚さが０．３ｍｍ未満であると、所望する正極端子の強度を維持できず、正極端子の厚さが０．５ｍｍを超えると、正極端子とバスバーとの溶接性が低下するので、好ましくない。

【００３４】

同様に、負極端子の厚さが０．１ｍｍ未満であると、所望する負極端子の強度を維持できず、負極端子の厚さが０．３ｍｍを超えると、負極端子とバスバーとの溶接性が低下するので、好ましくない。

【００３５】

電極端子の垂直断面積が互いに異なる好適例において、最外側電極端子は残りの電極端

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子に比べて幅（横幅）が広い構造であってもよい。

【００３６】

この構造において、前記最外側電極端子の幅又は横幅は、残り電池セルの電極端子の幅（横幅）を基準に１３０％乃至２００％であればよい。

【００３７】

このような構造の電池モジュールは、電池セルの電極端子のうち、電池モジュールの外部入出力端子と連結されている最外側電極端子の幅又は横幅を、残り電池セルの電極端子に比べて広く形成することによって、向上した信頼性と安全性を達成することができる。

【００３８】

本発明において、前記板状型電池セルは、電池モジュールの構成のために充積された時に全体大きさを最小化できるように、薄い厚さと相対的に広い幅及び長さを有する二次電池である。

【００３９】

このような二次電池の好ましい例としては、樹脂層及び金属層を含むラミネートシートの電池ケースに正極／分離膜／負極構造の電極組立体が内蔵されており、前記電池ケースの両端に正極端子及び負極端子が突出している構造の二次電池が挙げられ、具体的に、アルミニウムラミネートシートのパウチ形ケースに電極組立体が内蔵されている構造であってよい。このような構造の二次電池を「パウチ形電池セル」と呼ぶものとする。

【００４０】

好ましくは、セルユニットは、電池セルが互いに密着した状態で金属ハウジングに内蔵されていればよく、金属ハウジングは、２つ以上の電池セル、及び前記正極端子及び負極端子の部位を除いた電池セル積層体の外面全体を覆うように相互結合されていればよい。

【００４１】

一例として、前記金属ハウジングは、電池セル積層体の外面形状に対応する内面構造を有しており、且つ組立締結方式で結合されるとよい。

【００４２】

他の例として、前記金属ハウジングにおいて断面結合部は、金属ハウジングが互いに対面するように接触させた状態で加圧した時、弾力的な結合により噛み合うことができるように雌雄の結合構造にしてもよい。

【００４３】

一方、二次電池では、充放電過程で発熱がおき、発生した熱を外部に効果的に放出することが電池の寿命延長に重要な要素となる。そのため、前記金属ハウジングは、内部の電池セルで発生する熱が外部へより放出しやすくなるように、高い熱伝導性の金属板材で作製されるとよい。

【００４４】

前記セルユニットは、上述したように、２つ以上の電池セルが直列連結された状態で金属ハウジングに内蔵された構造になっており、好ましくは、２つの電池セルからなるとよい。

【００４５】

好ましい例において、前記セルユニットの直列連結は、第１セルユニットの電極端子の端部と第２セルユニットの電極端子の端部がそれぞれ断面

【００４６】

【数１】

「┐」

【００４７】

状に折れ曲がり、互いに重なる面が溶接されてなるとよい。

【００４８】

一方、中大型電池パックでは高出力・大容量の性能確保のために複数の電池セルが使用

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されるが、このような中大型電池パックを構成する電池モジュールには、限られた装着空間内での安全性の確保のために、より高い装着効率性、構造的安全性及び放熱効率性が要求される。

【００４９】

そこで、本発明は、前記電池モジュールを所望の出力及び容量に応じて複数個組み合わせてなる中大型電池パックを提供する。

【００５０】

本発明に係る中大型電池システムは、所望の出力及び容量に応じて電池パックを組み合わせて製造でき、よって、上述のような装着効率性、構造的安全性などの側面から、限られた装着空間を有し且つ頻繁な振動及び強い衝撃などに露出される電気自動車、ハイブリッド電気自動車、プラグ－インハイブリッドなどに好適に使用可能である。

【図面の簡単な説明】

【００５１】

【図１】パウチ形電池の斜視図である。

【図２】図１のパウチ形電池２個が直列に連結された電池セルの斜視図である。

【図３】図１のパウチ形電池２個が直列に連結された電池セルの斜視図である。

【図４】本発明の一実施例に係るセルユニット積層体の斜視図である。

【図５】本発明の他の実施例に係る電池モジュールの分解斜視図である。

【図６】図４のセルユニット積層体の平面図である。

【図７】図６のＡ部分を拡大した部分拡大図である。

【図８】本発明の他の実施例に係るセルユニットにおいて電極端子部位の部分詳細図である。

【発明を実施するための形態】

【００５２】

以下、添付の図面を参照して本発明の実施例について説明するが、これは、本発明のより容易な理解を助けるためのもので、本発明の範ちゅうを限定するものではない。

【００５３】

図１には、パウチ形電池の斜視図が模式的に示されている。図１を参照すると、パウチ形電池１００は、２つの正極端子１１０と負極端子１２０が互いに対向して電池本体１３０の上端部と下端部にそれぞれ突出している構造になっている。電池ケース１４０は、上下２単位からなっており、その内面に形成されている収納部に電極組立体（図示せず）を装着した状態で、相互接触部位である両側面１４０ｂ、上端部及び下端部１４０ａ，１４０ｃを貼り合わせることによって電池１００が作製される。電池ケース１４０は、樹脂層／金属箔層／樹脂層のラミネート構造からなり、互いに接する両側面１４０ｂ、上端部及び下端部１４０ａ，１４０ｃに熱と圧力を加えて樹脂層を相互融着させることで貼り合わせることができ、場合によっては接着剤にて張り合わせてもよい。

【００５４】

両側面１４０ｂは、上下電池ケース１４０の同一の樹脂層が直接接するから、溶融により均一な密封が可能である。一方、上端部１４０ａと下端部１４０ｃには正極端子１１０と負極端子１２０が突出しているため、電極端子１１０，１２０の厚さ及び電池ケース１４０との素材異質性から、電極端子１１０，１２０との間にフィルム上のシーリング部材１６０を挟んだ状態で熱融着を行い、密封性を高めている。

【００５５】

図２及び図３には、図１のパウチ形電池２個が直列に連結された電池セルの斜視図が模式的に示されている。

【００５６】

図２及び図３を図１と共に参照すると、２個のパウチ形電池セル１００，１０１をその電極端子１１０，１２０が連続的に相互隣接するように長さ方向に直列配列した状態で、電極端子１１０，１２０を溶接して互いに結合させた後、２つの単位に電池セル１００，１０１が重なるように畳む。図３に示すように、重なるように折り畳まれた状態の電池セ

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ル積層体１００ａにおいて、溶接により結合された電極端子連結部位１５０は、平面上
【００５７】
【数２】

「⊏」

【００５８】
状に折れ曲がっている。
【００５９】
図４には、本発明の一実施例に係るセルユニット積層体の斜視図が模式的に示されており、図５には、本発明の他の実施例に係る電池モジュールの分解斜視図が模式的に示されている。
【００６０】
図４及び図５を参照すると、電池モジュール３００は、４個の直方体のセルユニット２０２，２０３，２０４，２０５が積層された状態で直列連結されたセルユニット積層体２００を側面で直立させた状態で、上下組立型の上部ケース３１１と下部ケース３１２に装着した構造になっており、下部ケース３１２の前面には外部入出力端子３１４が装着されている。
【００６１】
セルユニット積層体２００は、電池セルを金属ハウジング２１０で外囲した構造にした４個のセルユニット２０２，２０３，２０４，２０５を互いに直列に連結された後、ジグザグ状に積層した構造になっている。
【００６２】
一方、金属ハウジング２１０の外面には、長さ方向に間隔を空けて線形突出部２１１ａ，２１１ｂ，２１１ｃ，２１１ｄ、２１１ｅが形成されており、特に、金属ハウジング２１０の両端には、幅方向の長さが金属ハウジング２１０のそれよりも短い線形突出部２１１ａ，２１１ｅが、互いに対角線位置に形成されている。
【００６３】
図６には、図４のセルユニット積層体の平面図が模式的に示されており、図７には、図６のＡ部分を拡大した部分拡大図が模式的に示されている。
【００６４】
図６及び図７を図４及び図５と共に参照すると、セルユニット２０２，２０３，２０４，２０５のうち、最外側に配置された電池セルの最外側電極端子４００，４０２は、残りの電池セルの電極端子４１０，４１２に比べて厚さがより厚く形成されており、外力による破たんを防止するようになっている。
【００６５】
具体的に、最外側電極端子４００，４０２の厚さＤ２は、残り電池セルの電極端子４１０、４１２の厚さＤ１よりも厚くなっている。すなわち、電極端子４００，４０２，４１０，４１２の幅（横幅）は互いに同一であるが、厚さが異なっており（Ｄ１＞Ｄ２）、結果的に電極端子４００，４０２の垂直断面積は電極端子４１０，４１２よりも大きい。
【００６６】
最外側電極端子４００，４０２は、電池モジュールの外部入出力端子３１４と連結されているバスバー５００に溶接により結合されており、最外側電極端子４００，４０２の厚さは、残り電池セルの電極端子の厚さを基準に２００％以上の大きさで形成されている。
【００６７】
具体例において、最外側電極端子のうち、正極端子の厚さは０．４ｍｍであり、負極端子の厚さは、正極端子の厚さよりも薄い範囲において０．２ｍｍとなっている。
【００６８】
電池セルの電極端子は、アルミニウムからなる正極端子４１０とニッケルメッキ銅からなる負極端子４１２とで構成され、バスバー５００は、ニッケルメッキ銅からなっている

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【００６９】
セルユニット２０２，２０３，２０４，２０５は、電池セルが互いに密着した状態で金属ハウジング２１０に内蔵されている構造であり、金属ハウジング２１０は、２個の電池セル、及び正極端子及び負極端子の部位を除いた電池セル積層体の外面全体を覆うように相互結合されている。
【００７０】
また、金属ハウジング２１０は金属板材であって、電池セル積層体の外面形状に対応する内面構造を有しており、且つ組立締結方式で結合される。金属ハウジング２１０の断面結合部は、雌雄の締結構造２２０になっており、金属ハウジング２１０が互いに対面するように接触させた状態で加圧すると弾力的な結合により噛み合うこととなる。
【００７１】
セルユニット２０２，２０３，２０４，２０５の直列連結は、第１セルユニット２０４の電極端子４１２の端部と第２セルユニット２０３の電極端子４１０の端部がそれぞれ断面
【００７２】
【数３】

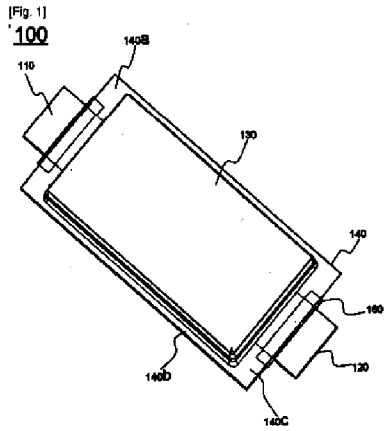
「┐」

【００７３】
状に折れ曲がり、互いに重なる面が溶接されてなる。
【００７４】
図８は、本発明のさらに他の実施例に係るセルユニットにおいて電極端子の部位を示す部分詳細図である。
【００７５】
図８を参照すると、セルユニットを構成する電池セル１００ｂ，１００ｃはそれぞれ、Ｗ１及びＷ２の幅（横幅）を持つ電極端子４０３，４０４を有している。
【００７６】
具体的に、最外側の電極端子を形成する電池セル１００ｃの電極端子４０４の幅Ｗ２は、電池セル１００ｂの電極端子４０３の幅Ｗ１を基準に１３０％乃至２００％の大きさで相対的に広く形成されている。すなわち、厚さは同一であるが、幅が異なっており（Ｗ２＞Ｗ１）、結果として、電池セル１００ｃの電極端子４０４の垂直断面積は電池セル１００ｂの電極端子４０３のそれよりも大きくなっている。
【００７７】
以上、図面を参照して本発明の実施例を説明してきたが、本発明の属する分野における通常の知識を有する者にとっては、上記内容に基づいて本発明の範ちゅう内で様々な応用及び変形が可能であろう。
【産業上の利用可能性】
【００７８】
以上説明した通り、本発明に係る電池モジュールは、セルユニットのうち、最外側に配置された電池セルの電極端子が残り電池セルの電極端子に比べて垂直断面積が広くなっているため、衝撃又は振動のような外力が電池モジュールに印加されても、電極リード同士の連結信頼性を確保することができる。
【符号の説明】
【００７９】
１００、１０１　パウチ形電池
１１０　正極端子
１２０　負極端子
１３０　電池本体

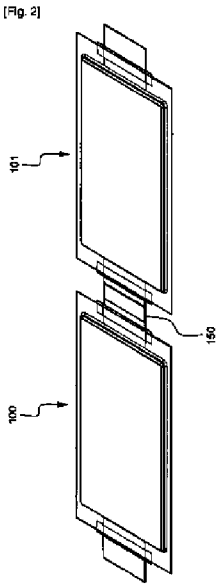
ADC EX1002
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１４０　電池ケース
１６０　シーリング部材
２００　セルユニット積層
２０２，２０３，２０４，２０５　セルユニット
２１０　金属ハウジング
３００　電池モジュール
３１１　上部ケース
３１２　下部ケース
３１４　外部入出力端子
４００，４０２　最外側電極端子
４１０，４１２　電極端子

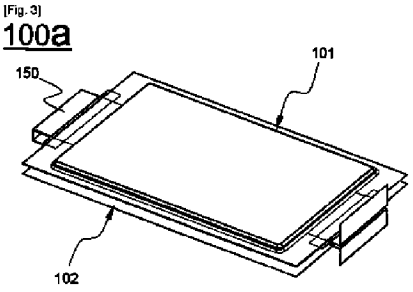
【図１】



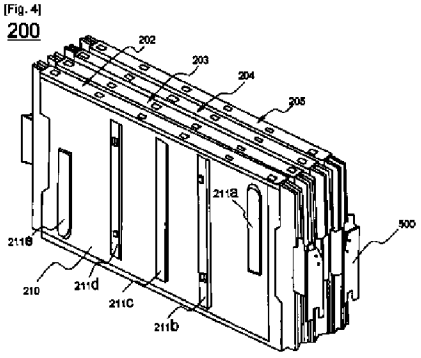
【図２】



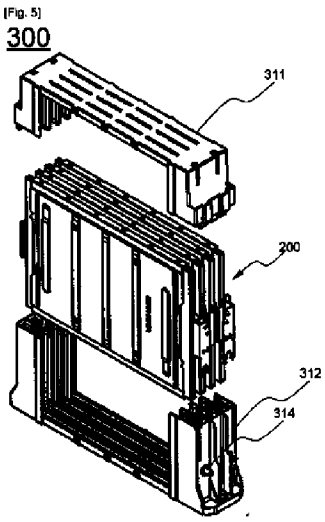
【図３】



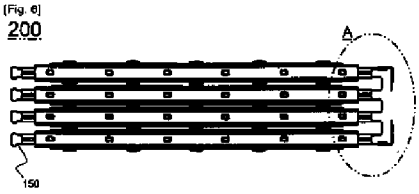
【図４】



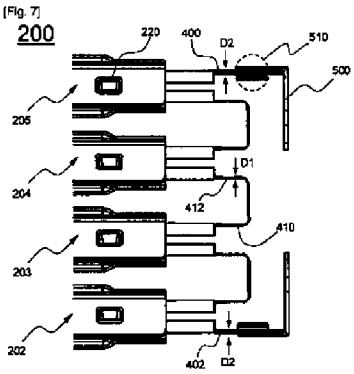
【図５】



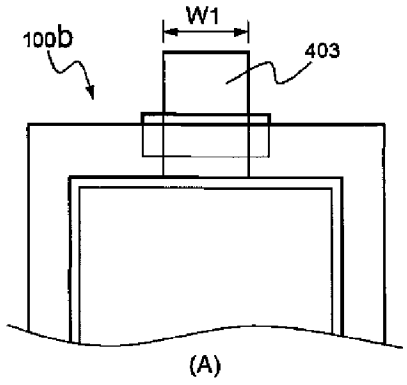
【図６】



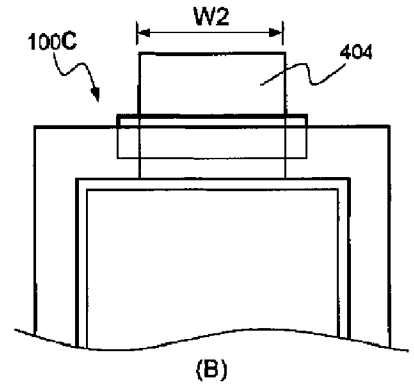
【図７】



【図８（Ａ）】



【図８（Ｂ）】



【国際調査報告】

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2012/005320

A. CLASSIFICATION OF SUBJECT MATTER

H01M 2/30(2006.01)i, H01M 2/26(2006.01)i, H01M 2/10(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01M 2/30; H01M 10/46; H01M 2/10; H01G 9/00; H01M 10/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: battery pack, battery module, outmost electrode terminal, cross section

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2009-0000292 A (LG CHEM. LTD.) 07 January 2009 See abstract, claims 1-15, paragraphs 29-58, and figures 1-4.	1-22
A	KR 10-2008-0107047 A (LG CHEM. LTD.) 10 December 2008 See abstract, claims 1-10, and figures 1-4.	1-22
A	KR 10-2007-0106814 A (LG CHEM. LTD.) 06 November 2007 See abstract, claims 1-16, and figures 1-16.	1-22
A	JP 2005-149882 A (SII MICRO PARTS LTD) 09 June 2005 See abstract, claims 1-8, and figures 1-5.	1-22

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 OCTOBER 2012 (29.10.2012)	**31 OCTOBER 2012 (31.10.2012)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2012/005320

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-2009-0000292 A	07.01.2009	NONE	
KR 10-2008-0107047 A	10.12.2008	NONE	
KR 10-2007-0106814 A	06.11.2007	CN 101479864 A	08.07.2009
		EP 2013928 A1	14.01.2009
		JP 2009-535777 A	01.10.2009
		US 2009-0305126 A1	10.12.2009
		WO 2007-126243 A1	08.11.2007
JP 2005-149882 A	09.06.2005	NONE	

Form PCT/ISA/210 (patent family annex) (July 2009)

국제조사보고서

국제출원번호
PCT/KR2012/005320

A. 발명이 속하는 기술분류(국제특허분류(IPC))

H01M 2/30(2006.01)i, H01M 2/26(2006.01)i, H01M 2/10(2006.01)i

B. 조사된 분야

조사된 최소문헌(국제특허분류를 기재)
H01M 2/30; H01M 10/46; H01M 2/10; H01G 9/00; H01M 10/04

조사된 기술분야에 속하는 최소문헌 이외의 문헌
한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC
일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC

국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우))
eKOMPASS(특허청 내부 검색시스템) & 키워드: 전지팩, 전지모듈, 최외곽 전극단자, 단면적.

C. 관련 문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
X	KR 10-2009-0000292 A (주식회사 엘지화학) 2009.01.07 요약, 청구항 1-15, 문단 29-58, 및 도면 1-4 참조.	1-22
A	KR 10-2008-0107047 A (주식회사 엘지화학) 2008.12.10 요약, 청구항 1-10, 및 도면 1-4 참조.	1-22
A	KR 10-2007-0106814 A (주식회사 엘지화학) 2007.11.06 요약, 청구항 1-16, 및 도면 1-16 참조.	1-22
A	JP 2005-149882 A (SII MICRO PARTS LTD) 2005.06.09 요약, 청구항 1-8, 및 도면 1-5 참조.	1-22

☐ 추가 문헌이 C(계속)에 기재되어 있습니다.

☒ 대응특허에 관한 별지를 참조하십시오.

* 인용된 문헌의 특별 카테고리:

"A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌

"E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌

"L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌

"O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌

"P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌

"T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌

"X" 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다.

"Y" 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다.

"&" 동일한 대응특허문헌에 속하는 문헌

국제조사의 실제 완료일	국제조사보고서 발송일
2012년 10월 29일 (29.10.2012)	**2012년 10월 31일 (31.10.2012)**

ISA/KR의 명칭 및 우편주소
대한민국 특허청
(302-701) 대전광역시 서구 청사로 189,
4동 (둔산동, 정부대전청사)
팩스 번호 82-42-472-7140

심사관
이성준

전화번호 82-42-481-8501

서식 PCT/ISA/210 (두 번째 용지) (2009년 7월)

국제조사보고서
대응특허에 관한 정보

국제출원번호
PCT/KR2012/005320

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
KR 10-2009-0000292 A	2009.01.07	없음	
KR 10-2008-0107047 A	2008.12.10	없음	
KR 10-2007-0106814 A	2007.11.06	CN 101479864 A	2009.07.08
		EP 2013928 A1	2009.01.14
		JP 2009-535777 A	2009.10.01
		US 2009-0305126 A1	2009.12.10
		WO 2007-126243 A1	2007.11.08
JP 2005-149882 A	2005.06.09	없음	

서식 PCT/ISA/210 (대응특허 추가용지) (2009년 7월)

フロントページの続き

(81)指定国 AP(BW,GH,GM,KE,LR,LS,MW,MZ,NA,RW,SD,SL,SZ,TZ,UG,ZM,ZW),EA(AM,AZ,BY,KG,KZ,RU,TJ,TM),EP(AL,AT,BE,BG,CH,CY,CZ,DE,DK,EE,ES,FI,FR,GB,GR,HR,HU,IE,IS,IT,LT,LU,LV,MC,MK,MT,NL,NO,PL,PT,RO,RS,SE,SI,SK,SM,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AO,AT,AU,AZ,BA,BB,BG,BH,BR,BW,BY,BZ,CA,CH,CL,CN,CO,CR,CU,CZ,DE,DK,DM,DO,DZ,EC,EE,EG,ES,FI,GB,GD,GE,GH,GM,GT,HN,HR,HU,ID,IL,IN,IS,JP,KE,KG,KM,KN,KP,KZ,LA,LC,LK,LR,LS,LT,LU,LY,MA,MD,ME,MG,MK,MN,MW,MX,MY,MZ,NA,NG,NI,NO,NZ,OM,PE,PG,PH,PL,PT,QA,RO,RS,RU,RW,SC,SD,SE,SG,SK,SL,SM,ST,SV,SY,TH,TJ,TM,TN,TR,TT,TZ,UA,UG,US,UZ,VC,VN,ZA,ZM

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Fターム(参考) 5H011 AA01 EE04 FF04 GG09 HH01 KK01 KK02
5H040 AA01 AA07 AA19 AS02 AS07 AT04 AT06 AY05 AY10 CC13
CC23 CC34 DD03 DD04 DD09 DD24 JJ02 JJ03 JJ04 JJ06
LL01 NN01 NN03
5H043 AA01 AA02 AA05 AA13 AA15 BA16 BA19 CA05 CA08 CA22
DA05 DA06 DA07 DA13 DA15 FA02 FA04 FA22 FA26 FA37
FA38 HA02F HA06F HA16F HA17F HA23D HA23F JA07F JA13D JA13F
KA07D KA07F KA08D KA08F KA09D KA44D KA44F LA02D LA02F LA11D
LA11F LA21D LA21F LA22F

ADC EX1002
IPR2025-00885

Espacenet

JP2008146998A BATTERY MODULE, BATTERY CASE, AND BUNDLE DEVICE AND BUNDLE METHOD OF BATTERY CASE

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Inventors: OTA MASAYASU

Classifications:
IPC ***H01M2/10;***

CPC Y02E60/10 (EP);

Priorities: JP2006332306A 2006-12-08

Application: JP2006332306A·2006-12-08

Publication: JP2008146998A·2008-06-26

Published as: JP2008146998A;**JP5082054B2**

BATTERY MODULE, BATTERY CASE, AND BUNDLE DEVICE AND BUNDLE METHOD OF BATTERY CASE

Abstract

PROBLEM TO BE SOLVED: To provide a battery module capable of coping with the same kind of module even if the connection route of a bus bar is simplified and capable of preventing a short circuit of output electrodes. SOLUTION: The battery module 30 is constituted of a laminate 20 of a plurality of unit cells 10 and a battery case 40 to house the unit cell laminate 10. The battery case 40 is formed by dividing into a lower case 42 of box shape with the upper side open and an upper case 41 of box shape with the lower side open. The unit cell laminate 20 is housed in the battery case 40 so as to combine the opening side of the upper and the lower cases 41, 42, and the opening end fringe parts of the upper and the lower cases 41, 42 are doubly bundled at the middle part in lamination direction of the unit cell laminate 20 to form a jointing part 43, and the unit cell laminate 20 is sealed. COPYRIGHT: (C)2008,JPO&INPIT

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2008-146998
(P2008-146998A)
(43)公開日　平成20年6月26日(2008.6.26)

(51)Int.Cl.		F I			テーマコード（参考）
H01M 2/10	***(2006.01)***	H01M	2/10	ZHVS	5H040
		H01M	2/10	Y	
		H01M	2/10	K	

審査請求 未請求　請求項の数 6　OL　（全 13 頁）

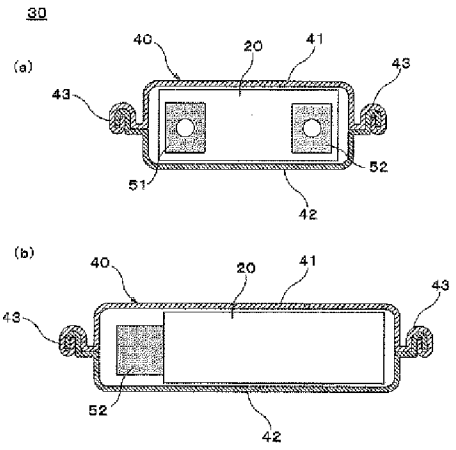
(21)出願番号　特願2006-332306 (P2006-332306)
(22)出願日　平成18年12月8日 (2006.12.8)

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(54)【発明の名称】電池モジュール、電池ケース、電池ケースの巻き締め装置および巻き締め方法

(57)【要約】
【課題】バスバーの接続経路を単純化しても同種類のモジュールで対応することができ、出力電極の短絡を防止することができる電池モジュールを提供する。
【解決手段】複数の単電池１０の積層体２０と、単電池積層体２０を収容する電池ケース４０と、から構成された電池モジュール３０であって、電池ケース４０は、上部が開口された箱体状の下部ケース４２と、下部が開口された箱体状の上部ケース４１と、に分割形成され、上下ケース４１、４２の開口側を合わせるように電池ケース４０内に単電池積層体２０を収容し、単電池積層体２０の積層方向の中間部において上下ケース４１、４２の開口端縁部を二重巻き締めして接合部４３を形成し、単電池積層体２０を封止する。
【選択図】図１



【特許請求の範囲】
【請求項1】
電池と、該電池を収容する電池ケースと、から構成され、
前記電池ケースは、上部が開口された箱体状の下部ケースと、下部が開口された箱体状の上部ケースと、に分割形成され、
上下ケースの開口側を合わせるように前記電池ケース内に前記電池を収容し、前記電池の厚さ方向の中間部において上下ケースの開口端縁部を二重巻き締めして前記電池の厚さ寸法の範囲内に接合部を形成し、前記電池を封止したことを特徴とする電池モジュール。
【請求項2】
前記電池ケース内に、前記電池の出力電極が配置されていることを特徴とする請求項１に記載の電池モジュール。
【請求項3】
前記電池が複数の単電池の積層体であることを特徴とする請求項１または請求項２に記載の電池モジュール。
【請求項4】
電池を収容する電池ケースであって、
上部が開口された箱体状の下部ケースと、下部が開口された箱体状の上部ケースと、に分割形成され、
上下ケースの開口側を合わせて内部に前記電池を収容し、前記電池の厚さ方向の中間部において上下ケースの開口端縁部を二重巻き締めして前記電池の厚さ寸法の範囲内に接合部を形成することを特徴とする電池ケース。
【請求項5】
上部が開口された箱体状の下部ケースと、下部が開口された箱体状の上部ケースと、からなる電池ケースの上下ケースの開口側を合わせて、上下ケースの開口端縁部を二重巻き締め接合する電池ケースの巻き締め装置であって、
前記上部ケースの外側面を被って保持すべく、下部が開口された箱体状の上部ケース保持治具と、
前記下部ケースの外周面を被って保持すべく、上部が開口された箱体状の下部ケース保持治具と、
前記上部ケース保持治具の開口部を下方に臨ませて支持する固定側のアンビルと、
前記下部ケース保持治具の開口部を上方に臨ませて支持する移動側のリフターと、
前記上下ケースの開口端縁部を二重巻き締め接合する巻き締めローラと、
を備えていることを特徴とする電池ケースの巻き締め装置。
【請求項6】
上部が開口された箱体状の下部ケースと、下部が開口された箱体状の上部ケースと、からなる電池ケースの上下ケースの開口側を合わせて、上下ケースの開口端縁部を二重巻き締め接合する電池ケースの巻き締め方法であって、
移動側のリフターに支持され、上部が開口された箱体状の下部ケース保持治具内に下部ケースを保持する工程と、
該下部ケース内に電池を収容すると共に、その上部を下部が開口された箱体状の上部ケースで被い、上下ケースの開口側を合わせる工程と、
固定側のアンビルに支持され、下部が開口された箱体状の上部ケース保持治具内に、前記リフターを上昇させて上部ケースを保持する工程と、
双方の治具から露出した上下ケースの開口端縁部を巻き締めローラにより二重巻き締め接合する工程と、
を有することを特徴とする電池ケースの巻き締め方法。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、電池ケース内に電池を収容した電池モジュール、電池を収容する電池ケース

、該電池ケースの接合部を二重巻き締めする巻き締め装置および巻き締め方法に関する。
【背景技術】
【0002】
電気自動車やハイブリッド自動車等に搭載される二次電池として、金属製の電池ケース内に複数の単電池を収容して巻き締め封止した電池モジュールが提案されている（特許文献１参照）。
【0003】
この種の電池ケースは、製缶技術における巻き締め接合（二重巻き締め）を応用した接合構造を採用している。すなわち、電池ケースは、ケース本体（缶胴）と蓋体（缶蓋）とにより構成され、ケース本体内に複数の単電池を収容して蓋体により押さえ、ケース本体の開口端縁部と蓋体の端縁部とを二重巻き締め接合して電池を封止している。
【特許文献1】特開平８－２２２１９６号公報
【発明の開示】
【発明が解決しようとする課題】
【0004】
ところで、従来の巻き締め封止された電池ケースを有する電池モジュールでは、電池ケースの巻き締め接合部が蓋体側に片寄って突設しており、電池モジュールが全体として上下非対称な形状を呈している。したがって、電池モジュール同士を直列接続して組電池を構成する場合に、電池モジュールを整列させ、かつバスバーによる接続経路を短縮して単純化するためには、左右の出力電極で極性の異なる二種類の電池モジュールを作製する必要があった。
【0005】
このような電池モジュールでは、出力電極が電池ケースから外部へ突設し露出しており、組電池の製造工程において、短絡防止のために電極を保護する必要があった。
【0006】
また、上記電池ケースのケース本体の側壁は電池（単電池積層体）の厚み以上の高さを有しており、このケース本体には、出力電極や電圧検出端子の取り出しのために数箇所の切欠き部を形成する必要がある。さらに、ケース本体と蓋体との断面形状が異なるので、外力に対する曲げ剛性が非対称であった。したがって、巻き締め装置による巻き締め接合時にケース本体の側壁が座屈し易かった。
【0007】
本発明は、上記の事情に鑑みて創案されたものであり、バスバーの接続経路を単純化しても同種類のモジュールで対応することができ、出力電極の短絡を防止することができる電池モジュール、ケース側壁の座屈を防止することができる電池ケース、該電池ケースの巻き締め装置および巻き締め方法を提供することを目的とする。
【課題を解決するための手段】
【0008】
上記目的を達成するための本発明に係る電池モジュールは、電池と、該電池を収容する電池ケースと、から構成され、前記電池ケースは、上部が開口された箱体状の下部ケースと、下部が開口された箱体状の上部ケースと、に分割形成され、上下ケースの開口側を合わせるように前記電池ケース内に前記電池を収容し、前記電池の厚さ方向の中間部において上下ケースの開口端縁部を二重巻き締め接合して、前記電池の厚さ寸法の範囲内に接合部を形成し、前記電池を封止したことを特徴とする。
【発明の効果】
【0009】
本発明に係る電池モジュールによれば、電池を収容する電池ケースが、上部が開口された箱体状の下部ケースと、下部が開口された箱体状の上部ケースと、に分割形成され、上下ケースの開口側を合わせるようにして前記電池の厚さ方向の中間部において上下ケースの開口端縁部が二重巻き締め接合される。したがって、電池ケースの巻き締め接合位置に片寄りがないので、適宜、電池モジュールの上下を逆に配置可能であり、バスバーの接続

経路を単純化しても同種類のモジュールで対応することができる。

【発明を実施するための最良の形態】

【0010】

以下、本発明の実施の形態を図面に基づいて説明する。

【0011】

図１は本発明に係る電池モジュールの一実施の形態を示し、（ａ）は正面から見た断面図、（ｂ）は右側面から見た断面図である。図２は本実施の形態に係る電池モジュールの外観を示し、（ａ）は正面図、（ｂ）は右側面図である。図３は扁平型電池の一例の斜視図である。なお、図１および図２において、理解を容易にするために、電池ケース３０の肉厚や巻き締め接合部４３等を実際よりも大きく誇張して図示している。

【0012】

図１から図３を参照して、電池モジュール３０は、後述する組電池（電池パック）８０を組み立てる際の単位ユニットをなし（図８および図９参照）、金属製の電池ケース４０内に電池２０が収容されている。本実施の形態では、電池２０は、電気的に接続された複数枚の扁平型電池（単電池）１０の積層体（単電池積層体）として構成されている。なお、電池モジュール３０は、電気的に接続された複数の単電池を備える点において組電池の一種であるが、本明細書においては、後述する組電池８０を組み立てる際の単位ユニットであって、複数の単電池１０を電池ケース４０内に収容してなるユニットを「電池モジュール」と称することとする。

【0013】

図３を参照して、扁平型電池（単電池）１０は、たとえば、扁平なリチウムイオン二次電池であり、正極板、負極板、およびセパレータを順に積層した積層型の発電要素（図示せず）がラミネートフィルムなどの外装材１０ａによって封止されている。電池１０は、発電要素に一端が電気的に接続されるとともに板状をなす電極タブ１０ｔ（プラス側電極タブ１０ｐおよびマイナス側電極タブ１０ｍの総称）が外装材１０ａから外部に導出されている。タブ１０ｔは、電池１０の長手方向の両側に延びている。積層型の発電要素を備える電池１０にあっては、電極板間の距離を均一に保って電池性能の維持を図るために、発電要素に圧力を掛けて押さえる必要がある。このため、単電池積層体２０を構成する各電池１０は、発電要素が押さえ付けられるように電池ケース４０内に収納される。

【0014】

図１および図２を参照して、電池ケース４０は、たとえばステンレス鋼により構成され、上部が開口された箱体状（矩形凹状）の下部ケース４２と、下部が開口された箱体状（矩形凹状）の上部ケース４１と、に分割形成されている。上下ケース４１、４２の開口端縁部には、巻き締め接合を行う巻き締め片４４、４５が外側方へ張り出すように形成されている（図６参照）。なお、巻き締め片４４、４５の形状については後述する。

【0015】

電池ケース４０は、上下ケース４１、４２の開口側を合わせて内部に単電池積層体２０を収容し、該単電池積層体２０の厚さ方向（積層方向）の中間部、本実施形態では中央部において上下ケース４１、４２の開口端縁部の巻き締め片４４、４５を二重巻き締めして、電池ケース４０の厚さ寸法の範囲内に接合部４３を形成することにより、単電池積層体２０を封止している。単電池積層体２０の前面には正負の出力電極（出力端子）５１、５２が突設されており、該出力端子５１、５２は電池ケース４０内に配置されている。そして、電池ケース４０の前面壁の上記出力電極５１、５２に対応する部位には切り欠き部６１、６２が形成され、これらの切欠き部６１、６２を通して、後述するバスバー９３が出力電極５１、５２に接続されることになる（図８および図９参照）。

【0016】

次に、図４から図５を参照して、電池ケース４０の巻き締め装置および巻き締め方法を説明する。図４は本実施の形態に係る電池モジュールの製造に用いる巻き締め装置である。図５から図７は本実施の形態に係る巻き締め方法を示し、図５（ａ）は下部ケース保持治具内に下部ケースを保持した状態の説明図、図５（ｂ）は下部ケース内に単電池積層体

を収容した状態の説明図、図６は下部ケース内に収容した単電池積層体の上部を上部ケースで被った状態の説明図、図７は巻き締め接合直前の状態の説明図である。

【0017】

図４を参照して、本実施の形態の巻き締め装置７０は、上記電池ケース４０の上下ケース４１、４２の開口側を合わせて、上下ケース４１、４２の開口端縁部の巻き締め片４４、４５（図６参照）を二重巻き締め接合する装置である。この巻き締め装置７０は、上部ケース４１の外側面を被って保持する上部ケース保持治具７１と、下部ケース４２の外周面を被って保持する下部ケース保持治具７２と、を備えている。上部ケース保持治具７１は、上部ケース４１を内部に保持して外側面を支承するように、下部が開口された箱体状（矩形凹状）の治具である。この上部ケース保持治具７１は、装置上方に設けられた固定側のアンビル７４にその開口部を下方に臨ませて支持されている。一方、下部ケース保持治具７２は、下部ケース４２を内部に保持して外側面を支承するように、上部が開口された箱体状（矩形凹状）の治具である。この下部ケース保持治具７２は、装置下方に設けられた移動側のリフター７５上にその開口部を上方に臨ませて支持されており、上記リフター７５によって昇降可能に設けられている。

【0018】

また、上ケース保持治具７２の下端位置の側方には、上部ケース保持治具７１および下部ケース保持治具７２によって保持された上下ケース４１、４２の開口端縁部の巻き締め片４４、４５を二重巻き締めして接合部４３を形成する巻き締めローラ７６が備えてられている。

【0019】

以上のように構成された巻き締め装置７０を用いて、本実施の形態に係る電池ケース４０の巻き締め方法は次のように実施される。

【0020】

図５（ａ）を参照して、本実施の形態に係る電池ケース４０の巻き締め方法は、まず、移動側のリフター７５上に支持され、上部が開口された箱体状の上部ケース保持治具７２内に、同様に上部が開口された箱体状の下部ケース４２を保持する。この下部ケース４２の開口縁部には、外側方に張り出した直状の下巻き締め片４５が斜め上方に臨むように形成されている。さらに、図５（ｂ）を参照して、この下部ケース４２内に単電池積層体２０を収容する。

【0021】

次に、図６を参照して、下部ケース４２内に収容した単電池積層体２０の上部を下部が開口された箱体状の上部ケース４１で被う。この上部ケース４２の開口縁部には、外側方に張り出した略Ｌ字状の上巻き締め片４４が下方に屈曲部を臨ませて形成されている。上部ケース４１を被せる際、上下ケース４１、４２の開口側を合わせて、略Ｌ字状の上巻き締め片４４の屈曲部が下巻き締め片４５の先端部近傍に載るように位置合わせを行う。上巻き締め片４４および下巻き締め片４５の形状は例示であって、図示の形状に限るものではなく、二重巻き締め接合し易いように形状を様々に工夫することができる。

【0022】

そして、図７を参照して、固定側のアンビル７４に支持され、下部が開口された箱体状の上部ケース保持治具７１内に、上記リフター７５を上昇させて、単電池積層体２０の上部を被う上部ケース４１を保持する。

【0023】

その後、双方の保持治具７１、７２から外側方へ露出した上下ケース４１、４２の巻き締め片４４、４５を巻き締めローラ７６により二重巻き締めして、単電池積層体２０の積層方向の中央部に接合部４３を形成する（図４参照）。なお、図４および図７において、１台の巻き締めローラ７６が図示されているが、１対の巻き締めローラ７６を対向させて配置してもよい。

【0024】

次に、上記電池モジュール３０を適宜配列して電気的に接続し、組電池８０を組み立て

る場合について説明する。図８は本実施の形態に係る電池モジュールを１０個配列して組電池を組み立てた状態の正面図である。図９は本実施の形態に係る電池モジュールを１２個配列して組電池を組み立てた状態の正面図である。図１０は本実施の形態に係る電池モジュールのバスバー接続状態を示す概略図である。

【0025】

図８および図９を参照して、電池モジュール３０を任意の個数直並列に接続することによって、所望の電流、電圧、容量に対応できる組電池８０が構成される。組電池８０として配列された各電池モジュール３０は、接続時の電気抵抗を小さくするため、基本的に最短距離で、つまり隣り合うモジュール同士でその正極５１と負極５２とが接続される。

【0026】

図８の組電池８０は、合計１０個の電池モジュール３０を含んでおり、上段電池群８１および下段電池群８３で構成されている。上段電池群８１および下段電池群８３には、出力電極５１、５２を同一面側（前面側）へ向けた状態で、それぞれ５個（列）の電池モジュール３０が行列（横列）されている。

【0027】

図８において、下段電池群８３の左から１列目の電池モジュール３０ａの正極５１には、組電池（電池パック）８０のプラス出力端子９１が接続されている。下段電池群８３の左から１列目の電池モジュール３０ａの負極５２と、左から２列目の電池モジュール３０ｂの正極５１とは、横方向（行方向）のバスバー９３によって最短距離で接続されている。同様にして、２列目の電池モジュール３０ｂから右方向へ５列目の電池モジュール３０ｅまで横方向のバスバー９３で接続している。

【0028】

上段電池群８１は、下段電池群８３に対して上下（天地）を転倒させた状態で行列され、上下の電池モジュール３０、３０で左右の極性が異なっている。下段電池群８３の左から５列目の電池モジュール３０ｅの負極５２と、上段電池群８１の左から５列目の電池モジュール３０Ｅの正極５１とは、縦方向（列方向）のバスバー９３で接続されている。さらに、上段電池群８１の左から５列目の電池モジュール３０Ｅの負極５２と、左から４列目の電池モジュール３０Ｄとは、安全スイッチ９４で接続されている。

【0029】

上段電池群８１において、左から４列目の電池モジュール３０Ｄから左方向へ１列目の電池モジュール３０Ａまで横方向のバスバー９３で接続している。そして、上段電池群８１の左から１列目の電池モジュール３０Ａの負極５２には、組電池（電池パック）８０のマイナス出力端子９２が接続されている。

【0030】

図９の組電池８０は、合計１０個の電池モジュール３０を含んでおり、上段電池群８１、中段電池群８２および下段電池群８３で構成されている。上段電池群８１、中段電池群８２および下段電池群８３は、出力電極５１、５２を同一面側（前面側）へ向けた状態で、それぞれ４個（列）の電池モジュール３０が行列（横列）されている。

【0031】

図９において、中段電池群８２の左から１列目の電池モジュール３０ｙａの正極５１には、組電池（電池パック）８０のプラス出力端子９１が接続されている。中段電池群８２の左から１列目の電池モジュール３０ｙａの負極５２と、２列目の電池モジュール３０ｙｂの正極５１とは、横方向（行方向）のバスバー９３によって最短距離で接続されている。同様にして、左から２列目の電池モジュール３０ｙｂと３列目の電池モジュール３０ｙｃとは、横方向のバスバー９３で接続している。

【0032】

上段電池群８１および下段電池群８３は、中段電池群８２に対して上下転倒させた状態で行列され、上段と中段、中段と下段とで電池モジュール３０、３０で左右の極性が異なっている。中段電池群８２の左から３列目の電池モジュール３０ｙｃの負極５２と、下段電池群８３の左から３列目の電池モジュール３０ｚｃの正極５１とは、縦方向（列方向）

のバスバー９３で接続されている。さらに、左方向へ下段電池群８３の左から１列目の電池モジュール３０ｚａまで横方向のバスバー９３で接続している。そして、下段電池群８３の左から１列目の電池モジュール３０ｚａの負極５２と、左から４列目の電池モジュール３０ｚｄの正極５１とは、安全スイッチ９４で接続されている。

【0033】

下段電池群８３の左から４列目の電池モジュール３０ｚｄの負極５２と、中段電池群８２の左から４列目の電池モジュール３０ｙｄの正極５１とは、縦方向のバスバー９３で接続されている。さらに、中段電池群８２の左から４列目の電池モジュール３０ｙｄの負極５２と、上段電池群８１の左から４列目の電池モジュール３０ｘｄの正極５１とは、縦方向のバスバー９３で接続されている。

【0034】

上段電池群８１において、左から４列目の電池モジュール３０ｘｄから左方向へ１列目の電池モジュール３０ｘａまで横方向のバスバー９３で接続している。そして、上段電池群８１の左から１列目の電池モジュール３０ｘａの負極５２には、組電池（電池パック）８０のマイナス出力端子９２が接続されている。

【0035】

図１０を参照して、本実施の形態に係る電池モジュール３０は出力電極５１、５２が電池ケース４０内に配置されているので、隣接配置した電池モジュール３０、３０の出力電極５１、５２同士の電気的接続は門型のバスバー９３を用いて行う。門型バスバー９３の両端部は相反する方向に張り出しており、その張出部９３ａ、９３ｂが電池ケース４０の切欠き部６１、６２からケース内に挿入され、出力電極５１、５２への接続部となる。この門型バスバー９３の張出部９３ａ、９３ｂには不図示の貫通孔が形成され、たとえば、ボルト９５によって出力電極５１、５２に固定される。

【0036】

次に、本実施の形態に係る電池モジュール３０および電池ケース４０の作用効果を説明する。以下の説明においては、作用効果の明確化のために、従来構造の電池モジュール１３０およびこれを用いて組電池１８０を形成する場合と比較する。図１１（ａ）は従来の電池モジュールの外観を示す正面図、（ｂ）は正面から見た断面図である。図１２は従来の電池モジュールを１０個配列して組電池を組み立てた状態の正面図である。図１３は従来の電池モジュールを１２個配列して組電池を組み立てた状態の正面図である。

【0037】

図１１を参照して、既述したように、従来の電池モジュール１３０では、電池ケース１４０がケース本体１４２と蓋体１４１とから構成され、これらを接合する巻き締め接合部１４３が蓋体１４１側に片寄っており、電池モジュール１３０が全体として上下非対称な形状を呈している。すなわち、巻き締め接合部１４３が蓋体１４１の上方に突設しており、出力電極５１、５２が下方側へ片寄っている。したがって、電池モジュール１３０を整列させ、かつバスバー１９３による接続経路を短縮して単純化するためには、左右の出力電極５１、５２で極性の異なる二種類の電池モジュール１３０Ａ、１３０Ｂを作製する必要があった（図１２および図１３参照）。

【0038】

これに対し、本実施の形態に係る電池モジュール３０によれば、電池ケース４０が、上部が開口された箱体状の下部ケース４１と、下部が開口された箱体状の上部ケース４２と、に分割形成され、上下ケース４１、４２の開口側を合わせるようにして、単電池積層体２０の積層方向の中間部において上下ケース４１、４２の開口端縁部の巻き締め片４４、４５が二重巻き締めされ、接合部４３が形成される。したがって、上下ケース４１、４２が略等しい形状を有し、電池ケース４０の巻き締め接合部４３の位置に概ね片寄りがなく、接合部４３が電池ケース４０の厚さ方向の範囲内にあるので、適宜、電池モジュール３０の上下を逆に転倒配置可能であり、バスバー９３の接続経路を単純化しても同種類のモジュール３０で対応することができる。

【0039】

また、従来の電池モジュール１３０では、出力電極５１、５２が電池ケース１４０から外部へ突設し露出している。したがって、組電池１８０の製造工程において、短絡防止のために端子カバー等を用いて出力電極５１、５２を保護する必要があった。

【0040】

これに対し、本実施の形態に係る電池モジュール３０によれば、出力電極５１、５２が電池ケース４０内に配置され、外部へ露出していないので、短絡防止のために出力電極５１、５２を保護する必要がなく、取り扱いが容易である。

【0041】

さらに、従来の電池ケース１４０のケース本体１４２の側壁は単電池積層体２０の厚み以上の高さを有している。このケース本体１４２には、出力電極５１、５２や電圧検出端子の取り出しのために数箇所の切欠き部を形成する必要があり、ケース本体１４２と蓋体１４１との断面形状が異なるので、外力に対する曲げ剛性が上下非対称である。したがって、巻き締め装置による巻き締め接合時にケース本体１４２の側壁が座屈し易かった。

【0042】

これに対し、本実施の形態に係る電池ケース４０によれば、上述したように、電池ケース４０の巻き締め接合部４３の位置に片寄りがないので、外力に対する曲げ剛性が上下で略対称となり、外部入力に対して耐性が向上する。また、電池ケース１４０の上下ケース４１、４２の側壁は単電池積層体２０の厚みの略半分の高さとなるので、巻き締め時の座屈耐性を向上させることができる。

【0043】

なお、上記の実施の形態では、電池モジュール３０を２段５列および３段４列に配置した組電池８０を例示したが、これに限られず、電池モジュール３０を任意の段（行）と列に配置した組電池であっても本発明の適用は可能である。

【0044】

また、上記の実施の形態では、すべての電池モジュール３０を直列接続して組電池８０を形成しているが、たとえば、複数個の電池モジュール３０を並列接続し、これを直列に接続するなど、電池モジュール３０、３０同士の接続形態は適宜変更可能であることは言うまでもない。

【図面の簡単な説明】

【0045】

【図1】本発明に係る電池モジュールの一実施の形態を示す断面図である。

【図2】本実施の形態に係る電池モジュールの外観を示す正面図および右側面図である。

【図3】扁平型電池の一例の斜視図である。

【図4】本実施の形態に係る電池モジュールの製造に用いる巻き締め装置である。

【図5】（ａ）は下部ケース保持治具内に下部ケースを保持した状態の説明図、（ｂ）は下部ケース内に単電池積層体を収容した状態の説明図である。

【図6】下部ケース内に収容した単電池積層体の上部を上部ケースで被った状態の説明図である。

【図7】巻き締め接合直前の状態の説明図である。

【図8】本実施の形態に係る電池モジュールを１０個配列して組電池を組み立てた状態の正面図である。

【図9】本実施の形態に係る電池モジュールを１２個配列して組電池を組み立てた状態の正面図である。

【図10】本実施の形態に係る電池モジュールのバスバー接続状態を示す概略図である。

【図11】（ａ）は従来の電池モジュールの外観を示す正面図、（ｂ）は正面から見た断面図である。

【図12】従来の電池モジュールを１０個配列して組電池を組み立てた状態の正面図である。

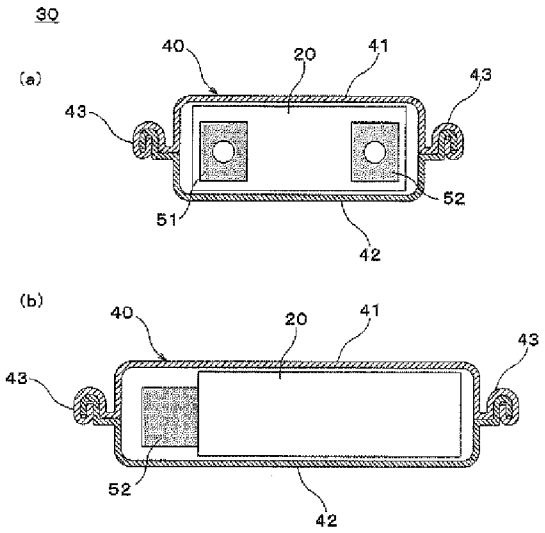
【図13】従来の電池モジュールを１２個配列して組電池を組み立てた状態の正面図である。

【符号の説明】

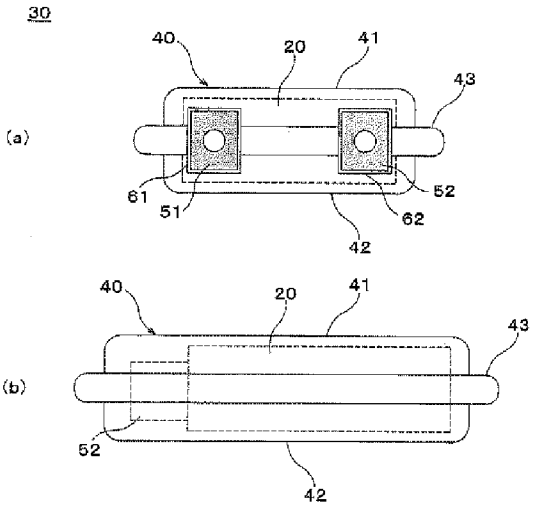
【0046】

１０　単電池、
２０　単電池積層体、
３０　電池モジュール、
４０　電池ケース、
４１　上部ケース、
４２　下部ケース、
４３　接合部、
４４　上巻き締め片、
４５　下巻き締め片、
５１　出力電極（正極）、
５２　出力電極（負極）、
７０　巻き締め装置、
７１　上ケース保持治具、
７２　下ケース保持治具、
７４　アンビル、
７５　リフター、
７６　巻き締めローラ
８０　組電池、
９３　バスバー。

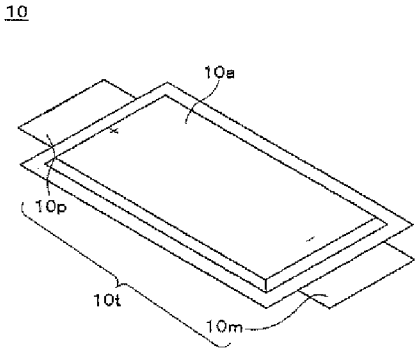
【図1】



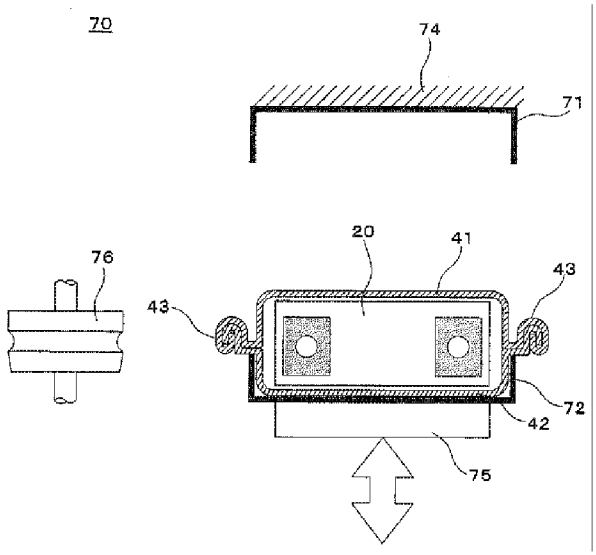
【図2】



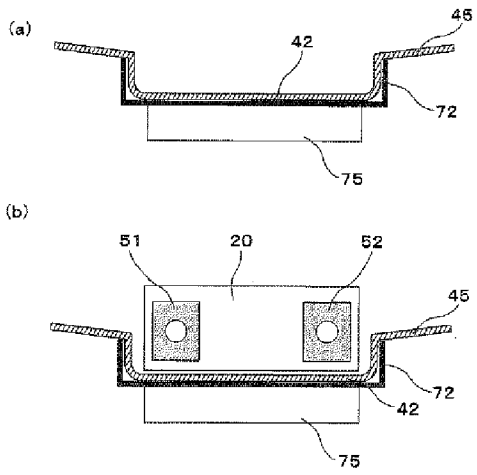
【図3】


10
10a
10p
10t
10m

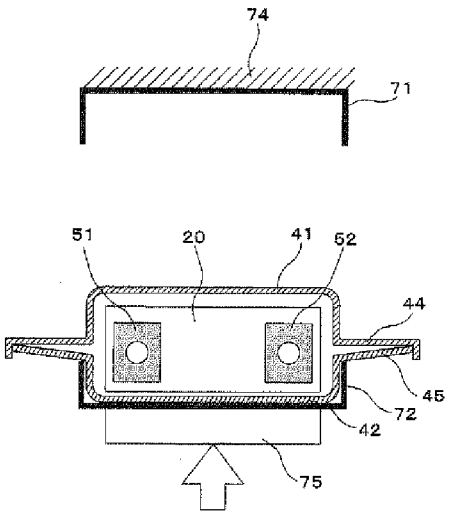
【図4】


70
74
71
76
20
41
43
43
72
42
75

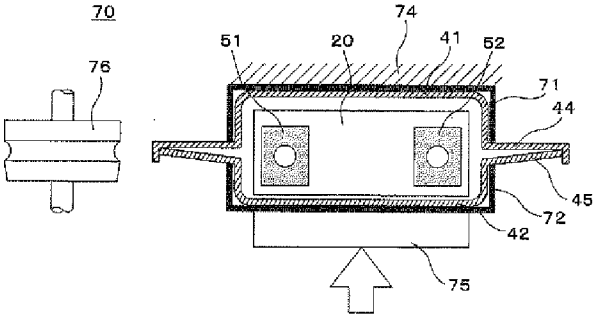
【図5】


(a)
45
42
72
75
(b)
51
20
52
45
72
42
75

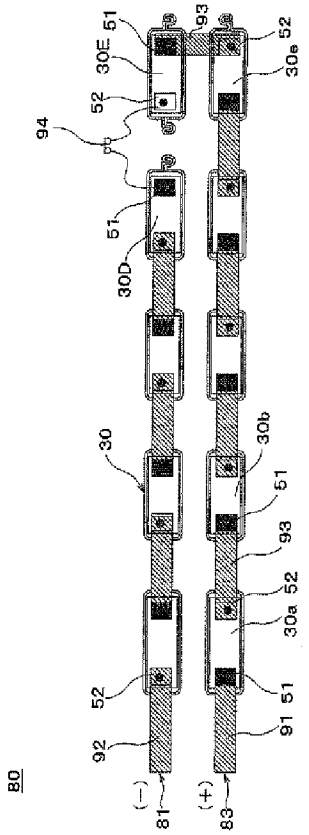
【図6】


74
71
51
20
41
52
44
45
72
42
75

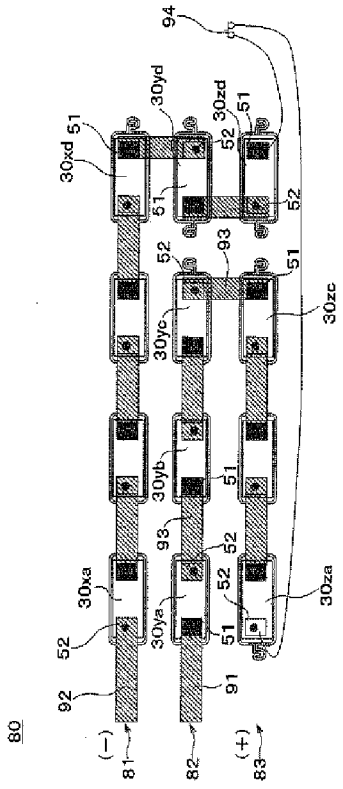
【図7】


70
76
74
51
20
41
52
71
44
45
72
42
75

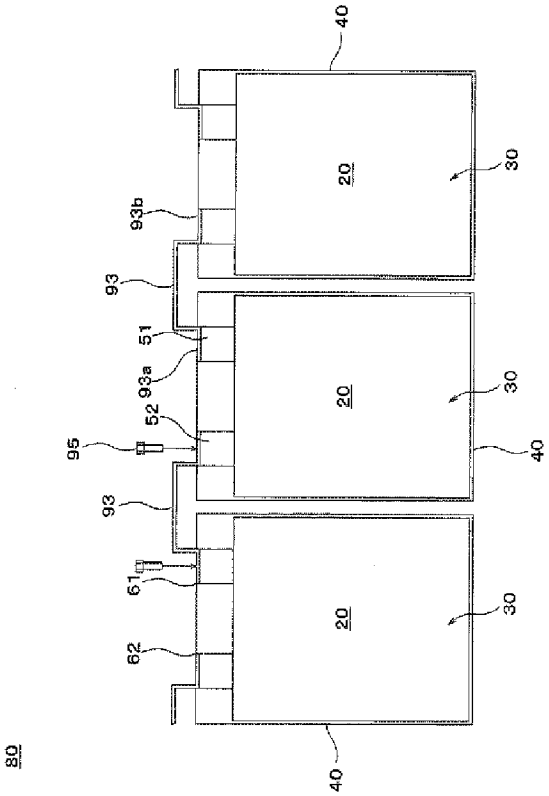
【図8】


51
93
52
30E
30a
52
94
51
30D
30
30b
51
93
52
30a
52
51
92
91
80
(−)
81
(+)
83

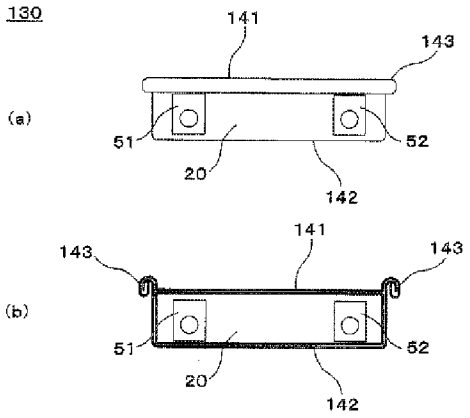
【図9】


94
30yd
30zd
51
30xd
51
52
52
51
52
93
51
30zc
30yc
30yb
51
93
52
30xa
52
30za
30ya
52
51
92
91
80
(−)
81
82
(+)
83

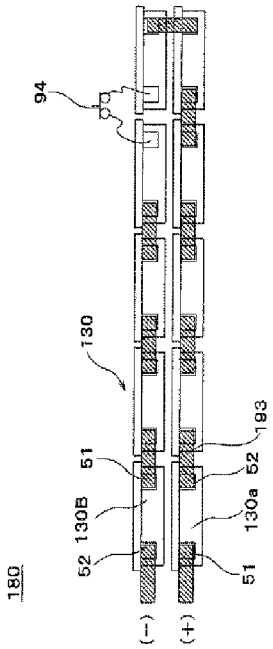
【図10】


40
20
30
93b
93
51
93a
52
95
40
93
61
62
40
80

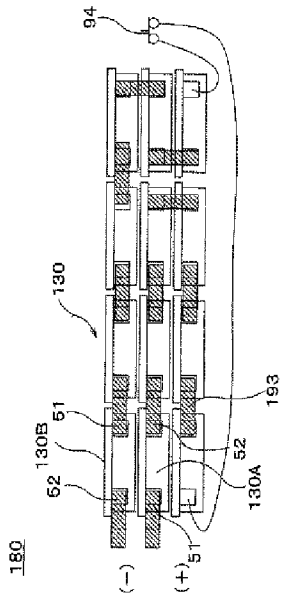
【図11】


130
141
143
(a)
51
52
20
142
141
143
143
(b)
51
52
20
142

【図12】


94
130
193
51
52
130B
130a
52
51
180
(−)
(+)

【図13】


94
130
193
51
130B
52
52
130A
51
180
(−)
(+)

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Ｆターム(参考) 5H040 AA14 AA18 AS07 AT04 AT06 AY05 CC33 JJ10

Espacenet

JP2011023249A SECONDARY BATTERY, BATTERY PACK

Applicants: NISSAN MOTOR

Inventors: MATOBA MASASHI,SUZUKI NAOTO

Classifications:

IPC ***H01M10/04; H01M10/0585; H01M2/10; H01M2/26; H01M2/30; H01M4/02; H01M4/13; H01M4/66; H01M4/70;***

CPC Y02E60/10 (EP);

Priorities: JP2009168203A 2009-07-16

Application: JP2011023249A·2009-07-16

Publication: JP2011023249A·2011-02-03

Published as: JP2011023249A

SECONDARY BATTERY, BATTERY PACK

Abstract

<P>PROBLEM TO BE SOLVED: To provide a secondary battery capable of suppressing unevenness of heat generation of a current collector in an in-plane direction. <P>SOLUTION: A cathode current collector 11 is formed of cathode conductive layers 111 (conductive material) on both surfaces of a reinforcing layer 140. The cathode conductive layer 111 is formed to become thicker in thickness from a first end part 112 side toward a second end part 113 side opposite to the first end part 112. Then, a cathode terminal lead 20 connecting electrically a cathode current collector tab 18 is connected with the second end part 113 side. <P>COPYRIGHT: (C)2011,JPO&INPIT

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2011-23249
(P2011-23249A)
(43)公開日　平成23年2月3日(2011.2.3)

(51)Int.Cl.		F I			テーマコード（参考）
H01M 10/04	(2006.01)	H01M	10/04	Z	5H017
H01M 4/66	(2006.01)	H01M	4/66	A	5H028
H01M 4/70	(2006.01)	H01M	4/70	A	5H029
H01M 4/02	(2006.01)	H01M	4/02	Z	5H040
H01M 10/0585	(2010.01)	H01M	10/00	117	5H043

審査請求 未請求　請求項の数 10　ＯＬ　（全 20 頁）　最終頁に続く

(21)出願番号　特願2009-168203 (P2009-168203)
(22)出願日　平成21年7月16日 (2009.7.16)

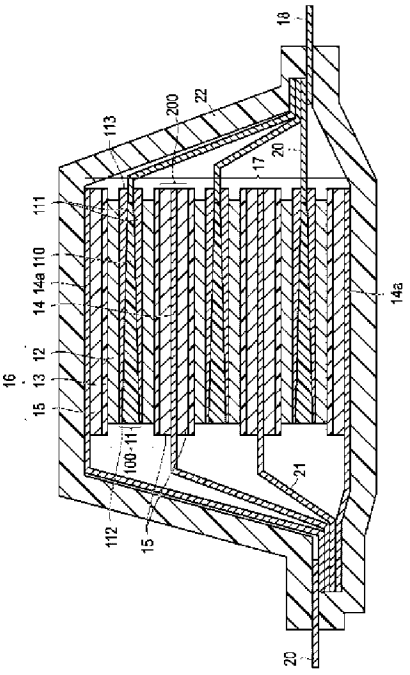
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Ｆターム(参考)　5H017 AA02 AA03 AS01 AS10 CC01 DD03 DD05 DD06 HH01 HH03 HH05

最終頁に続く

(54)【発明の名称】二次電池、組電池

(57)【要約】
【課題】集電体の面内方向における発熱の偏りを抑えた二次電池を提供する。
【解決手段】正極集電体１１が補強層１４０の両面に正極導電性層１１１（導電材）を形成したものを使用している。正極導電性層１１１は第１端部１１２側からそれとは反対側の第２端部１１３側にかけて厚みが厚くなるように形成している。そして第２端部１１３側に、正極集電タブ１８を電気的に接続する正極端子リード２０が接続される。
【選択図】図２



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【特許請求の範囲】
【請求項１】
正極活物質層が形成された第１集電体と、
前記正極活物質層に対して電解質層を介在させて対向する位置に配置された負極活物質層が形成された第２集電体と、
前記第１集電体および前記第２集電体のうち少なくとも一方の集電体に含まれ、第１端部からそれに対向する第２端部の方向に単位面積当たりの質量が重くなるように質量勾配をつけた導電材と、
前記第２端部側に電気的に接続された集電タブと、
を有することを特徴とする二次電池。
【請求項２】
正極活物質層が形成された第１集電体と、
前記正極活物質層に対して電解質層を介在させて対向する位置に配置された負極活物質層が形成された第２集電体と、
前記第１集電体および前記第２集電体のうち少なくとも一方の集電体に含まれ、第１端部からそれに対向する第２端部の方向にシート抵抗が低くなっている導電材と、
前記第２端部側に電気的に接続された集電タブと、
を有することを特徴とする二次電池。
【請求項３】
前記導電材は、厚みが前記第１端部から前記第２端部方向に厚くなっていることを特徴とする請求項１または２記載の二次電池。
【請求項４】
前記集電体は、前記導電材に沿って配置された補強層を含み、
前記補強層の厚みが前記導電材の厚みと逆に変化していることを特徴とする請求項３記載の二次電池。
【請求項５】
前記導電材は、導電部と非導電部とからなり、前記導電材内における単位面積あたりの前記非導電部の割合（前記非導電部の体積／前記導電材全体の体積）が前記第１端部から前記第２端部の方向へ小さくなることを特徴とする請求項１または２記載の二次電池。
【請求項６】
前記導電材は、前記第１端部から前記第２端部の方向に対して直交する方向には単位面積当たりの質量が同一であることを特徴とする請求項１～５のいずれか一つに記載の二次電池。
【請求項７】
前記導電材は、前記集電タブが電気的に接続された部分を中心とする同心円の円弧方向には単位面積当たりの質量が同一であることを特徴とする請求項１～５のいずれか一つに記載の二次電池。
【請求項８】
前記導電材を含む集電体を前記第１集電体および前記第２集電体の両方に用いて、当該第１集電体における第１端部と当該第２集電体における第２端部が互いに向かい合う位置となるように、前記第１集電体における前記正極活物質層、前記電解質層、および前記第２集電体における前記負極活物質層が積層されて、前記集電タブが互いに対向する位置に配置されていることを特徴とする請求項１～７のいずれか一つに記載の二次電池。
【請求項９】
前記正極活物質層はリチウムを含み、リチウムイオン二次電池になることを特徴とする請求項１～８のいずれか一つに記載の二次電池。
【請求項１０】
請求項１～９のいずれか１項に記載の電池が複数電気的に接続されてなることを特徴とする組電池。
【発明の詳細な説明】

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【技術分野】
【０００１】
本発明は、二次電池、およびこれを用いた組電池に関する。
【背景技術】
【０００２】
二次電池は、活物質を形成して保持し、かつ電流を集めるための集電体を有する。従来、この集電体として、多数のメッシュ孔を備えた電解箔に補強部を一体に形成してなるものがある（特許文献１）。
【先行技術文献】
【特許文献】
【０００３】
【特許文献１】特開２０００－２８５９２６号公報
【発明の概要】
【発明が解決しようとする課題】
【０００４】
ところで集電体には、そこから電流を外部へ取り出すための集電タブが接続される。従来の集電体に用いられる電解箔は、その厚みが面内方向に均一である。したがって、集電タブが接続された端部から、それとは反対の端側まで抵抗値が略同一となる。このため集電体全面から集められた電流が集電タブ接続部周囲に集中することになる。そうすると集電タブ接続端周辺では電流が集中することから、それとは反対の端側より相対的に発熱が多くなる。一方で電流集中のない集電タブ接続端の反対側では発熱が少ない。このような集電体の面内での発熱の偏りは、電池性能の低下や耐久性の低下につながる虞がある。
【０００５】
そこで、本発明の目的は、集電体の面内方向における発熱の偏りを抑えた二次電池を提供することである。
【課題を解決するための手段】
【０００６】
上記目的を達成するための本発明は以下のように構成される。
【０００７】
本発明の二次電池は、正極活物質層が形成された第１集電体と、この正極活物質層に対して電解質層を介在させて対向する位置に配置された負極活物質層が形成された第２集電体とを有する。そして第１集電体および第２集電体のうち少なくとも一方の集電体には、その第１端部からそれに対向する第２端部の方向に単位面積当たりの質量が重くなるように質量勾配をつけた導電材が含まれていて、第２端部側に集電タブが電気的に接続されている。
【０００８】
また、本発明の二次電池は、正極活物質層が形成された第１集電体と、この正極活物質層に対して電解質層を介在させて対向する位置に配置された負極活物質層が形成された第２集電体とを有する。そして第１集電体および第２集電体のうち少なくとも一方の集電体には、その第１端部からそれに対向する第２端部の方向にシート抵抗が低くなるようにした導電材が含まれていて、第２端部側に集電タブが電気的に接続されている。
【発明の効果】
【０００９】
本発明によれば、正極集電体または負極集電体のうち少なくとも一方の集電体において、第１端部側からそれとは反対側の第２端部方向に質量が重くなるようにして、第２端部側に集電タブが電気的に接続されようにしている。したがって、電流集中が起きる第２端部側で電流が流れやすくなり、その部分での発熱が抑えられて集電体の面内方向における発熱の偏りを抑えることができる。
【００１０】
また、本発明によれば、正極集電体または負極集電体のうち少なくとも一方の集電体に

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おいて、第１端部側からそれとは反対側の第２端部方向にシート抵抗が低くなるようにして第２端部側に集電タブが電気的に接続されようにしている。したがって、電流集中が起きる第２端部側での電流が流れやすくなり、その部分での発熱が抑えられて、集電体の面内方向における発熱の偏りを抑えることができる。

【図面の簡単な説明】

【００１１】

【図１】実施形態の二次電池の外観を示す外観図である。

【図２】実施形態１の二次電池を説明するための断面図である。

【図３】実施形態１の正極集電体を説明するための説明図であり、図３Ａは平面図、図３Ｂは図３ＡにおけるＡ－Ａ線に沿う断面図である。

【図４】二次電池から構成される組電池の代表的な実施形態の外観図であって、図４Ａは組電池の平面図、図４Ｂは組電池の正面図であり、図４Ｃは組電池の側面図である。

【図５】二次電池を搭載した車両の例を説明するための図である。

【図６】実施形態２の二次電池を説明するための要部断面図である。

【図７】実施形態２の二次電池に外部から導電体が貫通した場合を説明するための説明図である。

【図８】実施形態３の二次電池を説明するための要部断面図である。

【図９】実施形態４の二次電池を説明するための要部断面図である。

【図１０】実施形態４の正極集電体を説明するための説明図であり、図１０Ａは平面図、図１０Ｂは図１０ＡにおけるＡ－Ａ線に沿う断面図である。断面図である。

【図１１】実施形態５の正極集電体を説明するための説明図であり、図１１Ａは平面図、図１１Ｂは断面図である。

【発明を実施するための形態】

【００１２】

以下、図面を参照して本発明の実施形態について説明する。なお、図面において同一の機能を有する要素には同一の符号を付し、重複する説明を省略する。また、図面はあくまでも本発明の実施形態を説明するためのものであるので、各部材の寸法や比率は説明の都合上誇張または簡略化しており、実際の寸法や比率とは異なる。

【００１３】

［実施形態１］

以下では、本発明を適用した実施形態１として、リチウムイオン二次電池を例に挙げて説明するが、本発明の技術的範囲は下記の形態のみに制限されない。

【００１４】

（二次電池）

図１は、本実施形態の二次電池の外観を示す外観図であり、図２は、本実施形態の二次電池を説明するための断面図である。

【００１５】

図１および図２に示すように、本実施形態の二次電池１（リチウムイオン二次電池）は、発電要素１７（詳細後述）を収納した電池外装材２２によって密封されている。電池外装材２２は高分子－金属を複合したラミネートフィルムを用いて、その周辺部の全部を熱融着にて接合する。

【００１６】

発電要素１７の具体的な構成要素は以下の通りである。

【００１７】

発電要素１７は、正極活物質層１２、電解質層１３および負極活物質層１５からなる単電池層１６が複数積層された構成を有する。正極活物質層１２は、導電性材料を含む（例えば第１集電体）一枚の正極集電体１１の両面に形成されている。この正極集電体１１の両面に正極活物質層１２が形成されてなるものを正極１００（例えば第１電極）と称する。負極活物質層１５は導電性材料を含む負極集電体１４（例えば第２集電体）の両面に形成されている。この負極集電体１４の両面に負極活物質層１５が形成されてなるものを負

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極２００（例えば第２電極）と称する。

【００１８】

ここでは、正極集電体１１の片面の正極活物質層１２と隣接する負極集電体１４の片面の負極活物質層１５とが、電解質層１３を介して向き合うように、正極１００、電解質層１３、負極２００がこの順に積層されることで、単電池層１６が複数積層され、かつ単電池層１６が電気的に並列接続される形態となっている。

【００１９】

発電要素１７の両最外層には最外層負極集電体１４ａが位置する。最外層負極集電体１４ａは正極と対峙せず電池反応に関与しないため、発電要素の内側の面のみに負極活物質層１５が形成されている。なお、単電池層１６の積層数によっては、最外層には正極集電体の片面に正極活物質層１２が形成されてなるものを用いてもよい。

【００２０】

正極集電体１１および負極集電体１４は、それぞれの一端が正極端子リード２０および負極端子リード２１を介して正極集電タブ１８および負極集電タブ１９に電気的に接合されている。正極集電体１１および負極集電体１４は、その一部がラミネートフィルムとの熱融着を介して電池外装材２２の外部に露出されていて、発電要素１７からの電力を外部へ取り出したり、発電要素１７へ充電したりするための端子となる。この端子は、後述するように複数の二次電池１とバスバーやリード線など（連結端子２５と云う）により接続して組電池３００にする際にも使用される。

【００２１】

なお、正極集電体１１および負極集電体１４における正極端子リード２０および負極端子リード２１の接続には、半田付けや溶接、また超音波接合などが用いられる。同様に、正極端子リード２０および負極端子リード２１と正極集電タブ１８および負極集電タブ１９との接続には、半田付けや溶接、また超音波接合などが用いられる。

【００２２】

図３は、正極集電体１１を説明するための説明図であり、図３Ａは平面図、図３Ｂは図３ＡにおけるＡ－Ａ線に沿う断面図である。

【００２３】

正極集電体１１は、非導電性材料で構成される補強層１１０（樹脂層）の両面に正極導電性層１１１（導電材）が形成された構造としている。つまり、正極集電体１１に沿って補強層１１０が配置されているのである。なお、本実施形態１では、負極集電体１４は、その厚みに変化はなく、均等な厚みの一枚板（たとえばアルミニウムや銅などの金属箔膜）としている。

【００２４】

正極導電性層１１１（図３に示した補強層１１０を挟んで２枚あるうちの一方を云う。以下、正極導電性層１１１という場合は同じ意味である）だけでは正極集電体１１としての機械的強度が弱くなる場合がある。補強層１１０を用いることで正極集電体１１全体としての機械的強度を高めることができる。これにより、例えば、発電要素１７の組付けの際の機械的負荷に対しての耐性が高くなり製造が容易になる。また、電池運転時の熱負荷に伴う電池構成部材の膨張収縮に伴う機械的応力に対する耐性も強くなり、二次電池としての耐久性も高くすることができる。

【００２５】

正極導電性層１１１の形状は、その面内において第１端部１１２から、それとは反対側の第２端部１１３にかけて正極導電性層１１１の厚みを厚くするように直線的な勾配をつけて形成している。そして、第２端部１１２には正極端子リード２０を接続することで正極導電性層１１１と正極集電タブ１８と電気的に接続している。

【００２６】

一方、本実施形態１では、負極集電体１４は、その厚みに変化はなく、均等な厚みの一枚板（たとえばアルミニウムや銅などの金属箔膜）としている。

【００２７】

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このように正極導電性層１１１の厚みを変えることで正極導電性層１１１の活物質形成面における単位面積あたりの質量に勾配をつけて、単位面積あたりの正極活物質層１２と同等の電気抵抗となるようにしているのである。このようにすることで、導電性層１１１の活物質形成面では、シート抵抗が、第１端部１１２から第２端部１１３方向に低くなる。すなわち、第１端部１１２から第２端部１１３方向に電流がより流れやすく構成されているのである。

【００２８】

したがって、仮に図３Ａに示した点線ａ～ｆの位置で、一定の面積となるように切り出せば、その質量はａ＞ｂ＞ｃ＞ｄ＞ｅ＞ｆとなる。同じく点線ａ～ｆの位置で一定の面積部分のシート抵抗を測定すればａ＜ｂ＜ｃ＜ｄ＜ｅ＜ｆとなる。なお本実施形態においては、点線ａ～ｆのそれぞれの線上、すなわち、第１端部１１２から第２端部１１３への方向に直交する方向（点線ａ～ｆの方向）では同じ質量および同じシート抵抗となっている。

【００２９】

ちなみに、シート抵抗と部材の厚さとの関係は下記（１）および（２）式の通りである。

【００３０】

Ｒ＝（ρＬ）／（ｔＷ）＝Ｒｓ・（ρＬ）／Ｗ　　…（１）

したがって、Ｒｓ＝ρ／ｔ　　…（２）

各式中、Ｒは抵抗値、Ｒｓはシート抵抗、ｔは厚さ、Ｗは幅、Ｌは長さである。

【００３１】

（２）式から、部材の厚さｔが変わればシート抵抗が変化し、電流の流れやすさが違ってくることがわかる。

【００３２】

この正極導電性層１１１はできるだけ薄い方が好ましい。その理由は下記のとおりである。二次電池は様々な理由から内部短絡が発生するおそれある。内部短絡が起きる理由はたとえば導電性異物の混入や正極集電体または負極集電体でのデンドライトの成長などである。このような電池内部において内部短絡が発生した場合に、正極導電性層１１１をごく薄くしておけば内部短絡による電流集中でその部分が発熱して焼切れ、その部分での電流を止めてしまうことができる。このような作用を持たせるためには、例えばアルミニウムでは、１０μｍ以下とすることが好ましい。なお、下限値（最も薄くなる第１端部１１２部分）については特に限定されず、電流を流すことができる最小限の厚さでよい。特に本実施形態１の場合、補強層１１０が設けられているため、金属薄膜単独でその形状が維持できないほど薄くても電流を流すことができれば問題ない。

【００３３】

そして、このようなごく薄い金属膜を用いた場合でも集電体として必要な機能、つまり充放電レートを確保することができるようにするために既に説明した通り導電性層１１１に質量勾配およびシート抵抗の勾配を付けたのである。

【００３４】

正極集電体１１は、構成する材料に特に制限はなく、上記した金属以外にも導電性樹脂が採用されうる。金属を用いる場合には、例えば、上記アルミニウムのほか、銅やステンレス鋼などを用いることができる。なかでも電子伝導性、電池作動電位という観点からはアルミニウムが好ましい。

【００３５】

一方、導電性樹脂の場合は、樹脂全体が導電性を示す導電性高分子と非導電性の中に導電性フィラーを配合したもののいずれであってもよい。より具体的には下記のとおりである。

【００３６】

（高分子材料が導電性高分子である形態）

まず、簡単に樹脂を構成する高分子材料が導電性高分子である形態を説明する。この場

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合、正極導電性層１１１全体が導電性高分子材料からなることになる。

【００３７】

導電性高分子は導電性を有し、電荷移動媒体として用いられるイオンに関して伝導性を有さない材料から選択される。これらの導電性高分子は、共役したポリエン系がエネルギー帯を形成し伝導性を示すと考えられている。代表的な例としては電解コンデンサなどで実用化が進んでいるポリエン系導電性高分子を用いることができる。具体的には、ポリアニリン、ポリピロール、ポリチオフェン、ポリアセチレン、ポリパラフェニレン、ポリフェニレンビニレン、ポリアクリロニトリル、ポリオキサジアゾール、またはこれらの混合物などが好ましい。電子伝導性および電池内で安定に使用できるという観点から、ポリアニリン、ポリピロール、ポリチオフェン、ポリアセチレン、がより好ましい。

【００３８】

（非導電性樹脂および導電材（導電性フィラー）を含む形態）

次に、非導電性樹脂に導電性フィラーを含む形態について説明する。この場合、正極導電性層１１１全体が、非導電性樹脂に均一に導電性フィラーを配合して、全体として導電性樹脂となったものが用いられる。

【００３９】

導電性フィラーは、導電性を有する材料から選択される。好ましくは、導電性を有する樹脂層内のイオン透過を抑制する観点から、電荷移動媒体として用いられるイオンに関して伝導性を有さない材料を用いるのが望ましい。

【００４０】

導電性フィラーの具体例としては、アルミニウム材、ステンレス（ＳＵＳ）材、グラファイトやカーボンブラックなどのカーボン材、銀材、金材、銅材、チタン材などが挙げられるが、これらに限定されるわけではない。これらの導電性フィラーは１種単独で用いられてもよいし、２種以上併用してもよい。また、これらの合金材が用いられてもよい。好ましくは銀材、金材、アルミニウム材、ステンレス材、カーボン材、さらに好ましくはカーボン材である。またこれらの導電性フィラーは、粒子系セラミック材料や樹脂材料の周りに導電性材料（上記導電性フィラー）をめっき等でコーティングしたものでもよい。

【００４１】

また、導電性フィラーの形状（形態）は、粒子形態で用いればよいが、粒子形態に限られず、カーボンナノチューブなど、いわゆるフィラー系導電性樹脂組成物として実用化されている粒子形態以外の形態であってもよい。

【００４２】

導電性フィラーの平均粒子径は、特に限定されるものではないが、正極導電性層１１１に形成する際の厚さを考慮すれば、０．０１～１０μｍ程度であることが望ましい。つまり正極導電性層１１１の厚さを最大値１０μｍとする場合、これより大きな導電性フィラーを用いると、導電性フィラーが正極導電性層１１１の厚さを越えてしまうことになり、局所的な厚さばらつきが発生する原因になって好ましくないのである。もちろん正極導電性層１１１の厚さを厚くすれば、導電性フィラーを１０μｍ以上にしても差し支えない。

【００４３】

また、樹脂層が導電性フィラーを含む形態の場合、樹脂層を形成する樹脂は、導電性フィラーに加えて、導電性フィラーを結着させる導電性のない高分子材料を含んでいてもよい。樹脂層の構成材料として高分子材料を用いることで、導電性フィラーの結着性を高め、双極型二次電池の信頼性を高めることができる。高分子材料は、印加される正極電位および負極電位に耐えうる材料から選択される。

【００４４】

非導電性の樹脂である高分子材料の例としては、好ましくは、ポリエチレン（ＰＥ）、ポリプロピレン（ＰＰ）、ポリエチレンテレフタレート（ＰＥＴ）、ポリエーテルニトリル（ＰＥＮ）、ポリイミド（ＰＩ）、ポリアミド（ＰＡ）、ポリテトラフルオロエチレン（ＰＴＦＥ）、スチレンブタジエンゴム（ＳＢＲ）、ポリアクリロニトリル（ＰＡＮ）、ポリメチルアクリレート（ＰＭＡ）、ポリメチルメタクリレート（ＰＭＭＡ）、ポリ塩化

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ビニル（ＰＶＣ）、ポリフッ化ビニリデン（ＰＶｄＦ）、エポキシ樹脂、またはこれらの混合物が挙げられる。これらの材料は電位窓が非常に広く正極電位、負極電位のいずれに対しても安定である。また軽量であるため、二次電池の高出力密度化が可能となる。

【００４５】

非導電性樹脂に対する導電性フィラーの比率は、特に限定されず、十分な導電性が確保されていればよい。たとえば、高分子材料（非導電性の樹脂とその他の添加剤などを含む）および導電性フィラーの合計に対して、５～９０ｗｔ％、好ましくは５～４０ｗｔ％の導電性フィラーを均等に配合する。５～９０ｗｔ％程度であれば導電性を確保することができる。

【００４６】

また、樹脂成分内に結着剤を入れた場合には、好ましくは５～４０ｗｔ％程度とすることで結着性を高めることができ、形態（形状）が安定する。

【００４７】

結着剤として用いられる結着高分子は特に限定されるものではないが、たとえば下記のような高分子材料が使用されうる。エポキシ樹脂；スチレン－エチレン－ブチレン－スチレンブロック共重合体（ＳＥＢＳ）；アクリロニトリル－ブタジエン－スチレン共重合体（ＡＢＳ）；スチレンブタジエンゴム（ＳＢＲ）などの合成ゴム材料のほか、ポリエチレン（ＰＥ）、ポリプロピレン（ＰＰ）等のポリオレフィン；ポリエチレンテレフタレート（ＰＥＴ）、ポリエチレンナフタレート（ＰＥＮ）等のポリエステル；シリコーン、ポリイミド（ＰＩ）；ポリアミド（ＰＡ）；ポリフッ化ビニリデン（ＰＶｄＦ）；ポリテトラフルオロエチレン（ＰＴＦＥ）；ポリアクリロニトリル（ＰＡＮ）；ポリメチルアクリレート（ＰＭＡ）；ポリメチルメタクリレート（ＰＭＭＡ）；ポリ塩化ビニル（ＰＶＣ）などが挙げられる。これらの高分子材料は、１種単独で用いてもよいし、２種併用してもよい。

【００４８】

なお、導電性フィラーおよび非導電性の樹脂の他、他の添加剤を含んでいてもよい。

【００４９】

これら導電性樹脂による正極導電性層１１１は（高分子材料が導電性高分子である形態と非導電性樹脂に導電性フィラーを含む形態のどちらも）従来公知の手法により製造できる。たとえば、導電性高分子材料または導電性フィラーを含む非導電性高分子のスラリーを調製し、これを塗布し硬化させる手法が挙げられる。具体的にはたとえば、スプレー法やコーティング法により調整したスラリーを、塗り回数を変えたり、開口径の異なるノズルを使用するなどして、滑らかにあるいは段階的に厚さを変えて塗布する。またインクジェット方式により作製することも可能である。

【００５０】

次に、補強層１１０は、用いる材料の機械的強度に応じて必要最小限の厚み以上とする。しかし、厚すぎても発電要素１７の体積が必要以上に大きくなるため、例えば樹脂を用いる場合は補強層１１０の厚さとして１０～３０μｍにて構成することが好ましい。

【００５１】

この補強層１１０の厚みは、正極導電性層１１１の厚さの勾配とは逆勾配になるよう形成する。これにより正極集電体１１としての厚みを一定に保つことができ、ひいては単電池層１６としての厚みも一定に保たれて、発電要素１７を組付ける際に単電池層１６が斜めに積層されることを回避することができる。

【００５２】

補強層１１０を構成する材料としては、例えば、樹脂のほかに、セラミック、セラミックと樹脂の複合体などの絶縁性材料が挙げられる。なかでも補強層の軽量化という観点からは、補強層の構成材料は樹脂であることが好ましい。この樹脂も、特に制限はないが、たとえば、ポリイミド（ＰＩ）、ポリエチレンテレフタレート（ＰＥＴ）、ポリアクリロニトリル（ＰＡＮ）、ポリプロピレン（ＰＰ）、ポリエチレン（ＰＥ）などが用いられうる。なかでも、耐熱性という観点からは、ポリイミドまたはポリエチレンテレフタレート

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が好ましく、ポリイミドが特に好ましい。なお、ポリイミドの具体的な名称としては、カプトン（登録商標）が挙げられる。

【００５３】

なお、本実施形態の二次電池に使用される正極活物質、負極活物質および電解質については、通常リチウムイオン二次電池に使用される物質を使用すればよく特に限定されないため説明を省略する。また、本実施形態の二次電池としてリチウムイオン二次電池以外の二次電池とする場合には、それらに合わせた素材を使用すればよいことは云うまでもない。

【００５４】

（組電池）

次に、上述した二次電池の利用形態の一つである組電池について説明する。

【００５５】

図４は、上述した二次電池から構成される組電池の代表的な実施形態の外観図であって、図４Ａは組電池の平面図、図４Ｂは組電池の正面図であり、図４Ｃは組電池の側面図である。

【００５６】

図４に示すように、組電池３００は、まず、上述した二次電池を複数、直列および並列に接続して組電池２５０を構成し、さらにこの組電池２５０を複数、直列および並列に接続している。これにより、高体積エネルギー密度、高体積出力密度が求められる車両駆動用電源や補助電源に適した組電池３００となる。

【００５７】

組電池２５０は、バスバーのような電気的な接続手段を用いて相互に接続し、接続治具３１０を用いて複数段積層される。組電池２５０は、接続治具３１０によってくみつけられるため組電池３００に対して装脱着可能となっている。なお、組電池３００に組み込む組電池２５０の数およびその接続形態（直列か並列か）は、それを搭載する車両（電気自動車など）が必要とする電池容量や出力に応じて決めればよい。

【００５８】

なお、組電池２５０を構成する際の個々の二次電池１の接続形態（直列か並列か）についても同様であり、所望する出力電圧や電池容量に応じて決めればよい。

【００５９】

（車両）

次に、上述した二次電池の利用形態の一つである車両への搭載について説明する。

【００６０】

図５は、上述した二次電池を搭載した車両の例を説明するための図である。

【００６１】

本実施形態の二次電池電池は、例えば上述した組電池３００の形態に組み上げて、図５に示すように、たとえば電気自動車４００のような車両に搭載されうる。電気自動車４００に搭載された二次電池電池は、例えば、車両のモータを駆動する電源として用いられうる。

【００６２】

図示した電気自動車４００の例では、電気自動車４００の車体中央部の座席下に組電池３００を搭載している。座席下に搭載すれば、車内空間およびトランクルームを広く取ることができるからである。なお、組電池３００を搭載する場所は、座席下に限らず、後部トランクルームの下部でもよいし、車両前方のエンジンルームでも良い。

【００６３】

以上説明した本実施形態１によれば、以下のような効果を奏する。

【００６４】

本実施形態の正極集電体１１は、補強層１１０の片面または両面に正極導電性層１１１を接合させてなる構造とした。そして正極導電性層１１１は、第１端部１１２からそれとは反対側の第２端部１１３方向に質量が重くなるように質量勾配を持たせた。具体的には

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厚さが第１端部１１２から第２端部１１３方向に厚くなるようにしている。したがって、正極導電性層１１１は第１端部１１２から第２端部１１３方向にシート抵抗が低くなって電流が流れやすくなっている。

【００６５】

これにより、第１端部１１２側から第２端部１１３側に行くほど電気抵抗値が相対的に小さくなり、かつ熱容量も大きく保つことができる。したがって、二次電池１から電力を取り出すとき、および充電するときには、電流が集中する正極集電タブ１８を接続する側において余裕を持って電流を流すことが可能となる。その結果、正極集電タブ１８が接続されて電流が集中する側だけが相対的に発熱するようなことがなくなり、電池全体としても温度上昇を招くことが少ない。したがって発熱による充放電時のロスも少ない二次電池となる。

【００６６】

またこの構成により、十分な充放電レートを確保することができるため充放電特性がよくなる。

【００６７】

また、正極導電性層１１１の厚さを、二次電池内部で短絡が生じた際に、その温度上昇意より焼き切れる厚さとすることで、耐異常時の耐久性を向上することができる。そして、上記のような正極導電性層１１１の構成とすることで、そのように薄くした場合でも十分な充放電レートを確保することができる。

【００６８】

また、補強層１１０を設け、この補強層１１０に沿って正極導電性層１１１を配置したことで、正極導電性層１１１単独では十分な強度を得ることができない場合でも、正極集電体１１全体としては、十分な強度を確保することができる。しかも、補強層１１０は、その厚みの勾配を正極導電性層１１１の厚みの勾配と逆勾配としたことで、正極集電体１１としては平坦な構造とすることができる。そのため、二次電池を構成する際に斜めに積層されることがなく、組付け性がよい。

【００６９】

また、質量勾配は、第１端部１１２から第２端部１１３方向に直交する方向には単位面積あたり同一質量となるようにしたので、正極導電性層１１１の厚さを違える加工も容易である。

【００７０】

また、本実施形態の二次電池を複数接続した組電池２５０および３００とすることで、さまざまな出力電圧や電池容量とすることができる。しかも、一つひとつの電池は本実施形態の二次電池であるので、充放電特性がよいので高速充電に適したものとなる。このため高速充電時においても温度上昇が少なく、高い耐久性を有する。

【００７１】

さらに、上記組電池３００を用いた電気自動車４００は、組電池３００が高速充電時においても温度上昇が少なく、高い耐久性を有するので、長期間使用しても十分な出力を提供しうる。したがって、これを車両に搭載したことで、二次電池の交換回数も少なくでき、さらに、発熱による充放電時のロスも少ないので、燃費に優れた電気自動車、ハイブリッド自動車を提供できる。

【００７２】

［実施形態２］

図６は、実施形態２の二次電池を説明するための要部断面図である。

【００７３】

本実施形態２の二次電池２は、負極集電体１４を非導電性材料で構成される補強層１４０の両面に負極導電性層１４１を形成したものを使用している。負極導電性層１４１以外の他の構成は、実施形態１と同様であるので説明は省略する。なお、負極導電性層１４１は、図６に示した補強層１４０を挟んで２枚あるうちの一方を云う。以下、負極導電性層１４１という場合は同じ意味である。

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【００７４】
ここで用いている負極導電性層１４１（導電材）は、第１端部１４２側からそれとは反対側の第２端部１４３側にかけて厚みが薄くなるように形成している。負極集電タブ１９（図２参照）を電気的に接続する負極端子リード２１が接続される
これにより、負極導電性層１４１は、第１端部１４２から第２端部１４３方向に単位面積あたりの質量が重くなっている。これに伴いそのシート抵抗も第１端部１４２から第２端部１４３方向に低くなっている。すなわち、第１端部１４２から第２端部１４３方向に電流が流れやすくなっているのである。
【００７５】
なお、最外層の負極集電体１４ａは、補強層１４０に対して正極活物質層１２に対向する負極導電性層１４１が形成される方にのみ負極導電性層１４１が形成されてなる。
【００７６】
この負極導電性層１４１は、用いる材料に特に制限はなく、たとえば、金属や導電性高分子が採用されうる。具体的には、金属の場合は、例えば、ニッケル、銅、ステンレスなどの金属材料が挙げられる。なかでも、電子伝導性、電池作動電位という観点からは、銅が好ましい。
【００７７】
一方、本実施形態２では、正極集電体１１は、その厚みに変化はなく、均等な厚みの一枚板（たとえばアルミニウムや銅などの金属箔膜）としている。
【００７８】
正極集電体１１をたとえば、厚さについて特別な考慮をしないアルミニウムで構成し、負極導電性層１４１を銅の薄膜で上記のように厚さに勾配を持たせた構成とすることができる。この場合、アルミニウムの融点（６６０℃）よりも銅の融点（１０８３℃）が高いために、内部短絡が発生した際は、アルミニウムが特別厚さについて考慮しなくても先に焼き切れる。
【００７９】
また、仮に、図７に示すように、本実施形態２の二次電池２な複数の電池に外部から導電体９００が貫通した場合、正極集電体１１が焼ききれても、導電体９００が正極活物質１５に接触しているため正極集電体として作用する。このため隣接する単電池１６の間では負極導電性層１４１および負極集電タブ１９を通して短絡回路が形成されて短絡電流Ｉが流れ続ける。なお、負極導電性層１４１は、図２において負極集電体１４となるものであるから、その第２端部１４３側が負極集電タブ１９により互いに電気的に接続されている。
【００８０】
そこで、負極導電性層１４１の厚みを薄く、たとえば最大厚さを３μｍ以下に形成すれば、銅であっても瞬時に発熱より溶解し焼き切れる。このため内部短絡が発生した場合には、内部短絡部位の発熱による温度上昇が、その周囲に及ぶ前に電流を遮断することができる。
【００８１】
なお、銅を用いた場合の厚さの下限値（特に第１端部側）については特に限定されず、電流を流すことができる最小限の厚さでよい。特に本実施形態においても、補強層１４０が設けられているため、金属薄膜単独で、その形状が維持できないほど薄くても電流を流すことができれば問題ない。
【００８２】
一方、補強層１４０は負極導電性層１４１の厚みの勾配と逆勾配の厚みで形成されている。この補強層１４０については、実施形態１で説明したものと同じでよいので、詳細な説明は省略する。
【００８３】
また、負極集電体の材料として導電性樹脂を用いる場合も、実施形態１と同様の導電性樹脂を用いることができる。さらに、本実施形態２においても実施形態１同様にリチウム

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イオン電池以外の電池でも適用可能である。

【００８４】

以上説明した本実施形態２によれば、以下のような効果を奏する。

【００８５】

本実施形態の負極集電体１４として、補強層１４０の片面または両面に負極導電性層１４１を接合させてなる構造とした。そして、負極導電性層１４１は、第１端部１４２からそれとは反対側の第２端部１４３方向に質量が重くなるように勾配を持たせ、第２端部１４３側に負極集電タブ１９を電気的に接続している。具体的にはその厚さが、第１端部１４２から第２端部１４３方向に厚くなるようにしている。したがって、負極導電性層１４１は第１端部１４２から第２端部１４３方向にシート抵抗が低くなっている。

【００８６】

これにより、第１端部１４２側から第２端部１４３側に行くほど電気抵抗値が相対的に小さくなり、かつ熱容量も大きく保つことができる。したがって、二次電池２から電力を取り出すとき、および充電するときには、電流が集中する負極集電タブ１９を接続する側において余裕を持って電流を流すことが可能となる。その結果、電流が集中する負極集電タブ１９を接続する側だけが相対的に発熱するようなことがなくなり、電池全体としても温度上昇を招くことが少ない。したがって発熱による充放電時のロスも少ない二次電池となる。

【００８７】

またこの構成により、十分な充放電レートを確保することができるため充放電特性がよくなる。

【００８８】

また、負極導電性層１４１の厚さを、二次電池内部で短絡が生じた際に、その温度上昇意より焼き切れる厚さとすることで、耐異常時の耐久性を向上することができる。そして、上記のような負極導電性層１４１の構成とすることで、そのように薄くした場合でも十分な充放電レートを確保することができる。

【００８９】

また、補強層１４０を設け、この補強層１４０に沿って負極導電性層１４１を配置したことで、負極導電性層１４１単独では十分な強度を得ることができない場合でも、正極集電体１１全体としては、十分な強度を確保することができる。しかも、補強層１４０は、その厚みの勾配を負極導電性層１４１の厚みの勾配と逆勾配としたことで、負極集電体１４としては平坦な構造とすることができる。そのため、二次電池を構成する際に斜めに積層されることがなく、組付け性の悪化を抑制することができる。

【００９０】

また、質量勾配は、第１端部１４２から第２端部１４３方向に直交する方向には単位面積あたり同一質量となるようにしたので、負極導電性層１４１の厚さを違える加工も容易である。

【００９１】

さらに、本実施形態２の二次電池２についても、実施形態１同様に、組電池として構成することができる。また、この組電池を車両に搭載することもできる。この場合、組電池および車両としての作用効果なども実施形態１と同様に得ることができる。

【００９２】

［実施形態３］

図８は、実施形態３の二次電池を説明するための要部断面図である。

【００９３】

本実施形態３の二次電池３は、前述した実施形態１と実施形態２を統合した形態である。すなわち、正極集電体１１は非導電性材料で構成される補強層１４０の両面に正極導電性層１１１（導電材）を形成したものを使用している。正極導電性層１１１は第１端部１１２側からそれとは反対側の第２端部１１３側にかけて厚みが厚くなるように形成している。そして第２端部１１３側に、正極集電タブ１８（図２参照）を電気的に接続する正極

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端子リード２０が接続される。なお、正極導電性層１１１は、図８に示した補強層１１０を挟んで２枚あるうちの一方を云う。以下、正極導電性層１１１という場合は同じ意味である。

【００９４】

一方、負極集電体１４は、非導電性材料で構成される補強層１４０の両面に負極導電性層１４１（導電材）を形成したものを使用している。負極導電性層１４１は第１端部１４２側からそれとは反対側の第２端部１４３側にかけて厚みが厚くなるように形成している。そして、第２端部１４３側に負極集電タブ１９（図２参照）を電気的に接続する負極端子リード２１が接続される。なお、負極導電性層１４１は、図６に示した補強層１４０を挟んで２枚あるうちの一方を云う。以下、負極導電性層１４１という場合は同じ意味である。

【００９５】

したがって、正極導電性層１１１の構成は実施形態１と同様であり、負極導電性層１４１の構成は実施形態２と同様であるので、それらの詳細な説明は省略する。また、これら以外の構成についても実施形態１または実施形態２と同様であるので説明は省略する。

【００９６】

この本実施形態３によれば、以下のような効果を奏する。

【００９７】

正極集電体１１および負極集電体１４の両方を、それぞれ質量勾配を持たせた正極導電性層１１１および負極導電性層１４１を用いたことで、いっそう熱の偏りを抑えることができる。そして充放電レートもいっそう保たれるようになって高い電池性能を引き出すことができる。また、正極導電性層１１１および負極導電性層１４１の両方の溶解・焼切れ性を高めるために両方の厚さを極限まで薄くすることができる。したがって、電池の内部への異物混入やデンドライト成長に伴う内部短絡時および複数の電池に外部から導電体が貫通するような短絡時の場合に、面内のどの位置で短絡しても即刻、短絡電流の流れを遮断することができる。しかも充放電レートは十分に保って電池性能を向上させることができる。

【００９８】

また、本実施形態３では、正負極の集電タブ１８および１９を、二次電池の対向する位置に配置した。これにより正極導電性層１１１が厚い方向から薄い方向に対して負極導電性層１４１が薄い方向から厚い方向となるように積層されることになる。したがって、正極集電体１１と負極集電体１４で、その電気抵抗値の勾配の向きを逆になる。

【００９９】

このようにしたことで、仮に電池外部から導電性部材が貫通して電池内部で短絡が発生した場合、導電性部材が面内のどこで貫通しても正負極のいずれか薄い方が先に焼き切れるようになり、短絡電流の遮断性を向上することができる。したがって、電池の内部短絡に起因する安全性をさらに向上することができる。

【０１００】

そのほか、質量勾配をつけるための厚さや補強層については本実施形態３でも実施形態１および２と同様の効果を有する。

【０１０１】

もちろん本実施形態３においても、組電池とすることもできるし、車両に搭載することも可能であり、上述した実施形態１で説明した組電池および車両と同様の効果を得ることができる。

【０１０２】

［実施形態４］

図９は実施形態４の二次電池を説明するための要部断面図であり、図１０は実施形態４の正極集電体を説明するための説明図であり、図１０Ａは平面図、図１０Ｂは図１０ＡにおけるＡ－Ａ線に沿う断面図である。断面図である。

【０１０３】

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本実施形態４は、正極集電体１１として、補強層１１０の片面または両面に多孔体構造の正極導電性層１６１を設けた構造としたものである。そして、正極導電性層１６１は、第１端部１６２からそれとは反対側の第２端部１６３方向に単位面積あたりの多孔体の空隙率が段階的または滑らかに小さくするよう構成されている。そして、第２端部１６３側に正極集電タブ１８を電気的に接続する正極リード２０を接続している。

【０１０４】

すなわち、正極導電性層１６１は、図１０に示すように、たとえば、空隙部分１６８の数が第１端部１６２から第２端部１６３方向に少なくなっている。これにより導電要素部分１６７の面積が第１端部１６２から第２端部１６３方向に多くなって、導電材としては単位面積あたりの質量が重くなる。これによりシート抵抗も第１端部１６２から第２端部１６３方向に低くなって、第１端部１６２から第２端部１６３方向に電流が流れやすくなるようにしている。

【０１０５】

空隙部分１６８の大きさは、特に限定されるものではないが、正極活物質からの電流を受けて、第１端部１６２から第２端部１６３方向に確実に電流が流れるようにしておく必要がある。この観点からは、たとえば０．１～数百μｍ程度の大きさが好ましい。これは、空隙部分１６８の大きさがあまり大きいと導電要素部分１６７が途切れたり、隙間が大きくなりすぎて集電作用が低下するおそれがあるためである。

【０１０６】

その他の構成は実施形態１と同様であるので説明は省略する。

【０１０７】

この本実施形態４によれば、以下のような効果を奏する。

【０１０８】

本実施形態４では、空隙率を違えて質量勾配をつけシート抵抗に変化をつけることとしたので、正極導電性層１６１の厚みに勾配をつける必要がない。したがって、補強層１１０の厚みにも勾配をつける必要がないため、正極導電性層１６１および補強層１１０の加工性がよくなる。もちろん、電池の充放電レートを保って電池性能を確保しつつ正極導電性層１６１の溶解・焼切れ性を向上させることもできる。

【０１０９】

そのほか補強層については本実施形態４でも実施形態１および２と同様の効果を有する。

【０１１０】

なお、本実施形態４の構成は、負極導電性層１４についても適用することができる。また、正極集電体１１と負極集電体１４の双方に適用することも可能である。さらに、これら形態の二次電池を組電池とし、また車両に搭載できることは実施形態１で説明したものと同様であり、それらの作用効果も同様に得ることができる。

【０１１１】

また、多孔体構造は、その空隙部分１６８としてハニカム構造に似た６角形の場合を図示したが、このような形状以外にも、円形（楕円形を含む）やその他の多角形や不定形形状などであってもよい。また、空隙率を違えるためには空隙部分１６８の単位面積あたりの数を違えるのではなく、空隙部分１６８の単位面積あたりの大きさを違えることでもよい。さらに多孔体構造の空隙部分１６８は、空間とするのではなく非導電性素材（例えば樹脂）によって埋め込まれた構造であってもよい。つまり、導電材である正極導電性層１６１は、空隙または非導電性素材からなる非導電部の割合（非導電部の体積／導電材全体の体積）が第１端部から第２端部の方向へ小さくなるように構成されていればよいのである。

【０１１２】

また、図では平面的に空隙部分１６８が存在するように示したが、これは、厚さ方向に存在するようにしてもよいし、ポーラス構造のようにしてもよい。もちろんこれらの場合も、非導電部の割合（非導電部の体積／導電材全体の体積）が第１端部１６２から第２端

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部１６３の方向へ小さくなるように構成されていればよいのである。

【０１１３】

さらに本実施形態４の応用として、正極導電性層１６１として非導電性樹脂に導電性フィラーを配合した導電性樹脂を用いて、導電性フィラーの配合比率を単位面積あたりで違えることでもシート抵抗に差をつけることができる。

【０１１４】

つまり、第１端部１６２から第２端部１６３方向に、段階的にまたは滑らかに非導電性樹脂に対する導電性フィラーの配合量を多くするのである。これにより正極導電性層１６１の導電材としてのシート抵抗は第１端部１６２から第２端部１６３方向に低くなって、この方向に電流が流れやすくなる。この場合も正極導電性層１６１の厚さに変化をつけることなくシート抵抗を変化させることができる。

【０１１５】

［実施形態５］

図１１は実施形態５の正極集電体を説明するための説明図であり、図１１Ａは平面図、図１１Ｂは断面図である。

【０１１６】

本実施形態５は、前述した実施形態１における正極導電性層１１１の厚さを下記のようにしたものである。正極端子リード２０が接続された部分を略中心とした同心円の円弧（図示点線）上では同じ厚さにし、円弧に対し直交する方向（図示矢印）でかつ第１端部１１２から第２端部１１３方向には厚くなるようにしている。なお正極端子リード２０は第２端部１１３側に接続されている。これにより各矢印方向の断面を見れば、図１１Ｂのように正極導電性層１１１の厚さに勾配ができる。したがって、第１端部１１２から第２端部１１３方向を含む、正極集電タブ１８との電気的接続点となる略中心から円弧に対し直交する方向に質量勾配が生まれて、シート抵抗もこの方向に低くなる。ここで「略中心」としたのは、機械的な取り付け誤差の範囲があるためである。

【０１１７】

この際、補強層１１０は、正極導電性層１１１の勾配と逆勾配で形成されることは第１実施形態１と同様である。また、そのほかの構成も実施形態１と同様であるので説明を省略する。

【０１１８】

この本実施形態５によれば、以下のような効果を奏する。

【０１１９】

正極端子リード２０の幅Ｗ１に対して、正極導電性層１１１の幅Ｗ２が大きい場合などには、電流が正極端子リード２０の全周囲方向から流れ込む。このため第１端部１１２から第２端部１１３に向けて一方向に勾配をつける場合と比較して、特に第１端部１１２の辺に直交する辺１１４や１１５近傍の厚みを薄くすることができる。これにより、第１端部１１２の辺に直交する辺１１４や１１５から第２端部１１３方向である正極集電タブ１８との電気的接続点への電流の流れもよくなる。このため電池の充放電レートを保って電池性能を確保しつつ正極導電性層１１１の溶解・焼切れ性をさらに向上させることができる。

【０１２０】

なお、本実施形態５は、負極導電性層１４にも適用可能であるし、正極集電体１１と負極集電体１４の双方に適用することもでき、それらの場合に同様の効果を得ることができる。

【０１２１】

また、図においては、正極端子リード２０が接続された部分（集電タブとの電気的接続点）を正極集電体の一つの辺（第２端部１１３の辺）の中ほどに設けているが、この電気的接続点は正極集電体の一つの辺の端であってもよい。その場合も正極端子リード２０が接続された部分を略中心をして同心円の円弧上では正極導電性層１１１の厚さを同じ厚さにし、円弧に対し直交する方向でかつ第１端部１１２から第２端部１１３方向には厚くす

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る。これにより上記効果と同じ効果を得ることができる。そのほか本実施形態は正極端子リード２０が接続された部分が正極集電体のどこであっても同じように実施可能である。もちろん負極集電体においても同様に実施できる。

【０１２２】

以上、本発明を適用した実施形態を説明したが、本発明はこれら実施形態に限定されるものではない。

【０１２３】

たとえば、上述した実施形態は、厚さの勾配（実施形態１～３および５）においては、図示上滑らかな勾配をつけて説明したが、段差的な勾配であってもよい。

【０１２４】

また、上述した実施形態は、積層型の扁平な形状の二次電池により説明したが、そのほかにも巻回型の二次電池である、円筒型形状（楕円形状を含む）、角型形状のものであってもよい。円筒型や角型の形状のものでは、その外装材にラミネートフィルムを用いてもよいし、従来の円筒缶（金属缶）を用いてもよいなど特に制限されるものではない。

【０１２５】

また上述した実施形態は、リチウムイオン二次電池を例に説明した。これは、リチウムイオン二次電池が単電池（１セル）当たりの電圧が大きく、高エネルギー密度、高出力密度が達成でき、車両の駆動電源用や補助電源用として優れているためである。しかし本発明は、これに限らず、その他にもたとえばニッケル水素二次電池などにも適用可能である。

【０１２６】

また、本実施形態の二次電池や組電池は、車両に搭載する以外にも、たとえば無停電電源装置などの載置用電源（固定型電源）として利用することも可能である。

【０１２７】

そのほか、本発明は、本発明の技術思想の範囲内においてさまざまな実施形態が可能であることはいうまでもない。

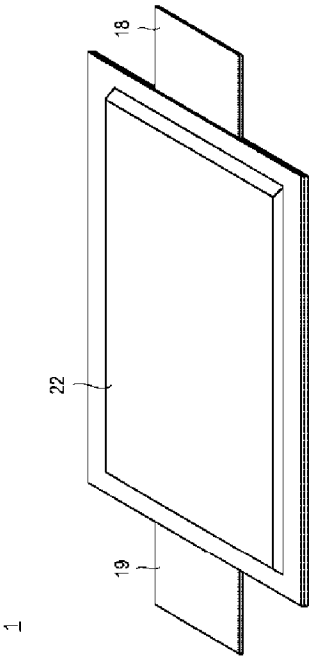
【符号の説明】

【０１２８】

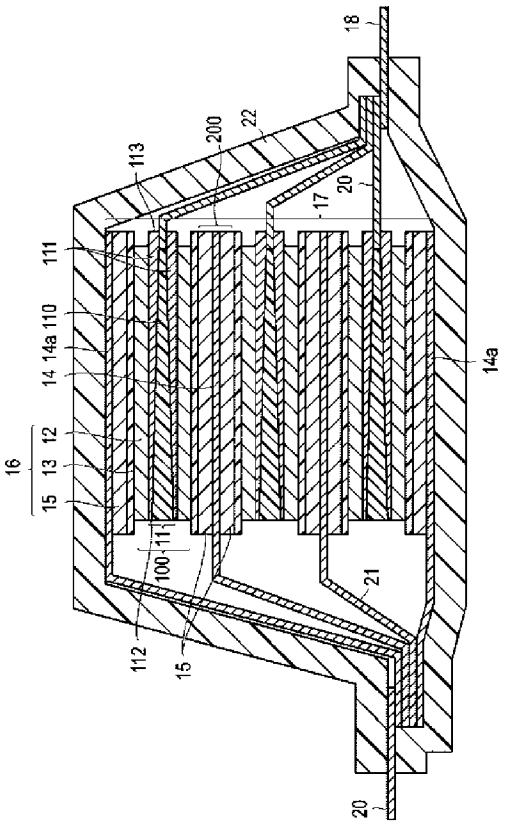
１、２、３、４　二次電池、
１１　正極集電体、
１４　負極集電体、
１８　正極集電タブ、
１９　負極集電タブ、
２０　正極端子リード、
２１　負極端子リード、
１１０、１４０　補強層、
１１１、１６１　正極導電性層
１１２、１４２、１６２　第１端部、
１１３、１４３、１６３　第２端部、
１４１　負極導電性層、
１６７　導電要素部分、
１６８　空隙部分。

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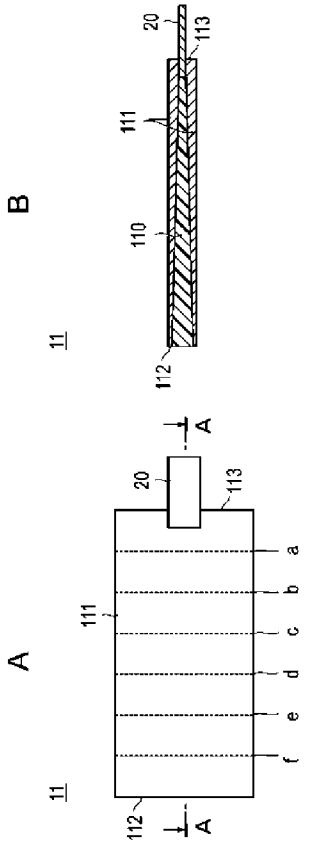
【図１】



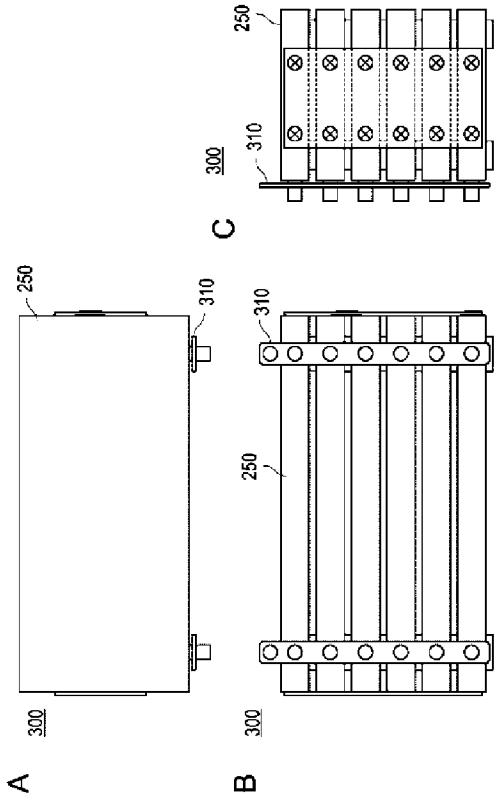
【図２】



【図３】

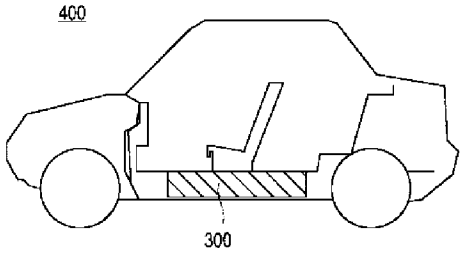


【図４】

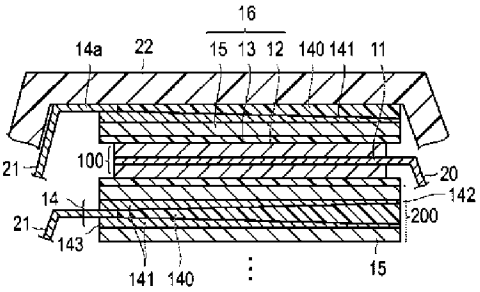


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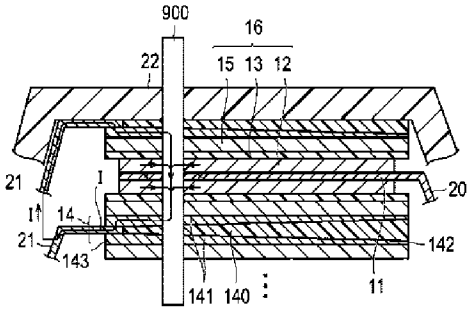
【図５】



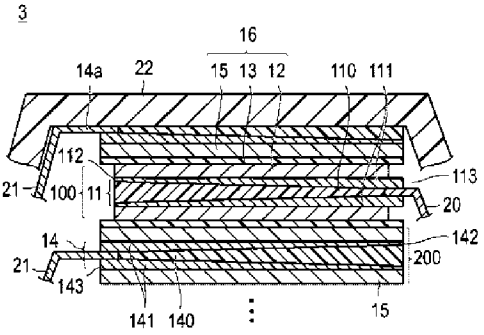
【図６】



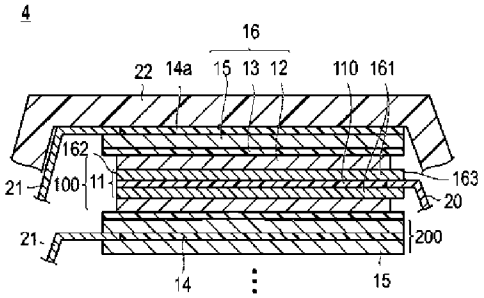
【図７】



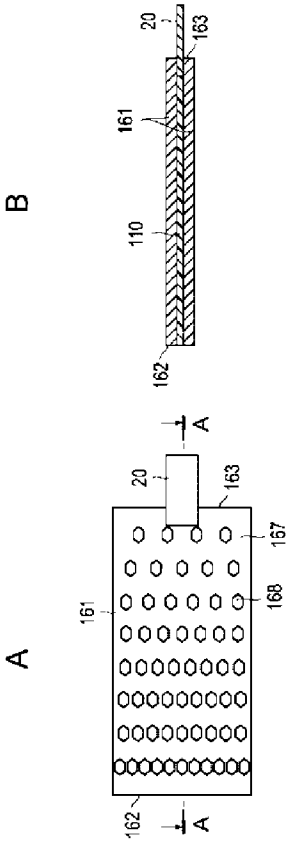
【図８】



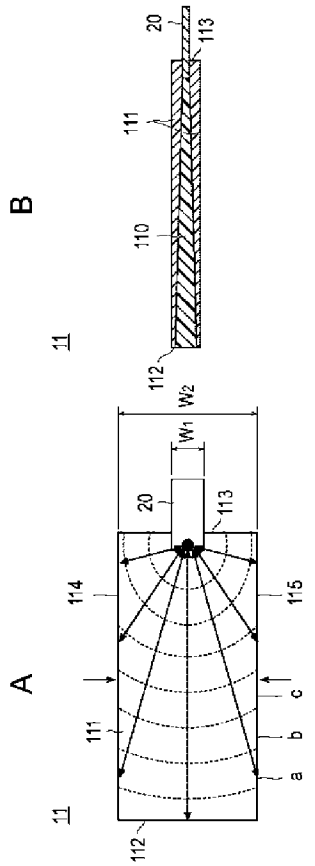
【図９】



【図１０】



【図１１】



フロントページの続き

(51)Int.Cl.			F I				テーマコード（参考）
H01M	***4/13***	***(2010.01)***	H01M	4/02	101		5H050
H01M	***2/30***	***(2006.01)***	H01M	2/30		D	
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H01M	***2/10***	***(2006.01)***	H01M	2/10		E	

Fターム(参考) 5H028 AA01 AA05 CC01 CC02 CC05 CC10 CC11 EE10 HH01 HH05
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ADC EX1002
IPR2025-00885

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 December 2014 (31.12.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/206323 A1

(51) International Patent Classification:
H01M 10/36 (2010.01)

(21) International Application Number:
PCT/CN2014/080868

(22) International Filing Date:
26 June 2014 (26.06.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13107541.4 26 June 2013 (26.06.2013) HK
13107780.4 3 July 2013 (03.07.2013) HK

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) **Title**: BATTERY PACK,TOOL BATTERY AND BATTERY OPERATED TOOL

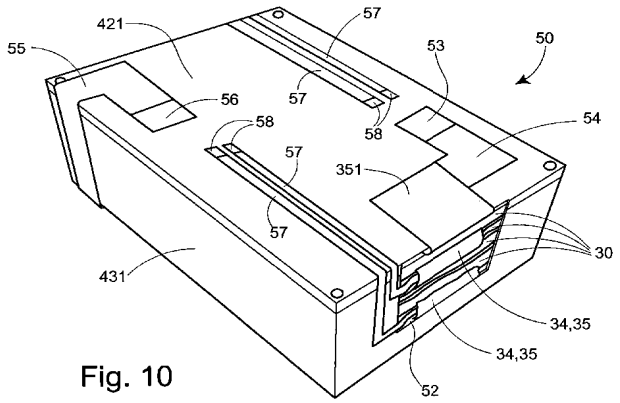


Fig. 10

(57) **Abstract**: A lithium-polymer based battery pack for power a hand held power tool or a garden tool,the battery pack has a plurality of battery cells located within housing that is selectively connectable to and supportable by a hand held power tool or a garden tool. The battery cells have a lithium- polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 5 milliohms.In one embodiment the cells are think cells are stacked within the housing such that each sell is layered over or under an adjacent cell and a resiliently deformable substrate located between adjacent battery cells.In another embodiment the cells may be interconnected to have a combined output voltage of at least 9 volts and to produce a combined average discharge current of greater than 20 amps.A lithium-polymer tool battery and a battery powered tool are also part of the invention.

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BATTERY PACK, TOOL BATTERY AND BATTERY OPERATED TOOL

Field of the Invention

The present invention relates to battery packs, and to tool batteries and battery operated tools. In particular, the invention relates to a battery pack suitable for powering a hand held cordless power tool.

Background to the invention

Power tools and in particular hand held power tools are increasingly relying on cordless rechargeable battery packs as a powering energy source. Such battery packs are preferably compact and lightweight, but must still deliver relatively high current and voltage for powering the tool motor.

Summary of the Invention

The present invention provides a lithium-polymer based battery pack, a lithium-polymer based tool battery and a lithium-polymer based battery operated tool as set forth in any one of the appended claims.

In particular, in a first aspect of the invention there is provided a lithium-polymer based battery pack for powering a hand held power tool or garden tool, the battery pack comprises a housing selectively connectable to and supportable by a hand held power tool or a garden tool, at least one battery cell located within the housing, the cell having an output voltage of at least 4 volts and producing an average discharge current of greater than 10 amps, wherein the battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms. Preferably there is a plurality of battery cells located within the housing, the plurality of cells being interconnected to have a combined output voltage of at least 4 volts and a combined average discharge current of greater than 10 amps, wherein each cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

In a second particular aspect of the invention there is provided a lithium-polymer based tool battery comprising a battery housing selectively connectable to and supportable by a hand held

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power tool or a garden tool, a plurality of substantially flat battery cells stacked within the housing such that each sell is layered with an adjacent cell, and a resiliently deformable substrate located between the adjacent battery cells, wherein each battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

In a third particular aspect of the invention there is provided a lithium-polymer battery powered tool comprising a tool housing, an electrical motor in the tool housing, a motor controller for controlling power supplied to the motor from an electrical energy source, a battery housing selectively connectable to and supportable by the tool housing, and a battery within the battery housing for supplying power to the motor controller and motor when the battery housing is connected with the power tool housing, the battery comprising one or more battery cells, the cell or cells being having a combined output voltage of at least 4 volts and producing a combined average motor supply current of at least 10 amps, wherein each battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

Further aspects of the invention will become apparent from the following description which is given by way of example only to illustrate the invention.

Description of the Drawings

Various embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 illustrates a power tool battery,

Figure 2 illustrates a cordless power tool,

Figure 3 illustrates a lithium-polymer based battery cell according to the invention,

Figure 4 illustrates a cell pouch for a lithium-polymer based battery,

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Figure 5 illustrates a string of the five battery cells having terminals welded in series prior to forming into a stack of Figure 4,

Figure 6 illustrates a stack of five interconnected lithium-polymer based battery cells forming a tool battery according to the invention,

Figure 7 illustrates a battery cell according to the invention and a resiliently deformable cradle for the battery cell,

Figure 8 illustrates a second view of the battery cell and cradle,

Figure 9 illustrates an explored view of a battery comprising a polarity of lithium-polymer battery cells,

Figure 10 illustrates a first perspective view of a battery case for a lithium-polymer based battery according to the invention,

Figure 11 illustrates a second perspective view of the battery case for a lithium-polymer based battery according to the invention, and

Figure 12 illustrates different connection arrangements for a stack of lithium-polymer battery cells.

Detailed Description of Preferred Embodiments of the Invention

The following description is given by way of example only to illustrate embodiments of the invention. The terminology used is for illustrative purpose only and is not intended to limit the scope or use of the invention, unless the text clearly and explicitly requires otherwise.

Figures 1 and 2 illustrate a typical tool battery 10 and a cordless (battery power) tool 20. The illustrated tool 20 is a drill or driver having a tool housing 21 and a pistol type handle 24. A

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motor 23 (indicated by broken lines) is located within the housing for driving a tool output 22. A battery 10 is connectable to a supported by the tool handle 24. A tool controller such as a trigger 25 is located adjacent the junction between the housing 21 and handle 24 for coupling energy from the battery 10 to the motor 23. This is, however, not intended to limit the scope of use of a battery according to the invention. Such a battery could be used in other types of cordless tools and in particular in hand-held cordless tools or in cordless lawn and garden equipment such as lawn mowers, hedge trimmers and the like. Such a battery could also be used in floor care products such as vacuum cleaners, hand-vacs and cordless sweepers.

A preferred embodiment of a battery for such types of cordless tools has a battery pack housing 11 have a mating face 12 for connecting to the tool. The battery housing 11 is selectively receivable with and supportable by the tool housing via battery connection features, and may be selectively separated from the tool for charging in a separate charger (not shown). One typical embodiment of battery mating features is illustrated in Figures 1. In the illustrated embodiment the battery connection features are a terminal post 13 and battery terminals 14, 15 on the post 13 for connecting the battery energy sources with the tool controller or trigger 25. In alternative embodiments the battery connection features may be slide-type connection features or any other type of battery connection features known in the art. The type of battery connection features in not an essential feature of the invention.

Figures 3 to 11 show details of a battery 40 for location within the battery pack housing 11. The battery 40 comprises a plurality of substantially flat lithium-polymer battery cells 30. Each lithium-polymer cell 30 comprises a first electrode sheet 31 and a second electrode sheet 32 laminated to respective sides of a polymer based separator substrate 33. Connection tabs/tapes 34 and 35 are connected to the respective first and second electrodes sheets 31, 32. The first and second electrode sheets 31, 32 may be any of the lithium-polymer cell anode and cathode combinations known in the art. The polymer separator 33 may be a dry solid polymer electrolyte or porous or micro-porous polymer substrate holding a lithium based electrolyte. The particular anode, cathode and lithium-polymer separator chemistry of the cell is chosen to provide a nominal charged internal cell impedance of less than or equal to approximately 10 milliohms. Each cell 30 may have a typical nominal cell voltage of between 2 volts and 4.2 volt and a

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nominal amp-hour capacity of greater than 1.5 amp-hours. Each cell is preferably, although not exclusively enclosed in a flexible and lightweight pouch 301. The pouch 301 is formed from, for example, an Aluminum laminate film that is folded around the cell 30 and sealed along the three adjoining sides 302, 303, 304. The connection tabs/tapes 34 and 35 protrude from the pouch between the sealed edges of the film.

A substantially flat cell 30 according the invention has a cell length L, cell width W and cell height or thickness H. In the preferred embodiment the cell thickness H is less than 10% of the cell width W. This provides a substantially flat lithium-polymer cell which can be stacked in interconnected groups, as illustrated in Figures 5 to 11 for example, to form a tool battery. For use a tool battery a plurality of the stacked battery cells 30 should have a combined output voltage of at least 4 volts and as high as 40 volts or more. Tool batteries are typically available in stepped voltages of, for example, 4, 9, 12, 18, and as high as 40 volts for some lawn and garden type tools such as lawn mowers. In order to provide sufficient torque in the tool motor the combine average discharge current provide by the plurality of battery cells 30 should be greater than 10 amps, but more preferably 20 amps, although different tools and tool motors will produce different average battery discharge currents.

The tabs 34, 35 from respective ones of the stacked plurality of battery cells 30 are connect together in series and/or parallel in order to provide the required average discharge current and combine output voltage of the battery 40. The connection between the respectively terminal tabs 34, 35 of adjacent cells 30 must be of a lower resistance than the internal resistance of the cells 30 and preferably of a very low resistance so as to prevent heating in the interconnection joint between the cells 30. It is typical in battery manufacturing to interconnect adjacent battery cells by welding respective cell tabs at a weld joint 38. In the preferred embodiment of the invention each battery cell 30 has its respectively pair of tabs 34, 35 on different edges of the cell 30 and preferably on symmetrically opposite edges of the cell 30. This arrangement allows the plurality of cells to be easily interconnected in a string of cells 30 by jointing respective tabs 34, 35 of adjacent cells 30 with a weld joint 38. As the terminal tabs 34, 35 of the cells extend from opposite ends of the cell 30 the weld joint can be quickly and easily formed by a weld between

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adjacent cells 30 without potential for bridging or shorting adjacent terminal tabs of the same cell which in prior art battery designs may be along a same edge of the cell.

After electrical interconnection of the cell tabs 34, 35 the interconnected cells 30 are formed into a vertical stack of cells 30 as shown in Figure 6, for example. In a vertical stack of cells each cell 30 is lying over or under an adjacent one of the cells 30. Although in the illustrated embodiment the cells are stacked vertically with reference to the horizontal plane this is for illustrative and descriptive purposes only and the stack of individual cell 30 may be stacked with each cell lying in a vertical, or any other, plane where each cell 30 is layered with an adjacent one of the cells 30. For the purpose of describing the invention, stacked means each cell lying in adjacent parallel planes. During charge and discharges cycles of the battery the thickness H of each cell 30 may very normally by up to 5% of the cell thickness H. In order to accommodate this variation in cell thickness during charge and discharges cycles the cell stack includes a resiliently deformable substrate 37 interposed between each adjacent battery cell 30. The thickness of the resiliently deformable substrates 37, and thus the distance between adjacent cells, is preferably between 5% and 10% of the normal cell thickness H in order to accommodate for variation in individual cell thickness up to 5%. In some embodiments the resiliently deformable substrate 37 between cells 30 may be provided with a thermally conductive characteristic for conducting heat away from the cells during charge and discharge cycles. For example, the substrate may be resiliently deformable and thermally conductive, or the substrate may be porous, such as a spongy material, and impregnated with a thermally conductive substance.

The cell interconnection tabs 34, 35 extended between adjacent stacked cells 30. To support and protect the interconnection tabs 34, 35 from mechanical damage in some embodiments of the invention a guide member 36 is provided at respective locations adjacent the edge of the stacked cells 30 to abut the interconnected tabs 34, 35 between adjacent cells 30. The guide member 36 has a convex guiding surface that abuts the joined tabs 34, 35 extending between the adjacent cells and supports the joined tabs about a smooth radius between the adjacent cells 30.

The interconnected stack of cells 30 forming battery 40 is located within a battery pack housing such as housing 11 of the battery of Figure 1. It will be appreciated by a skilled person that the

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battery 40 constructed of pouch cells must be physically and mechanically supported within the battery housing 11 against mechanical vibrations and shocks that might be experienced during use of the tool to which a battery pack 10 is connected. Figures 6 to 10 show a cradle and shell arrangement for mechanically supporting a stack of battery cells 30 within the battery housing 11 in some embodiments. Figure 7 shows an individual battery cradle 39 for supporting a substantially flat lithium-polymer battery cell 30. The cradle 39 is a flat substrate of resiliently deformable material such as EVA foam or the like and has a wide cell-channel extending through one face of the substrate. An individual battery cell 30 locates within the cell-channel for support by the cradle. The cradle 39 has side edges 40 to provide mechanical protection for the sides of the battery cell 30 and integrally combines the resiliently deformable cell spacer substrate 37, below the cell-channel, and cell tab guide 36 into a single protective cradle for an individual battery cell 30. Figure 9 shows a stack of battery cells 30 each held within its own individual resiliently deformable cradle 39. The cradled stack of battery cell 30 locates within a cradle frame 43 and is fitted with a cover 42 in order to mechanically hold the stack of battery cells 30 together. A printed circuit board assembly (PCBA) 44 can optionally be attached to or incorporated with the cover 42. The PCBA can contain battery pack electronics and protection circuits. The cradle frame 43 supporting the battery 40 is located within a battery housing 11. The cradles 39 and cradle frame 42, 43 are preferably a "friction fit" within the battery housing 11 such that the battery 40 is mechanically supported against and variations and shocks experienced during use of the battery on a power tool.

In some embodiments further mechanical protection of the pouch cell battery is provided by enclosing the stack of battery cells 30 within a shell or case 50 as shown in Figures 10 and 11. The case 50 comprises a case enclosure 431 having a base and four surrounding side walls defining a cavity into which the stacked battery cells 30 are located. A cover 421 is fixed to the tops of the four surrounding side walls to enclose the cavity and stacked battery cells 30. An opening 51, 52 is provided in each of the opposed end side walls of the case enclosure 431 to allow space for and accommodate connection access to the interconnected terminal tabs 34, 35 of adjacent cells 30. The free end terminal tabs 341 and 251 of the stack of cells 30 pass though respective end openings 51, 52 and are folded through substantially 180-degrees to lie substantially flat with respective upper and lower surfaces of the case 50. The first free terminal

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tab 351 of the stacked cells 30 is folded back against a first surface of the case 50 and electrically connected with one end of a conductive lead strap 54. The second end of the first conductive lead strap 54 has a first exposed connection terminal 53 of copper or other electrically conductive terminal material. The conductive lead strap 54 is preferably a copper strap having an insulated coating such as a polyurethane insulating varnish. The terminal end 53 of the strap is free of the insulating varnish to allow for electrical connection to the strap. The second free terminal tab 341 of the stacked cells 30 is folded back against the second opposite surface of the case 50 and electrically connected with one end of a second conductive lead strap 55. The second conductive lead strap 55 extends flat with the case surface around the side of the case to the first surface of the case 50 where it is provided with a second exposed connection terminal 56 of copper of other electrically conductive terminal material. The second conductive lead strap 55 is preferably a copper strap having an insulated coating such as a polyurethane insulating varnish. The terminal end 56 of the strap is free of the insulating varnish to allow for electrical connection to the strap. In some embodiments auxiliary conductive straps 57 of a type the same or similar to first and second conductive straps 54, 55 are provided for providing addition signal connections to the stack of cells 30. For example, auxiliary conductive straps 57 are preferably provided for each of the interconnected terminal tabs 34, 35 between stacked cells for providing means for measuring individual cell voltages. Each auxiliary conductive strap 57 has a connection terminal 58 at its distal end. Auxiliary conductive straps 57 may also be provided to temperature and other sensors associated with the stack of cells 30. A printed circuit board assembly (PCBA) can optionally be attached to or incorporated with the enclosure cover 421 or within the case 50. The PCBA can contain battery pack electronics and protection circuits.

Within some embodiment a small PCBA is attached to the tabs 34, 35 of the battery cells. Such a PCBA can comprises a sensor for transmitting a voltage dependent sensor signal to the battery controller 44, or a battery charger controller for determining cell voltages for using in, for example, cell balancing operations. In a further embodiment of the invention one or more sensor elements can be located between adjacent cells for measuring temperature and other cell characteristics. In one embodiment a pressure sensor is provided between adjacent cells for detecting expansion in cell thickness during charge and discharge cycles. If pressure or deformation of the substrate between adjacent cells exceeds a threshold this may indicate an

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abnormal and possibly dangerous cell condition. Signals from such sensors are transmitted to the battery controller 44, or a battery charger controller.

Traditional lithium ion cells used in tool batteries are mechanically contained in a strong cylindrical metal can. These cans are grouped together to form a battery and located in a battery pack housing. The interior of the housing has a first housing volume and the grouped cell cans defines a combined battery volume. The fill-factor of a cylindrical body in a substantially square or rectangular housing is at best Pi divided by 4 (Π/4) or 78%. The stacked flat cells of the present invention provides a ratio of the combined battery volume to housing volume (fill ration) of greater than 80%, allowing for a smaller more light weight battery.

In the various embodiments described above the battery comprises a plurality of interconnected cells. In at least one alternative embodiment the battery may comprises just one lithium polymer based chemistry cell. In other alternative embodiment the battery may comprises between 2 and 20 interconnected cells, or more preferably between 2 and 10 interconnected cells. In yet another embodiment the battery may comprises between 3 and 5 cells interconnected in series. In the various embodiments the cells may be interconnected in series, in parallel, or groups of series cells may be interconnected in parallel in order to obtain a desired output voltage and combined average discharge current.

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CLAIMS

1. A lithium-polymer based battery pack for powering a hand held power tool or a garden tool, the battery pack comprising:

a housing selectively connectable to and supportable by a hand held power tool or a garden tool,

a battery cell located within the housing, the cell having an output voltage of at least 4 volts and producing an average discharge current of greater than 10 amps, wherein the battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

2. The lithium-polymer based battery pack of claim 1 further comprising a plurality of the battery cells located within the housing, the plurality of cells being interconnected to have a combined output voltage of at least 4 volts and a combined average discharge current of greater than 10 amps, wherein each cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

3. The lithium-polymer based battery pack of claim 2 wherein the plurality of the battery cells comprises between 2 and 20 cells interconnected in series.

4. The lithium-polymer based battery pack of claim 2 wherein the plurality of the battery cells comprises between 2 and 10 cells interconnected in series.

5. The lithium-polymer based battery pack of claim 2 wherein the plurality of the battery cells comprises between 3 and 5 cells interconnected in series.

6. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells has a nominal amp-hour capacity of greater than 1.5 amp-hours.

7. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells has a nominal cell voltage of between 2 volts and 4.2 volts.

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8. The lithium-polymer based battery pack of any preceding claim wherein the battery cells have a combined output voltage of between 4 volts and 40 volts.

9. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells comprises an anode electrode sheet, a cathode electrode sheet and a lithium-polymer based substrate lamented between the anode and cathode electrode sheets.

10. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells is generally flat and has a cell width and a cell thickness, the cell thickness being less than 15% of the cell width.

11. The lithium-polymer based battery pack of any one of claims 2 to 10 wherein the plurality of battery cells are layered within the housing such that each cell is lying adjacent another one of the cells, and further including a resiliently deformable substrate between the adjacent cells.

12. The lithium-polymer based battery pack of claim 11 wherein a distance between the adjacent cells in greater than 5% of the cell width.

13. The lithium-polymer based battery pack of claim 11 wherein the resiliently deformable substrate is thermally conductive or contains a thermally conductive component.

14. The lithium-polymer based battery pack of claim 11 including at least one sensor element located between at least two adjacent ones of the cells, said sensor element providing a sensor signal to a battery controller.

15. The lithium-polymer based battery pack of claim 14 wherein the sensor element comprises a temperature sensor.

16. The lithium-polymer based battery pack of claim 14 wherein the sensor element comprises a temperature sensor, and wherein a second pressure sensing element is located

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between at least two adjacent ones of the cells and provides a pressure sensor signal to a battery controller

17. The lithium-polymer based battery pack of any one of claims 2 to 16 wherein the housing defines a housing volume and the plurality of cells provides a combined battery volume, and wherein a ratio of the combined battery volume to the housing volume is greater than 80%.

18. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells comprises a first connection lead connected with an anode sheet of the cell and a second connection lead connected with a cathode sheet of the cell, the first connection lead extending from a first edge of the cell and the second connection lead extending from a second edge of the cell, the second edge being a different edge to the first edge of the cell.

19. The lithium-polymer based battery pack of claim 18 wherein the second edge is symmetrically opposite the first edge.

20. The lithium-polymer based battery pack of claim 18 or 19 wherein the plurality of battery cells is stacked within the housing such that each cell is lying adjacent another one of the cells, at least one of the connection leads joined with a connection lead of an adjacent cell.

21 The lithium-polymer based battery pack of claim 20 further including a guide member having a convex guiding surface abutting the joined connection leads extending between adjusted cells.

22. The lithium-polymer based battery pack of claim 21 wherein the guide member supports the joined connection leads about a smooth radius between the adjusted cells.

23. The lithium-polymer based battery pack of claim 21 or 22 further including a resiliently deformable substrate between adjacent cells.

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24. The lithium-polymer based battery pack of claim 23 wherein the guide member and resiliently deformable substrate between adjacent cells is a single integral member.

25. The lithium-polymer based battery pack of any preceding claim wherein the plurality of battery cells is supported within the housing in a resiliently deformable cradle surrounding at least a part of each cell.

26. The lithium-polymer based battery pack of claim 25 wherein the resiliently deformable cradle comprises two or more resiliently deformable members each abutting at least one battery cell.

27. A lithium-polymer tool battery comprising:

a housing selectively connectable to and supportable by a hand held power tool or a garden tool,

a plurality of substantially flat battery cells stacked within the housing such that each sell is layered over or under an adjacent cell and a resiliently deformable substrate located between adjacent battery cells, wherein each battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

28. The lithium-polymer tool battery of claim 27 further including the lithium-polymer battery based pack features of any one of claims 3 to 26.

29. A lithium-polymer battery powered tool comprising:

a power tool housing

an electrical motor in the housing,

a motor control circuit for controlling power supplied to the motor from an electrical energy source,

a battery housing selectively connectable to and supportable by the power tool housing,

a battery within the battery housing for supplying power to the motor control circuit and motor when the battery housing is connected with the power tool housing,

the battery comprising at least one battery cell having an output voltage of at least 4 volts

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and producing a combined average motor supply current of at least 10 amps, wherein each battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

30. The lithium-polymer tool of claim 29, further including the lithium-polymer battery based pack features of any one of claims 2 to 26.

31. The lithium-polymer tool of claim 29 or 30, wherein the tool is one of a hand held power tool such as a drill or saw, a lawn or garden care tool such as a lawn mower or edge trimmer, or a floor cleaner such as a vacuum cleaner.

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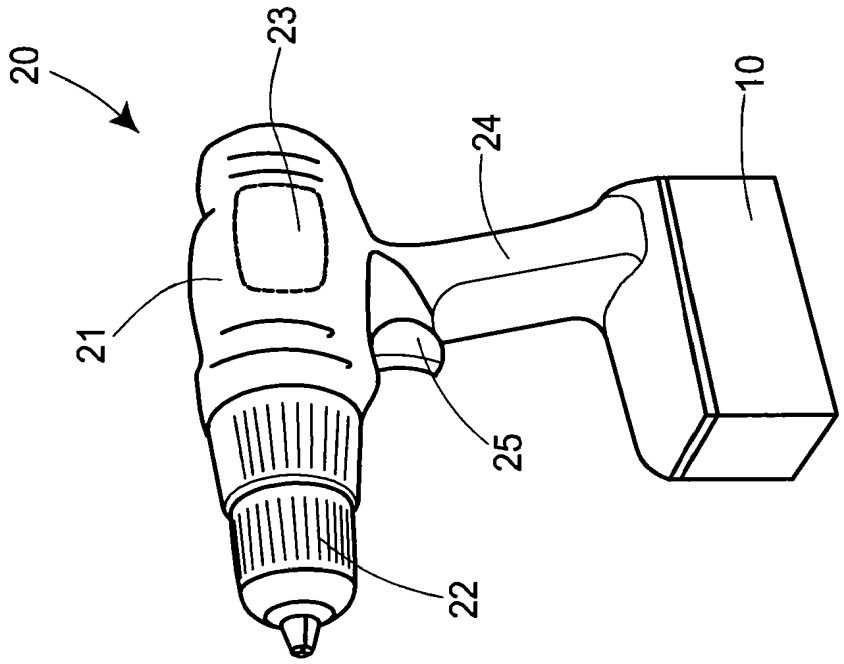


Fig. 2

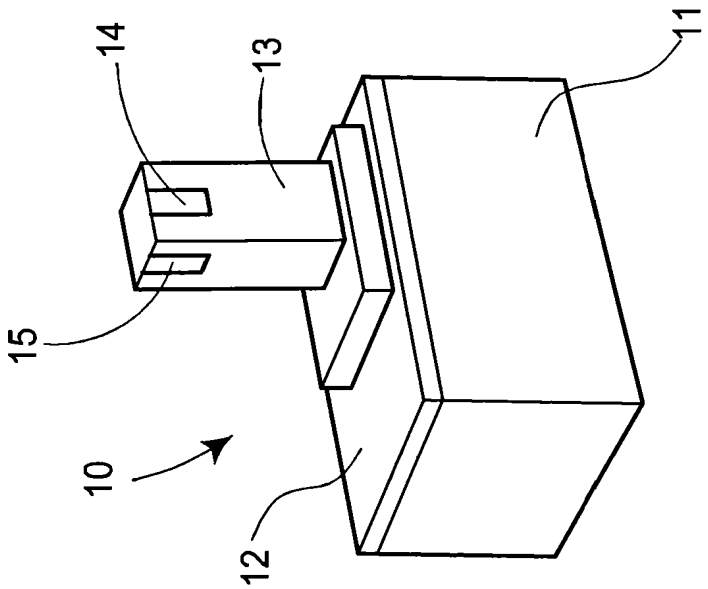


Fig. 1

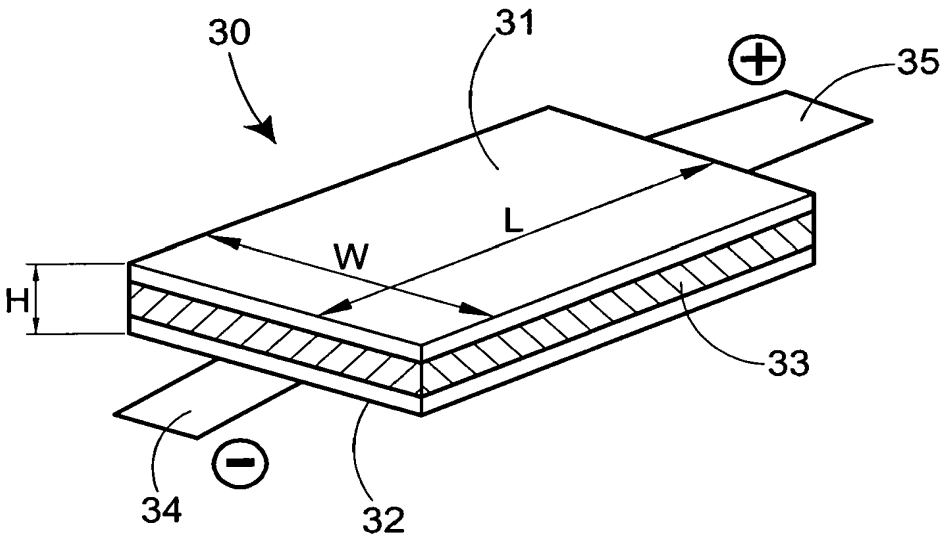


Fig. 3

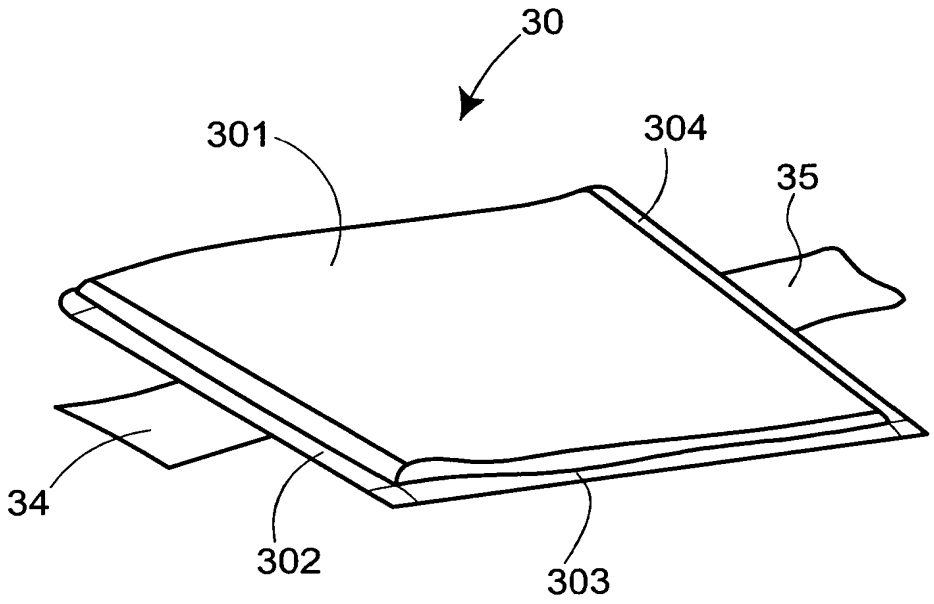


Fig. 4

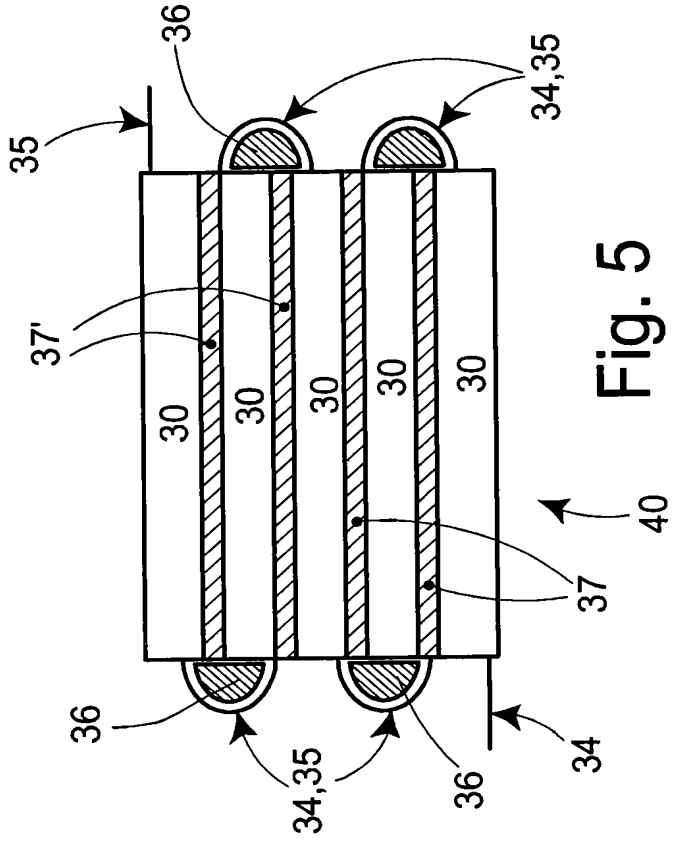

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Fig. 5

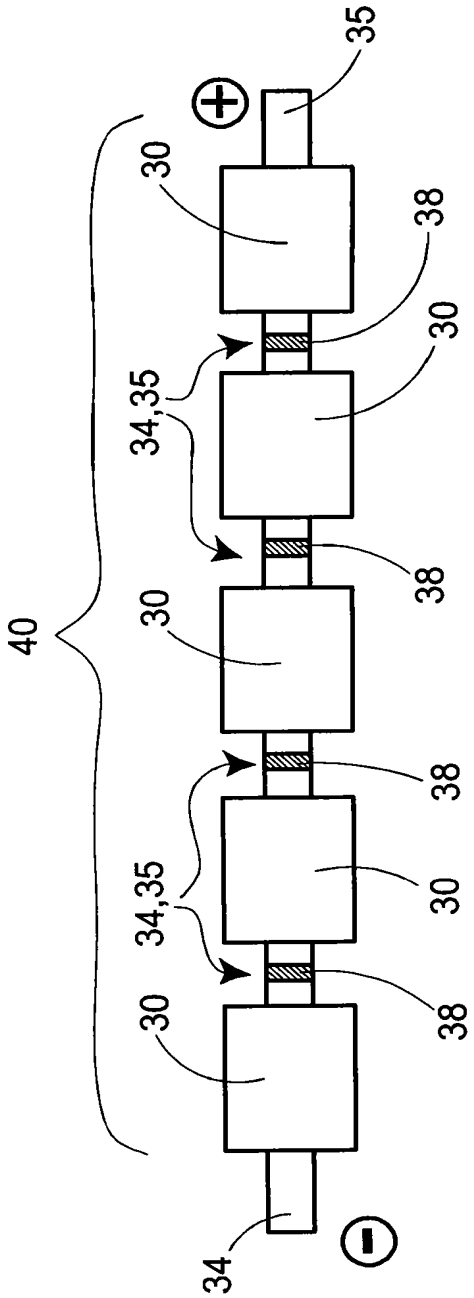

35
30
38
30
34,35
38
30
34,35
30
38
30
34
40

Fig. 6

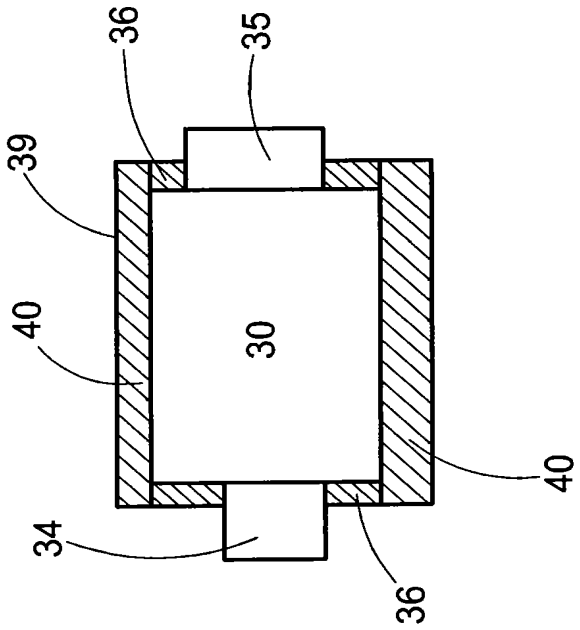


Fig. 8

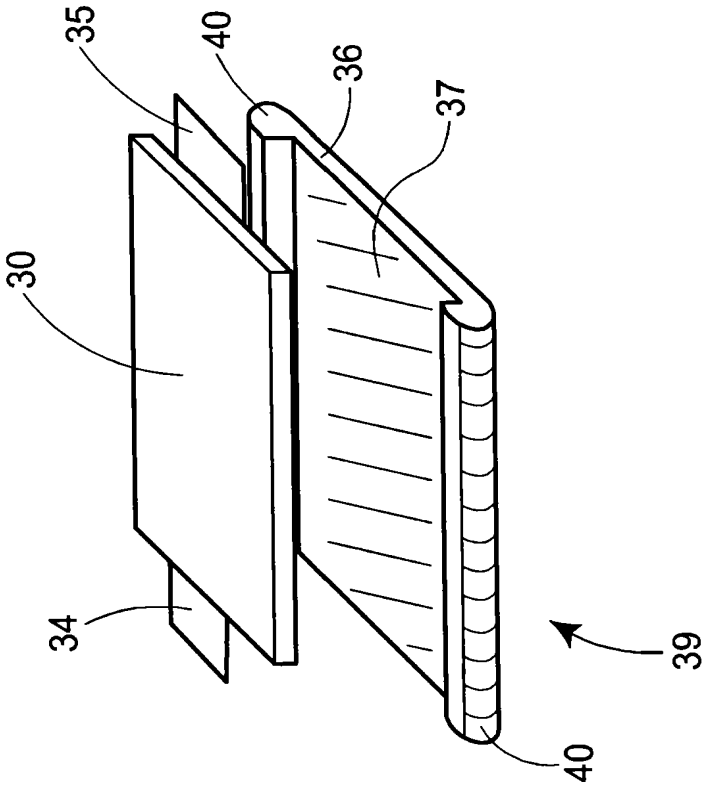


Fig. 7

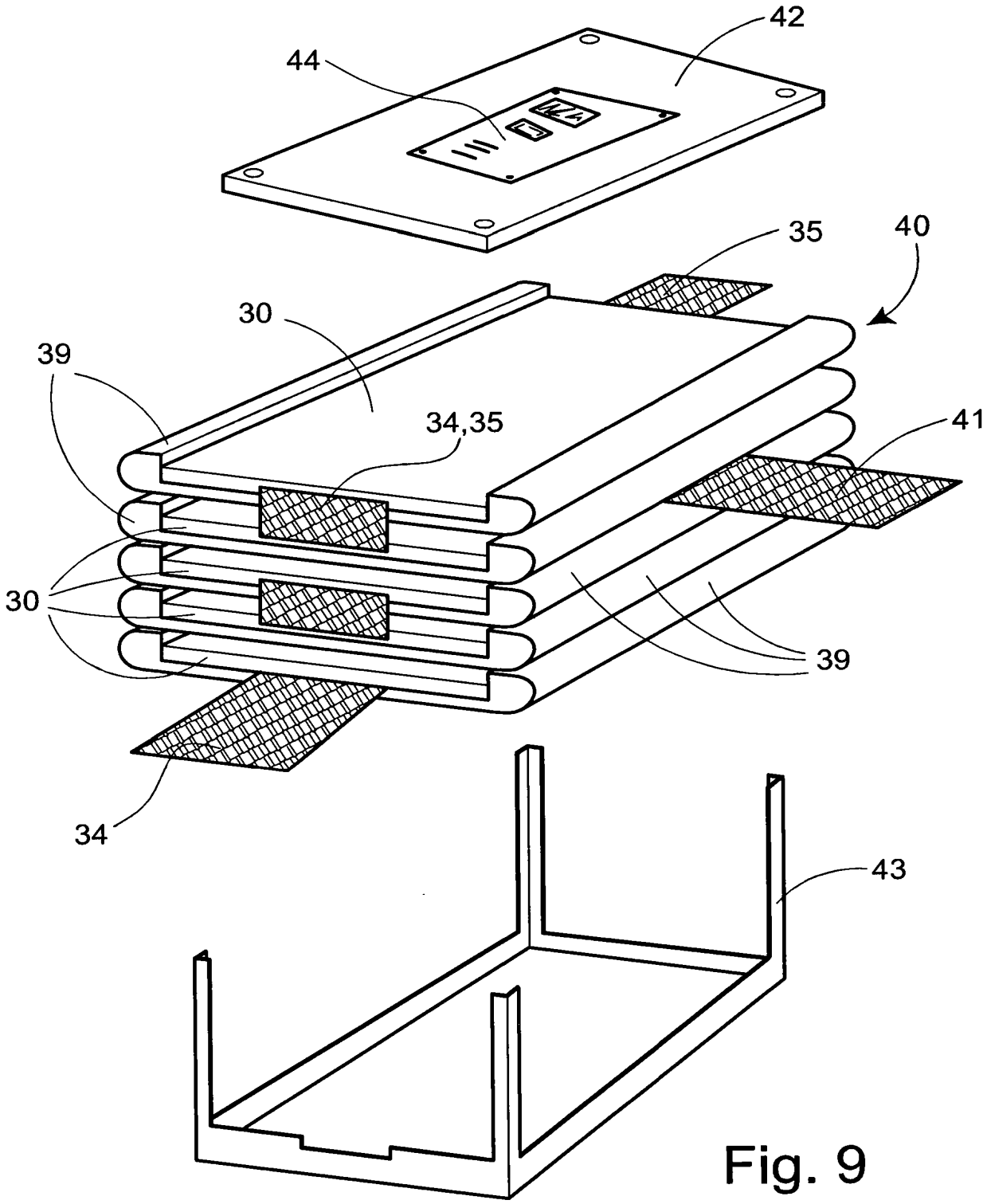


Fig. 9

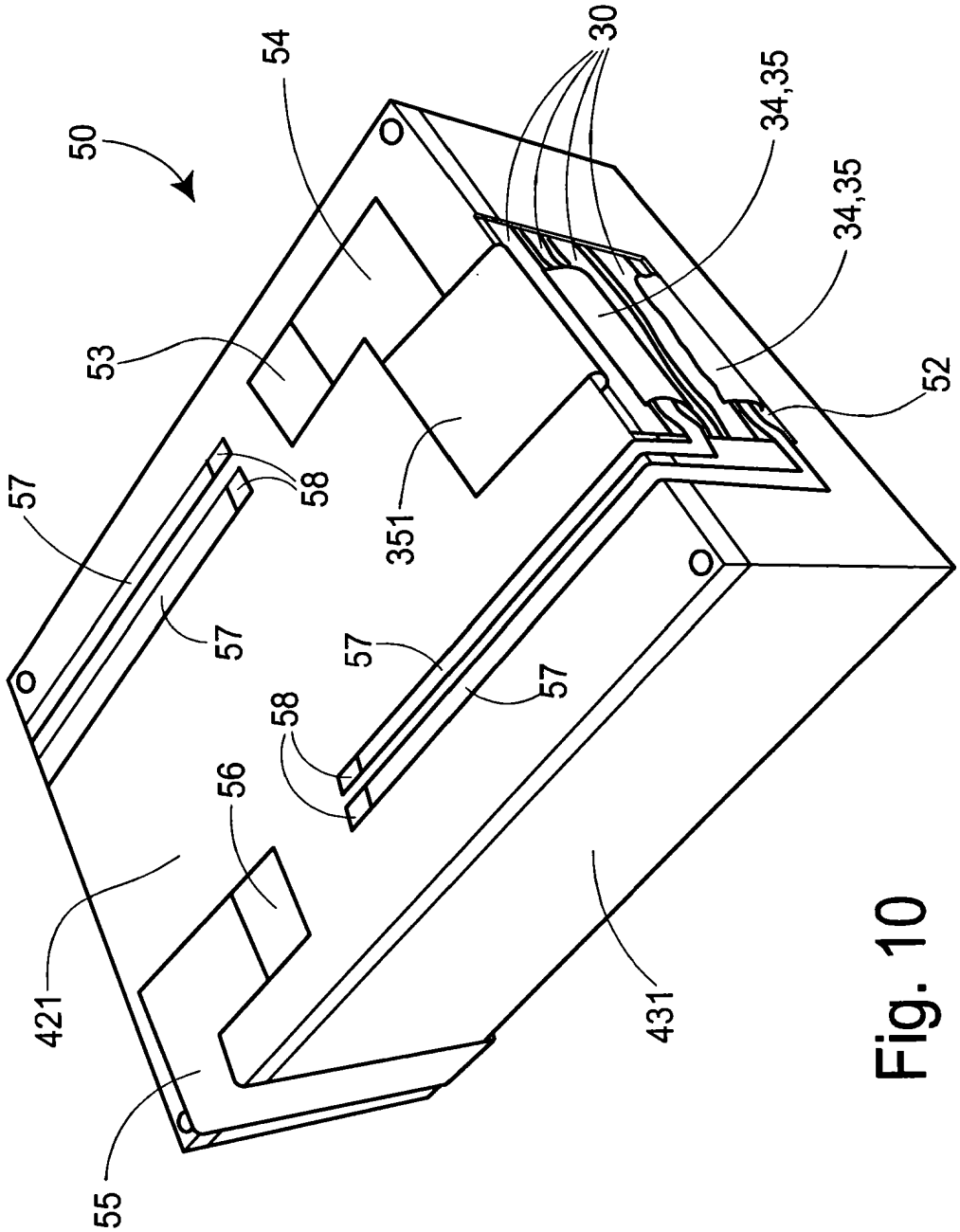


Fig. 10

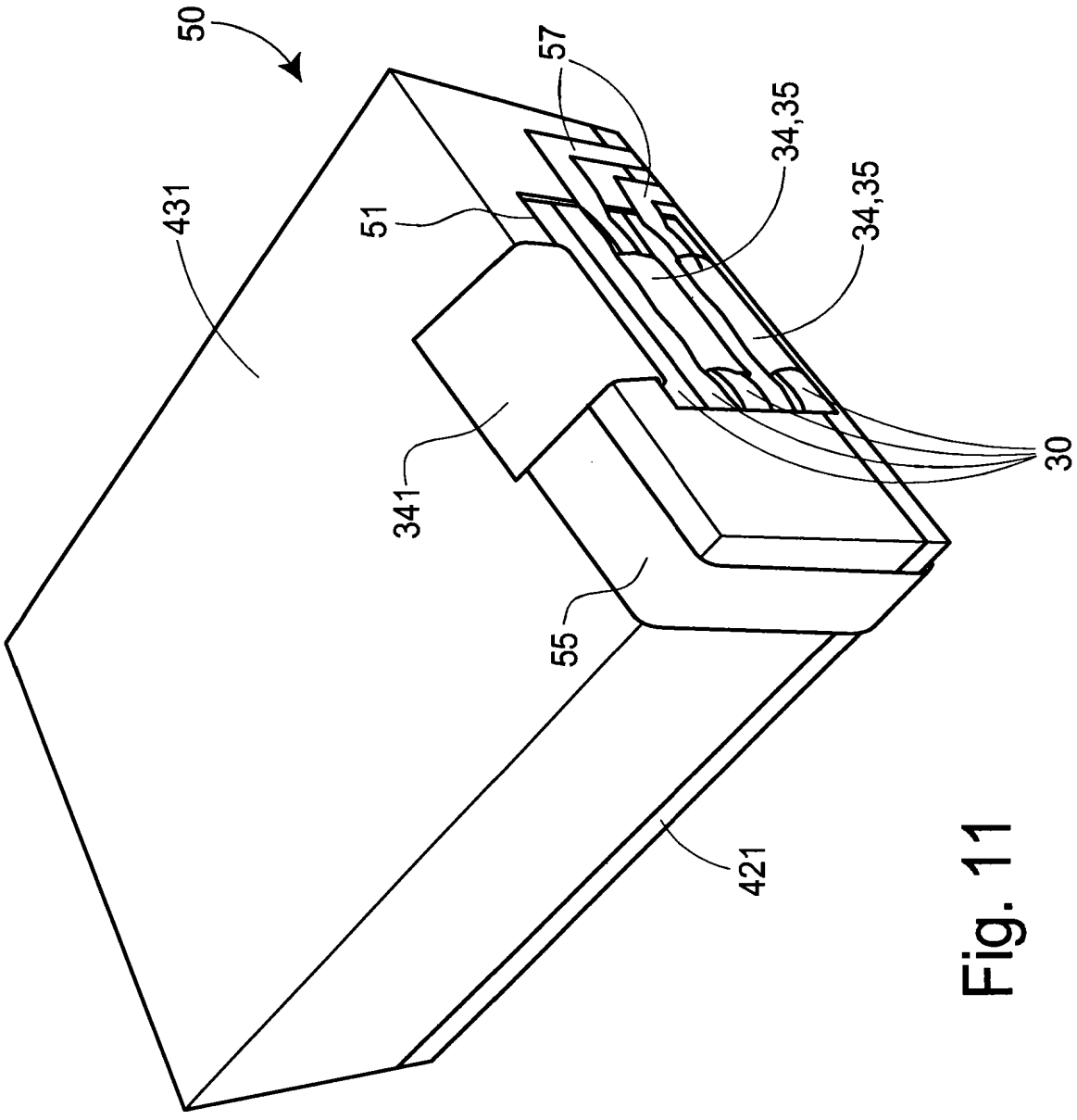


Fig. 11

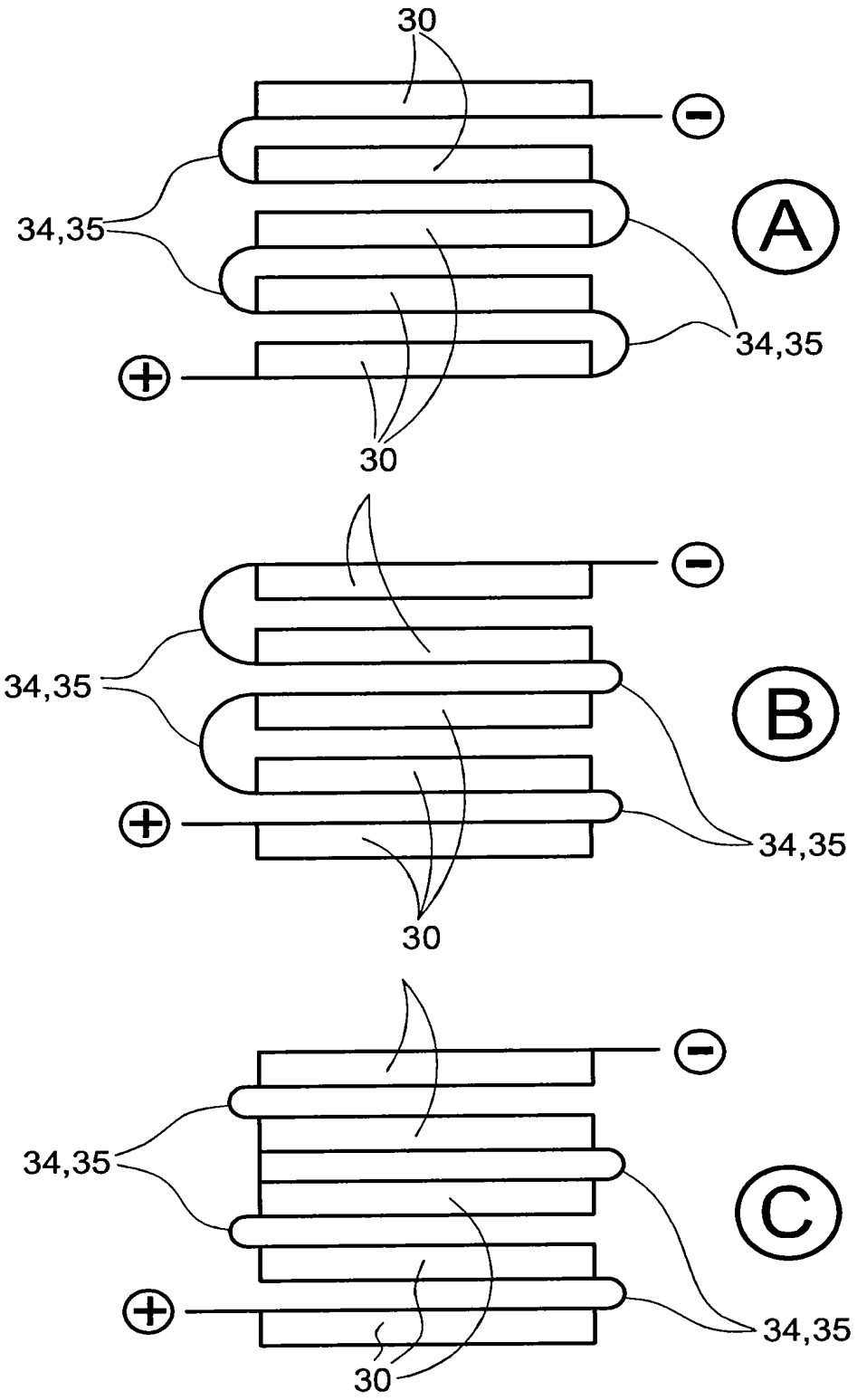


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/080868

A. CLASSIFICATION OF SUBJECT MATTER

H01M 10/36(2010.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01M H02K B25F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI,EPODOC,CNABS,CNTXT,CNKI:battery,cell,motor,tool,selective+,detachable,elastic+,spacer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008211327 A1 (SCHLEGEL, ANDREAS ET AL.) 04 September 2008 (2008-09-04) abstract, description,paragraphs [0022]-[0027] and figure 1	1-10,17,25-26,29-31
Y	US 2008211327 A1 (SCHLEGEL, ANDREAS ET AL.) 04 September 2008 (2008-09-04) abstract, description,paragraphs [0022]-[0027] and figure 1	11-16,18-24,27-28
Y	US 2009297936 A1 (NEMOTO, SEIJI ET AL.) 03 December 2009 (2009-12-03) description,paragraphs [0089]-[0097] and figures 6-7	11-16,18-24,27-28
X	CN 202952236 U (NINGBO YOUNGSUN ENTERPRISE CO., LTD.) 29 May 2013 (2013-05-29) description,paragraphs [0010]-[0012] and figure1	1-10,17,25-26,29-31
Y	CN 202952236 U (NINGBO YOUNGSUN ENTERPRISE CO., LTD.) 29 May 2013 (2013-05-29) description,paragraphs [0010]-[0012] and figure1	11-16,18-24,27-28
A	US 2008003505 A1 (WUENSCH, STEFFEN ET AL.) 03 January 2008 (2008-01-03) the whole document	1-31

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 August 2014	**28 September 2014**

Name and mailing address of the ISA/	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN) **6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China**	**XIONG,Yue**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)82245487**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/080868

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2008211327 A1	04 September 2008	DE 102004036588 A1	23 March 2006
		EP 1774607 A2	18 April 2007
		WO 2006010676 A3	12 October 2006
		WO 2006010676 A2	02 February 2006
		CN 1989635 A	27 June 2007
		JP 2008507421 A	13 March 2008
US 2009297936 A1	03 December 2009	WO 2008007767 A1	17 January 2008
		CN 101490870 B	26 October 2011
		CN 101490870 A	22 July 2009
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US 2008003505 A1	03 January 2008	CN 101115587 A	30 January 2008
		CN 101115587 B	05 October 2011
		EP 1848570 A1	31 October 2007
		WO 2006081894 A1	10 August 2006
		DE 102005005553 A1	10 August 2006

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[19] **Intellectual Property Office of the Philippines**
Bureau of Patents

[11] Patent No.: 1/2013/500793

[45] Issued: 31 January 2017

[21]	Application No:	1/2013/500793
	National Phase Entry Date	23 April 2013
[22]	International Filing Date:	25 November 2011
[43]	International Publication Date:	31 May 2012
[86]	International Application No.:	PCT/AU2011/001532
[87]	International Publication No.:	WO2012/068635 A1
[60]	Division of Application No.:	
[54]	Title:	USB OUTLET CHARGER
[71]	Applicant(s):	CLIPSAL AUSTRALIA PTY LTD [New South Wales, AU]
[72]	Inventor(s):	DE MAN, Gerrit [New South Wales, Australia]
[30]	Foreign Application Priority Data:	2010905218 25.11.2010 AU
[51]	Int. Class[8]:	H 01R 13/648, 31/06, H 02J 7/00, H 05K 5/04
[58]	Field of search:	H 01R 13/648, 31/06, H 02J 7/00, H 05K 5/04

[56] Reference(s) Considered/Cited:

Document description
CN 2012 13213 (Y) - 25 March 2009 - WENZHI WU

[57] **ABSTRACT**

Disclosed is a Universal Serial Bus (USB) charging module for installation with a surface mounted power outlet. The charging module allows convenient and flexible installation in certain new and already installed power outlets to provide a convenient charging facility of devices with USB connection. Also disclosed is a housing for the charging module, a charging circuit and a method of installation.

Industry / Technical Field					
No. of Claim(s)	32	claim/s	Drawing(s)	17	sheet/s
Multiple Dep. Claim(s)	11	claim/s	Specification and Claim(s)	31	page(s)
Specie/s Claim(s)	0	claim/s	Sequence Listings	0	page(s)
Total No. of Claim(s)	43	claim/s			

Examiner: Leodelino C. Paden

Attorney/Agent: A.Q. ANCHETA AND PARTNERS

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hbo

USB OUTLET CHARGER

FIELD OF THE INVENTION

The present invention relates to an electrical power outlet in a building such as a hotel, office or home. In a particular form, the invention relates to a power outlet providing an interface for charging Universal Serial Bus (USB) compatible devices.

PRIORITY

The present application claims priority from Australian Provisional Patent Application No. 2010905218 entitled "USB Outlet Charger" filed on 25 November 2010.

The entire contents of this document are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Many electronic devices such as mobile phones, mp3 players and digital cameras are charged through USB ports in either a computer or a USB Alternating Current (AC) adaptor which may be plugged into a wall socket or power outlet. Charging devices through a USB port on a computer requires the computer to be switched on and also prevents other peripheral devices such as mice and memory devices from accessing the port while in use. By using a USB AC adaptor the electronic device may be charged at a wall socket or power outlet. One portion of the adaptor has AC prongs which engage into AC receptacles of the wall socket while another portion of the adaptor has a USB port to interface with a USB connector of an appliance or electronic device to be

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charged. The disadvantage with this arrangement is that the USB AC adaptor is a separate component that must be purchased and carried around and also that the AC prongs will only be suitable for a particular country or region. This leads to another drawback with using USB AC adaptors in foreign countries, namely that additional AC adaptors are necessary to engage with sockets found in different areas around the world.

There are also USB wall outlets wherein the USB charger is integral with the power outlet. Having the USB charger integral with the power outlet can lead to increased complexity during installation and costly repair and replacement of parts.

An object of the present invention is to ameliorate one or more of the above described difficulties or at least provide a useful alternative for charging USB compatible devices.

Other advantages of the present invention will become apparent from the following description, taken in connection with the accompanying drawings, wherein, by way of illustration and example, several aspects and embodiments of the present invention are disclosed.

SUMMARY

In one aspect of the invention, there is proposed a Universal Serial Bus (USB) charging module housing adapted for securement to a surface mountable power outlet, the housing including:

an engaging portion for connecting the housing to a supporting portion of the power outlet;

access means to allow a USB charging circuit to be inserted into the housing; and

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an aperture for allowing external access to a USB port.

In one form, the USB charging module housing further includes at least one aperture for receiving wires carrying mains power.

In one form, the access means to allow the USB charging circuit to be inserted into the housing is provided by an aperture in an external face of the housing.

In one form, the aperture is covered by a removable portion.

In one form, the removable portion includes at least one aperture for receiving wires carrying mains power.

In one form, the supporting portion of the power outlet is an integral portion of a grid or face plate.

In another form, the supporting portion of the power outlet is located in a mounting plate that is adapted to be connected to the rear of a grid or face plate.

In one form, the housing is connected to the supporting portion of the power outlet from the front of the grid or face plate.

In one form, the housing is connected to the supporting portion of the power outlet from the rear of the grid or face plate.

In one form, the engaging portion of the USB charging module housing includes a plurality of clips extending outwardly from one or more exterior faces of the housing, said clips for engagement with one or more surfaces of the supporting portion of the power outlet in a snap fit arrangement.

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In one form, the clips have a tapered front face and a substantially vertical rear face.

In one form, the USB charging module housing has an aperture located on the front face of the housing for allowing external access to a USB port.

In a further aspect of the invention there is proposed a USB charging module adapted for securement to a surface mountable power outlet, the charging module including:

a USB port;

a USB charging circuit that is capable of receiving a mains power input;

a housing, said housing including an engaging portion for connecting the housing to a supporting portion of the power outlet; access means to allow the USB charging circuit to be inserted into the housing and an aperture for allowing external access to the USB port.

In one form, the USB charging module includes a USB charging circuit with a printed circuit board (PCB).

In one form, the USB charging module includes a plurality of wires that are soldered directly to the PCB for connection to mains power either directly or via a switch.

In another form, the USB charging module includes a terminal block mounted on the PCB for connection to wires carrying mains power either directly or via a switch.

In other embodiments, there are provided screwed terminals for wire termination.

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In a further aspect of the invention there is proposed a surface mountable power outlet for allowing a user to charge a USB compatible device, the power outlet including:

a supporting portion;

a USB charging module including a USB port; a USB charging circuit that is capable of receiving a mains power input; a housing, said housing including an engaging portion for connecting the housing to the supporting portion of the power outlet; access means to allow the USB charging circuit to be inserted into the housing and an aperture for allowing external access to the USB port;

a grid or face plate adapted to allow a user to access the USB port;

a connection between the USB charging module and mains power; and

mounting means for mounting the power outlet to a mounting surface.

In one form, the mounting surface is a wall or floor.

In one form, the power outlet further includes a cover plate.

In one form, the mains power is between about 100-240V alternating current (AC).

In a further aspect of the invention there is proposed a method of installing a power outlet for allowing a user to charge a USB compatible device as herein described, comprising the steps of:

connecting the engaging portion of the USB charging module housing to the supporting portion of the power outlet;

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connecting the mains power to the USB charging module; and

mounting the power outlet to the mounting surface.

In a further aspect of the invention there is proposed a method of installing a power outlet for allowing a user to charge a USB compatible device as herein described, comprising the steps of:

connecting the engaging portion of the USB charging module housing to the supporting portion of the power outlet;

connecting the mounting plate to the rear of a grid or face plate.

connecting the mains power to the USB charging module; and

mounting the power outlet to the mounting surface.

In one form, the power outlet is attached or mounted to the mounting surface by fastening the grid or face plate to the surface by screws.

It will be understood that the term "comprise" and any of its derivatives (e.g. comprises, comprising) as used in this specification is to be taken to be inclusive of features to which it refers, and is not meant to exclude the presence of any additional features unless otherwise stated or implied.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that such prior art forms part of the common general knowledge of the technical field.

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DRAWINGS

Various aspects of the present invention will be described in detail with reference to the following drawings in which:

FIGURE 1 is a front perspective view of a USB charging module housing according to a first aspect of the present invention;

FIGURE 2 is a rear perspective view of the USB charging module housing of Figure 1;

FIGURE 3 is a detailed view of part of an engaging portion of the USB charging module housing as shown in Figure 1;

FIGURE 4 is a view of a removable cover that fits into the rear opening of a USB charging module housing;

FIGURE 5 shows an embodiment of a supporting portion of a surface mountable power outlet adapted to engage with a USB charging module housing;

FIGURE 6 is a detailed view of the mating interface of the supporting portion shown in Figure 5;

FIGURE 7 is a perspective view of a USB charging module according to an embodiment of a second aspect of the present invention;

FIGURE 8 is a perspective view of a USB charging module according to another embodiment of the second aspect of the present invention;

FIGURE 9 is a side view of the USB charging module shown in Figure 8;

FIGURE 10 is an end or rear view of the USB charging module shown in Figure 7 (wires not shown);

FIGURE 11 is a view of a USB charging module engaged with a grid or face plate of a surface

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mountable power outlet according to an embodiment of the present invention;

FIGURE 12 is a view of a USB charging module engaged with a grid or face plate of a surface mountable power outlet according to another embodiment of the present invention;

FIGURE 13 is a surface mountable power outlet according to an embodiment of a third aspect of the present invention;

FIGURE 14 shows a surface mountable power outlet according to another embodiment of the third aspect of the present invention;

FIGURE 15 is a circuit schematic depicting an embodiment of the AC mains voltage step down and regulation component of the USB charging circuit;

FIGURE 16 is a circuit schematic of a power conditioning circuit with a DC-DC converter to regulate the current and voltage suitable for the USB charging module;

FIGURE 17 is a top view of a USB charging circuit adapted to fit inside the USB charging module housing of Figure 1;

FIGURE 18 is a perspective view of the USB charging circuit as shown in Figure 17;

FIGURES 19a-19c depict a sequential series of views of a method of installing a USB charging module to a surface mountable power outlet according to a fourth aspect of the present invention; and

FIGURE 20 shows a flow diagram illustrating a general method of installing a USB charging module into a surface mountable power outlet according to a fourth aspect of the present invention.

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FIGURE 21 is a perspective view of an embodiment of a USB charging module suitable for front entry engagement with a power outlet.

FIGURE 22 is a section view through A-A of the engaging portion of the USB charging module housing of Figure 23;

FIGURE 23 is a front view of the USB charging module housing as depicted in Figure 21;

FIGURE 24 is a section view B-B of the supporting portion of the grid or face plate depicted in Figure 25;

FIGURE 25 is a front view of a grid or face plate suitable for engagement with the USB charging module of Figure 21;

FIGURE 26 shows the USB charging module of Figure 21 to be connected from the front of the grid or face plate according to an embodiment of the present invention; and

FIGURE 27 shows the USB charging module of Figure 21 to be connected from the front of the grid or face plate according to another embodiment of the present invention.

In the following description, like reference characters designate like or corresponding parts throughout the several views of the drawings.

DESCRIPTION

Referring now to Figures 1-4, there is shown a USB charging module housing 10 according to a first aspect of the present invention. The housing 10 has an aperture 12 through a front face 11 that is large enough to provide access for a USB connector to plug

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into a USB port or socket 50 enclosed within the housing (see Figure 7). At the rear of the housing 10 (see Figure 2) is an opening or aperture 13 which enables access for inserting a USB charging circuit 60 (see Figure 7) into the housing 10. Although this embodiment shows the rear of the housing as being open to provide an access means for the USB charging circuit 60, it is possible that the opening 13 could be located on a different face and may constitute an entire face or a part thereof. Figure 4 shows a removable cover 20 that engages with the rear of the housing 10 to substantially seal the enclosure from dust and ingress. The removable cover 20 has angled clips 26 and 27 that engage into mating apertures 16 and 15 respectively of the housing 10 in a snap fit arrangement. The lip of the angled clips 27 are inserted directly into apertures 15 and then the cover 20 is closed by applying force proximate the clips 26 until they snap into apertures 16. The clips 26, 27 are flexible and resilient so that they may bend sufficiently to allow fitment into the apertures 15, 16 whereupon they return to their undeformed positions.

In one embodiment, a feature of the housing 10 is the clip interface comprising four clips 14 that are positioned around the four side faces of the housing 10. These clips form an engaging portion that connects the housing 10 to a supporting portion 30 (see Figure 5) of a surface mountable power outlet. The supporting portion 30 may be integral with a grid or face plate of the power outlet or located on a mounting plate that is adapted to be connected to the rear of a grid or face plate. Figure 3 shows a detailed view of a clip 14, in

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particular illustrating a type of clip with a tapered front face 14b and substantially vertical rear face 14a. These clips are designed to engage with the mating interface 34 of the supporting portion 30 which is most clearly illustrated in Figure 6. Figure 6 shows detail of a typical mating interface 34 which will connect to a USB charging module housing 10. As the housing 10 is inserted into the supporting portion 30, the tapered surface 14b of the clip 14 will engage a corresponding tapered surface 35 of the supporting portion 30. As more insertion force is applied, the clip 14 will deflect slightly as it passes the vertical surface 37 of the supporting portion 30. The substantially vertical rear face 14a of the clip 14 will eventually pass the lowest point of the vertical surface 37, upon which it reaches the recessed horizontal surface 36 of the supporting portion 30. The compression force acting on the clip 14 is then released and it deflects back to its undeformed position and the substantially vertical rear face 14a engages in surface to surface contact with the horizontal recessed surface 36 of the supporting portion 30 to thereby retain housing 10 to the supporting portion 30. In the embodiment shown in Figure 5, the supporting portion 30 has only two mating interfaces 34 requiring that only two of the four clips 14 be used to connect the housing 10 to the supporting portion 30. In practice, two or more of the clips 14 may be used to secure the housing, and the supporting portion 30 may also have two or more mating interface 34.

Referring now to Figure 7, there is shown a USB charging module 40 according to an embodiment of a

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second aspect of the present invention. Enclosed inside the housing 10 is a USB port 50 and a USB charging circuit 60. Wires 70, 71 to be connected to mains power are soldered directly onto a printed circuit board (PCB) 62 of the charging circuit 60 (see Figure 16). The wires 70, 71 exit the housing 10 through apertures 22 located through the removable cover 20 (see Figure 10). During installation these wires may be connected to mains power either directly or via a switch. In other embodiments, there may be simply provided screwed terminals for wire termination instead of a terminal block.

Referring now to Figures 8 and 9, there is shown a USB charging module 80 according to another embodiment of the second aspect of the present invention. Enclosed inside the housing 10 is USB port 50 and USB charging circuit 60 with a terminal block 65 to be connected to mains power. During installation, wires carrying mains power either directly or via a switch are connected to the terminal block 65 to power the USB charging circuit 60. The wires enter the housing 10 through apertures 18 located on one side of the housing 10.

In the USB charging module embodiments described above, the power input to the module is mains power (also known as household, supply or grid power) supplied between about 100-240V alternating current (AC). The USB charging circuit 60 regulates the voltage and steps it down to a usable 4.75-5.25V direct current (DC) which is typically required to charge many electronic devices.

Referring now to Figures 11-14, there are shown various embodiments of the USB charging module 40 or 80

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connected to a grid or face plate of a surface mountable power outlet. Figure 11 shows USB charging module 40 engaged with a supporting portion 30 which is integral with a grid or face plate 100. In one example, the supporting portion 30 is integrally machined into the grid or face plate 100 during manufacture. In other embodiments, the supporting portion 30 is provided as a separate piece and is attached to the grid or faceplate during or before installation. The grid or face plate 100 can be constructed from plastic, metal or any other suitable materials. Figure 11 shows a grid or face plate 100 with two apertures 102 (only one visible in this view) capable of receiving switches or other electrical connectors in addition to USB ports. Further, as the USB charging module is modular in design, it can always be easily interchanged for a switch or other desired user interface. The grid or face plate 100 shown in Figure 11 may be adapted in many ways such as providing for AC receptacles as commonly found in most household power outlets. The grid or face plate 100 is fastened to a wall by screws or other suitable fasteners through mounting lugs 101. These may be arranged in any suitable position on the grid or face plate 100 and may vary in quantity.

Figure 12 shows a USB charging module 80 engaged with a supporting portion 30 located in a mounting plate 200 that is adapted to be inserted into the rear of a grid or face plate 110. In this arrangement the supporting portion 30 is integrally machined into mounting plate 200. Such a mounting plate 200 (also known as a base or base plate) in standard power outlets, commonly includes electrical contacts for AC

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receptacles, switch mounting and terminals to connect mains power wiring. The mounting plate 200 is designed to be received by the rear of a grid or face plate 110. As shown in Figure 12, the mounting plate 200 is fastened to the grid or face plate 110 by screws at mounting positions 201. The grid or face plate 110 is mounted onto a wall by screws at mounting locations 111, 112.

Figure 13 more specifically shows a surface mountable power outlet 500 according to a third aspect of the present invention allowing a user to charge USB compatible devices. In this arrangement the USB charging module 40 or 80 is connected to a supporting portion 30 that may either by integral with the grid or face plate or located on a mounting plate adapted to be connected to the rear of the grid or face plate. In this embodiment the power outlet 500 has a pair of switches and AC receptacles in addition to the USB charging module 40 or 80. A power outlet 500 such as this allows a user to plug in normal AC type connectors with power switched on or off and advantageously also provides a user with access to a USB port 50 for charging electronic devices. If the USB charging module 40 or 80 is wired directly to mains without a switch then the charging module 40 or 80 is constantly connected to mains power so that when a user connects their device into the USB port, charging will begin automatically. If the USB charging module 40 or 80 is wired to mains via a switch, then power will not be drawn until the user engages the switch to an "ON" position. As shown in Figure 14 in another embodiment of a wall mounted power outlet 510, there is a USB

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charging module 40 or 80 provided additionally with LED status lights 55 that indicate whether the device connected to the port is charging or not. In both Figures 13 and 14 there is also shown a cover plate 90, 91 that is adapted to fit around the periphery of the power outlet. The cover plate 90, 91 usually snap fits around the grid or face plate and is provided primarily for aesthetics when the power outlet is mounted to a surface such a wall or floor.

It will be appreciated by those skilled in the art that the surface mountable power outlet embodiments illustrated in this text are by no means limiting to how the invention may be performed. The geometric arrangement of switches, AC receptacles, USB ports or other network connection ports may be customised to suit a particular application. The supporting portion 30 also need not necessarily be limited to being an integral portion of a grid or face plate or located on a mounting plate adapted to be inserted into the rear of a grid or face plate. The supporting portion 30 could be mounted or machined into almost any structure, including a box or other structural housing. Further, the engaging portion of the USB charging module housing and supporting portion of the power outlet may be designed with alternative interfaces to the clip arrangement shown which achieves the principle aim of the invention in providing a modular USB housing which is adapted to be installed in a surface mountable power outlet thereby allowing a user to charge USB compatible devices.

Referring now to Figures 15-19, there is shown the USB charging circuit 60 that receives a 240V AC mains

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power input and provides a 5V DC output to the USB port 50, suitable for charging USB compatible electronic devices. The USB charging circuit 60 comprises the following stages. In the first stage, shown in Figure 15, the 240V AC mains input is first stepped down using a transformer 61 to reduce the high AC voltage to a low AC voltage (e.g. 15V, 1.2A). This stepped down AC voltage is then passed through a rectifier circuit 63 (e.g. bridge rectifier) that outputs a full wave varying rectified voltage shown as the output across load R_L. As shown in Figure 16, this varying voltage is then smoothed with a capacitor to produce a relatively smooth DC voltage with a small ripple. A voltage regulator (e.g. 7812 Integrated Circuit (IC)) is then used to output a regulated 12V DC output as will be understood by the person skilled in the art.

In the second stage, an embodiment of which is shown in Figure 16, a DC-DC converter (e.g. Texas Instruments TPS40210 current mode boost controller) is then used to regulate the output suitable for the USB charger. The TPS40210 implements a DC-DC single-ended primary inductance converter (SEPIC) with input and output current regulation, as well as output voltage regulation implemented by closed loop feedback control. The TPS40210 ensures that the output voltage of the USB charger is between about 4.75 and 5.25 V (nominally 5V DC) with an operating current of about 1A and also prevents overcharging. The voltage input in Figure 16 is the regulated 12V from the first stage, which is converted to a regulated 5V DC voltage output by the circuit shown. It should be understood that this is just one example of how a USB charging circuit may be

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implemented and any other suitable circuit arrangement may be used.

Referring specifically to Figures 17 and 18 there is shown an embodiment of the physical circuit layout of the USB charging circuit 60. A double layered PCB 62 is used which provides a compact and efficient way to house all of the components inside the housing 10. On one layer of the PCB 62 there is mounted the USB port 50, an optional terminal block 65 and the circuit components for the AC mains voltage step down and first stage regulation (including transformer, capacitors, 7812 IC voltage regulator and rectifier circuit). On the second layer of the PCB 62 there is provided the power conditioning circuitry for the USB charger output (including the TPS40210 and various other capacitors, inductors, resistors and diodes).

In other embodiments, there is provided 2 or 3 or more PCBs over which the circuit components are arranged, rather than (or as well as) a double layered arrangement.

Referring now to Figures 19a-19c there is shown a sequential series of views of a method of installing the USB charging module 80 to a surface mountable power outlet according to a fourth aspect of the present invention. In this embodiment, the mounting surface is a wall 90. In Figure 19a there is shown the step of connecting the engaging portion of the USB charging module housing 10 to a supporting portion 30 of the power outlet. Figure 19a shows the USB charging module 80 already having been engaged with the supporting portion 30. Figure 19b illustrates the next step of connecting the mains power to the USB charging circuit

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60. The USB charging module 80 and grid or face plate assembly is held in close proximity to a wall opening where the power outlet is to be located. The wiring from the mains (typically active and neutral wires, with earth optional) is physically connected to the USB charging circuit 60. The particular embodiment illustrated in Figures 19a-19c shows a USB charging module 80 with a terminal block 65 for terminating the mains wires. The final step in the installation is to attach or mount the power outlet to the wall 90 as illustrated in Figure 19c. The grid or face plate is held flat against the wall 90 and screws or other suitable fastening means are inserted through mounting apertures in the grid or face plate and fastened securely to the wall 90. In another example, the USB charging module 40 may be connected using wires 70, 71 as previously described.

Figure 20 illustrates a flow diagram of a method of installing the USB charging module 40 or 80 to a surface mountable power outlet. In step 600, the installer begins with the USB charging module. In step 601, the engaging portion of the USB charging module housing 10 is connected to the supporting portion 30 of the power outlet. In step 602, a determination is made as to whether the supporting portion is located in a mounting plate that is not integral with the grid or faceplate. If the supporting portion 30 is integral with the grid or face plate, the mains power is connected to the USB charging circuit 60 and the power outlet is attached or mounted to the mounting surface (which may be a wall or floor or other appropriate surface) in step 604. If the supporting portion 30 is

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located in a mounting plate that is not integral with the grid or face plate, then there is an additional step 603 of connecting the mounting plate to the grid or face plate.

In step 605, the installer then connects the AC mains power to the USB and then in step the power outlet assembly is mounted or attached to the mounting surface such as the wall 90 or a floor. In step 606, the resulting product of the method is a surface mounted USB power or charging outlet.

Once installation is complete, the power outlet provides an interface to charge USB compatible devices. The USB charging module 40,80 receives a mains input power between about 100-240V AC and converts this to a regulated 5V DC output suitable for charging USB compatible electronic devices. The modular housing 10 enables the power outlet to have interchangeable interfaces to suit operational requirements. The USB charging module 40,80 may be removed from the power outlet and replaced with a switch or any other interface without having to replace the entire power outlet.

Referring now to Figures 21-27, there is shown a further embodiment whereby the USB charging module 40,80 is connected to the supporting portion 130 of a grid or face plate 120 of a surface mountable power outlet from the front thereby providing a 'front entry' insertion option. Whereas previously described the USB charging module 40,80 is connected into a supporting portion 30 in the rear of the grid or face plate, it is also desirable to be able to insert the module from the front of the grid or face plate. It will be appreciated

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that this connection may be facilitated in many ways, an example of which is shown in Figures 21-27. Figure 21 generally shows a USB charging module 40,80 which can be connected to mains power as previously described. In one form, the module may have a clip interface comprising clips 18 as shown in more detail in Figures 22-23. Figure 23 is a front view of a USB charging module housing 10 showing the location of two clips 18 suitable for front entry connection of the module. Figure 22 is a sectional view through A-A of Figure 23 providing detail of a possible clip arrangement. This clip arrangement allows the housing 10 to engage with a supporting portion 130 of a grid or face plate 120 as shown in Figure 25. Figure 24 shows as a sectional view through B-B of Figure 25 which generally shows the supporting portion 130 in more detail. The housing 10 of the USB charging module 40,80 is inserted through aperture 132 of the supporting portion 130. The clip arrangement facilitates a snap-fit connection between the clips 18 and the supporting portion 130. As the module is inserted into the grid or face plate, the resilient clips 18 bend slightly as force is applied such that the outer most surface 18b of the clips 18 can pass the inner most surface 133 of the supporting portion 130.Once engaged, surface 19 of the housing 10 mates with recessed surface 131 of the supporting portion 130 and surface 18a of the clips 18 is in contact with surface 134 of the supporting portion 130.

Figures 26-27 show exploded views of the USB charging module 40,80 and grid or face plate front entry installation. Figure 26 shows a grid or face

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plate 120 with two apertures 132 which enables more than one USB charging module 40,80 to be inserted. Figure 27 shows a grid or face plate 140 with a single aperture 132 for receiving a USB charging module 40,80 from the front. In addition, Figure 27 shows a cover plate 145 that is attached or mounted to the grid or face plate after the USB charging module 40,80 has been connected and screws 146 for attaching or mounting the grid or face plate to a surface such as a wall or floor.

Although various illustrative embodiments of the present invention have been described in the foregoing detailed description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the scope of the invention as set forth and defined by the following claims.

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CLAIMS:

1. A Universal Serial Bus (USB) port housed in a housing including an engaging portion, the engaging portion including at least two deflectable clips, each for engaging with a corresponding recessed surface of a corresponding mating interface of a supporting portion disposed at the rear of a power outlet for retaining the USB port to the power outlet, upon insertion of the engaging portion into the supporting portion from the rear of the power outlet.

2. A Universal Serial Bus (USB) port housed in a housing as claimed in claim 1, wherein the at least two deflectable clips each has a tapered surface for engaging with a corresponding tapered surface of the corresponding mating interface of the supporting portion and for causing deflection of the corresponding deflectable clip upon insertion of the engaging portion into the supporting portion.

3. A Universal Serial Bus (USB) port housed in a housing as claimed in claim 2 wherein the at least two deflectable clips each includes a face for engaging with the corresponding recessed surface of the supporting portion for thereby retaining the USB port to the power outlet.

4. A Universal Serial Bus (USB) port housed in a housing as claimed in any one of claims 1 to 3

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wherein the engaging portion includes four deflectable clips for engaging with the supporting portion.

5. A Universal Serial Bus (USB) charging module including:

a housing;

a USB port;

an engaging portion including at least two deflectable clips, each for engaging with a recessed surface of a corresponding mating interface of a supporting portion of a power outlet disposed at the rear of the power outlet for retaining the USB port to the power outlet upon the at least two deflectable clips being inserted into the supporting portion from the rear of the power outlet; and

a USB charging circuit housed in the housing and electrically connected to the USB port at an output and for connection to mains power at an input.

6. A Universal Serial Bus (USB) charging module as claimed in claim 5 wherein the at least two deflectable clips each has a tapered surface for engaging with a corresponding tapered surface of the corresponding mating interface of the supporting portion and for causing deflection of the corresponding deflectable clip upon insertion of the engaging portion into the supporting portion.

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7. A Universal Serial Bus (USB) charging module as claimed in claim 6 wherein the engaging portion includes four deflectable clips for connecting the USB charging module to the supporting portion.

8. A Universal Serial Bus (USB) charging module as claimed in claim 7 wherein the USB charging module is removable from the supporting portion once connected to the supporting portion.

9. A Universal Serial Bus (USB) charging module as claimed in claim 5 wherein the USB charging circuit, in use, converts mains power input of between 100V and 240V alternating current (AC) to between 4.75V and 5.25V direct current (DC) at the output for supply to the USB port.

10. A method of connecting a Universal Serial Bus (USB) housing to a power outlet having a front side accessible by a user when the power outlet is mounted to a surface, the USB housing housing a USB port and including an engaging portion, the method including:

engaging the engaging portion of the USB housing with a supporting portion located at a rear side of the power outlet by inserting the engaging portion into the supporting portion from the rear side of the power outlet, thereby retaining the USB housing to the power outlet.

11. A method of connecting a Universal Serial Bus (USB) housing as claimed in claim 10 wherein the

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step of engaging the engaging portion of the USB housing with the supporting portion includes causing at least two clips of the engaging portion to each deflect upon engaging with a corresponding tapered surface of the supporting portion upon inserting the engaging portion into the supporting portion and then causing the at least two clips to each assume an undeflected position upon further inserting the engaging portion into the supporting portion.

12. A method of connecting a Universal Serial Bus (USB) housing as claimed in any one of claims 10 or 11 wherein the step of inserting the engaging portion into the supporting portion also causes the USB port to be located within an aperture in the power outlet to allow access to the USB port by a user via the aperture.

13. A method of connecting a Universal Serial Bus (USB) housing as claimed in claim 10 further including the step of connecting one or more electrical terminals of the USB housing to mainspower.

14. A power outlet for allowing a user to charge a device via a Universal Serial Bus (USB) connector of the device, the power outlet having a front side accessible by a user when the power outlet is mounted to a surface, the power outlet including:

an aperture for receiving a switch; and

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a USB port housed in a housing as claimed in claim 1 , for receiving the USB connector; wherein the USB port is disposed in the aperture and is connected to the power outlet at the supporting portion located at the rear of the power outlet.

15. A power outlet as claimed in claim 14 wherein the USB port is electrically connected to an output of a USB charging circuit, the USB charging circuit also including an input for connection to mainspower.

16. A power outlet as claimed in claim 15 further including a second aperture in which is disposed a switch for controlling mains power supplied to the USB charging circuit.

17. A power outlet as claimed in any one of claims 15 or 16 wherein, in use, the USB charging circuit converts mains power received at the input of between 100V and 240V alternating current (AC) to between 4.75V and 5.25V direct current (DC) at the output for supply to the USB port.

18. A power outlet for allowing a user to charge a device via a Universal Serial Bus (USB) connector of the device and for allowing the user to provide mains power to a further device via an alternating current (AC) connector, the power outlet having a front side accessible bya user, and the power outlet including:

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at least one power socket for connection to mains power and for receiving the AC connector; an aperture for receiving a switch; and a Universal Serial Bus (USB) port housed in a housing as claimed in claim 1, for receiving the USB connector.

19. A power outlet as claimed in claim 18 wherein the USB port is electrically connected to an output of a USB charging circuit, the USB charging circuit also including an input for connection to mainspower.

20. A power outlet as claimed in claim 19 wherein, in use, the USB charging circuit converts mains power at the input of between 100V and 240V alternating current (AC) to between 4.75V and 5.25V direct current (DC) at the output for supply to the USB port.

21. A power outlet as claimed in any one of claims 18 to 20 wherein the engaging portion is provided by four deflectable clips for connecting the USB charging module to the supporting portion of the power outlet.

22. A power outlet as claimed in claim 18 including a second power socket and two switches, at least one switch for controlling mains power supplied to at least one of the power sockets.

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23. A method of installing a Universal Serial Bus (USB) charging module as claimed in claim 5, in a power outlet, the method including:

connecting the USB charging module to the power outlet from a rear of the power outlet by connecting the engaging portion to a supporting portion at the rear of the power outlet so that the USB port is accessible via an aperture in the power outlet;

connecting the input of the USB charging circuit to mains power; and

mounting the power outlet to a mounting surface.

24. A method of installing a Universal Serial Bus (USB) charging module as claimed in claim 23 wherein the step of connecting the USB charging module to the power outlet includes inserting the engaging portion of the USB charging module into the supporting portion of the power outlet causing the at least two clips of the engaging portion to each deflect upon engaging with a corresponding tapered surface of the supporting portion and then causing the at least two clips to each assume an undeflected position upon further inserting the engaging portion into the supporting portion, to thereby retain the engaging portion to the supporting portion.

25. A method of installing a Universal Serial Bus (USB) charging module as claimed in any one of claims 23 to 24 wherein the step of connecting the input of the USB charging circuit to mains power

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includes connecting an active wire and a neutral wire of the USB charging module to mainspower.

26. A method of installing a Universal Serial Bus (USB) charging module as claimed claim 23 wherein the step of connecting the input of the USB charging circuit to mains power occurs after the step of connecting the USB charging module to the power outlet.

27. A method of installing a Universal Serial Bus (USB) charging module as claimed claim 23 wherein the step of mounting the power outlet to a mounting surface includes mounting the power outlet to a wall around an aperture in the wall, and wherein the USB charging module is thereby retained within a cavity behind the wall.

28. An interface between a supporting portion located at a rear of a power outlet and a USB port, the power outlet having a front side accessible by a user when the power outlet is mounted to a surface, and the interface including at least two mating interfaces of the supporting portion, each engaging with a corresponding deflectable clip of an engaging portion disposed about the USB port to thereby retain the USB port to the power outlet, the interface having been formed by inserting the engaging portion into the supporting portion from a rear side of the power outlet.

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29. An interface as claimed in claim 28 wherein the at least two mating interfaces each includes a recessed surface engaging with a face of the corresponding deflectable clip.

30. An interface as claimed in claim 29 wherein the at least two mating interfaces each includes a tapered surface for engaging a tapered surface of the corresponding clip upon insertion of the corresponding clip into the at least two mating interfaces.

31. An interface as claimed in any one of claims 28 to 30 wherein the supporting portion is disposed about an aperture in the power outlet.

32. An interface as claimed in claim 31 wherein the USB port is disposed within the switch aperture and is accessible via the aperture.

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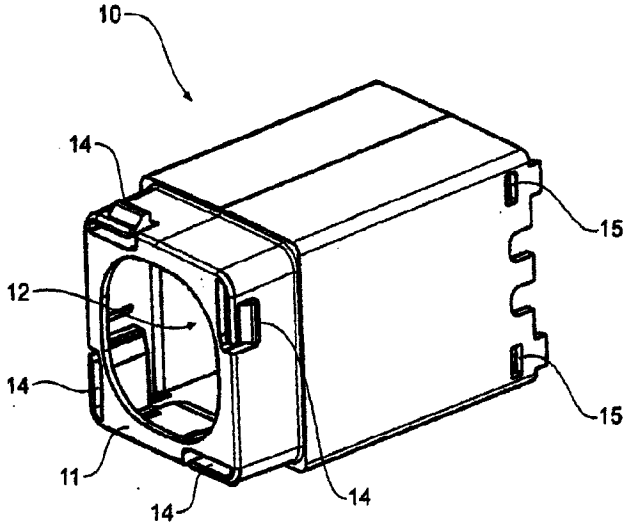


FIG.1

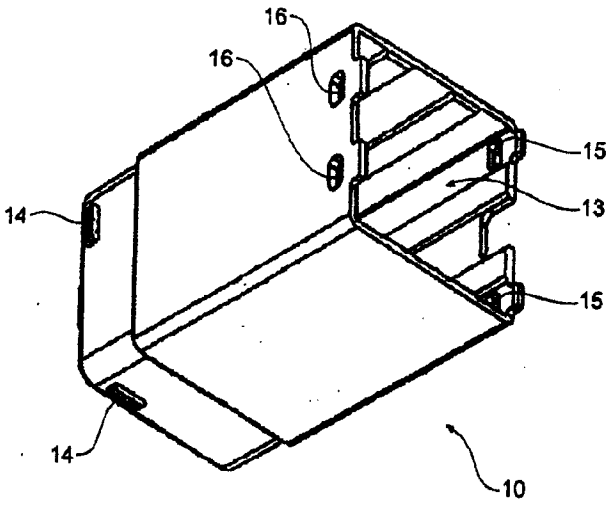


FIG.2

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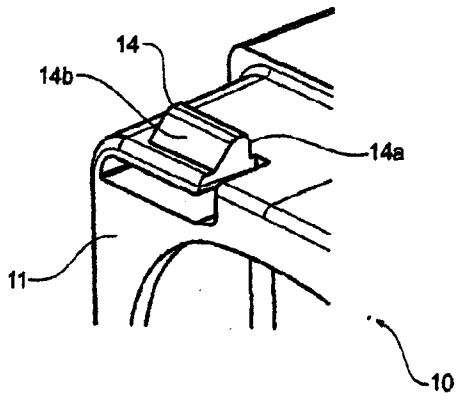


FIG.3

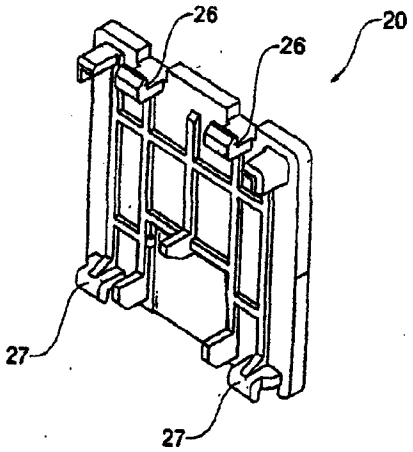


FIG.4

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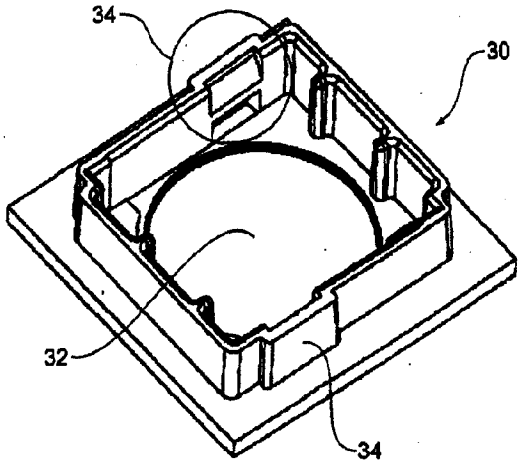


FIG.5

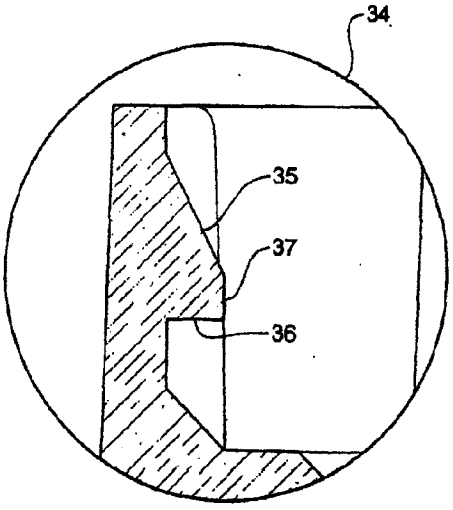


FIG.6

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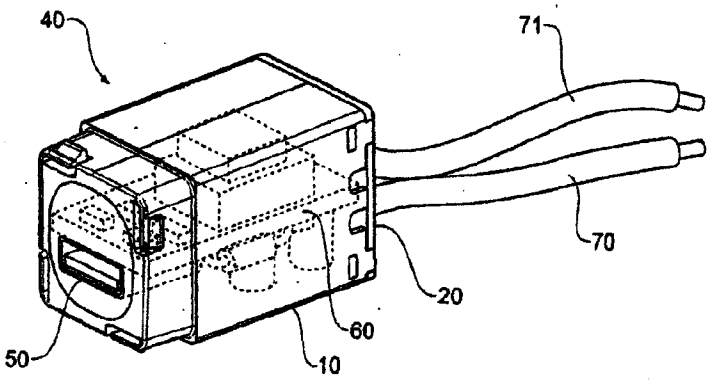


FIG.7

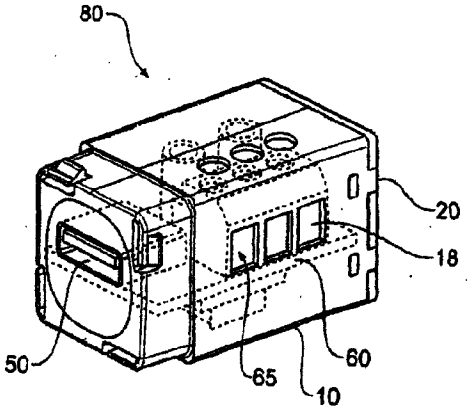


FIG.8

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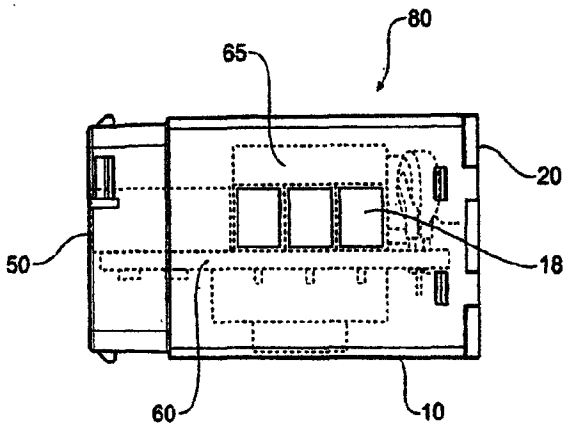


FIG.9

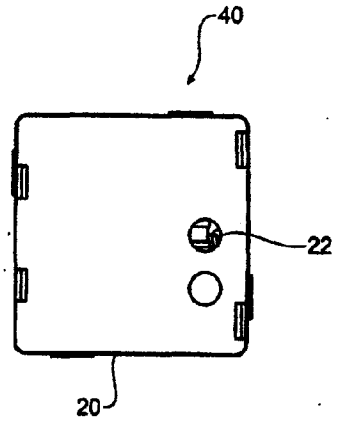


FIG.10

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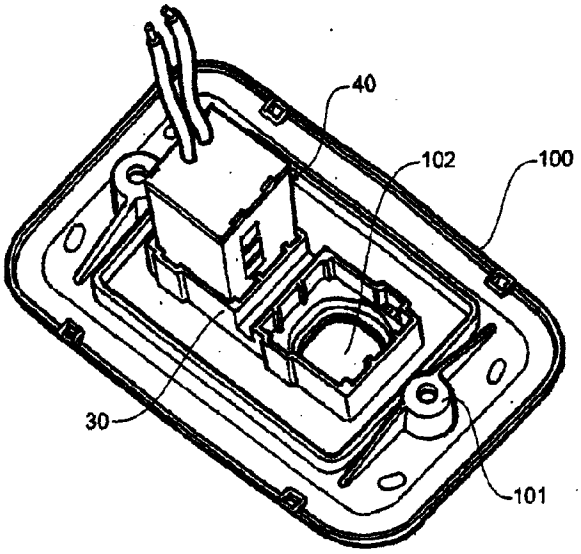


FIG.11

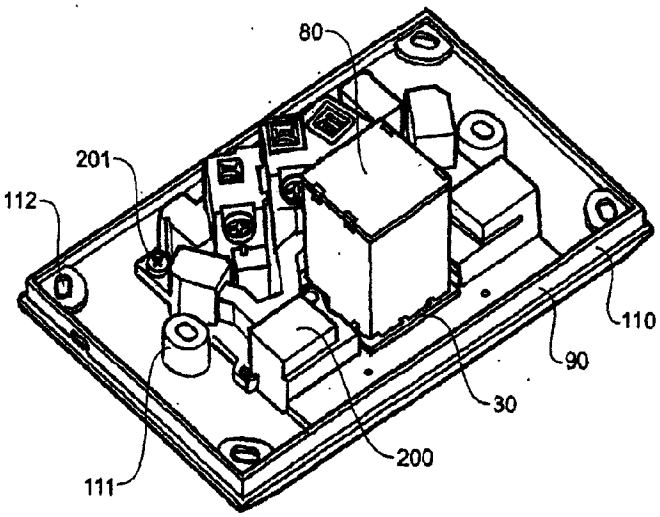


FIG.12

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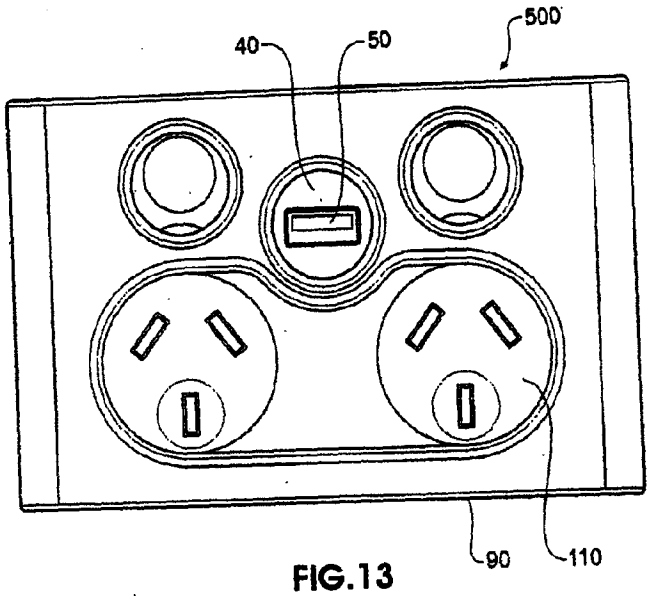


FIG.13

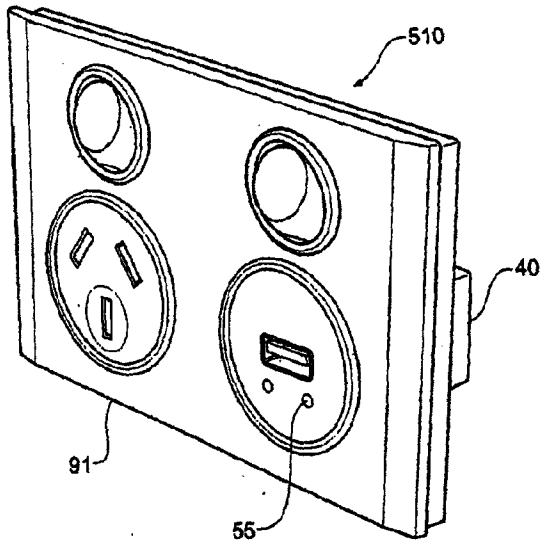


FIG.14

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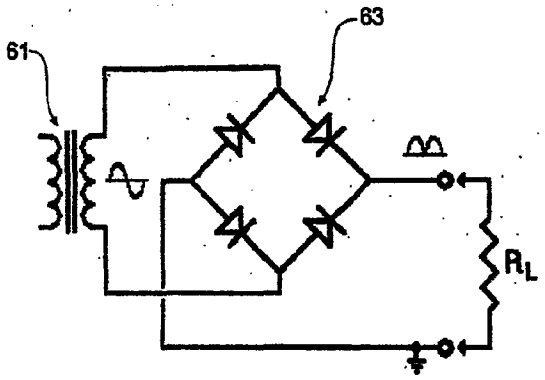


FIG.15

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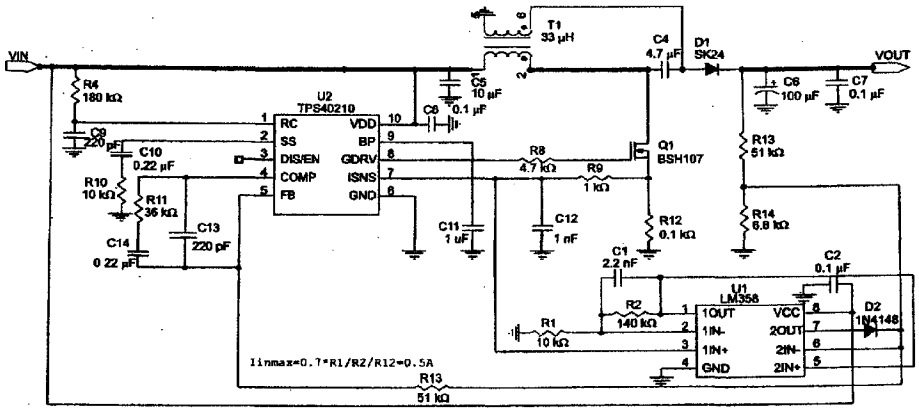


FIG.16

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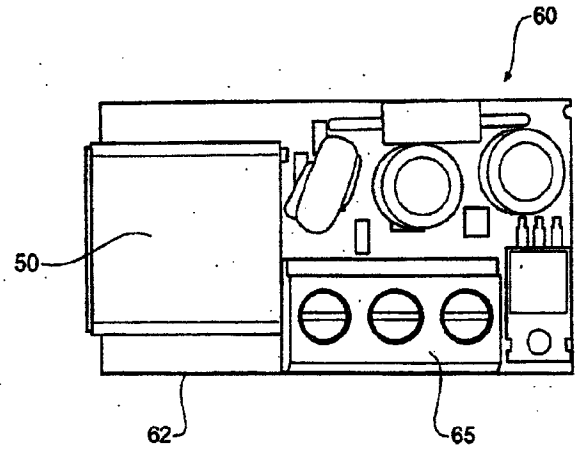


FIG.17

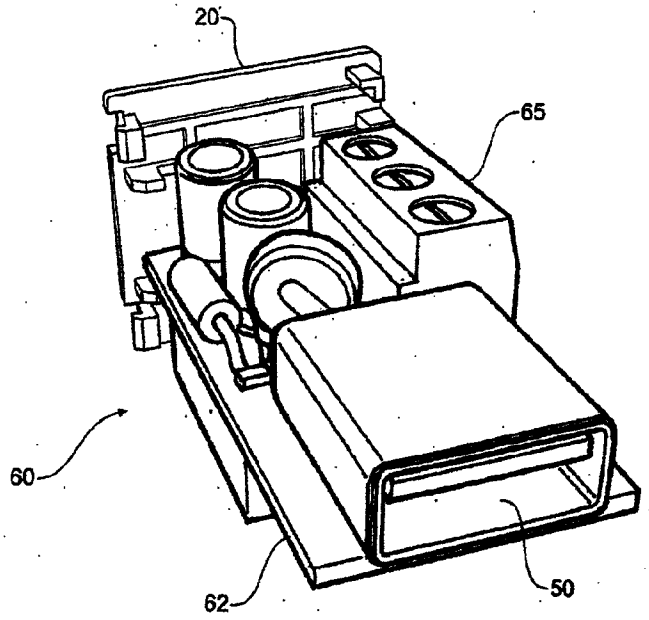


FIG.18

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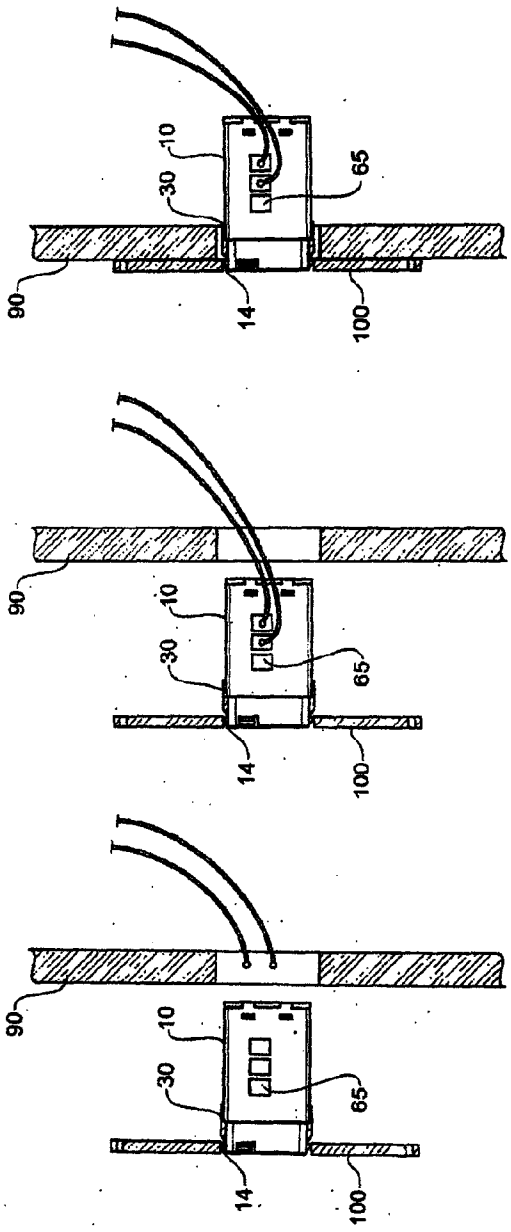


FIG.19c

FIG.19b

FIG.19a

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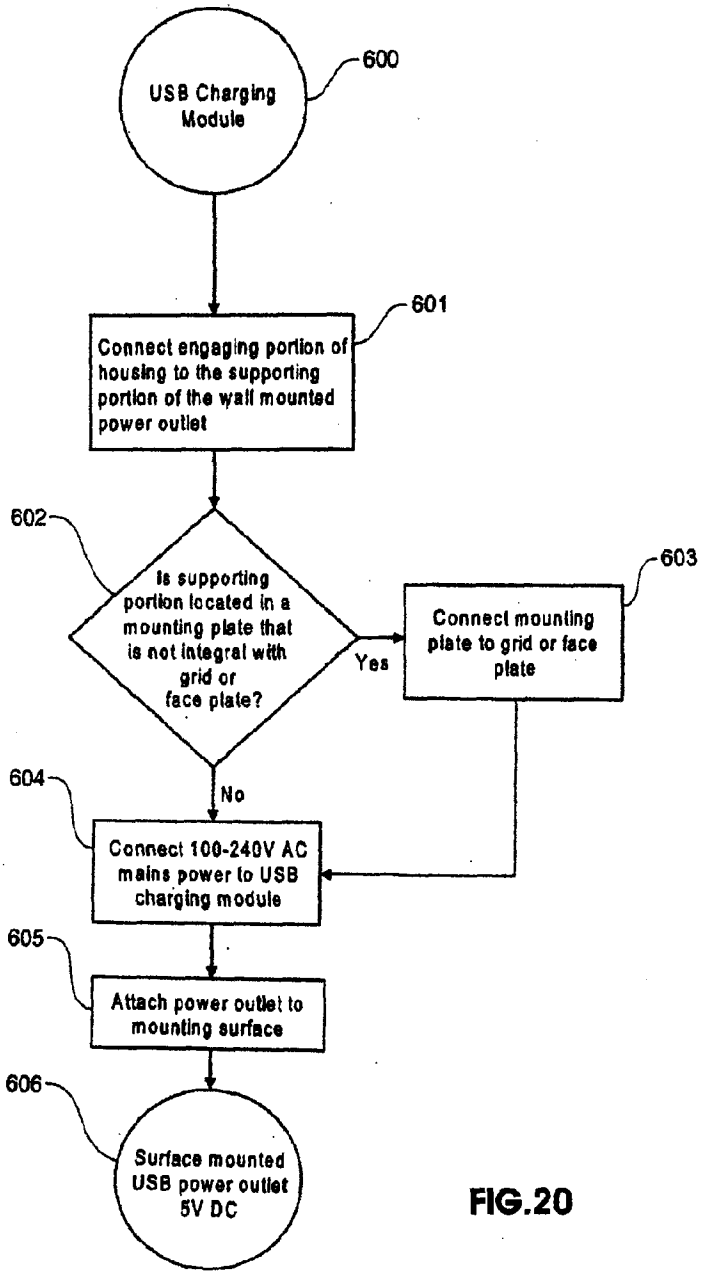


FIG.20

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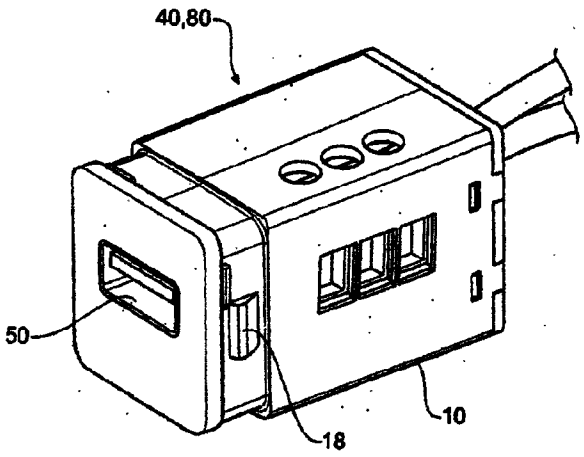


FIG.21

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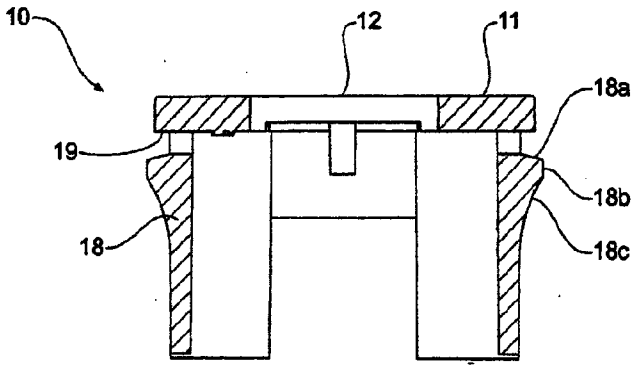


FIG.22

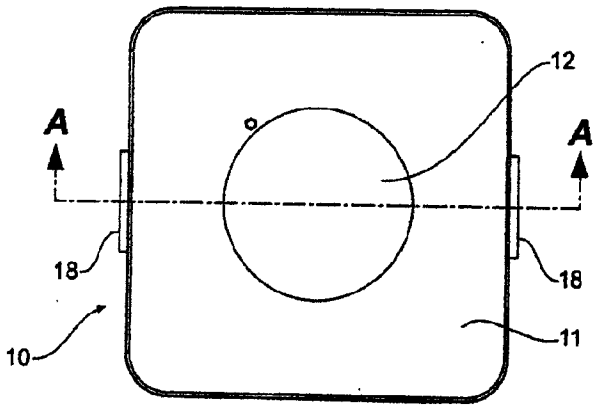


FIG.23

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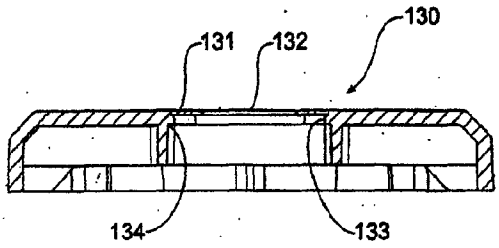


FIG.24

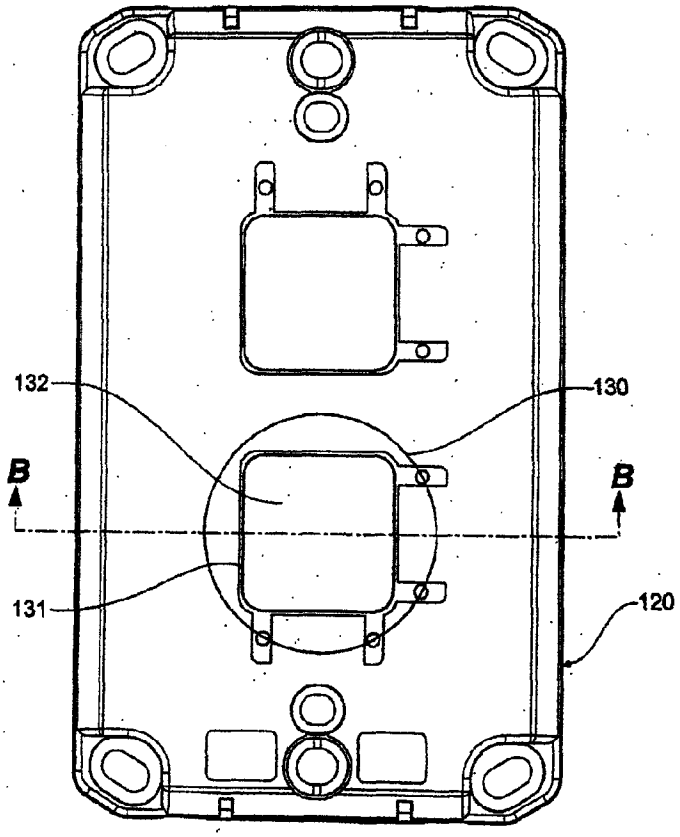


FIG.25

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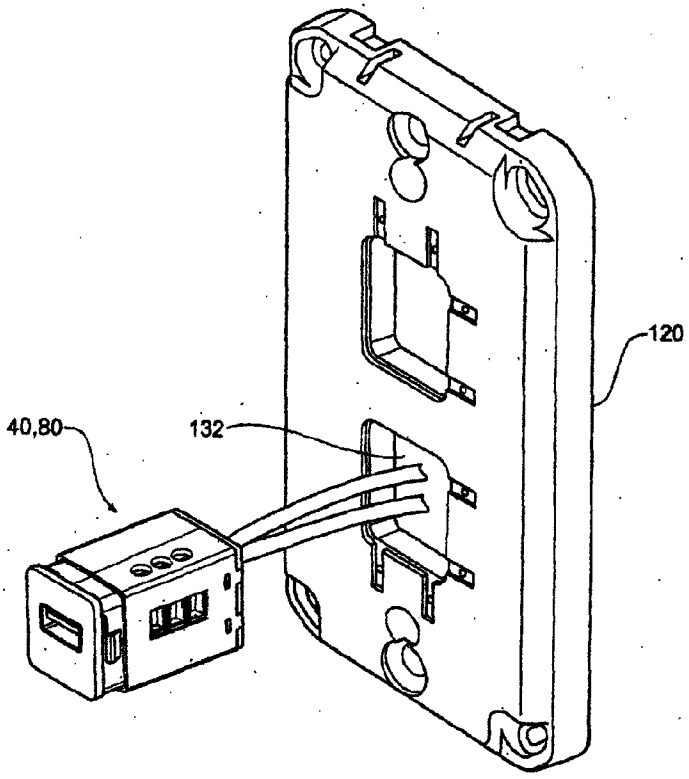


FIG.26

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Applicant

By:

MARI-LEN P. MORIDA
Resident Agent

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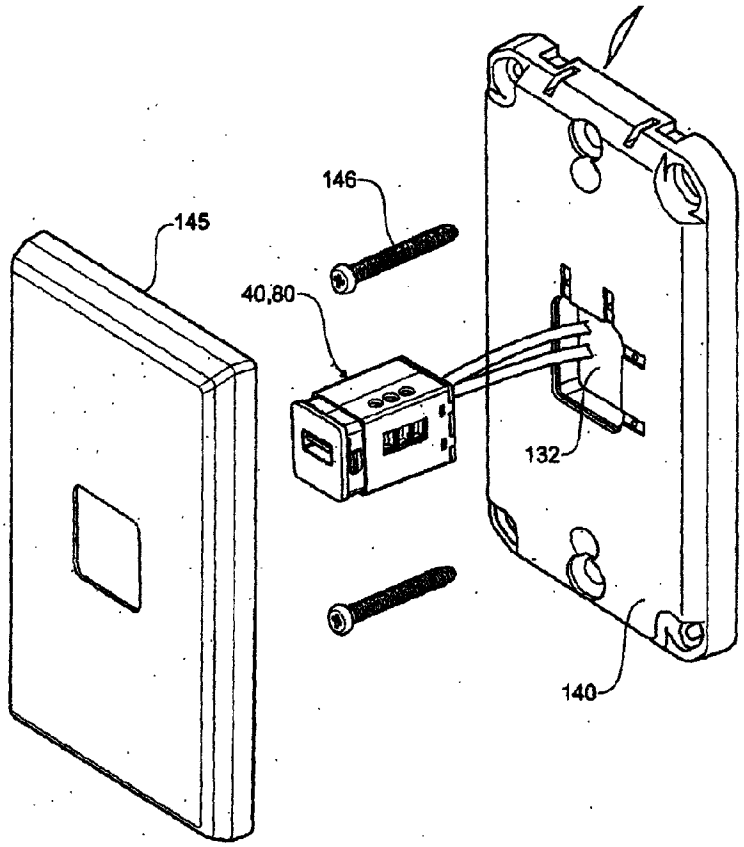


FIG.27

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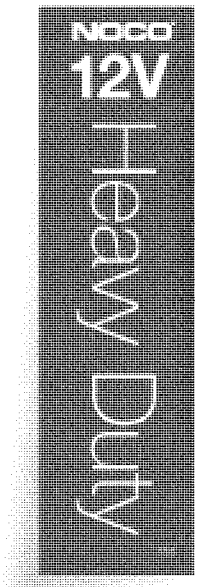
GB70 Lithium **2000**A 12V | **8.0**L 6.0L Diesel

Lead Acid: Wet | Gel | MF | EFB | AGM

Auto | Marine | RV | Powersport | Lawn & Garden

Genius BOOST**HD** Jump Starter™





Safely Jump Start A Dead Battery In Seconds.™

For High-Displacement Gas And Diesel Engines In Cars, Trucks, Boats And More.

Ultra-safe, ultra-compact, rugged, and portable lithium-ion jump starter. Features **spark proof technology** and **reverse polarity protection**. Ideal for a wide range of small vehicle applications to larger vehicles with **8.0L gas** and **6.0L diesel** engines. Provides **remote power** with 12V plug (incl) for tire pumps, inverters, & phone chargers.

SAFE

UltraSafe™

Protects against reverse polarity, sparks, over-charging, over-current, open-circuits and over-heating.

40X

Jump Starts Per Charge

Full power to jump start a vehicle up to 40 times in one charge. Compatible with engines up to 8.0L.

USB

2.1A

Recharge virtually any USB device (smartphones, tablets). Recharge the unit from any USB port or 12V charger.

8XLED

400 Lumen Ultra-bright LED flashlight for visibility and with 7 modes, including SOS and emergency strobe.

For Engines Up To **8.0L** 6.0L Diesel Safe To Use On Engines Of Any Size.

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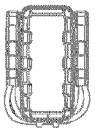
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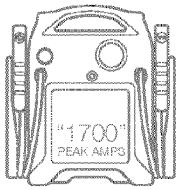
2X More **Power**,
A Fraction Of The Size.

+ Holds Charge 4 Times Longer

Available Starting Power (joules) = Power (w) X Time (sec)



VS



Genius BOOST**HD**™
5lbs
15700 joules[3S]

Leading Traditional Jump Starter
18lbs
6950 joules[3S]

3X Fast Recharge

Go From Zero To Jump Starting In 15 Minutes, Fully Charges In Just Over 2 Hours.

Manual Override is a special feature designed for rare situations when a vehicle's battery is below 2-volts. Simply press and hold the manual overide button for 3 seconds, until the Boost LED starts flashing, to enter into the mode. Press the button again (Or the power button) to exit Manual Override. This mode should be used cautiously, as Manual Override disables safety protection while enabled.



12V Portable Power

Remote Power For A Wide Range Of 12V Devices Including Tire Pumps, Inverters, Lights, Phone Chargers And More

NOCO Designed In the **USA**
Patent US 9,007,015 B1

Technical Specifications

Internal Battery:	Lithium Ion	Micro USB (Input):	5V, 2.1A
Peak Current Rating:	2000A	USB (Output):	5V, 2.1A
Joules[3S]:	15700+	Housing Protection:	IP65 (w/ Ports closed)
Operating Temperature:	-30°C to +50°C	Cooling:	Natural Convection
Charging Temperature:	0°C to +40°C	Dimensions (LxWxH):	8.6 x 6 x 2.5 in
Storage Temperature:	-20°C to +50°C	Weight:	5 Pounds
12V (Input/Output):	12V, 3A IN / 12V, 15A OUT	Lumens (LEDs):	400L

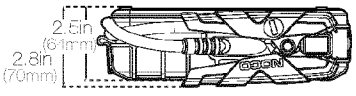
What's In The Box

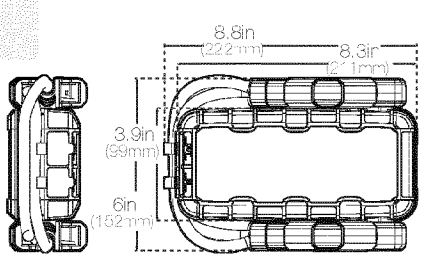
- GB70 Lithium Jump Starter w/HD Battery Clamps
- Micro USB Cable
- 12V Female Plug (OUT)
- 12V Male Plug (IN)
- 12V XGC Cable
- User Guide & Information Guide and Warranty

Recharging a GB70

(for reference, results may vary)

USB Charger Rating	Charging Time	12V Fast Charge
5A	28hr	3A @ 12V (36W)
1A	14hr	2-3hr
2A	7hr	





Retail Packaging:
Dimensions: 7.4"x3.7"x12.6"
Weight: 5lbs
UPC: 0-46221-15005-6
Inner Carton:
Dimensions: 7.7"x4.1"x12.9"
Weight: 5.3lbs

Master Carton:
Dimensions: 13.5"x16.2"x8.98"
Weight: 21.85lbs
Quantity: 4
UCC: 10046221150053
Units Per Pallet: 180 Units

CE FC
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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 December 2015 (23.12.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/195321 A1

(51) International Patent Classification:
H02J 7/00 (2006.01)

(21) International Application Number:
PCT/US2015/033743

(22) International Filing Date:
2 June 2015 (02.06.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/014,910 20 June 2014 (20.06.2014) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: ENGINE START AND BATTERY SUPPORT MODULE

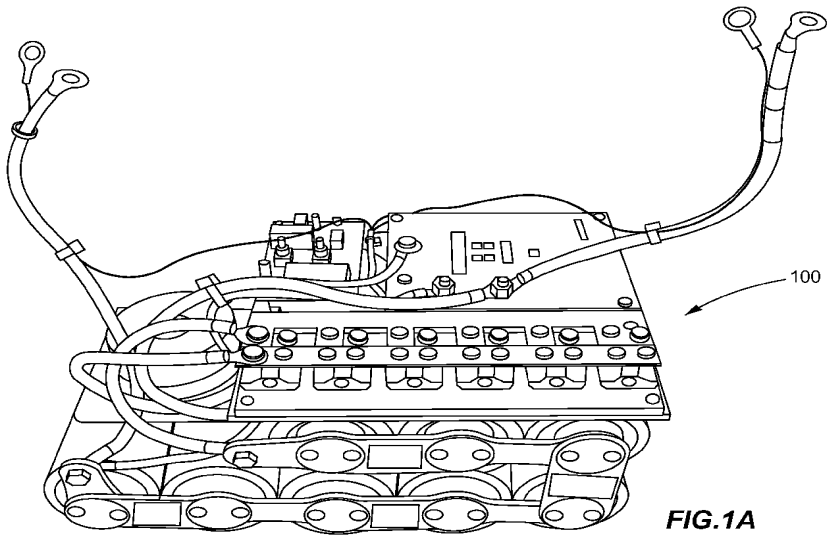


FIG.1A

(57) Abstract: An Engine Start and Battery Support Module for a vehicle is provided that utilizes a bank of Ultra Capacitors (UCs) charged with or without running the vehicles alternator to levels that support both engine starting assistance and hotel load support. The UCs per-cell charge can be adjusted and raised during periods of low temperatures and even higher during ultralow temperatures. The adjustment, which can be dynamic and/or automatic, increases the UC energy storage capability. Further, the release of energy from the UCs is controlled by a pulse width modulation (PWM) controller based on the DC bus voltage. The UCs can be charged either from an onboard DC/DC converter, an AC hook up, or from smartly switching the banks of UCs between parallel and serial configurations.

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Engine Start and Battery Support Module

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the priority benefit, under 35 U.S.C. 119(e), of U.S. Application No. 62/014,910, entitled "Energy Start and Battery Support Module" and filed on June 20, 2014. The aforementioned application is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Changes to common practice, laws, and accepted behavior in both the automotive and trucking industries has forced the shutdown of engines during stops. Shutting down a car or truck engine causes stress on the battery and starter motor, leading to weakened batteries and overall lower system performance. Harsh conditions such as extreme cold environments exacerbate the problem and may lead to outright battery failure and/or starter failure.

[0003] The number of shutdowns per day for an engine may depend on the vehicle architecture, vehicle use, etc. In general, there are two types of vehicle architectures: "local delivery" vehicles, which can have, for example, as many as 250 shut-off events per day, and "long haul" vehicles, which can have up to, for example, 25 shut-off events per day. These shut-off events create low voltage conditions on the vehicle's DC electrical bus, which result in higher power requirements from the on-board energy storage system. Low voltage conditions on the DC electrical bus can also stress other vehicle components, including Electronic Control Units (ECUs), relays, switches, and pumps.

SUMMARY

[0004] Embodiments of the present invention include an energy start and battery support module configured to support the supply of energy directly to the vehicle's direct current (DC) voltage bus using Ultra Capacitors (UCs) that allow both the spinning of the starter motor and voltage support for short term battery loads during stops when the vehicle's engine is off. This module does not necessarily require any wiring changes to the vehicle, nor does it necessarily require or involve any vehicle alterations or changes to vehicle operating procedures.

[0005] The module can automatically stabilize the vehicle's DC voltage during off sequences regardless of the static load variations or engine starter variations by modulating the transfer of energy—including during engine start—in order to support a healthy battery

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and longer starter life. It can automatically adjust the amount of energy it stores in order to prolong the lives of the UCs and the electronics within the module. In some cases, the module supplies the proper voltage for the vehicle's electronics and/or the vehicle's starter in the event that the vehicle's battery is totally dead.

[0006] Some embodiments of the module can recharge the UCs automatically based on the ability of the vehicle to supply power. For example, the module may include a DC boost converter that recharges the UCs or a switch that splits the UCs into two or more equal or unequal stacks and buck charges the stacks in parallel. The module may transfer more power to the UCs if the alternator is running and less power if the vehicle's batteries do not have enough energy to initiate a vehicle starting sequence. The module can also transfer energy from the UCs when the vehicle's alternator is not running. In some cases, the module may not drain the vehicle's battery below a preset voltage level, e.g., 9 volts in a 12-volt system or 18 volts in a 24-volt system.

[0007] In some embodiments, the module allows a vehicle's operator to re-initiate the charging of the module in the event the vehicle does not start on the first try or the batteries are too weak to supply enough power on their own, eliminating the use of a separate jump start. In some embodiments, the module can fit into a standard battery area on the vehicle using a standard battery case size or can be scaled for any vehicle as desired.

[0008] In some embodiments, the system can pass the 30-day airport test in any vehicle without causing the batteries to go dead. As understood by those of skill in the art, the 30-day airport test simulates leaving a vehicle parked at an airport, at temperatures down to –20 °C, for 30 days. During these 30 days, the vehicle's electrical system consumes energy from the battery or energy storage system to run critical vehicle systems, such as alarms, computers, locking mechanisms, clocks, etc. When the vehicle owner returns, the vehicle should have enough energy remaining in its energy storage system (traditionally a lead acid battery) to initiate the cranking event and support the engine starting systems. Passing the 30-day airport test is a common requirement for automotive battery and electrical systems.

[0009] The module can be implemented as a solid-state system (e.g., without relays to transfer of energy in either direction). For example, the module's electronics may include one or more enhancement mode n-channel field-effect transistors (N-FETS), which can be used in parallel to reduce the Equivalent Series Resistance (ESR) of the delivery of the energy or even in the split mode recharging scheme. In some embodiments, the total quiescent current of the electronics may be less than 50 mA so that excess drain does not occur over extended periods of time.

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[0010] A module may include a DC converter whose input and output voltage and current can be controlled, allowing: (1) the voltage on the back of UCs to be controlled precisely; (2) the charge current on the UCs to be controlled, facilitating the ability to bring a completely dead set of UCs up to full charge; (3) the input current to be set so as not to draw too much power out of the system, allowing the vehicle's DC bus to operate other devices; and/or (4) the minimum input voltage to be set for throttling back the UCs charging in order to avoid operating the battery systems outside of a desired or predetermined (e.g., safe) operating regime.

[0011] The DC converter can be broken up into multiple phase angles, enabling lower peak currents, less electromagnetic interference (EMI), and/or smaller more efficient components. The multiple phases may be equally spaced on a 360° basis. For example, a 4-phase DC converter splits the current pump charge into four equal parts that are 90 degrees apart in the time spectrum. The DC converter can control the current and/or voltage on the input side and the current and/or voltage on the output side. For instance, the voltage output can set the maximum voltage potential that is stored on the UCs, which may equal the stored energy (the energy may be expressed by the equation $E = 0.5CV^2$). Current output control may allow the DC converter to charge a completely empty bank of UCs without excessive current (e.g., current that would normally collapse the converter). In some embodiments, the input voltage limit and the input current control may allow the system to operate when the alternator is not running and energy being transferred off the battery is limited to prevent the DC bus from going below a predetermined voltage (e.g., 9 V for a 12 V system or 18 V for a 24 V system).

[0012] The module can be packaged to have only two terminal connections to the outside world and can be connected to an engine just like a battery is connected to the engine. Installation may be simple and safe, and little to no current may flow when the module is initially connected. The controls can be co-located on a single printed circuit board assembly (PCBA) for simplicity and lower cost.

[0013] Control of the entire system can be based on the DC voltage, which enables the bidirectional transfer of energy using acceptable set points and predetermined battery voltages. This control can be accomplished in either the analog or digital domain; control can also be asynchronous and therefore adaptable to just about any vehicle. The control has appreciably zero built-in hysteresis, thus allowing fast and extremely steady voltage levels. Stability may be achieved because it is asynchronous and has no forced frequency domain in the response. In other words, the transfer of energy may not be forced at any rate or regulator repeated pulses. In some cases, only enough energy is transferred to satisfy the set points.

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Since each vehicle and each vehicle's wiring loads are unique, this allows a one-size-fits-all module architecture.

[0014] An example module can include active balancing circuits for controlling (e.g., equalizing) the Ultra Capacitor charge, thereby preventing any single Ultra Capacitor from taking too much energy. The UC balancing circuit can be dynamic and the set points may vary with temperature. Because the energy is modulated back to the vehicle's DC bus, the energy stored in the UCs can be higher than that of the vehicle's rated system itself. This allows more energy to be stored and fewer peak currents to occur than is the case when energy is stored at a nearly equipotential. This method supports extended static vehicle load support for longer periods, including those in the delivery vehicle use case. There is no practical limit to the number of Ultra Capacitors used to store energy or their exact parallel/series configurations as long as the total cell voltage is higher than the voltage level of the vehicle's battery system.

[0015] In some embodiments, the module can include multiple voltage comparators (e.g., three for each DC converter) and logic coupled to the voltage comparators. The logic determines whether or not to recharge or deliver energy based on the values of some or all of the voltage comparators (e.g., two of the three voltage comparators). This substantially increases the system's overall reliability and dependability. It can also include two smaller DC converters that support the operation of the system's electronics over a very wide DC bus operating range and overcome the gate-source voltage threshold.

[0016] The module can be compatible with batteries of any chemistry, including but not limited to lead acid batteries.

[0017] Additional embodiments of the present technology include methods for regulating a voltage level of a vehicle battery in a vehicle. In an example method, control logic determines if the voltage level is below a predetermined voltage threshold, which may be based on the vehicle battery age, vehicle age, vehicle battery condition, vehicle battery quantity, vehicle battery type, vehicle starter type, starter age, temperature, and experience of the vehicle driver. If the voltage level is below the predetermined voltage threshold, the control logic initiates a discharge of at least one ultracapacitor in electrical communication with the vehicle battery. The control logic modulates the discharge of the ultracapacitor so as to raise the voltage level at least to the predetermined voltage threshold, e.g., by by controlling current flow through at least one transistor in electrical communication with the ultracapacitor.

[0018] In addition, the control logic may transfer energy from the vehicle battery to the ultracapacitor while the vehicle alternator is off. This transfer of energy can be initiated after

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determining that the voltage level exceeds a recharge voltage threshold. In some cases, the transfer of energy is initiated only when voltage amount of the vehicle battery exceeds the recharge voltage threshold. Energy may also be transferred from the vehicle battery to the ultracapacitor when the voltage level is less than a voltage level required to start the vehicle.

[0019] In some cases, there may a plurality of ultracapacitors that are switched by the control logic between a parallel configuration for charging and a serial configuration for discharging.

[0020] Another example of the present technology includes an apparatus for regulating a voltage level of a vehicle battery. This apparatus may comprise a plurality of ultracapacitors connected in series to store charge; at least one voltage comparator in electrical communication with the vehicle battery and the ultracapacitors; and control logic in electrical communication with the voltage comparator and the ultracapacitors. In operation, the comparator performs a comparison of the voltage level to a predetermined voltage threshold. And the control logic modulate discharges of the ultracapacitors based on the comparison so as to raise the voltage level to at least the predetermined voltage threshold.

[0021] In some embodiments, the control logic comprises at least one transistor, in electrical communication with the ultracapacitors, to control current flow into and/or out of the ultracapacitors. The comparator can be in electrical communication with a gate of the transistor to control the current flow into and/or out of the ultracapacitors.

[0022] The apparatus may also comprising a direct current (DC) converter in electrical communication with the ultracapacitors and the voltage comparator(s). In operation, the DC converter charges the ultracapacitors in response to a comparison of the voltage level and a recharge voltage threshold. In these examples, the voltage comparator may comprises a first voltage comparator in electrical communication with the DC converter and a second voltage comparator in electrical communication with the control logic. The first voltage comparator enables the DC converter if the voltage level exceeds the recharge voltage threshold, and the second voltage comparator performs the comparison of the voltage level to the predetermined voltage threshold. The DC converter can also be configured to transfer charge from the vehicle battery to the ultracapacitors in response to an output from the voltage comparator indicating that voltage level is above the recharge voltage threshold. And the DC converter can deliver energy to a vehicle bus of the vehicle in response to an output from the comparator(s).

[0023] The apparatus may also include a temperature sensor, operably coupled to the DC converter, to monitor a temperature of the vehicle battery. If desired, the DC converter can be

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configured to vary the predetermined voltage threshold and/or the recharge voltage threshold based on the temperature of the vehicle battery.

[0024] The apparatus may also include a switch, in electrical communication with the ultracapacitors, to switch the ultracapacitors between a serial configuration and a parallel configuration, e.g., for discharging and charging, respectively. And the apparatus may include a manual interface, operably coupled to the control logic, that enables a driver of the vehicle to engage and/or disengage the apparatus.

[0025] Another embodiment includes an apparatus for regulating a voltage level of a vehicle battery that includes: a plurality of ultracapacitors; a first voltage comparator in electrical communication with the vehicle battery; control logic in electrical communication with the first voltage comparator and the ultracapacitors; a second voltage comparator in electrical communication with the vehicle battery; control logic in electrical communication with the first voltage comparator and the ultracapacitors; a DC converter in electrical communication with the ultracapacitors and the second voltage comparator; and a temperature sensor operably coupled to the DC converter. In operation, the first voltage comparator compares the voltage level to a first voltage threshold. The control logic discharges the ultracapacitors if the voltage level is below the first voltage threshold. The second voltage comparator compares the voltage level to a second voltage threshold. The control logic discharges the ultracapacitors if the voltage level is above the second voltage threshold. The DC converter charges the plurality of ultracapacitors if the voltage level is above the second voltage threshold. And the temperature sensor monitors a temperature of the vehicle battery. The DC converter can also vary the first voltage threshold and/or the second voltage threshold based on the temperature of the vehicle battery.

[0026] It should be appreciated that all combinations of the foregoing concepts and additional concepts discussed in greater detail below (provided such concepts are not mutually inconsistent) are contemplated as being part of the inventive subject matter disclosed herein. In particular, all combinations of claimed subject matter appearing at the end of this disclosure are contemplated as being part of the inventive subject matter disclosed herein. It should also be appreciated that terminology explicitly employed herein that also may appear in any disclosure incorporated by reference should be accorded a meaning most consistent with the particular concepts disclosed herein.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The skilled artisan will understand that the drawings primarily are for illustrative purposes and are not intended to limit the scope of the inventive subject matter described herein. The drawings are not necessarily to scale; in some instances, various aspects of the inventive subject matter disclosed herein may be shown exaggerated or enlarged in the drawings to facilitate an understanding of different features. In the drawings, like reference characters generally refer to like features (e.g., functionally similar and/or structurally similar elements).

[0028] FIG. 1A is a photograph of an example Engine Start and Battery Support Module.

[0029] FIGS. 1B-C are schematic diagrams illustrating example use of Engine Start and Battery Support Module installed in a vehicle (e.g., a car or truck).

[0030] FIGS. 2A-B show circuit diagrams depicting an overall master architecture for an example Engine Start and Battery Support Module.

[0031] FIGS. 3A-C show several embodiments of a DC converter that may be used in the Engine Start and Battery Support Module to recharge a bank of expended ultracapacitors.

[0032] FIGS. 3D-E show example features of the isolated DC converters of FIG. 3C.

[0033] FIG. 4 shows switches in an Engine Start and Battery Support Module for switching inter-cell connections between ultracapacitors from series connections to parallel connections and vice versa.

[0034] FIGS. 5A-B shows ultracapacitors arranged in a non-split (FIG. 5A) and split (FIG. 5B) series configuration for use in an Energy Start and Battery Support Module.

[0035] FIGS. 6A-B show circuit diagrams of example direct current converters that can be used in the Engine Start and Battery Support Module.

[0036] FIG. 7 shows a flow diagram illustrating an example operation of an Engine Start and Battery Support Module.

DETAILED DESCRIPTION

[0037] Ultracapacitor-based engine cranking systems can be used to assist vehicle battery systems to crank when initiating an engine starting sequence. With these systems, existing vehicle wiring systems may be rerouted to create a direct connection from the ultracapacitors to the starter motor. In some cases, the ultracapacitors may be in parallel with the vehicle batteries. As the starting sequence is initiated, the ultracapacitors are discharged, providing

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energy to spin the starter motor. After the engine is started, the vehicle's alternator/generator is used to generate electricity and thus recharge the ultracapacitors. This system may also include a DC/DC converter that recharges the ultracapacitors from the parallel connected batteries.

[0038] An Example Engine Start and Battery Support Module

[0039] FIG. 1 shows an example ultracapacitor (UC)-based Engine Start and Battery Support Module (hereinafter a "Module") 100 that can be used to assist a vehicle battery system during an engine starting sequence. The Module 100 shown in FIG. 1 is a two-wire system and can be included into any standard DC bus in parallel with any number of batteries. The Module 100 can be used to maintain a healthy DC bus voltage for a vehicle that is starting (e.g., by vehicle starter 101) or consuming a large load while stopped. It may be used to augment existing batteries 102 in vehicles, e.g., as shown in FIGS. 1B-C, or as a replacement for traditional lead acid batteries. Some of the advantages of such a module are that it can be installed safely and without special tools and may require little or no wiring changes to existing infrastructures.

[0040] In some embodiments, the Module 100 can include a bank of UCs that supports both engine 103 starting assistance and "hotel load" 104a support. The term "hotel load" refers to the non-driving energy demands on a vehicle, including energy use for lights, air conditioning, heating, computers, tracking systems, safety systems, etc., which are indicated in FIG. 1C as vehicle loads 104a and accessory loads 104b. When a vehicle's engine 103 is off, the vehicle's energy demands constitute the hotel load. The Module 100 can be used to start a vehicle and/or to deliver energy back to the vehicle in a controlled fashion to support either the vehicle's static loads during short term stops and/or to supply energy to get the vehicle's electronics functioning, thus allowing the vehicle to start once the engine 103 is cranked. Examples of static loads during short stops may be the electronics, air-conditioning, lighting systems, etc., left on once the vehicle's engine 103 has stopped. In some embodiments, the static loads may include accessory loads 104b.

[0041] In some embodiments, the Module 100 can be configured to address the difficulty/inability of vehicles to start in adverse weather, under duress from extremely weak batteries, and/or from the effects of an excessively high number of engine starts. Further, the Module 100 enhances the health of the vehicle's battery 102 and starter motor 101 by maintaining (e.g., increasing if it has fallen) the voltage on the vehicle's direct current (DC) bus 106, which comprises, for example, negative DC bus 106a and positive DC bus 106b (FIG. 1C), during short off times and cranking. For example, maintaining a higher and/or

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more stable voltage allows for increases in the life of the batteries 102 and the starter motor 101, in some cases dramatically.

[0042] In some embodiments, the Module 100 may be all solid-state. As understood in the art of electronic, solid-state components, including field-effect transistors (FETs) and insulated gate bipolar transistors (IGBT), tend to be faster, more reliable, and consume less power than relays and contactors. Further, the Module 100 may provide capabilities to allow a driver a manual "Redo" button that would start the transfer of energy from the batteries 102 to the UCs. For example, this may be used in the situation where the vehicle may not start the first time. Such may allow the system to recharge on command even when the alternator 105 is not running. While the duration-to-charge time may be longer, the net result may be the same. In addition, more and/or larger banks of UCs can be added to increase the system's total energy storage capabilities, for example, for an Auxiliary Power Unit (APU).

[0043] In some embodiments, the Module 100 can, physically and/or energetically, be scaled to meet most or all applications. For example, the Module 100 can be designed to fit into battery group Battery Council International (BCI) size 31 (e.g., corresponding to heavy-duty commercial grade batteries). In some embodiments, the overall shape can be approximately rectangular, and the two wires can correspond to the positive and negative battery terminals. In some embodiments, the Module 100 may be compatible with existing vehicle battery systems and may not require special installation methods, tools, and/or safety requirements, serving as a one size fits all type of architecture. For example, the Module 100 can be designed to fit into housing that is a standard battery size, and can also tie directly on the bus. In some embodiments, the Module 100 can fit into a Group 31 size with a height that is slightly higher than the standard Group 31 battery or "bumped out" to support 18 cells with electronics. A newly tooled case can be used to maximize space as the Module 100 can be lighter than a heavy lead battery. FIGS. 1B-C show schematic diagrams illustrating example use of Engine Start and Battery Support Module 100 installed in a vehicle.

[0044] Engine Start and Battery Support Module Architectures

[0045] FIGS. 2A-B show circuit diagrams depicting an overall master architecture 200 for an example Engine Start and Battery Support Module 100 with a two wire system corresponding to a positive battery terminal 212a and a negative battery terminal 212b. The architecture 200 allows for independent adjustments of the voltage levels at which hotel loads and engine starts are supported, thus providing for variable energy delivery depending on the specific application and/or exact installation. The Module 100 is capable of modulating the transfer of energy between the UCs 201 and the system batteries 102 in both directions. For

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example, the Module 100 recognizes when to deliver charge to keep batteries 102 alive for short stops without the engine running. It also recognizes the static loads to reset the electronics in some applications prior to starting. In addition, it may automatically connect any remaining energy in the UC bank 201 directly in parallel to the batteries 102 during an engine start, thereby keeping the system voltage above some determined lower levels that may cause premature battery and starter motor failures. In effect, it changes the ESR of the entire vehicles DC system. Different combinations of series and parallel cell configurations may be used depending on the amount of ESR to be used in comparison to hotel load.

[0046] For example, the architecture 200 contains a serial string of UCs 201, each of which can be high specific capacitance electrochemical capacitor that stores energy electrostatically. A typical UC 201 has a capacitance value that is about 10,000 times that of an electrolytic capacitor, an energy density approximately 10% that of a conventional battery, and a power density up to 100 times that of the battery. This allows for a faster charge and discharge cycles for ultra-capacitors 201 compared to conventional batteries. It can also give UCs 201 extremely long cycle lives compared to batteries.

[0047] Each UC 201 can be charged to a predetermined level of per cell voltage. As a specific example, the UCs 201 may be charged to support 2.7 V/cell. The per-cell voltage value may be shifted automatically higher (e.g., 3.0 V/cell) when a low temperature is reached (e.g., 0° F) and even higher per-cell voltage (e.g., 3.3 V/cell) when the temperature falls even lower (e.g., below –20° F). In some embodiments, the temperature may be measured by a sensor 202. In some embodiments, each pack of UCs 201 may use a DC/DC converter (e.g., a 500 W DC/DC converter) 203 that can be settable in a factory to a voltage range, e.g., from 16.2 V to 24 V. The converter 203 may have either a boost or single-ended primary inductor converter (SEPIC) topography.

[0048] In some embodiments, the energy stored in the UCs 201 may be taken from the DC bus, and in some instances, it may be transferred directly back from the UCs 201 onto the same DC bus, allowing for a controlled charging process of batteries 102 in a vehicle. Effectively, the Module 100 dynamically adjusts the Equivalent Series Resistance (ESR) of the vehicle's electrical system substantially constantly. In some embodiments, the Module 100 comprises UCs 201 that may have significantly lower ESR than a typical battery and offer the ability to store energy quickly and to deliver the stored energy back to the vehicle with minimal interface based on the vehicle's changing needs both instantly and/or on a continuous basis. The lower the ESR of the UCs 201, the more efficient the overall energy transfer can be. The system can be scalable to the desired energy, which may be dictated by

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the size of the vehicle and its "work flow." The Module 100, by modulating the transfer of energy from the UCs 201 back to the DC battery bus, delivers the desired amount of energy, instead of delivering too much energy (and wasting excess energy) or falling short and not delivering enough energy, as may happen when a module delivers a predetermined amount of power. In some embodiments, the modulation of the transfer of energy and/or the charging and/or discharging of UCs 201 may be controlled by a logic control 210 that may be in electrical communication with the DC converter 203 and the UCs 201, and can be accomplished via FET 220. The Module 100 determines how to modulate the energy transfer based on variations in voltage and/or current caused by several variables, including but not limited to vehicle DC bus loads, starter motor sizes, battery age, wiring conditions, battery conditions, battery quantity, accessories, starter type, starter age, battery type, temperature, experience of the driver, etc.

[0049] For example, the Module 100 may allow for energy to be drawn from otherwise dead batteries over an extended period of time without further collapsing them below a destructive voltage level. For example, a lead-acid battery that is discharged to a point where its voltage is not high enough to start an internal combustion engine may still possess enough energy to completely charge one or more UCs (e.g., if the UC stores less energy than the battery). The Module 100 may charge the UCs 201 from the battery 102 using a DC converter 203 that controls both the current and voltage on both the input side and the output side of the UC 201 and battery 102 couple.

[0050] In supporting the DC bus voltage of the vehicle's battery 102, in some embodiments, the transfer of energy to the DC bus may be pulsed, e.g., by a buck converter. For example, the pulse may not be a fixed pulse-width modulation (PWM) 204 but rather may be at the natural frequency of the specific truck that it is installed in. In short, energy transferred from the UCs 201 to the battery 102 is based on the vehicle's demand at that moment. The recharge of the UCs 201 can be either pulsed if the cells are divided to enable a buck converter or recharged using a DC converter 203. In either case, the total voltage on the bank of UCs 201 may be actively adjusted both upwards and downwards depending on some parameter of interest, a particular example being the temperature in the module, as measured by a temperature sensor 202, for example. Such an embodiment may make efficient use of the potential energy that can be stored in each cell as well as extend the life of the cells.

[0051] In some embodiments, the Module may recharge the UCs 201 when the alternator 105 isn't running. The DC converter 203 may recharge the bank of UCs 201 by transferring the energy proportional to the vehicle's ability to deliver it. For example, the Module 100

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may not take too much energy out of the batteries 102 that the batteries 102 would drain below some lower limit potential (e.g., lower than 9 V). In addition, the power transfer to recharge the UCs 201 can be scalable using parallel combinations of controller chips arranged in a master and (many) slave organization where each controller contributes an additional phase worth of energy up to 12 phases. As such, a 250 W, 500 W, 750 W, etc. charger could be used with little expense. In implementing multiple phases, one phase controls the master timing and the other "slave" phases are shifted by equal intervals from the master. The use of multiple phases allows the power transfer to be spread over time, thus effecting smaller peak currents and smaller more efficient components.

[0052] In some embodiments, the UCs 201 can be charged primarily using the vehicle's alternator 105 (shown in FIGS. 1B and 1C). In some embodiments, the UCs 201 can be charged by drawing energy from the batteries 102 of the vehicle. The recharging of the UCs 201 may be either automatic and can occur when the engine103 is running (*i.e.,* alternator 105 is on) or it may be when commanded to do so during an emergency situation where the vehicle is without enough power to start on its own. For example, the Module 100 can power up and reset itself automatically upon being connected into a live battery system. For example, if the Module 100 is connected in parallel to the battery system 102, when the vehicle is started, the alternator 105 charges the batteries 102 as originally intended while the Module 100 draws energy from the batteries 102. The Module 100 can balance the voltage on the power bus between the UC's 201 and batteries 102 until the UC's 201 have reached capacity.

[0053] In some embodiments, each Module 100 may be able to operate in either an automatic and/or manual mode, e.g., via the manual interface 214 shown in FIG. 2A. The automatic mode may be utilized for delivery applications and very short haul uses where the number of engine starts per day are large, where it will be used to keep the battery bus alive for hotel support during a delivery stop. The manual mode may be utilized to start the truck where it will be used to energize the starter 101 with minimal energy used to operate the truck, enough to keep alive the electronics during a start sequence. In some embodiments, whether the Module 100 is in a manual mode or an automatic mode may be controlled by a switch 216 that, when turned on, allows the driver to engage the Module 100 via the manual interface 214.

[0054] In the automatic mode of operation, the energy is released initially slowly to maintain a specified battery bus voltage until the UC bank 201 is expended. When the bus voltage equals the UCs voltage, the two systems are effectively in parallel from then on. In

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the automatic mode, the actual battery bus voltage determines when the system goes from charging to neutral to discharging. When the mode of operation is manual, the energy is released slowly initially to maintain a specified battery bus voltage and then when the UC voltage equals the battery bus voltage the two systems are effectively in parallel. In manual mode, the Module senses an attempt to start the engine as indicated, e.g., by a turn of the ignition key or the voltage on a voltage meter on the instrument panel. Otherwise this system operates just like in the automatic mode except the beginning of the event is triggered intentionally. In the manual mode, the UC system does not lengthen the starting sequence and the driver starts the truck as normal.

[0055] Further, in some embodiments, the UCs' per-cell charge can be adjusted and raised during periods of low temperatures (e.g., less than 0° F) and even higher during ultra-low temperatures (e.g., less than –20° F). The raising of the cell voltage, which can be dynamic and/or automatic, may lead to an increase in the UC energy storage capability. In addition, some embodiments allow for the slow release of this energy based on the DC bus voltage using a pulse-width modulation (PWM) controller. The charging can be either from an onboard DC/DC converter 203, an alternating current (AC) hook up, and/or from smartly switching the banks of UCs 201 between parallel and serial connections.

[0056] The cell charging system has three characteristics, the first being where possible the alternator 105 may be used to recharge the UCs 201 up to a predetermined voltage, e.g., 14.5 V. This may be accomplished using a FET 220 when the bus voltage is higher than the voltage across the UC bank 201. Second, above 14.5 V, each product can use a 500 W DC/DC converter 203 that is settable in the factory to a desired voltage range, e.g., from 16.2 V to 24 V. The converter 203 may be designed on a boost or SEPIC topography, and is capable of working down to 9 V in the event a future re-start option is included. Third, when the voltage on the pack reaches its predetermined set point, even when the truck is off for extended periods, the converter 203 may be designed to minimize its quiescent current to keep the overall system's drain low, yet with the dependability of being available for a start at any time. The current drain may be approximately 1 W per 100 kJ of stored energy, once charged, for example.

[0057] Cell balancing can be a clamping type in order to reduce or minimize self-drain. It can have temperature compensated set points with one or more distinct levels, e.g., three levels at 2.7 V, 3 V, and 3.3 V. In some embodiments, the voltage set points may be maintained at the DC system voltage regulator 230, e.g., the DC system voltage regulator 230 may be set to match various ultracapacitor cell voltages for balancing. In some cases, the

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balancing may be supplied by the ultracapacitors 201 and/or the DC system voltage regulator 230 to reduce or minimize self-drain. In some embodiments, this compensation may happen automatically. In some embodiments, the cell balancing can be on the same Printed Circuit Board Assembly (PCBA) as the control logic 210 in FIG. 2A.

[0058] In the exemplary implementations discussed herein and/or any other implementations of the embodiments of the present technology, additional features may be available. For example, a smart user interface 107 could be included (e.g., connected to the Module 100 via a cable as shown in FIG. 1B) to indicate to the driver the status of the UC pack 201 (e.g., UC power level). The smart user interface 107 may include LED status indicators or a "smart" UC fuel gauge display that indicate the status of the UC pack 201. It may also include "Redo" button that gives the driver the option to redo a charge sequence. Further, connections to the controller area network bus (CANbus) of the vehicle could be offered for better integration into the vehicle's system, in some cases by the vehicle manufacturer as an integral part of the built-in display.

[0059] In some embodiments, the energy in the Module 100 may be stored at a level that is higher than the nominal voltage on the bus and may then be released as desired to support the healthy DC bus voltage of a vehicle regardless of the static load 104 or even during the vehicle's starting sequence. In some embodiments, the vehicle starting event may be regarded as a big static load, and the Module's support of the DC bus may cover both the vehicle starting sequence and the static load. In these embodiments, rewiring the vehicle or delivering energy to the starter motor 101 may become unnecessary. The module architecture 200 keeps the voltage stored in the UC bank 201 at a higher level than the battery bus and releases it slowly depending on the dip of that bus voltage due to load changes. Pure DC is pushed to the bus using a PWM buck converter with N-channel FETs 205 delivering the power with an inductor sized for the hotel or truck electronics load only after which it saturates when the FETs 205 are on fully. The PWM 204 puts the UC bank 201 in parallel to the battery 102 when the PWM 204 reaches 100% on. The loop maintains a predetermined battery bus voltage level with a time response rated at >10 kHz.

[0060] In some embodiments, the Module 100 delivers energy directly to the DC bus and does so in an asynchronous way without (intentional) hysteresis. As such, even during an engine cranking, the system may maintain a voltage as close to a set point (e.g., 12.5 V) as possible even as the load of the system changes by a large factor (e.g., 1000 or more) during a starting cycle. In some embodiments, the recharge may be multi-phase and dynamic with four quadrants being controlled allowing the system to adjust to the environment, the state of

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charge of the UCs, and the system batteries. (Here, the term "quadrants" refers to the current and voltage control of the input and output of the converter.) Further, the transfer of energy is pulsed in variable amounts, thereby reducing pseudo Electro-Magnetic Interference (EMI) emitted from the module. The Module 100 acts very much like a frequency-hopping radio in this regard. The pulses may occur at a fixed repetition frequency or have fixed pulse widths.

[0061] DC Converters for Recharging Ultracapacitors

[0062] FIGS. 3A-C show several embodiments of a DC converter 303 that may be used in the Module 100 to recharge the bank of UCs 301 when they are expended. The recharge may occur in between start cycles and while the engine is running. Further, in some embodiments, the converters 303 may be used to charge the UC bank 301 initially when the Module 100 has been installed and to recharge the UC bank 301 when the batteries 302 and the bank of UCs 301 are depleted either by extended vehicle off-time or when the vehicle will not start after the initial attempt(s). In such embodiments, the DC converter 303 may be able to control the input voltage cutoff so as not to ruin an otherwise depleted battery (e.g., when it is drawing energy from the battery 302 to charge up the UCs 301), control both the input and output current in order to be able to charge nearly empty UCs 301, and/or control a variable output voltage set point in order to control the energy stored on the bank of UCs 301 as the temperature varies.

[0063] Exemplary embodiments of DC converters 303 that can be used in the Module 100 comprise enhancement mode (normally open) N-FETs that allow for the modulation of the transfer of power to a vehicle's DC bus. In some embodiments, the DC converter 303 may be bi-directional, while in others it may not be bi-directional, but rather may comprise separate converters that regulate the transfer of power by monitoring the currents on either side. Further, in some embodiments, the DC converters 303 in the Module 100 may have no limitations as to how much energy can be transmitted on the delivery side. In addition, they may be scalable. For example, during an engine start the energy may be transferred without much delay and with as much energy as the UCs 301 have stored in order to keep that DC bus at some desired voltage (e.g., 12.5 V), which may effectively result in the UCs 301 being in parallel to the battery 302 in a starting sequence.

[0064] FIG. 3A shows an example module architecture 300a coupled to a conventional battery 302 in vehicle. The module includes a bank of UCs 301 connected in series with a DC voltage bus that is electrically connected to the battery's 302 positive terminal and an isolated DC converter 303a. The DC converter 303a may be electrically isolated as the positive is connected to the positive battery terminal (BAT+) through the inductor, effectively changing

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its ground potential. In these embodiments, the control of voltage and current on its input and output may have to be transferred over the isolated barrier.

[0065] The ground side of the UC bank 301 is coupled to the drain side of a set of N-FETs 305, which have sources coupled to the battery's 302 negative terminal and the DC converter 303a. In some embodiments, the gates of the N-FETs 305 are coupled to the output of a first voltage comparator 306, which has an input coupled to the DC voltage bus. A second voltage comparator 307 has an input coupled to the DC voltage bus and an output that enables or disables the isolated DC converter 303a. In operation, the first voltage comparator 306 compares the bus voltage to a set point voltage (e.g., 12 V) and triggers a pulse from the UC bank 301 whenever the bus voltage falls below the set point voltage, thereby maintaining the bus voltage at or above the set point voltage. The second voltage comparator 307 compares the bus voltage to charge voltage (e.g., 13.5 V) and enables the DC converter 303a whenever the bus voltage falls below the charge voltage. In response to the enable signal, the DC converter 303a charges the UC bank 301.

[0066] FIG. 3B shows a non-isolated DC converter 303b where the N-FETs 305 are in the high side and the DC converter 303b charges the "tops" of the UCs 301 maintaining a ground connection all the time. This allows the DC converter 303b not to be isolated, reducing the cost of it significantly in both prototyping and production terms. In some embodiments, the drive circuit for the N-FETs 305 may have the gate-source voltage $V_{gate\text{-}source}$ to be at least several volts (e.g., 10 V) higher than the source voltage V_{source} (and in some instances, the V_{source} may be BAT+). Since, in such embodiments, BAT+ may be sitting between 9 volts and 14.5 volts above ground, this may cause $V_{gate\text{-}source}$ to be approximately 24 volts, which could result in the use of a small separate boost circuit. In some embodiments, one may also use isolated high side FET drivers that can switch this voltage level into the high gate capacitance for the parallel bank of N-FETS that may be used to deliver the current during an engine start. The exemplary embodiment shown in FIG. 3B has the advantages of having fewer connections and components.

[0067] FIG. 3C shows a system comprising two DC converters 303c and 303d, where one converter 303d is used to charge or recharge the bank of UCs and the other converter 303c is used to deliver the energy back to the DC bus. Each of these converters in their "normal" mode may have a set point that triggers the converter to turn on. For example, to promote a healthy battery, an exemplary 12.5 V set-point may be chosen to deliver energy back to the DC bus and a 13.75 V set-point to initiate a recharge cycle. Other set points can be determined differently as these are adjustable. However, the Module architecture 300c also

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monitors the input and output currents. This feature allows the recharging of the UCs 301 to begin at times other than just when the alternator 105 is running, such as but not limited to when the batteries 302 are too weakened to perform a start and the bank of UCs 301 are exhausted such as during an extended stop.

[0068] FIG. 3E and FIG. 3D show details of some example features of the isolated DC converters 303c and 303d, respectively. In some embodiments, these converters may be bi-directional, and in others, they may not be bi-directional. In the examples shown in FIGS. 3D-E, the separate isolated converters regulate the transfer of power by monitoring currents on the charge input side (FIG. 3E) and the discharge output side (FIG. 3D).

[0069] As discussed above, in some embodiments, a Module's energy may be stored in UCs 201 that may be configured in series and/or parallel configurations. The amount of capacitance and/or the type of battery a Module 100 is compatible with may not be restricted, and in most embodiments, the voltage on the capacitors 201 may be higher than the voltage in the vehicle. The method of boosting the voltage can employ a conventional boost style converter that can be configured as a flyback, straight boost, or SEPIC, and may be either isolated or non-isolated. The converter can use a multi-phase approach to minimize the peak switching currents, which can in turn allow smaller, more efficient components, better EMI performance, and lower cost. In increments of a set amount of power (e.g., 250 W), more phases can be added that may increase the recharge power level and reduce the recharge time. When each phase is added its switching frequency may intentionally be out of phase with the first switch.

[0070] Internal Ultracapacitor Connections for Charging and Discharging

[0071] FIG. 4 shows an embodiment depicting the changing of inter-cell connections within UCs 401 between series and parallel connections to accommodate a buck-only charge and discharge scheme is shown. In some embodiments, the UCs 401 may be recharged by splitting them up into equal banks of cells 401a and 401b where their fully charged total voltage is less than the vehicle's system. In some embodiments, the UCs 401 may be charged by splitting the UCs 401 into several banks, each bank containing same and/or different number of UCs 401. In such embodiments, the UCs 401 can be recharged in a buck mode where energy is pulsed down to the caps. Such embodiments require more solid state switches and additional current control. When charged, the packs may be put back in series and readied for delivering power. In some embodiments, a series/parallel switch 402 can split the UCs 401 into two parallel banks 401a and 401b with equal numbers UCs 401 with total voltages below the vehicle's system voltage, or connect them to form a single UC bank with

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a total voltage above the vehicle's system voltage. In some embodiments, this may allow a single buck converter to be used for charging and discharging the UCs 401.

[0072] FIGS. 5A and 5B show converters 503 that can be used in some exemplary methods of charging the UCs 501 in the Module 100. FIG. 5A shows a separate and dedicated non-isolated DC converter 503a that boosts the voltage up to the UCs 501a during a recharge cycle. FIG. 5B shows splitting the cell stack in two 501b and 501c (e.g., equal halves each containing half of total number of cells) and then buck charging each half in parallel using the vehicle's nominal DC bus as the point where the energy is taken from. In some embodiments, the vehicle's voltage may be higher than each of the split cells. The energy may be pulsed in a controlled manner to each stack in a buck mode concept. The switches 502 represent points where the stacks are "put together" and then "separated" to accomplish this. Once charged to a given voltage, the two stacks are then put back in series for use in the "delivery" mode, *i.e.*, energy out mode. The mechanical switches 502 shown represent the "solid state" switching that may occur in real time.

[0073] In some embodiments, the switches 502 may be comprised of enhancement mode N-FETs and may carry the appropriate maximum current when connected in the delivery (energy out) mode (e.g., up to 2500 A). In some embodiments, the FETs can be sized to handle the charging current which may be in the range of 10–25 A. The switching of FIG. 5B may be less expensive and may provide for smaller electronics and allow for the re-usage of the on-board inductor in both directions. In some embodiments, the current mode controller may monitor and limit the root mean square (RMS) current that flows from the vehicle's battery to the two stacks of UCs 501b and 501c smartly and under most or all circumstances of the state of the charge on the capacitors. In some embodiments, more capacitors 501, and more stacks of UCs (e.g., 3, 4, 5, etc.) may be used, where each stack may contain same and/or different number of UCs.

[0074] In some embodiments, the DC converters shown in FIG. 5B can be utilized to buck switch the charging of the bank of UCs 501 by splitting the UCs 501 into two equal stacks 501b and 501c, then recombining them in series when they are charged and readied for use. The splitting of the UCs 501 in two equal stacks may allow the UCs' fully charged voltage to be double when recombined (e.g., each is charged to 12.0 V, or 24.0 V when recombined). The example as shown in FIG. 5B includes four switch circuits 502a, 502b, 502c and 502d where two of those switches 502c and 502d may be capable of handling the high currents during an engine start and the other two 502 a and 502b can be sized smaller as they are used

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to let charging currents pass through them. An example of a switch that can be used is N-FET.

[0075] In some embodiments of FIG. 5B, several N-FETs may be used to modulate power back to the DC bus. For example, if a Module 100 in a non-split configuration (e.g., FIG. 5A) includes ten N-FETs, the total number of N-FETs for split cell configuration (e.g., FIG. 5B) could increase to 22 N-FETs. In such embodiments, depending on the current level, inductive current sensing instead of standard current sense resistors may be used for sensing high current. Some embodiments may include one or more voltage sensors to measure small voltage drop across the inductor and then create the closed loop controls around their values.

[0076] FIGS. 6A-B shows detailed circuit diagram schematics of exemplary DC converters that may be used in the Module. The DC converters can be multi-phase boost converters capable of delivering 250 W/phase with four-quadrant current and voltage control on both the input and output. This system can have an efficiency of approximately 95% and can be single phase. As each phase gets added, the power can increase proportionally. Each successive phase is intentionally "out of phase" with the preceding one by 360°/n where n is the total number of phases. This reduces the peak currents and keeps the component sizes small. The system may allow for faster recharge rates where these phases could be added at the request of the customer, or they may be proportional to the size of the vehicle where the module is to be installed.

[0077] Operation of an Engine Start and Battery Support Module

[0078] FIG. 7 shows a flow diagram illustrating an example operating process for an Engine Start and Battery Support Module 100. In some embodiments, the DC converter may be able to control or set the thresholds and maximum values for both the input and output voltages and current. Charging UCs 701 when they are empty may present a problem in that they may act like dead shorts, and unless the output current is sensed and controlled the DC converter may hiccup, collapse, or burn up. Setting an output current limit should help avoiding or limiting such complications.

[0079] In some embodiments, the output voltage setting may set the desired voltage on the UCs 701 and may be variable based on temperature in order to increase or maximize the capacitor's life and deliver the appropriate energy when desired, especially in ultra-cold environments. And the input current limit and minimum voltage can be useful in avoiding the collapse of the batteries 702 below their safe operating region (e.g., 9 volts in a 12-volt system) when the DC bus is being drained during a recharge recycle while the alternator is off. In some embodiments, this function may be dynamic and the control may be

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proportional—the more power is available for the recharge, the more power the system (e.g., converter 703) may take. For example, at 9 volts, the power consumed by the converter may be zero, and at 13.75 volts the power may be 250 Watts for a single phase system and for any voltage in between, the power consumed may be proportionally in between 0 Watts and 250 Watts. In some embodiments, the converter may also have a quiescent current of less than 25 mA when it is disabled which may be useful in maintaining overall system performance.

[0080] Example Engine Start and Battery Support Modules

[0081] The following non-limiting examples are intended to highlight aspects of Engine Start and Battery Support Modules according to principles of the present disclosure.

[0082] *Example device 1*: Number of cells: eight in series; UC cell capacitance: 3000 F; Total Capacitance: 375 F; Voltage: 21.6 V when the temperature is greater than about 0° F and 24 V when the temperature is less than about 0° F.

[0083] Example device 1 can provide "hotel load" support as a primary function with the secondary function being reserving energy for the actual starting sequence. The ratio is approximately 10:1 with the hotel load support getting more energy. The system automatically supports a battery bus voltage from a string of UCs stacked in series and charged up to 2.7 V/cell or 3.0 V/cell depending on temperature. When the voltage on the cells equals the battery voltage they are then put in parallel by the design of the architecture. Exemplary application of this device is when vehicles are used for delivery.

[0084] *Example device 2*: Number of cells: two parallel strings of six cells each in series; UC cell capacitance: 3000 F; Total Capacitance: 1000 F; Voltage: 16.2 V when the temperature is greater than about 0° F and 18.0 V when the temperature is less than about 0° F.

[0085] Example device 2 can deliver energy to crank the vehicle while providing a reduced or minimal amount of energy to keep alive the vehicle electronics during that process. Exemplary application of this device is when vehicles are used for capacitance without auxiliary power units.

[0086] *Example device 3*: Number of cells: three parallel strings of six cells each in series; UC cell capacitance: 3000 F; Total Capacitance: 1500 F; Voltage: 16.2 V when the temperature is greater than about 0° F and 18.0 V when the temperature is less than about 0° F.

[0087] Example device 3 can deliver energy to crank the vehicle while providing a reduced minimal amount of energy to keep alive the vehicle electronics during that process. This

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application supports delivering more energy for vehicle electronics during vehicle starting event, especially on vehicles where there are more than four batteries in parallel. Exemplary application of this device is when vehicles are used for capacitance with auxiliary power units.

[0088] *Example device 4*: Number of cells: three parallel strings of six cells each in series UC cell capacitance: 3000 F; Total Capacitance: 1500 F; Voltage: 16.2 V when the temperature is greater than about 0° F, 18.0 V when the temperature is less than about 0° F, and 19.8 V when the temperature is less than about –20° F.

[0089] Example device 4 delivers increased or maximum energy to crank the vehicle in ultra-low temperature applications.

[0090] Conclusion

[0091] While various inventive embodiments have been described and illustrated herein, those of ordinary skill in the art will readily envision a variety of other means and/or structures for performing the function and/or obtaining the results and/or one or more of the advantages described herein, and each of such variations and/or modifications is deemed to be within the scope of the inventive embodiments described herein. More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the inventive teachings is/are used. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific inventive embodiments described herein. It is, therefore, to be understood that the foregoing embodiments are presented by way of example only and that, within the scope of the appended claims and equivalents thereto; inventive embodiments may be practiced otherwise than as specifically described and claimed. Inventive embodiments of the present disclosure are directed to each individual feature, system, article, material, kit, and/or method described herein. In addition, any combination of two or more such features, systems, articles, materials, kits, and/or methods, if such features, systems, articles, materials, kits, and/or methods are not mutually inconsistent, is included within the inventive scope of the present disclosure.

[0092] The above-described embodiments can be implemented in any of numerous ways. For example, embodiments of the present technology may be implemented using hardware, firmware, software or a combination thereof. When implemented in firmware and/or software, the firmware and/or software code can be executed on any suitable processor or

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collection of logic components, whether provided in a single device or distributed among multiple devices.

[0093] In this respect, various inventive concepts may be embodied as a computer readable storage medium (or multiple computer readable storage media) (e.g., a computer memory, one or more floppy discs, compact discs, optical discs, magnetic tapes, flash memories, circuit configurations in Field Programmable Gate Arrays or other semiconductor devices, or other non-transitory medium or tangible computer storage medium) encoded with one or more programs that, when executed on one or more computers or other processors, perform methods that implement the various embodiments of the invention discussed above. The computer readable medium or media can be transportable, such that the program or programs stored thereon can be loaded onto one or more different computers or other processors to implement various aspects of the present invention as discussed above.

[0094] The terms "program" or "software" are used herein in a generic sense to refer to any type of computer code or set of computer-executable instructions that can be employed to program a computer or other processor to implement various aspects of embodiments as discussed above. Additionally, it should be appreciated that according to one aspect, one or more computer programs that when executed perform methods of the present invention need not reside on a single computer or processor, but may be distributed in a modular fashion amongst a number of different computers or processors to implement various aspects of the present invention.

[0095] Computer-executable instructions may be in many forms, such as program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. Typically the functionality of the program modules may be combined or distributed as desired in various embodiments.

[0096] Also, data structures may be stored in computer-readable media in any suitable form. For simplicity of illustration, data structures may be shown to have fields that are related through location in the data structure. Such relationships may likewise be achieved by assigning storage for the fields with locations in a computer-readable medium that convey relationship between the fields. However, any suitable mechanism may be used to establish a relationship between information in fields of a data structure, including through the use of pointers, tags or other mechanisms that establish relationship between data elements.

[0097] Also, various inventive concepts may be embodied as one or more methods, of which an example has been provided. The acts performed as part of the method may be

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ordered in any suitable way. Accordingly, embodiments may be constructed in which acts are performed in an order different than illustrated, which may include performing some acts simultaneously, even though shown as sequential acts in illustrative embodiments.

[0098] All definitions, as defined and used herein, should be understood to control over dictionary definitions, definitions in documents incorporated by reference, and/or ordinary meanings of the defined terms.

[0099] The indefinite articles "a" and "an," as used herein in the specification and in the claims, unless clearly indicated to the contrary, should be understood to mean "at least one."

[0100] The phrase "and/or," as used herein in the specification and in the claims, should be understood to mean "either or both" of the elements so conjoined, i.e., elements that are conjunctively present in some cases and disjunctively present in other cases. Multiple elements listed with "and/or" should be construed in the same fashion, i.e., "one or more" of the elements so conjoined. Other elements may optionally be present other than the elements specifically identified by the "and/or" clause, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, a reference to "A and/or B", when used in conjunction with open-ended language such as "comprising" can refer, in one embodiment, to A only (optionally including elements other than B); in another embodiment, to B only (optionally including elements other than A); in yet another embodiment, to both A and B (optionally including other elements); etc.

[0101] As used herein in the specification and in the claims, "or" should be understood to have the same meaning as "and/or" as defined above. For example, when separating items in a list, "or" or "and/or" shall be interpreted as being inclusive, i.e., the inclusion of at least one, but also including more than one, of a number or list of elements, and, optionally, additional unlisted items. Only terms clearly indicated to the contrary, such as "only one of" or "exactly one of," or, when used in the claims, "consisting of," will refer to the inclusion of exactly one element of a number or list of elements. In general, the term "or" as used herein shall only be interpreted as indicating exclusive alternatives (i.e. "one or the other but not both") when preceded by terms of exclusivity, such as "either," "one of," "only one of," or "exactly one of." "Consisting essentially of," when used in the claims, shall have its ordinary meaning as used in the field of patent law.

[0102] As used herein in the specification and in the claims, the phrase "at least one," in reference to a list of one or more elements, should be understood to mean at least one element selected from any one or more of the elements in the list of elements, but not necessarily including at least one of each and every element specifically listed within the list of elements

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and not excluding any combinations of elements in the list of elements. This definition also allows that elements may optionally be present other than the elements specifically identified within the list of elements to which the phrase "at least one" refers, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, "at least one of A and B" (or, equivalently, "at least one of A or B," or, equivalently "at least one of A and/or B") can refer, in one embodiment, to at least one, optionally including more than one, A, with no B present (and optionally including elements other than B); in another embodiment, to at least one, optionally including more than one, B, with no A present (and optionally including elements other than A); in yet another embodiment, to at least one, optionally including more than one, A, and at least one, optionally including more than one, B (and optionally including other elements); etc.

[0103] In the claims, as well as in the specification above, all transitional phrases such as "comprising," "including," "carrying," "having," "containing," "involving," "holding," "composed of," and the like are to be understood to be open-ended, i.e., to mean including but not limited to. Only the transitional phrases "consisting of" and "consisting essentially of" shall be closed or semi-closed transitional phrases, respectively, as set forth in the United States Patent Office Manual of Patent Examining Procedures, Section 2111.03.

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CLAIMS

1. A method for regulating a voltage level of a vehicle battery in a vehicle, the method comprising:

determining if the voltage level is below a predetermined voltage threshold;

if the voltage level is below the predetermined voltage threshold, initiating a discharge of at least one ultracapacitor in electrical communication with the vehicle battery; and

modulating the discharge of the at least one ultracapacitor so as to raise the voltage level at least to the predetermined voltage threshold.

2. The method of claim 1, wherein the predetermined voltage threshold is determined based on at least one of vehicle battery age, vehicle age, vehicle battery condition, vehicle battery quantity, vehicle battery type, vehicle starter type, starter age, temperature, and experience of a driver of the vehicle.

3. The method of claim 1, wherein modulating the discharge of the at least one ultracapacitor comprises controlling current flow through at least one transistor in electrical communication with the at least one ultracapacitor.

4. The method of claim 1, further comprising:

while a vehicle alternator is off, transferring energy from the vehicle battery to the at least one ultracapacitor.

5. The method of claim 4, wherein the transfer of energy is initiated after determining that the voltage level exceeds a recharge voltage threshold.

6. The method of claim 5, wherein the transfer of energy is initiated only when voltage amount of the vehicle battery exceeds the recharge voltage threshold.

7. The method of claim 1, further comprising:

transferring energy from the vehicle battery to the at least one ultracapacitor when the voltage level is less than a voltage level required to start the vehicle.

8. The method of claim 1, wherein the at least one ultracapacitor comprises a plurality of ultracapacitors, and further comprising:

switching the plurality of ultracapacitors between a parallel configuration for charging and a serial configuration for discharging.

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9. An apparatus for regulating a voltage level of a vehicle battery, the apparatus comprising:

a plurality of ultracapacitors connected in series to store charge;

at least one voltage comparator, in electrical communication with the vehicle battery and the plurality of ultracapacitors, to perform a comparison of the voltage level to a predetermined voltage threshold; and

control logic, in electrical communication with the at least one voltage comparator and the plurality of ultracapacitors, to modulate discharge of the plurality of ultracapacitors based on the comparison so as to raise the voltage level to at least the predetermined voltage threshold.

10. The apparatus of claim 9, wherein the control logic comprises at least one transistor, in electrical communication with the plurality of ultracapacitors, to control current flow into and/or out of the plurality of ultracapacitors.

11. The apparatus of claim 10, wherein the at least one comparator is in electrical communication with a gate of the at least one transistor to control the current flow into and/or out of the plurality of ultracapacitors.

12. The apparatus of claim 9, further comprising:

a direct current (DC) converter, in electrical communication with the plurality of ultracapacitors and the at least one voltage comparator, to charge the plurality of ultracapacitors in response to a comparison of the voltage level and a recharge voltage threshold.

13. The apparatus of claim 12, wherein the at least one voltage comparator comprises:

a first voltage comparator, in electrical communication with the DC converter, to enable the DC converter if the voltage level exceeds the recharge voltage threshold; and

a second voltage comparator, in electrical communication with the control logic, to perform the comparison of the voltage level to the predetermined voltage threshold.

14. The apparatus of claim 13, wherein the DC converter is configured to transfer charge from the vehicle battery to the plurality of ultracapacitors in response to an output from the voltage comparator indicating that voltage level is above the recharge voltage threshold.

15. The apparatus of claim 12, further comprising:

a temperature sensor, operably coupled to the DC converter, to monitor a temperature of the vehicle battery.

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16. The apparatus of claim 15, wherein the DC converter is configured to vary the predetermined voltage threshold and/or the recharge voltage threshold based on the temperature of the vehicle battery.

17. The apparatus of claim 12, wherein the DC converter is further configured to deliver energy to a vehicle bus of the vehicle in response to an output from the at least one comparator.

18. The apparatus of claim 9, further comprising:

a switch, in electrical communication with the plurality of ultracapacitors, to switch the plurality of ultracapacitors between a serial configuration and a parallel configuration.

19. The apparatus of claim 9, further comprising:

a manual interface, operably coupled to the control logic, to enable a driver of the vehicle to engage the apparatus.

20. An apparatus for regulating a voltage level of a vehicle battery, the apparatus comprising:

a plurality of ultracapacitors;

a first voltage comparator, in electrical communication with the vehicle battery, to compare the voltage level to a first voltage threshold;

control logic, in electrical communication with the first voltage comparator and the plurality of ultracapacitors, to discharge of the plurality of ultracapacitors if the voltage level is below the first voltage threshold;

a second voltage comparator, in electrical communication with the vehicle battery, to compare the voltage level to a second voltage threshold;

control logic, in electrical communication with the first voltage comparator and the plurality of ultracapacitors, to discharge of the plurality of ultracapacitors if the voltage level is above the second voltage threshold;

a direct current (DC) converter, in electrical communication with the plurality of ultracapacitors and the second voltage comparator, to charge the plurality of ultracapacitors if the voltage level is above the second voltage threshold; and

a temperature sensor, operably coupled to the DC converter, to monitor a temperature of the vehicle battery,

wherein the DC converter is configured to vary the first voltage threshold and/or the second voltage threshold based on the temperature of the vehicle battery.

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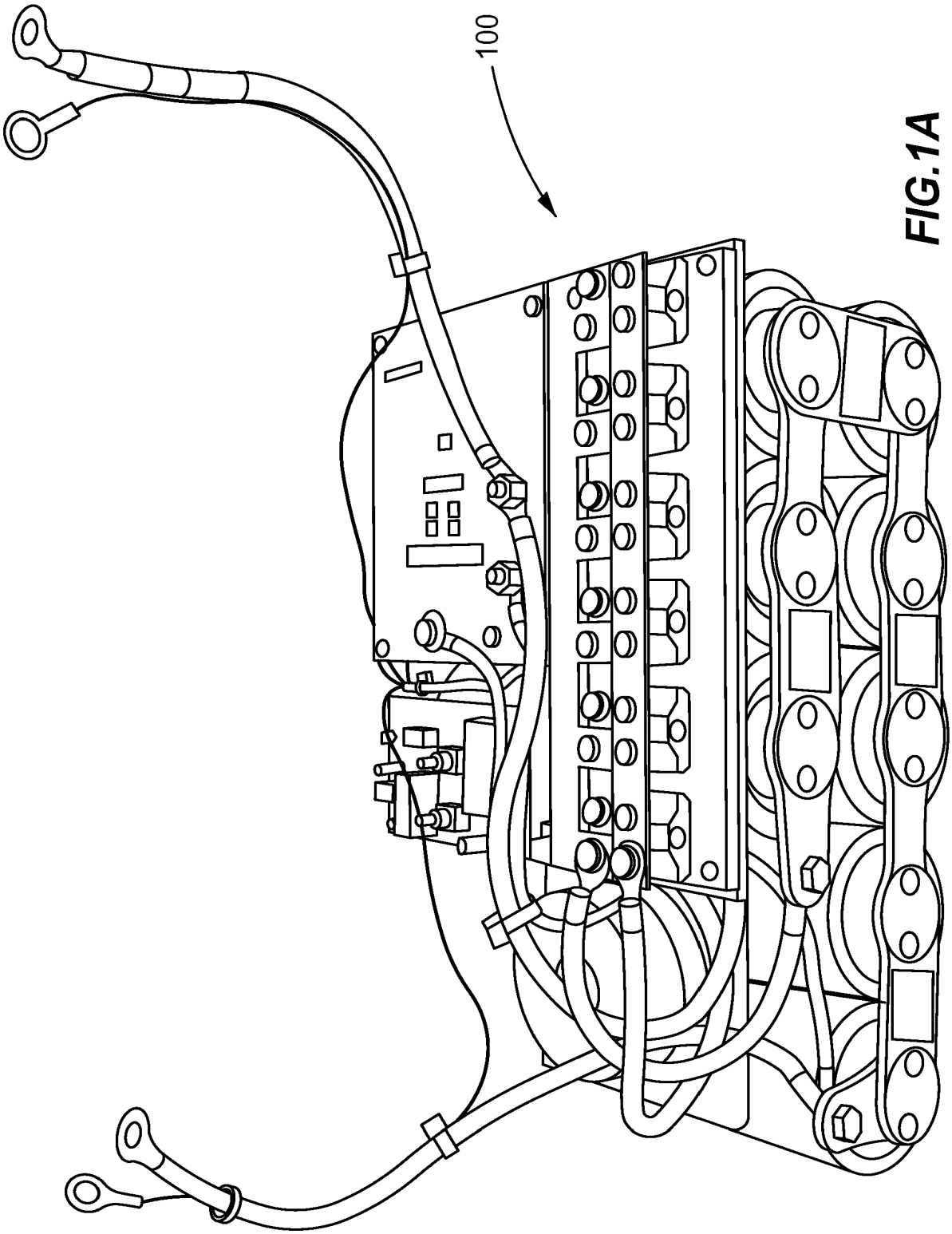


FIG.1A

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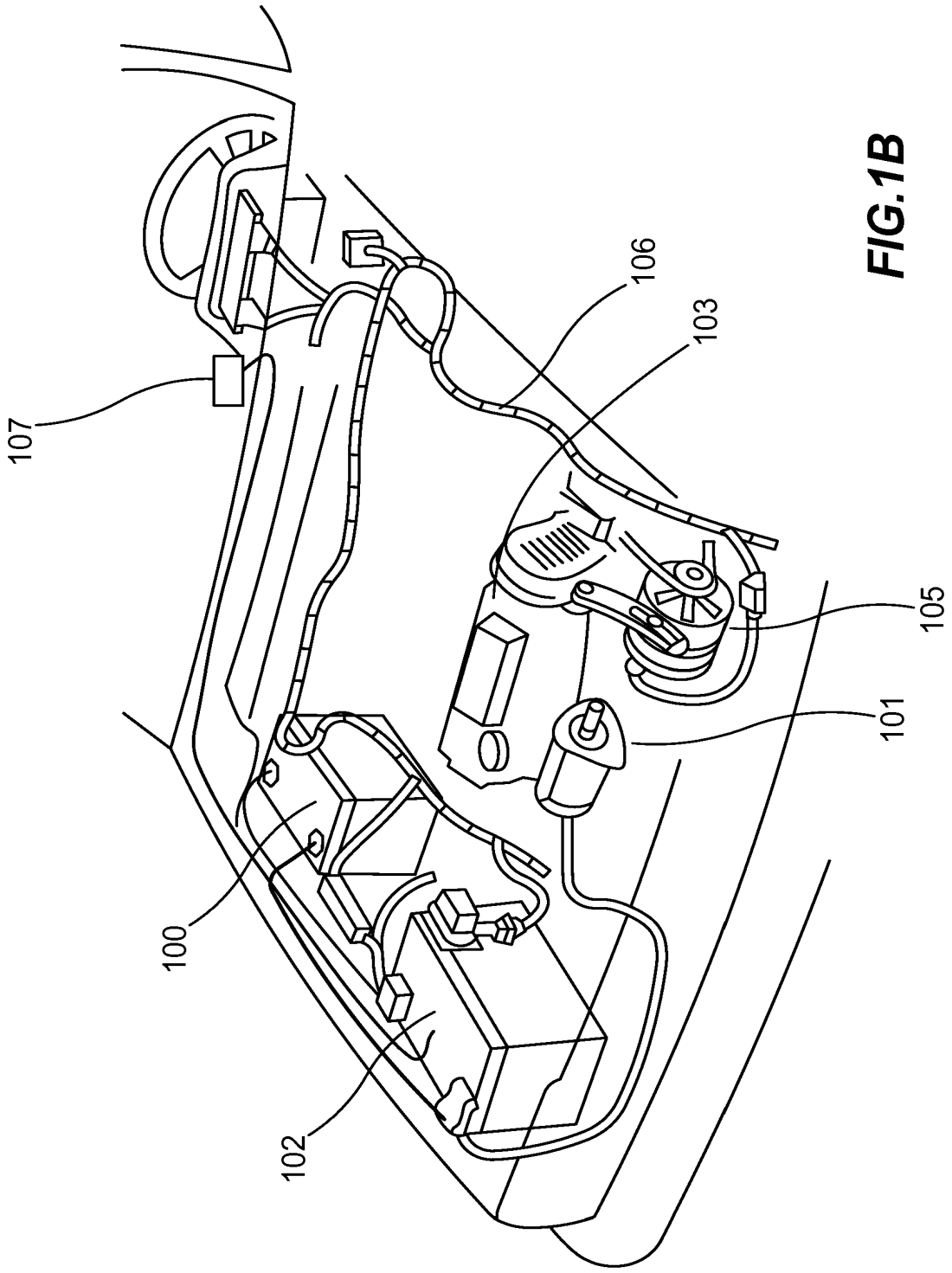


FIG.1B

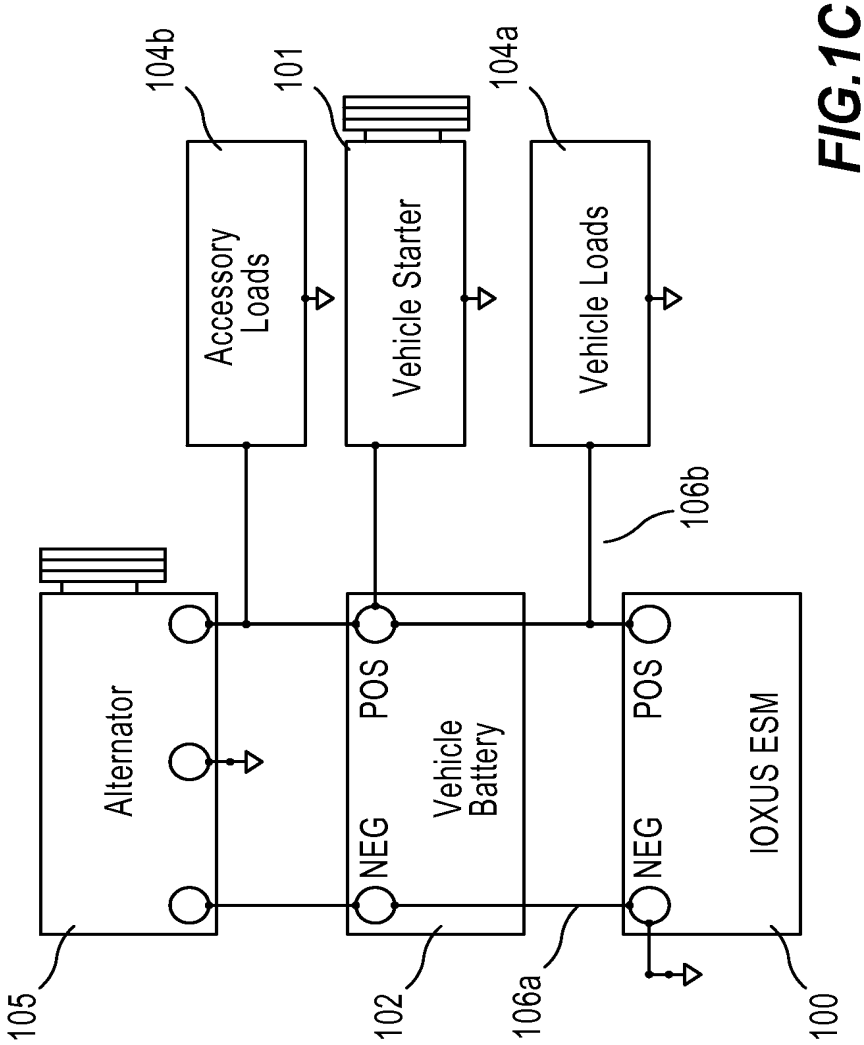

104b
101
104a
Accessory Loads
Vehicle Starter
Vehicle Loads
106b
Alternator
POS
NEG
Vehicle Battery
POS
NEG
IOXUS ESM
105
102
106a
100

FIG.1C

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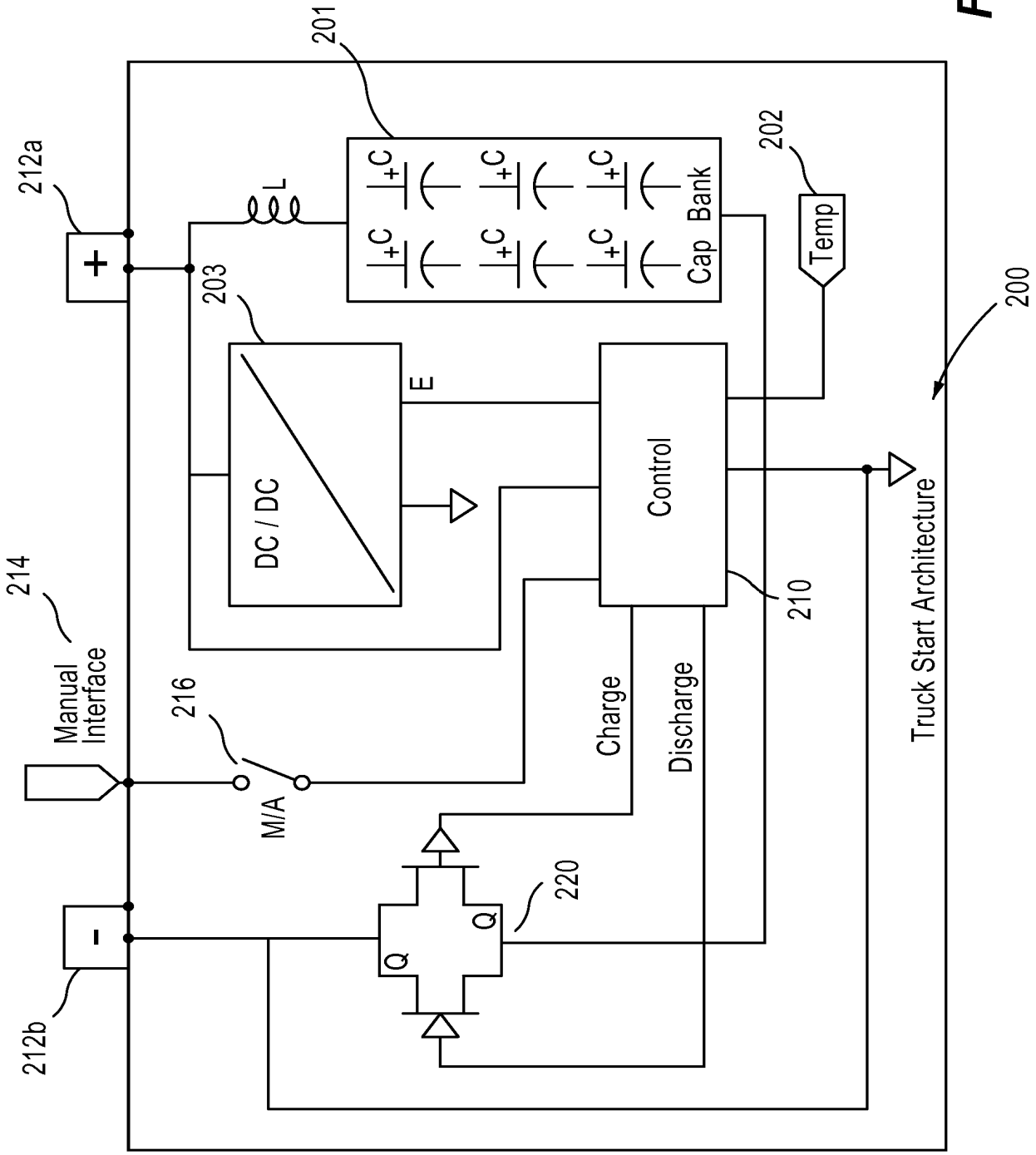

201
212a
+
L
+C
Cap Bank
202
Temp
203
200
DC / DC
E
Control
214
Manual Interface
216
M/A
Charge
Discharge
210
Truck Start Architecture
220
Q
Q
-
212b

FIG.2A

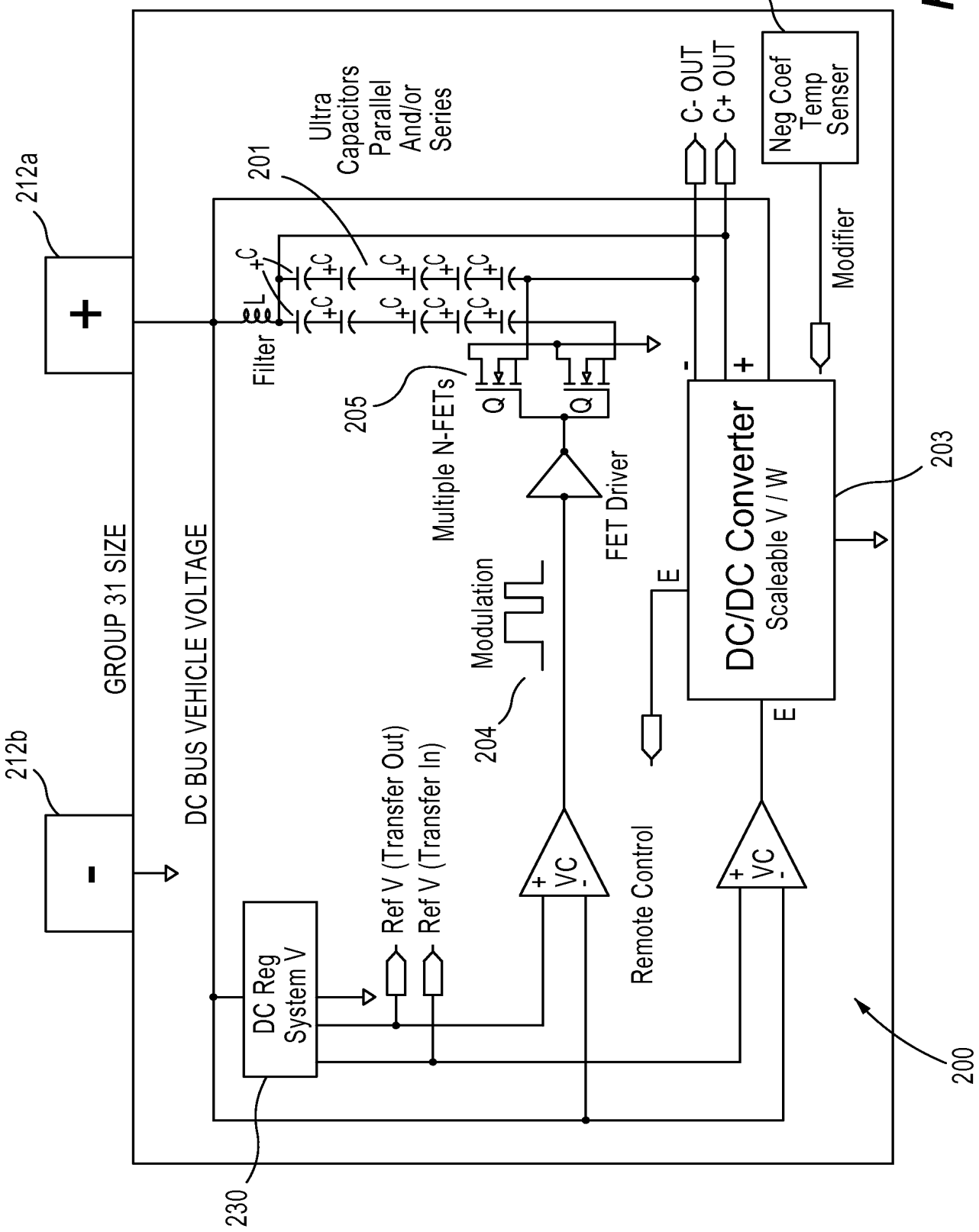
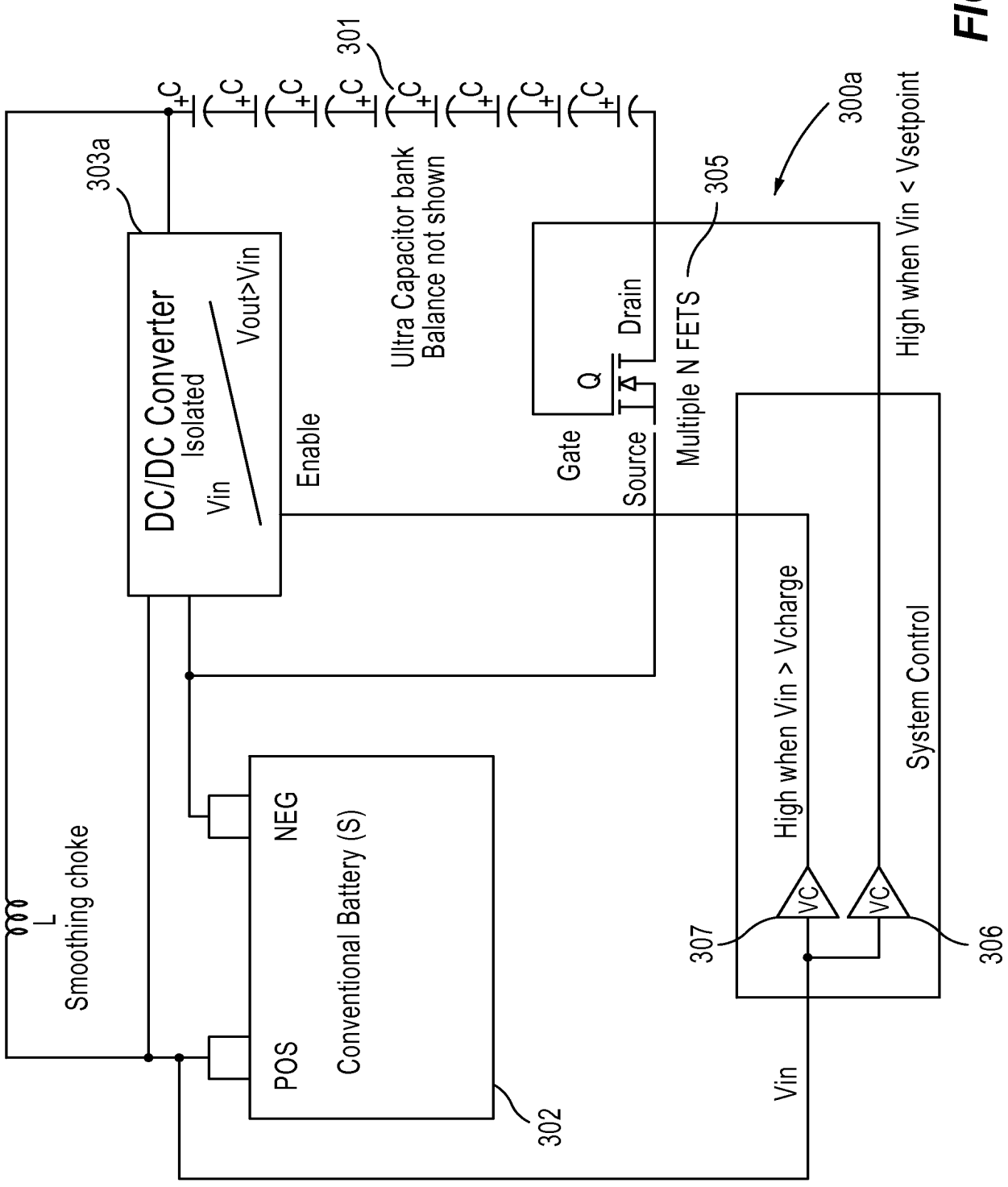

212a
+
212b
-
GROUP 31 SIZE
DC BUS VEHICLE VOLTAGE
201
Ultra Capacitors Parallel And/or Series
+C
L
Filter
205
Multiple N-FETs
Q
Q
FET Driver
Modulation
204
Ref V (Transfer Out)
Ref V (Transfer In)
DC Reg System V
230
VC
Remote Control
E
DC/DC Converter
Scaleable V / W
203
202
Neg Coef Temp Senser
C- OUT
C+ OUT
Modifier
200

FIG.2B

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FIG.3A


301
C
303a
DC/DC Converter
Isolated
Vout>Vin
Vin
Enable
Ultra Capacitor bank
Balance not shown
300a
305
Q
Drain
Gate
Source
Multiple N FETS
High when Vin < Vsetpoint
High when Vin > Vcharge
System Control
VC
307
306
L
Smoothing choke
NEG
POS
Conventional Battery (S)
302
Vin

7/14

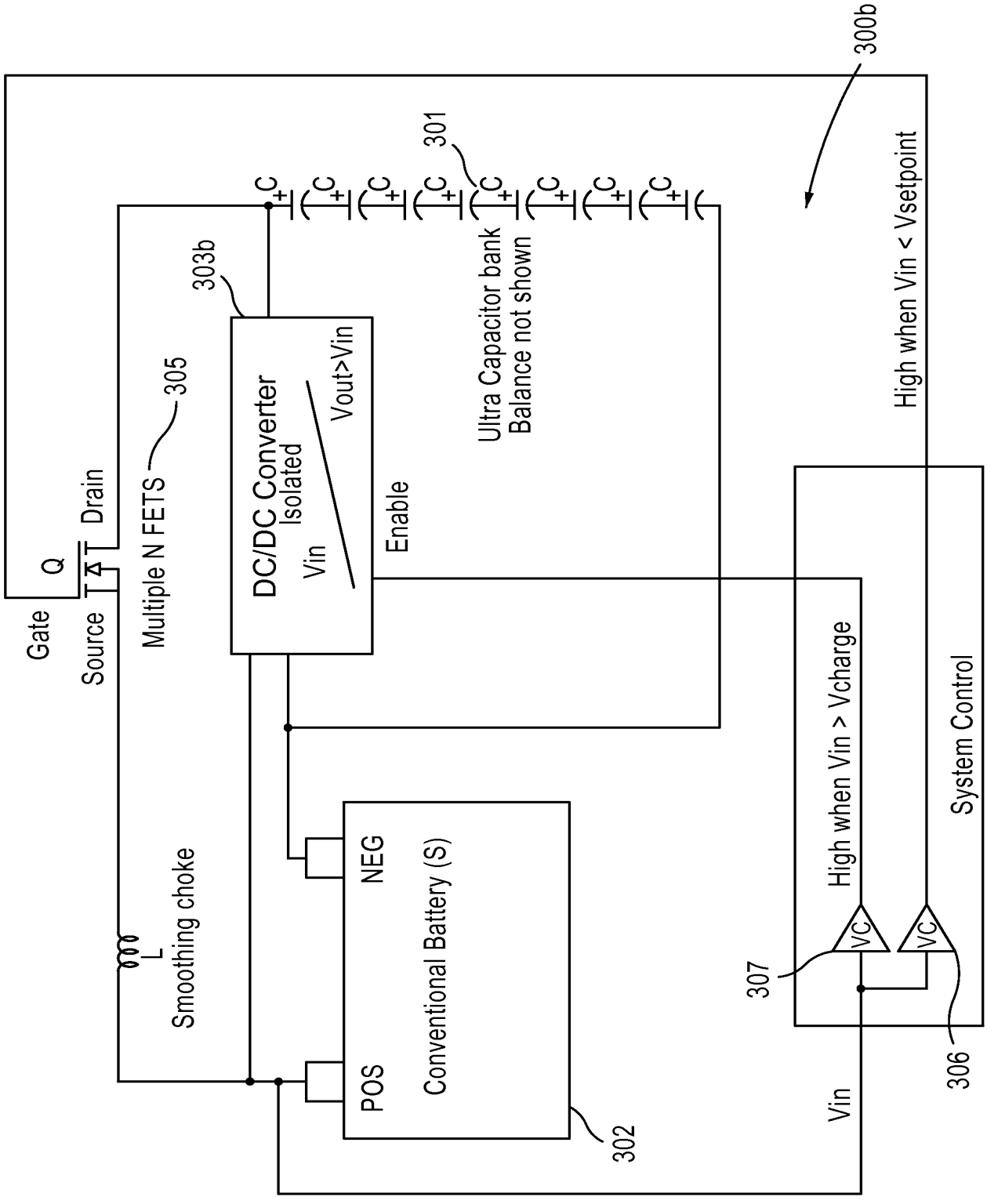

300b
301
C
Ultra Capacitor bank
Balance not shown
303b
DC/DC Converter
Isolated
Vout>Vin
Vin
Enable
305
Multiple N FETS
Drain
Q
Gate
Source
L
Smoothing choke
NEG
POS
Conventional Battery (S)
302
High when Vin < Vsetpoint
High when Vin > Vcharge
System Control
VC
307
306
Vin

FIG.3B

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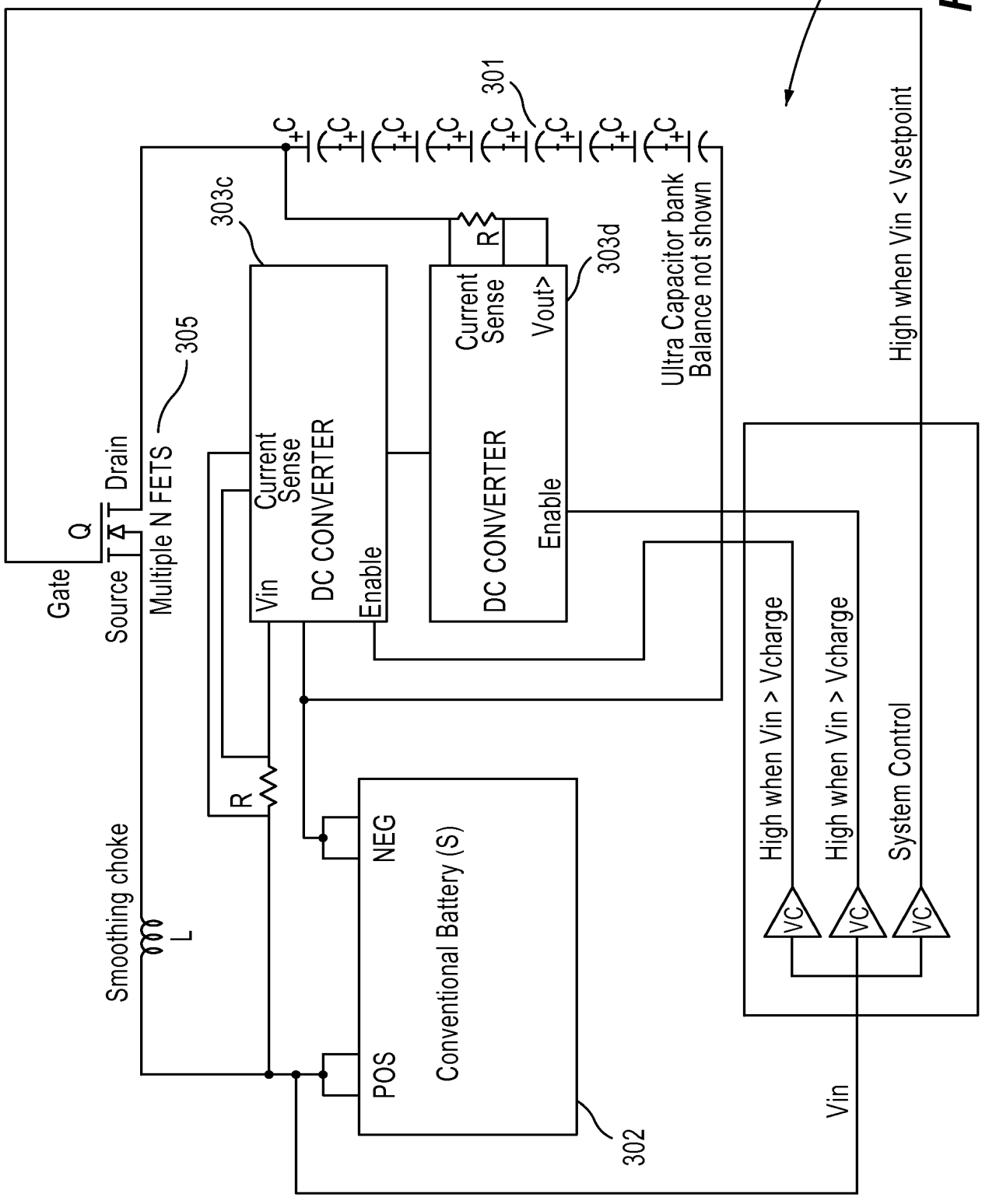

300c
301
C
303c
303d
R
Current Sense
Vout>
DC CONVERTER
Enable
Ultra Capacitor bank
Balance not shown
High when Vin < Vsetpoint
305
Multiple N FETS
Drain
Q
Gate
Source
Current Sense
Vin
DC CONVERTER
Enable
High when Vin > Vcharge
High when Vin > Vcharge
System Control
VC
Smoothing choke
L
NEG
POS
Conventional Battery (S)
302
Vin

FIG.3C

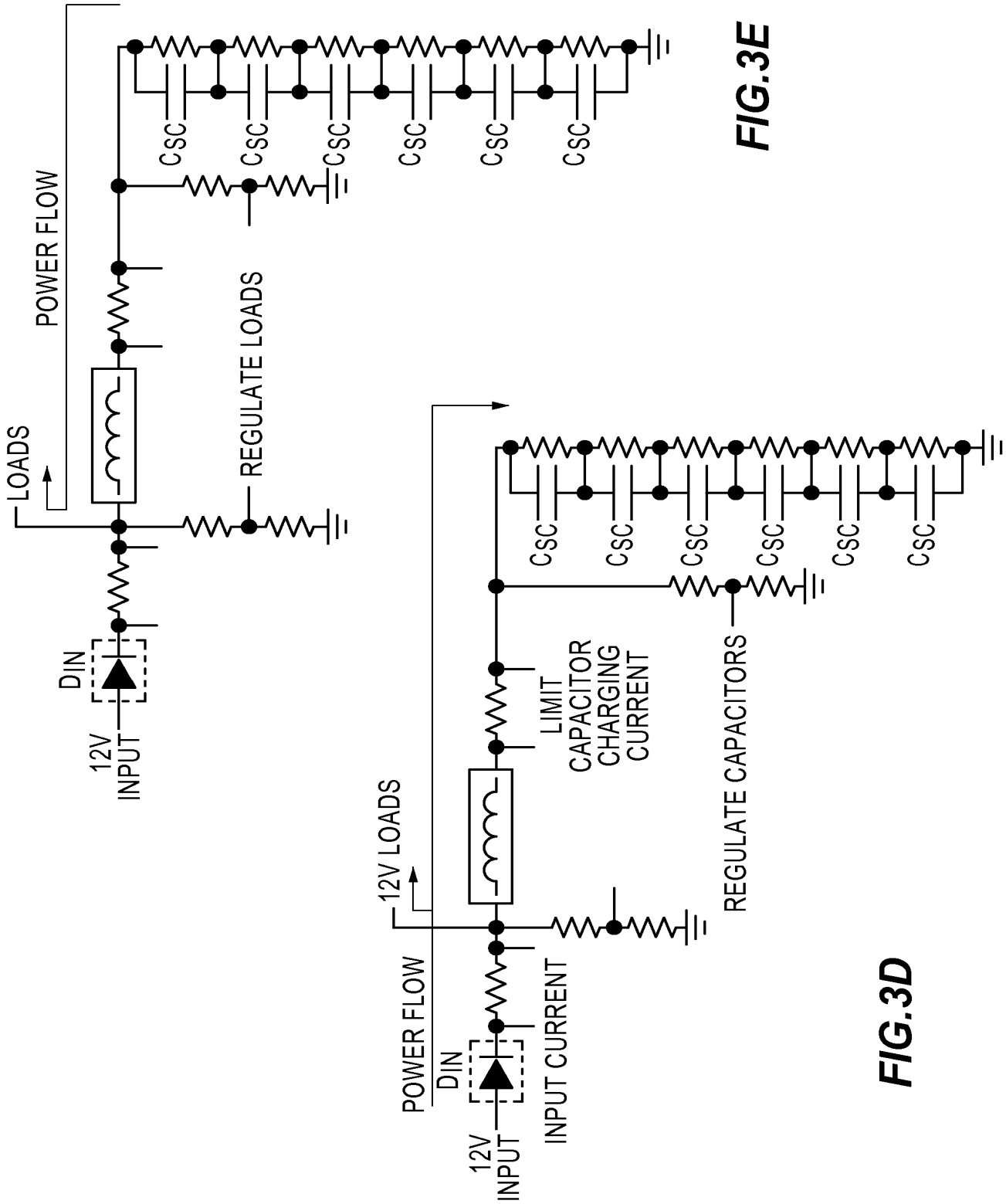

CSC
CSC
CSC
CSC
CSC
CSC
POWER FLOW
REGULATE LOADS
LOADS
DIN
12V
INPUT
CSC
CSC
CSC
CSC
CSC
CSC
LIMIT
CAPACITOR
CHARGING
CURRENT
REGULATE CAPACITORS
12V LOADS
POWER FLOW
DIN
12V
INPUT
INPUT CURRENT

FIG.3E

FIG.3D

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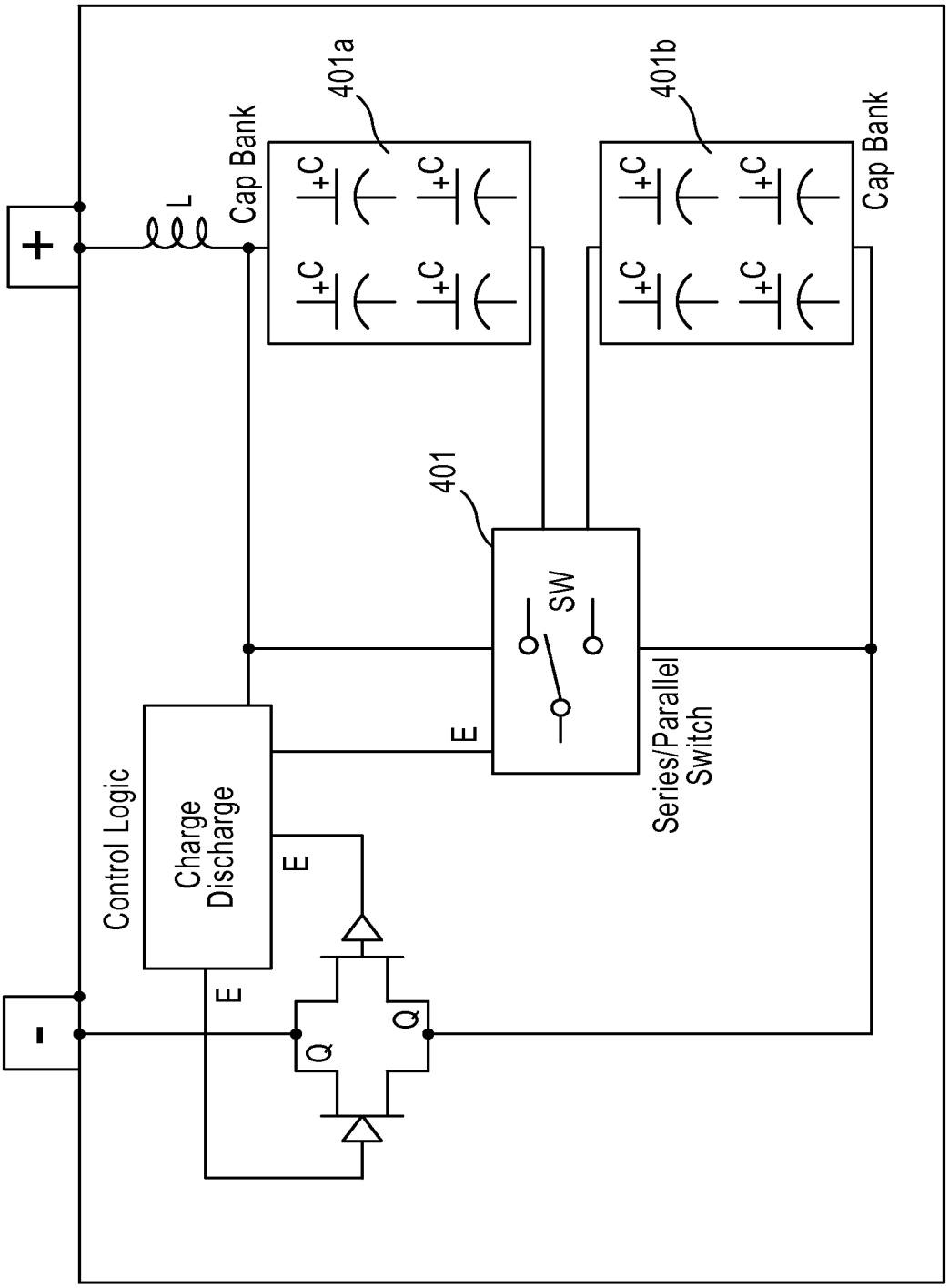

+
-
L
Cap Bank
401a
401b
Cap Bank
+C
401
SW
Series/Parallel
Switch
E
Control Logic
Charge
Discharge
E
E
Q
Q

FIG.4

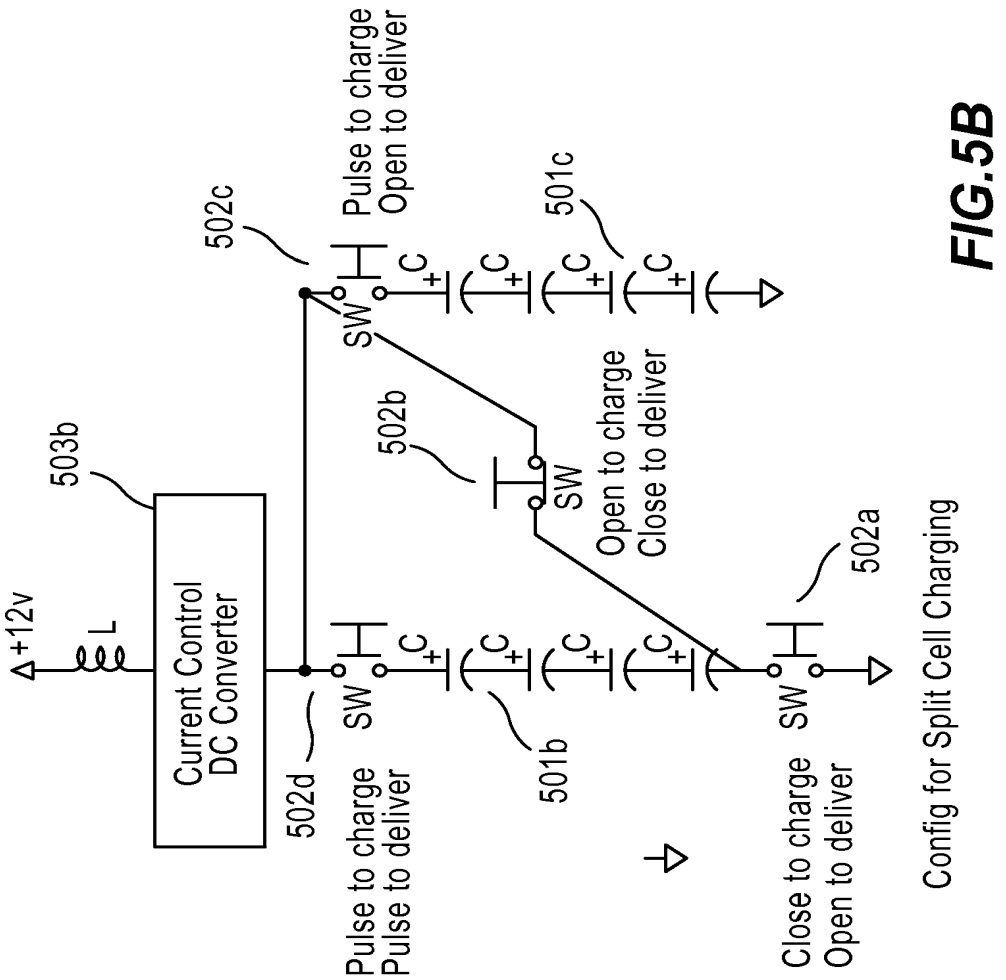

+12v
L
Current Control
DC Converter
503b
502d
Pulse to charge
Pulse to deliver
SW
C
501b
502b
Open to charge
Close to deliver
502c
Pulse to charge
Open to deliver
501c
502a
Close to charge
Open to deliver
Config for Split Cell Charging

FIG.5B

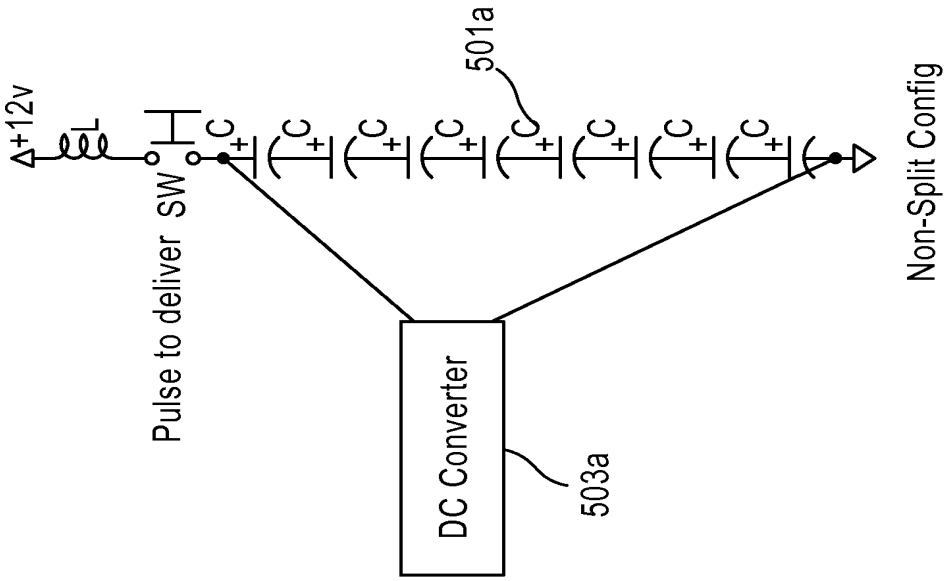

+12v
L
Pulse to deliver
SW
C
501a
DC Converter
503a
Non-Split Config

FIG.5A

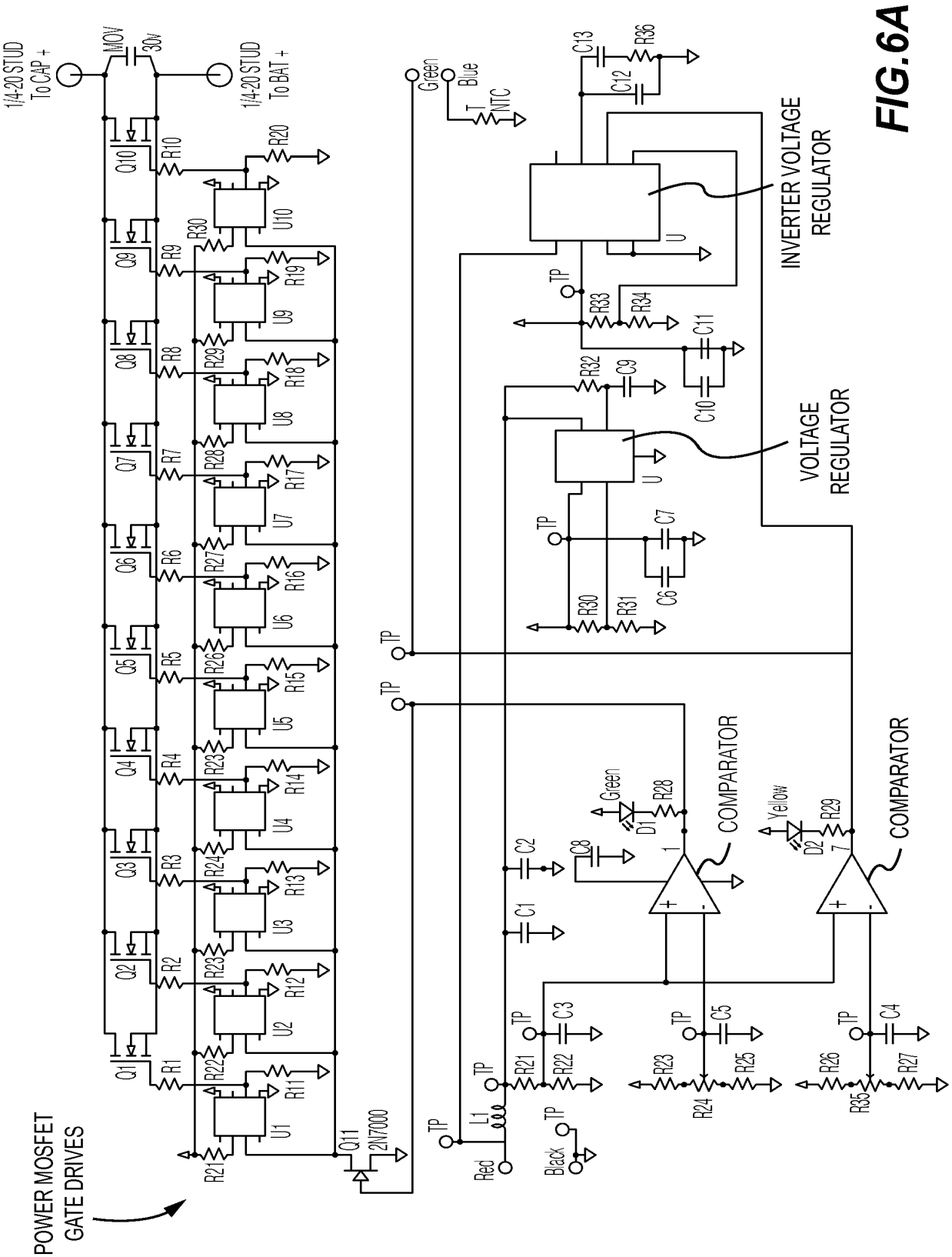

1/4-20 STUD To CAP +
MOV
30v
1/4-20 STUD To BAT +
POWER MOSFET GATE DRIVES
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
Q11
2N7000
Green
Blue
T NTC
C13
R36
C12
INVERTER VOLTAGE REGULATOR
U
TP
R33
R34
C11
C10
R32
C9
VOLTAGE REGULATOR
C7
C6
R30
R31
C2
C8
C1
Green
D1
R28
COMPARATOR
Yellow
D2
R29
C3
C5
C4
R21
R22
R23
R24
R25
R26
R27
R35
L1
Red
Black

FIG.6A

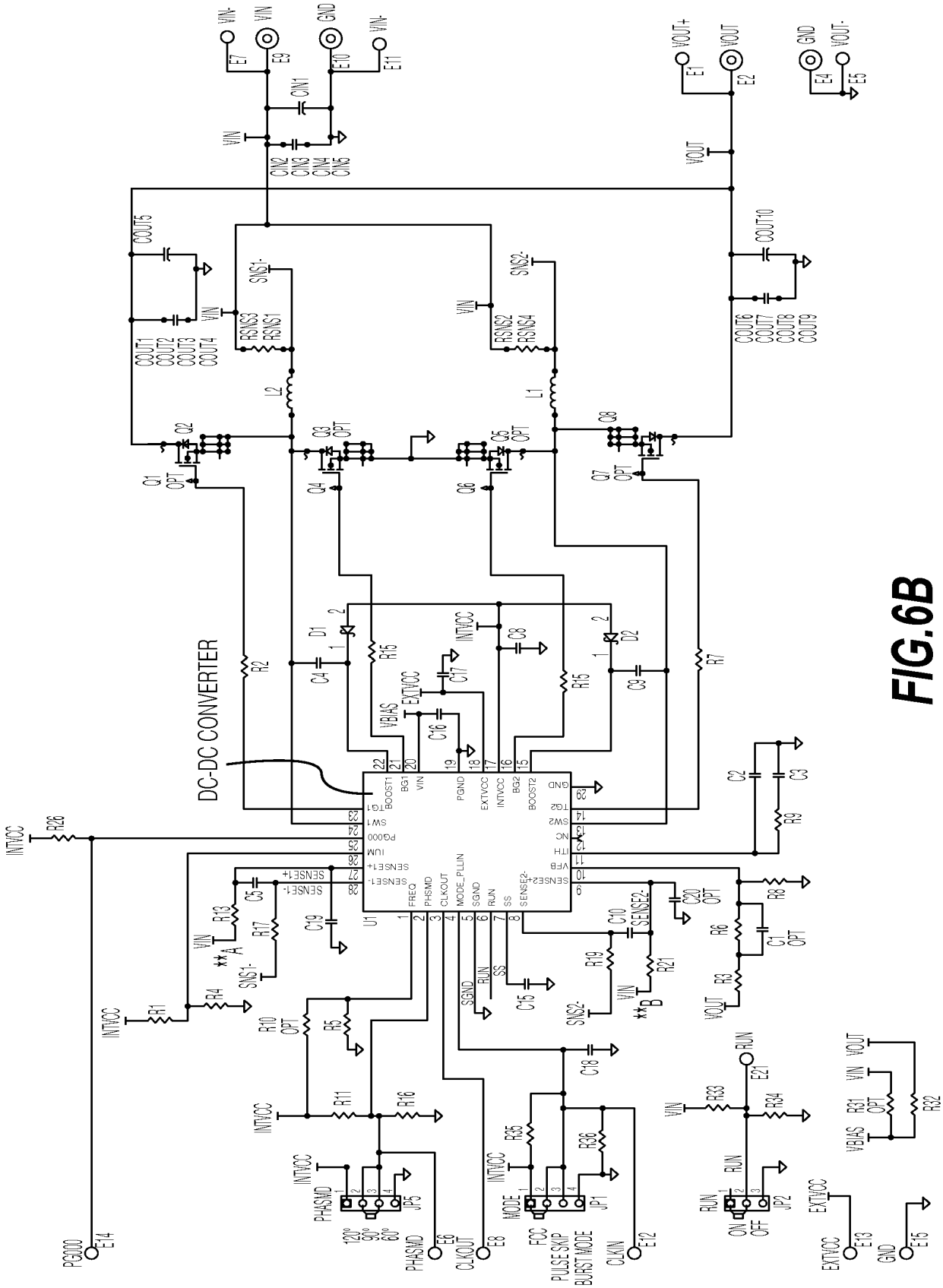

DC-DC CONVERTER
VIN-
VIN
GND
VOUT+
VOUT
GND
VOUT-
INTVCC
EXTVCC
VBIAS
RUN
SGND
PGOOD
PHASMD
CLKOUT
MODE
CLKIN
SENSE1+
SENSE1-
SENSE2+
SENSE2-
SNS1-
SNS2-
U1
JP1
JP2
JP5

FIG.6B

14/14

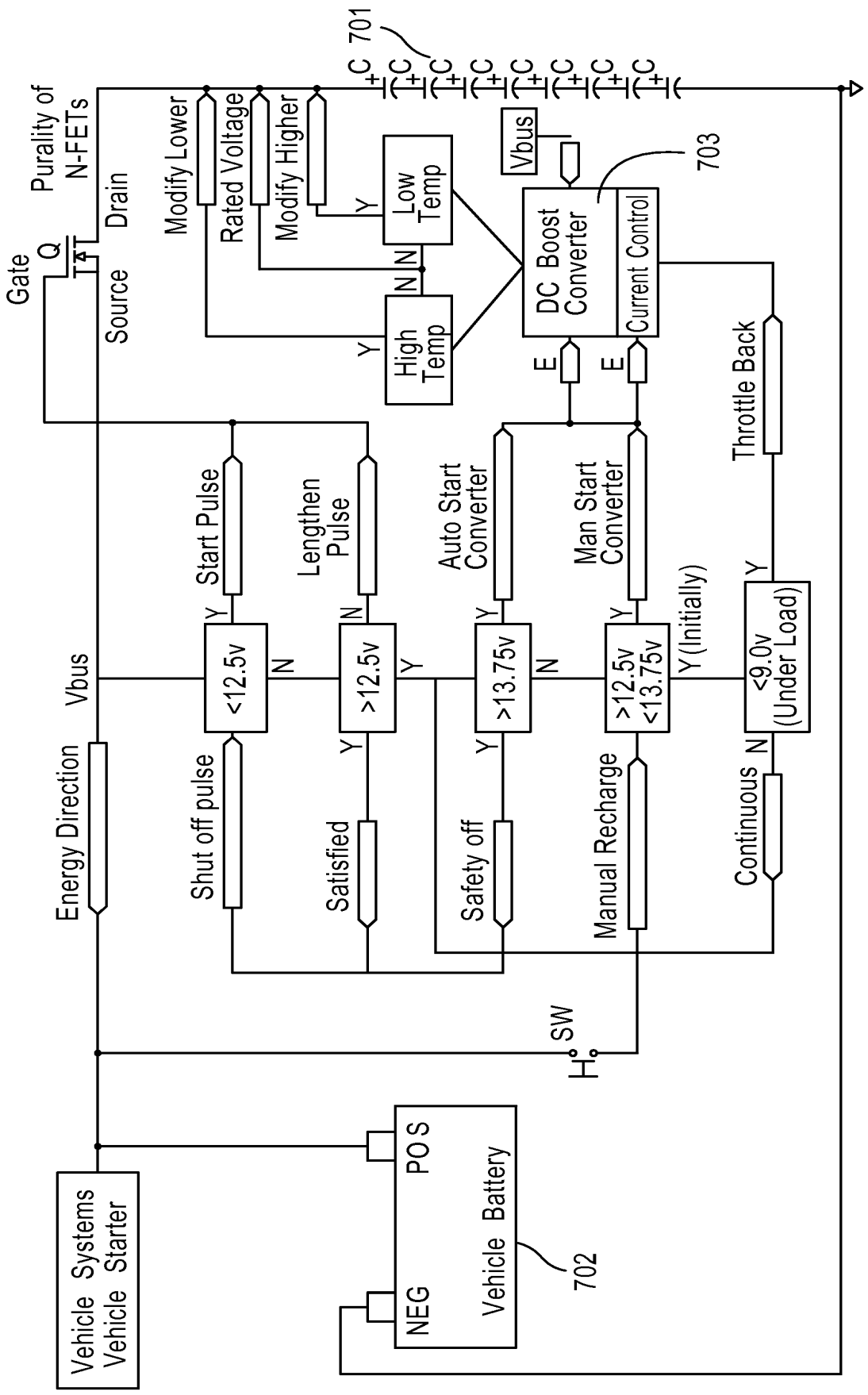

701
C
Purality of N-FETs
Drain
Gate
Q
Source
Modify Lower
Rated Voltage
Modify Higher
Low Temp
High Temp
Y
N
Vbus
DC Boost Converter
Current Control
703
E
Throttle Back
Start Pulse
Lengthen Pulse
Auto Start Converter
Man Start Converter
<12.5v
>12.5v
>13.75v
>12.5v <13.75v
Y (Initially)
<9.0v (Under Load)
Energy Direction
Shut off pulse
Satisfied
Safety off
Manual Recharge
Continuous
SW
Vehicle Systems Vehicle Starter
POS
NEG
Vehicle Battery
702

FIG.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/033743

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H02J 7/00 (2015.01)
CPC - H02J 7/00 (2015.04)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - (B60K 6/00, 6/448; B60L 1/00, 11/00; B60R 16/02, 16/03; G05B 23/00, 23/02; H02J 7/00, 7/02, 7/34 2015.01)
USPC -180/65.1, 65.21, 65.22, 65.225, 65.24, 65.275, 65.29; 307/9.1; 320/137, 162, 167

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - see last page

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google Scholar, ProQuest
Search terms used:vehicle, battery, ultracapacitor, voltage, regulate, monitor, control, threhsold, limit, charge, discharge, communication, transistor, temperature, sensor, dc, converter.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2010/0148582 A1 (CARTER) 17 June 2010 (17.06.2010) entire document	1-12,15-18 --- 13,14,19,20
Y	US 2003/0151875 A1 (NGUYEN et al.) 14 August 2003 (14.08.2003) entire document	13,14, 20
Y	US 2014/0041179 A1 (CLEAN EMISSIONS TECHNOLOGIES, INC) 13 February 2014 (13.02.2014) entire document	19
A	US 6,799,070 B2 (WOLFE et al.) 28 September 2004 (28.09.2004) entire document	1-20
A	US 2013/0031318 A1 (CHEN et al.) 31 January 2013 (31.01.2013) entire document	1-20
A	US 2012/0237799 A1 (JIANG et al.) 20 September 2012 (20.09.2012) entire document	1-20
A	US 7,633,271 B2 (SCHULTE et al.) 15 December 2009 (15.12.2009) entire document	1-20
A	US 5,710,699 A (KING et al.) 20 January 1998 (20.01.1998) entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 August 2015	25 AUG 2015
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2015/033743

Continuation of Box B Fields Searched

CPC Class/Subclass(es): B60K 6/00, 6/448; B60L 1/00, 11/00, 11/005, 11/18, 11/1861, 11/1866, 2210/20, 2220/44, 2270/36, 2200/26; B60R 16/03; B60W 10/08, 10/26, 20/00; B60Y 2400/114; G05B 23/00, 23/02; H02J 7/00, 7/0018, 7/025, 7/345; Y02T 10/7005, 10/7022, 10/7055 (2015.04) (keyword delimited)

ADC EX1002
IPR2025-00885

(19)日本国特許庁(JP)　(12)登録実用新案公報(U)　(11)実用新案登録番号
実用新案登録第3182855号
(U3182855)
(45)発行日　平成25年4月11日(2013.4.11)　(24)登録日　平成25年3月21日(2013.3.21)

(51)Int.Cl.　F I
H02J 7/00 (2006.01)　H02J 7/00 303C
H02J 7/00 302B

評価書の請求 未請求　請求項の数 9　OL　（全 17 頁）

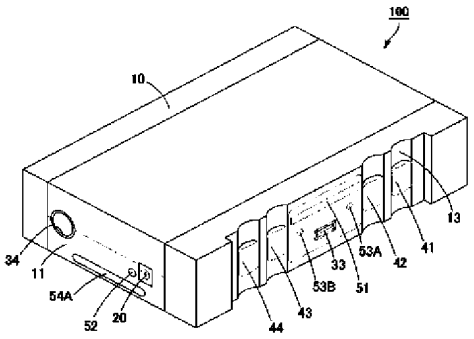
(21)出願番号　実願2013-523(U2013-523)
(22)出願日　平成25年2月1日(2013.2.1)

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最終頁に続く

(54)【考案の名称】車両用補助給電装置

(57)【要約】　（修正有）
【課題】ジャンプスタータとポータブル電源としての機能を有し、小型軽量で携帯性に優れ、使い勝手のよい車両用補助給電装置を提供する。
【解決手段】内部接続された充電回路部、リチウムイオン蓄電池、出力回路部、制御回路部を筐体内に備え、制御回路部は、ＤＣ出力端子に給電されると充電回路部の動作を制御して、リチウムイオン蓄電池を充電する。制御回路部は、リチウムイオン蓄電池から、第１のＤＣ出力端子に外部接続される車両バッテリにジャンプスタート用の電源を供給し、第２のＤＣ出力端子に外部接続されるＰＣにＰＣ駆動用の電源を供給し、第３のＤＣ出力端子３３に外部接続されるＵＳＢ機器にＵＳＢ機器駆動用の電源を供給し、第４のＤＣ出力端子３４に外部接続される外部機器に外部機器駆動用の電源を供給するように出力回路部の動作を制御する。
【選択図】図１



【実用新案登録請求の範囲】
【請求項１】
筐体と、
上記筐体の側壁に設置され、充電用の給電ケーブルがＤＣプラグを介して外部接続されるＤＣジャックからなるＤＣ入力端子と、
上記筐体内に設置され、上記ＤＣ入力端子に内部接続された充電回路部と、
上記筐体内に設置され、上記充電回路部に内部接続されたリチウムイオン蓄電池と、
上記筐体内に設置され、上記リチウムイオン蓄電池に内部接続された出力回路部と、
上記筐体内に設置され、上記充電回路部及び出力回路部の動作を制御する制御回路部と、
上記筐体の側壁に設置され、上記出力回路部に内部接続されており、ブースタケーブルがプラグを介して外部接続されるジャックからなるジャンプスタート用の第１のＤＣ出力端子と、
上記筐体の側壁に設置され、上記出力回路部に内部接続されており、ＰＣ電源ケーブルがプラグを介して外部接続されるジャックからなるＰＣ電源用の第２のＤＣ出力端子と、
上記筐体の正面壁に設置され、上記出力回路部に内部接続されており、ＵＳＢケーブルがＵＳＢプラグを介して外部接続されるＵＳＢソケットからなる第３のＤＣ出力端子と、
上記筐体の背面壁に設置され、上記出力回路部に内部接続されており、外部電源ケーブルがシガープラグを介して外部接続されるシガーソケットからなる第４のＤＣ出力端子と、
上記筐体の正面壁に設置され、上記制御回路部に内部接続された電源スイッチ、ジャンプスタートスイッチと、
上記筐体の正面壁に設置され、上記制御回路部により制御されて上記リチウムイオン蓄電池の充電量をレベルバー表示する充電量表示部と
を備え、
上記制御回路部は、上記リチウムイオン蓄電池の充電量を監視し、上記充電量を上記充電量表示部によりレベルバー表示させる制御を行うとともに、
上記制御回路部は、上記第１のＤＣ出力端子にブースタケーブルを介して車両バッテリが外部接続され、上記電源スイッチがＯＮされた状態で、上記ジャンプスタートスイッチの操作入力を受け付けることにより、上記出力回路部から上記第１のＤＣ出力端子を介してジャンプスタート用の電源を供給する制御を行い、上記第２のＤＣ出力端子にＰＣ電源ケーブルを介してＰＣが外部接続された状態で、上記電源スイッチの操作入力を受け付けることにより、上記出力回路部から上記第２のＤＣ出力端子を介してＰＣ駆動用の電源を供給する制御を行い、上記第３のＤＣ出力端子にＵＳＢケーブルを介してＵＳＢ機器が外部接続された状態で、上記電源スイッチの操作入力を受け付けることにより、上記出力回路部から上記第３のＤＣ出力端子を介してＵＳＢ機器駆動用の電源を供給する制御を行い、上記第４のＤＣ出力端子に外部電源ケーブルを介して外部機器が外部接続された状態で、上記電源スイッチの操作入力を受け付けることにより、上記出力回路部から上記第４のＤＣ出力端子を介して外部機器駆動用の電源を供給する制御を行うことを特徴とする車両用補助給電装置。
【請求項２】
上記ＤＣ入力端子には、一端にＡＣアダプタ又はシガーソケットを備えた上記充電用の給電ケーブルを介して給電され、
上記制御回路部は、上記ＤＣ入力端子に上記充電用の給電ケーブルを介して給電された状態を検出すると、上記充電回路部を介して上記リチウムイオン蓄電池を充電する制御を行い、充電制御中は、上記出力回路部から外部への電源供給を禁止する制御を行うことを特徴とする請求項１記載の車両用補助給電装置。
【請求項３】
上記制御回路部は、上記電源スイッチの操作による電源ＯＮを検知して上記充電量表示部の動作を制御し、電源ＯＮを表示するパワーランプとして上記充電量表示部を機能させ

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、この電源ＯＮ状態で上記ジャンプスタートスイッチの短時間操作によるジャンプスタートを検知してジャンプスタートモードの制御を行い、このジャンプスタートモードの制御において、上記第１のＤＣ出力端子に外部接続されたブースタケーブルを介してジャンプスタートさせる自動車の車載バッテリの電圧を正常に検知できた場合に、上記出力回路部の動作を制御し、上記リチウムイオン蓄電池をジャンプスタート用の電源として上記出力回路部を介して上記第１のＤＣ出力端子に接続するとともに、上記充電量表示部の動作を制御し、ジャンプスタートを表示するジャンプスタートランプとして上記充電量表示部を機能させることを特徴とする請求項１又は請求項２の何れか１項記載の車両用補助給電装置。

【請求項４】

上記制御回路部は、上記電源ＯＮ状態で上記ジャンプスタートスイッチが長時間操作されたことを検知してチャージブーストモードの制御を行い、このジャンプスタートモードの制御において、上記第１のＤＣ出力端子に外部接続されたブースタケーブルを介してジャンプスタートさせる自動車の車載バッテリの電圧を正常に検知できた場合に、上記出力回路部の動作を制御し、上記リチウムイオン蓄電池をチャージブースト用の電源として上記出力回路部を介して上記第１のＤＣ出力端子に接続するとともに、上記充電量表示部の動作を制御し、チャージブーストを表示するチャージブーストランプとして上記充電量表示部を機能させることを特徴とする請求項３記載の車両用補助給電装置。

【請求項５】

上記充電量表示部は、上記制御回路部により制御されて上記リチウムイオン蓄電池の充電量を発光色の変化とともにレベルバー表示する直線上に配置された複数個の発光素子からなり、

上記制御回路部は、上記複数個の発光素子の１つを第１の発光色で点灯させることにより、上記電源ＯＮを表示するパワーランプとして上記充電量表示部を機能させ、

上記複数個の発光素子の他の１つを第２の発光色で点灯させることにより、上記ジャンプスタートを表示するジャンプスタートランプ又は上記チャージブーストを表示するチャージブーストランプとして上記充電量表示部を機能させることを特徴とする請求項４記載の車両用補助給電装置。

【請求項６】

上記第４のＤＣ出力端子に上記外部電源ケーブルを介して外部機器として車両のＯＢＤ（On-Board Diagnostic system）システムが外部接続された状態で、上記制御回路部が上記電源スイッチの操作入力を受け付けることにより、上記出力回路部から上記第４のＤＣ出力端子を介して外部機器駆動用の電源として、上記ＯＢＤのメモリバックアップ用の電源供給を行うことを特徴とする請求項１乃至５項いずれか１項に記載の車両用補助給電装置。

【請求項７】

上記リチウムイオン蓄電池として上記筐体内に設置した複数個の充電式リチウムイオン電池を備えることを特徴とする請求項７項記載の車両用補助給電装置。

【請求項８】

上記筐体内に３．６Ｖの充電式リチウムイオンを３個実装することにより、重さ８３０ｇ程度で１２Ｖ／４．５Ａｈの容量のジャンプスータとして機能させることを特徴とする請求項７項記載の車両用補助給電装置。

【請求項９】

上記筐体内に３．６Ｖの充電式リチウムイオンを６個実装することにより、重さ１３００ｇ程度で１２Ｖ／９Ａｈの容量のジャンプスータとして機能させることを特徴とする請求項７項記載の車両用補助給電装置。

【考案の詳細な説明】

【技術分野】

【０００１】

本考案は、車両のバッテリが上がった場合に、車載バッテリに接続されて、エンジンを

始動させるスタータを含む車両の電気負荷に対して電力を供給して、上記エンジンを始動させるジャンプスタートさせるための車両用補助給電装置に関する。

【背景技術】

【０００２】

従来より、例えば路上等において、消費電気量の増加等により、車両に搭載されたバッテリが放電気味となりバッテリ容量が不足して電圧が低下し、電装品が作動しなくなった場合（いわゆるバッテリあがりの場合）に、他の自動車のバッテリや非常携帯電源（ジャンプスタータ）からブースタケーブルを介して電力を供給することによりエンジンを始動させるジャンプスタートが行われている。そして、ジャンプスタートのための電気的な接続を容易にする技術（例えば、特許文献１，２参照）や、ジャンプスタートを判定する技術（例えば、特許文献３参照）など各種提案がなされている。

【０００３】

従来、ジャンプスタータでは、コストと容量の関係から密閉式鉛蓄電池が用いられていた。

【０００４】

また、ＡＣアダプタを用いて充電可能なバッテリ駆動型のノートＰＣやその付帯機器などの情報機器が広く普及している。また、車両の車内に標準的に搭載されているＤＣ１２Ｖ／２４Ｖの車内用電源ソケット、いわゆるシガーソケットに接続して利用可能な車載対応の電気機器が数多く提供されている。また、近年の携帯電話やＵＳＢ（Universal Serial Bus）で給電可能な携帯音楽プレーヤ等の省電力で駆動可能な電子機器が広く使用されている。従来から、屋外で電気機器を使用するためにポータブル電源装置が用いられている。

【先行技術文献】

【特許文献】

【０００５】

【特許文献１】特開２００４－１３４２７８号公報

【特許文献２】特開２０１１－９７７１０号公報

【特許文献３】特開２００７－２７８２１６号公報

【考案の概要】

【考案が解決しようとする課題】

【０００６】

ところで、一般的な密閉式鉛蓄電池を用いた従来のジャンプスタータでは、５～７ｋｇ程度の重量があり、携帯性に欠けるという問題点があった。また、満充電に平均１０～１５時間程度を要し、満充電状態での始動（ジャンプスタート）可能回数は平均で５回程度であった。さらに、鉛蓄電池は、過放電や過充電を行うと劣化が早くなり、自己放電も進みやすい性質があり、通常の鉛蓄電池の放電率は３０％程度であって、不使用状態でも自己放電して充電の必要性が出てくる。なれない人では適正な時期に充電操作が行えず、過充電や過放電を起こしてしまうことが多く、誰でも簡単に取り扱いができるものではなく、使い勝手が非常に悪いものであった。

【０００７】

また、従来のポータブル電源装置においても、鉛蓄電池が使われていたので重く、可搬性や使い勝手等の観点から従来のジャンプスタータと同様な問題点があった。

【０００８】

本考案は、上述の如き従来の実情に鑑みてなされたものであり、その目的は、ジャンプスタータとしての機能を有し、しかも、バッテリ駆動型のノートＰＣやその付帯機器などの情報機器、シガーソケットに接続して利用可能な車載対応の電気機器、携帯電話やＵＳＢで給電可能な携帯音楽プレーヤ等の使用を可能にするポータブル電源としての機能を有し、さらに、ＯＢＤ（On-Board Diagnostic system）システムに対応した車両のメモリバックアップ用のポータブル電源として機能する小型軽量で携帯性に優れ、使い勝手のよい車両用補助給電装置を提供することにある。

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【０００９】
本考案のさらに他の目的、本考案によって得られる具体的な利点は、以下において図面を参照して説明される実施に形態から一層明らかにされる。
【課題を解決するための手段】
【００１０】
本考案は、車両用補助給電装置であって、筐体と、上記筐体の側壁に設置され、充電用の給電ケーブルがＤＣプラグを介して外部接続されるＤＣジャックからなるＤＣ入力端子と、上記筐体内に設置され、上記ＤＣ入力端子に内部接続された充電回路部と、上記筐体内に設置され、上記充電回路部に内部接続されたリチウムイオン蓄電池と、上記筐体内に設置され、上記リチウムイオン蓄電池に内部接続された出力回路部と、上記筐体内に設置され、上記充電回路部及び出力回路部の動作を制御する制御回路部と、上記筐体の側壁に設置され、上記出力回路部に内部接続されており、ブースタケーブルがプラグを介して外部接続されるジャックからなるジャンプスタート用の第１のＤＣ出力端子と、上記筐体の側壁に設置され、上記出力回路部に内部接続されており、ＰＣ電源ケーブルがプラグを介して外部接続されるジャックからなるＰＣ電源用の第２のＤＣ出力端子と、上記筐体の正面壁に設置され、上記出力回路部に内部接続されており、ＵＳＢケーブルがＵＳＢプラグを介して外部接続されるＵＳＢソケットからなる第３のＤＣ出力端子と、上記筐体の背面壁に設置され、上記出力回路部に内部接続されており、外部電源ケーブルがシガープラグを介して外部接続されるシガーソケットからなる第４のＤＣ出力端子と、 上記筐体の正面壁に設置され、上記制御回路部に内部接続された電源スイッチ、ジャンプスタートスイッチと、上記筐体の正面壁に設置され、上記制御回路部により制御されて上記リチウムイオン蓄電池の充電量をレベルバー表示する充電量表示部とを備え、上記制御回路部は、上記リチウムイオン蓄電池の充電量を監視し、上記充電量を上記充電量表示部によりレベルバー表示させる制御を行うとともに、上記制御回路部は、上記第１のＤＣ出力端子にブースタケーブルを介して車両バッテリが外部接続され、上記電源スイッチがＯＮされた状態で、上記ジャンプスタートスイッチの操作入力を受け付けることにより、上記出力回路部から上記第１のＤＣ出力端子を介してジャンプスタート用の電源を供給する制御を行い、上記第２のＤＣ出力端子にＰＣ電源ケーブルを介してＰＣが外部接続された状態で、上記電源スイッチの操作入力を受け付けることにより、上記出力回路部から上記第２のＤＣ出力端子を介してＰＣ駆動用の電源を供給する制御を行い、上記第３のＤＣ出力端子にＵＳＢケーブルを介してＵＳＢ機器が外部接続された状態で、上記電源スイッチの操作入力を受け付けることにより、上記出力回路部から上記第３のＤＣ出力端子を介してＵＳＢ機器駆動用の電源を供給する制御を行い、上記第４のＤＣ出力端子に外部電源ケーブルを介して外部機器が外部接続された状態で、上記電源スイッチの操作入力を受け付けることにより、上記出力回路部から上記第４のＤＣ出力端子を介して外部機器駆動用の電源を供給する制御を行うことを特徴とする。
【００１１】
本考案車に係る両用補助給電装置において、上記ＤＣ入力端子には、一端にＡＣアダプタ又はシガーソケットを備えた上記充電用の給電ケーブルを介して給電され、上記制御回路部は、上記ＤＣ入力端子に上記充電用の給電ケーブルを介して給電された状態を検出すると、上記充電回路部を介して上記リチウムイオン蓄電池を充電する制御を行い、充電制御中は、上記出力回路部から外部への電源供給を禁止する制御を行うものとすることができる。
【００１２】
また、本考案車に係る両用補助給電装置において、上記制御回路部は、上記電源スイッチの操作による電源ＯＮを検知して上記充電量表示部の動作を制御し、電源ＯＮを表示するパワーランプとして上記充電量表示部を機能させ、この電源ＯＮ状態で上記ジャンプスタートスイッチの短時間操作によるジャンプスタートを検知してジャンプスタートモードの制御を行い、このジャンプスタートモードの制御において、上記第１のＤＣ出力端子に外部接続されたブースタケーブルを介してジャンプスタートさせる自動車の車載バッテリ

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の電圧を正常に検知できた場合に、上記出力回路部の動作を制御し、上記リチウムイオン蓄電池をジャンプスタート用の電源として上記出力回路部を介して上記第１のＤＣ出力端子に接続するとともに、上記充電量表示部の動作を制御し、ジャンプスタートを表示するジャンプスタートランプとして上記充電量表示部を機能させるものとすることができる。

【００１３】

また、本考案車に係る両用補助給電装置において、上記制御回路部は、上記電源ＯＮ状態で上記ジャンプスタートスイッチが長時間操作されたことを検知してチャージブーストモードの制御を行い、このジャンプスタートモードの制御において、上記第１のＤＣ出力端子に外部接続されたブースタケーブルを介してジャンプスタートさせる自動車の車載バッテリの電圧を正常に検知できた場合に、上記出力回路部の動作を制御し、上記リチウムイオン蓄電池をチャージブースト用の電源として上記出力回路部を介して上記第１のＤＣ出力端子に接続するとともに、上記充電量表示部の動作を制御し、チャージブーストを表示するチャージブーストランプとして上記充電量表示部を機能させるものとすることができる。

【００１４】

また、本考案車に係る両用補助給電装置において、上記充電量表示部は、上記制御回路部により制御されて上記リチウムイオン蓄電池の充電量を発光色の変化とともにレベルバー表示する直線上に配置された複数個の発光素子からなり、上記制御回路部は、上記複数個の発光素子の１つを第１の発光色で点灯させることにより、上記電源ＯＮを表示するパワーランプとして上記充電量表示部を機能させ、上記複数個の発光素子の他の１つを第２の発光色で点灯させることにより、上記ジャンプスタートを表示するジャンプスタートランプ又は上記チャージブーストを表示するチャージブーストランプとして上記充電量表示部を機能させるものとすることができる。

【００１５】

また、本考案車に係る両用補助給電装置は、上記第４のＤＣ出力端子に上記外部電源ケーブルを介して外部機器として車両のＯＢＤ（On-Board Diagnostic system）システムが外部接続された状態で、上記制御回路部が上記電源スイッチの操作入力を受け付けることにより、上記出力回路部から上記第４のＤＣ出力端子を介して外部機器駆動用の電源として、上記ＯＢＤのメモリバックアップ用の電源供給を行うものとすることができる。

【００１６】

また、本考案車に係る両用補助給電装置は、上記リチウムイオン蓄電池として上記筐体内に設置した複数個の充電式リチウムイオン電池を備えるものとすることができる。

【００１７】

また、本考案車に係る両用補助給電装置は、上記筐体内に３．６Ｖの充電式リチウムイオンを３個実装することにより、重さ８３０ｇ程度で１２Ｖ／４．５Ａｈの容量のジャンプスタータとして機能させるものとすることができる。

【００１８】

さらに、本考案車に係る両用補助給電装置は、上記筐体内に３．６Ｖの充電式リチウムイオンを６個実装することにより、重さ１３００ｇ程度で１２Ｖ／９Ａｈの容量のジャンプスタータとして機能させるものとすることができる。

【考案の効果】

【００１９】

本考案によれば、ジャンプスタータとしての機能を有し、しかも、バッテリ駆動型のノートＰＣやその付帯機器などの情報機器、シガーソケットに接続して利用可能な車載対応の電気機器、携帯電話やＵＳＢで給電可能な携帯音楽プレーヤ等の使用を可能にするポータブル電源としての機能を有し、さらに、ＯＢＤ（On-Board Diagnostic system）システムに対応した車両のメモリバックアップ用のポータブル電源として機能する小型軽量で携帯性に優れ、使い勝手のよい車両用補助給電装置を提供することができる。

【図面の簡単な説明】

【００２０】

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【図１】本考案を適用した車両用補助給電装置を前方側左斜め上方から見た外観斜視図である。
【図２】上記車両用補助給電装置を前方側右斜め上方から見た外観斜視図である。
【図３】上記車両用補助給電装置の構成要素の電気的な接続状態を示すブロック図である。
【図４】上記車両用補助給電装置のＤＣ入力端子に接続される充電用の給電ケーブルを示す平面図であり、（Ａ）はＡＣアダプタケーブルを示し、（Ｂ）はシガープラグケーブルを示している。
【図５】上記ＤＣ入力端子にＡＣアダプタを接続した状態の上記車両用補助給電装置を示す外観斜視図である。
【図６】充電レベルのバー表示状態を示す上記車両用補助給電装置の充電量表示部の正面図である。
【図７】上記車両用補助給電装置の第１のＤＣ出力端子に接続されるブースタケーブルを示す平面図である。
【図８】上記第１のＤＣ出力端子にブースタケーブルを介してジャンプスタートさせる自動車の車載バッテリを接続した状態の上記車両用補助給電装置を示す外観斜視図である。
【図９】第３のＤＣ出力端子にＵＳＢケーブルを介してＵＳＢ機器を接続した状態の上記車両用補助給電装置を示す外観斜視図である。
【図１０】上記車両用補助給電装置の第４のＤＣ出力端子に接続されるシガープラグケーブルを示す平面図であり、（Ａ）は一端にＤＣプラグを備える第１のシガープラグケーブルを示し、（Ｂ）は一端にＯＢＤ２コネクタに備える第２のシガープラグケーブルを示している。
【図１１】上記車両用補助給電装置の側面壁に設けられた側面照明灯の点灯状態を示す上記車両用補助給電装置の外観斜視図である。
【考案を実施するための形態】
【００２１】
以下、本考案の実施の形態について、図面を参照しながら詳細に説明する。なお、本考案は、以下の実施の形態のみに限定されるものではなく、本考案の要旨を逸脱しない範囲内において種々の変更が可能であることは言うまでもない。
【００２２】
本考案を適用した車両用補助給電装置１００を前方側左斜め上方から見た外観斜視図及び前方側右斜め上方から見た外観斜視図を図１及び図２に示す。また、上記車両用補助給電装置１００の構成要素の電気的な接続状態を示す図３のブロック図に示す。
【００２３】
この車両用補助給電装置１００は、図１及び図２の外観斜視図に示すように薄型箱状の筐体１０を備え、また、図３のブロック図に示すように上記筐体１０の内部に設置された充電回路部１、リチウムイオン蓄電池２、出力回路部３及び制御回路部４を備える。
【００２４】
そして、この車両用補助給電装置１００では、図１の外観斜視図に示すように、家庭用電源や自動車バッテリから例えば１２Ｖの電源供給を受けるためのＤＣ入力端子２０が上記筐体１０の左側面壁１１に設置されている。
【００２５】
このＤＣ入力端子２０は、後述するように充電用の給電ケーブルがＤＣプラグを介して外部接続されるＤＣジャックからなる。
【００２６】
このＤＣ入力端子２０には、図３のブロック図に示すように上記充電回路部１が内部接続されている。上記充電回路部１には、上記リチウムイオン蓄電池２が内部接続されている。また、上記リチウムイオン蓄電池２には、上記出力回路部３が内部接続されている。さらに、上記充電回路部１及び出力回路部３には、上記制御回路部４が内部接続されている。

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【００２７】
また、この車両用補助給電装置１００は、図３のブロック図に示すように、上記出力回路部３に内部接続されたジャンプスタート用の第１のＤＣ出力端子３１、ＰＣ電源用の第２のＤＣ出力端子３２、ＵＳＢ電源用の第３のＤＣ出力端子３３及びメモリバックアップ電源用の第４のＤＣ出力端子３４を備える。
【００２８】
上記第１のＤＣ出力端子３１は、後述するようにブースタケーブルがプラグを介して外部接続されるジャックからなる。
【００２９】
上記第２のＤＣ出力端子３２は、後述するようにＰＣ電源ケーブルがプラグを介して外部接続されるジャックからなる。
【００３０】
上記第３のＤＣ出力端子３３は、後述するようにＵＳＢケーブルがＵＳＢプラグを介して外部接続されるＵＳＢソケットからなる。
【００３１】
上記第４のＤＣ出力端子３４は、後述するように外部電源ケーブルがシガープラグを介して外部接続されるシガーソケットからなる。
【００３２】
上記ジャンプスタート用の第１のＤＣ出力端子３１と、ＰＣ電源用の第２のＤＣ出力端子３２は、図２の外観斜視図に示すように、上記筐体１０の右側面壁１２に設置されている。また、図１の外観斜視図に示すように、上記ＵＳＢ電源用の第３のＤＣ出力端子３３は、上記筐体１０の正面壁１３に設置されており、上記メモリバックアップ電源用の第４のＤＣ出力端子３４は、上記筐体１０の左側面壁１１に設置されている。
【００３３】
また、この車両用補助給電装置１００は、図３のブロック図に示すように、上記制御回路部４に内部接続された電源スイッチ４１、ジャンプスタートスイッチ４２、ライトセレクトスイッチ４３及びサイドライト・オン／オフ・スイッチ４４を備える。上記電源スイッチ４１、ジャンプスタートスイッチ４２、ライトセレクトスイッチ４３及びサイドライト・オン／オフ・スイッチ４４は、図１の外観斜視図に示すように、上記筐体１０の正面壁１３に設置されている。
【００３４】
さらに、この車両用補助給電装置１００は、図３のブロック図に示すように、上記制御回路部４に内部接続された充電量表示部５１、バッテリロー表示灯５２、一対の非常用警告灯５３Ａ，５３Ｂ及び一対の側面照明灯５４Ａ，５４Ｂを備える。
【００３５】
上記充電量表示部５１及び一対の非常用警告灯５３Ａ，５３Ｂは、図１の外観斜視図に示すように、上記筐体１０の正面壁１３に設置されている。
【００３６】
上記充電量表示部５１は、直線状に配置された発光色の異なる複数（この実施の形態では、赤・橙・黄・緑の４色）のＬＥＤにより構成されている。この充電量表示部５１は、上記制御回路部４により制御されて、充電量をバー表示する機能を果たすばかりでなく、緑点灯によりパワーランプとして機能し、また、黄点灯によりジャンプスタートランプとして機能する。また、上記一対の非常用警告灯５３Ａ，５３Ｂは、赤色ＬＥＤと白色ＬＥＤからなり、上記制御回路部により制御されて、交互に点滅することにより非常用警告灯として機能する。
【００３７】
また、上記バッテリロー表示灯５２は、図２の外観斜視図に示すように、上記筐体１０の右側面壁１２に設置されている。
【００３８】
上記バッテリロー表示灯５２は、赤色ＬＥＤからなり、上記制御回路部４により制御さ

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れて、上記リチウムイオン蓄電池２の電圧が所定値まで低下すると点滅状態あるいは点灯状態となることにより、バッテリロー表示灯として機能する。

【００３９】

また、上記一対の側面照明灯５４Ａ，５４Ｂ、図１及び図２の外観斜視図に示すように、上記筐体１０の左側面壁１１と右側面壁１２に設置されている。

【００４０】

上記一対の側面照明灯５４Ａ，５４Ｂは、それぞれ直線状に配置された複数の白色ＬＥＤにより構成されている。

【００４１】

このような構成の車両用補助給電装置１００において、上記筐体１０内に設置された制御回路部４は、上記充電回路部１の動作を制御する充電制御部、上記出力回路部１の動作を制御する出力制御部、充電量表示部５１５１等の動作を制御する表示制御部として機能するマイクロコンピュータからなり、内部接続された上記充電回路部１及び出力回路部３の動作を次のように制御する。

【００４２】

ここで、この車両用補助給電装置１００に接続される充電用の給電ケーブルとしては、図４の（Ａ），（Ｂ）に示すように、家庭用電源から充電用の１２Ｖの電源供給するためのＡＣアダプタケーブル１１０Ａと、自動車バッテリから例えば１２Ｖの電源供給を供給するためのシガープラグケーブル１１０Ｂが準備されている。

【００４３】

図４の（Ａ）に示すＡＣアダプタケーブル１１０Ａは、家庭用電源から充電用の１２Ｖの電源供給するためのＡＣアダプタ１１１Ａを一端に備え、上記ＤＣジャックからなるＤＣ入力端子２０にＤＣプラグ１１２を介して外部接続される。また、図４の（Ｂ）に示すシガープラグケーブル１１０Ｂは、自動車バッテリから例えば１２Ｖの電源供給を供給するためのシガープラグ１１１Ｂを一端に備え、上記ＤＣジャックからなるＤＣ入力端子２０にＤＣプラグ１１２を介して外部接続される。

【００４４】

そして、上記車両用補助給電装置１００における上記制御回路部４は、図５に示すように、上記ＤＣ入力端子２０にＡＣアダプタケーブル１１０Ａ又はシガープラグケーブル１１０Ｂが外部接続され、家庭用電源又は自動車バッテリから充電用の電源が供給されることにより、上記ＤＣ入力端子２０に所定電圧値以上の電圧が印加されたことを検出すると、充電モードの制御を行う。

【００４５】

この充電モードの制御において、上記制御回路部４は、充電制御部により上記充電回路部１の動作を制御して、上記充電回路部１を介して上記リチウムイオン蓄電池２を充電し、上記リチウムイオン蓄電池２が満充電まで充電されると過充電保護回路を機能させ、充電を終了する。

【００４６】

また、上記制御回路部４は、充電制御中には、出力制御部により上記出力回路部３の動作を制御して、上記出力回路部３から外部への電源供給を禁止する。

【００４７】

さらに、上記制御回路部４は、充電制御中には、表示制御部により上記充電量表示部５１の動作を制御して、上記充電量表示部５１を制御して充電量をバー表示する。

【００４８】

上記充電量表示部５１は、上記制御回路部４により動作が制御されて、図６に示すように、未充電状態から、バッテリ残量２０％以下を示す赤色点状態、バッテリ残量２０％から３０％を示す赤色点灯、バッテリ残量３０％から４０％を示す橙色点滅状態、バッテリ残量４０％から７０％を示す黄色点灯状態、バッテリ残量７０％から１００％を示す緑色点灯状態へと、満充電状態まで充電が進むに従って、点灯状態が順次変化する。

【００４９】

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上記車両用補助給電装置１００は、上記リチウムイオン蓄電池２を充電した状態で、可搬型ジャンプスータとして機能し、また、屋外で電気機器を使用するためにポータブル電源装置として使用することができる。

【００５０】

ここで、この車両用補助給電装置１００には、図７に示すように、車載バッテリの電極端子を掴む接続クリップ１２１Ａ、１２１Ｂが２本のケーブルの一端に設けられ、上記ジャンプスタート用の第１のＤＣ出力端子３１を構成しているジャックにプラグ１２２を介して外部接続されるジャンプスタート用のブースタケーブル１２０が準備されている。

【００５１】

そして、この車両用補助給電装置１００は、次のようにしてジャンプスータとして使用される。

【００５２】

すなわち、この車両用補助給電装置１００をジャンプスータとして使用する場合、当該車両用補助給電装置１００の電源スイッチ４１がＯＦＦの状態で、図８に示すように、上記ジャンプスタート用のブースタケーブル１２０がユーザにより上記第１のＤＣ出力端子３１に接続される。

【００５３】

上記車両用補助給電装置１００のユーザは、上記充電量表示部５１を構成している複数のＬＥＤが全て消灯していることで、電源スイッチ４１がＯＦＦの状態であることを確認することができる。

【００５４】

次に、ユーザが電源スイッチ４１を押して電源ＯＮにすると、この車両用補助給電装置１００の制御回路部４は、電源ＯＮを検知して上記表示制御部により充電量表示部５１の動作を制御し、上記充電量表示部５１を緑色点灯状態とする。上記充電量表示部５１は、緑色点灯により電源ＯＮを表示するパワーランプとして機能する。

【００５５】

そして、この電源ＯＮ状態でユーザがジャンプスタートスイッチ４２を押してジャンプスタートすると、この車両用補助給電装置１００の制御回路部４は、上記ジャンプスタートスイッチ４２の短時間操作によるジャンプスタートを検知して、ジャンプスタートモードの制御を行う。

【００５６】

このジャンプスタートモードの制御において、上記制御回路部４は、上記ジャンプスタート用の第１のＤＣ出力端子３１にブースタケーブル１２０を介してジャンプスタートさせる自動車の車載バッテリ２００の電圧を正常に検知できた場合に、上記出力制御部により出力回路部３の動作を制御し、上記リチウムイオン蓄電池２をジャンプスタート用の電源として上記出力回路部３を介して上記ジャンプスタート用の第１のＤＣ出力端子３１に接続するとともに、上記表示制御部により充電量表示部５１の動作を制御し、上記充電量表示部５１を黄色点灯状態とする。上記充電量表示部５１は、黄色点灯によりジャンプスタートを表示するジャンプスタートランプとして機能する。このジャンプスタートモードでは、上記充電量表示部５１は、緑色点灯により電源ＯＮを表示するとともに黄色点灯によりジャンプスタートを表示している。

【００５７】

このジャンプスタートモードの状態で、ユーザは、この車両用補助給電装置１００が接続されている上記車載バッテリ２００を搭載した自動車のエンジンを始動させるジャンプスタートを行うことができる。

【００５８】

ここで、従来の一般的な鉛蓄電池を用いた１２Ｖ／４．５Ａｈ程度の容量のジャンプスタータは、本体重量が５ｋｇ～７ｋｇ程度あり、満充電電状態での始動可能回数は平均５回程度であったのに対し、本考案を適用した上記車両用補助給電装置１００は、例えば４５ｍｍ×１９０ｍｍ×１２０ｍｍ（高さ×幅×奥行き）の大きさの筐体１０内に例えば３

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．６Ｖの充電式リチウムイオンを３個直列接続して実装することにより、重さ８３０ｇ程度で３０００ｃｃまでのガソリン乗用車に対応する１２Ｖ／４．５Ａｈの容量の可搬型ジャンプスタータとして機能し、小型軽量で、しかも、満充電電状態での始動可能回数も１０～２０回程度に向上している。

【００５９】

また、上記車両用補助給電装置１００は、例えば４５ｍｍ×１９０ｍｍ×１６０ｍｍ（高さ×幅×奥行き）の大きさの筐体１０を用いて、２倍の６個の充電式リチウムイオンを実装することにより、重さ１３００ｇ程度でガソリン乗用車全般及び３０００ｃｃ４気筒までのディーゼル車に対応する１２Ｖ／９Ａｈの容量の可搬型ジャンプスタータとして機能する。

【００６０】

また、この車両用補助給電装置１００における上記制御回路部４は、上記電源ＯＮ状態でユーザがジャンプスタートスイッチ４２を長時間操作すなわち例えば５秒以上長押しすると、チャージブーストモードの制御状態となり、上記リチウムイオン蓄電池２に充電されている電気を１度に放出するように、上記出力制御部により上記出力回路部３の動作を制御する。このチャージブーストモードの制御状態では、上記表示制御部により充電量表示部５１の動作を制御し、上記充電量表示部５１を黄色点灯状態とする。すなわち、上記充電量表示部５１は、黄色点灯によりチャージブーストモードを表示するチャージブーストモードとして機能する。このチャージブーストモードは、車載バッテリが深放電状状態になっている場合に使用される。

【００６１】

また、この車両用補助給電装置１００は、上述の如く１２Ｖ／４．５Ａｈの容量のもので重さ８３０ｇ程度、１２Ｖ／９Ａｈの容量のものでも１３００ｇ程度の重量で小型軽量であるので、可搬性に優れ、しかも、上記ジャンプスタート用の第１のＤＣ出力端子３１の他に、屋外で電気機器を使用するための外部接続用の第２乃至第４のＤＣ出力端子３２～３４を備えているので、次のようにポータブル電源として使用することができる。

【００６２】

すなわち、この車両用補助給電装置１００において、上記第２のＤＣ出力端子３２には、ＰＣ電源ケーブルを介してＰＣを外部接続することができる。

【００６３】

この車両用補助給電装置１００における上記制御回路部４は、上記第２のＤＣ出力端子３２を構成しているにジャックにＰＣ電源ケーブルがプラグを介して外部接続され、上記ＰＣ電源ケーブルを介してＰＣが外部接続された状態で、ユーザが電源スイッチ４１を押して電源ＯＮにすると、電源ＯＮを検知して上記表示制御部により充電量表示部５１の動作を制御し、上記充電量表示部５１を緑色点灯状態として電源ＯＮを表示するとともに、上記出力制御部により上記出力回路部３の動作を制御して、ＤＣ１９ＶのＰＣ駆動用の電源を上記第２のＤＣ出力端子３２からＰＣ電源ケーブルを介してＰＣに供給する。

【００６４】

また、この車両用補助給電装置１００において、上記第３のＤＣ出力端子３３には、ＵＳＢ（Universal Serial Bus）で給電可能な携帯音楽プレーヤ等の電子機器を市販のＵＳＢケーブルを介して接続することができる。

【００６５】

この車両用補助給電装置１００における上記制御回路部４は、図９に示すように、上記第３のＤＣ出力端子３３を構成しているにＵＳＢジャックにＵＳＢケーブル１３０がＵＳＢプラグを介して外部接続され、上記ＵＳＢ電源ケーブル１３０を介してＵＳＢ機器３００が外部接続された状態で、ユーザが電源スイッチ４１を押して電源ＯＮにすると、電源ＯＮを検知して上記表示制御部により充電量表示部５１の動作を制御し、上記充電量表示部５１を緑色点灯状態として電源ＯＮを表示するとともに、上記出力制御部により上記出力回路部３の動作を制御して、ＤＣ５ＶのＵＳＢ駆動用の電源を上記第３のＤＣ出力端子３３からＵＳＢ電源ケーブル１３０を介してＵＳＢ機器３００に供給する。

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【００６６】
さらに、この車両用補助給電装置１００には、シガーソケットからなる第４のＤＣ出力端子３４に外部接続されるシガープラグケーブルとして、図１０の（Ａ），（Ｂ）に示すように、２種類のシガープラグケーブルが準備されている。
【００６７】
図１０の（Ａ）に示す第１のシガープラグケーブル１４０Ａは、車両の車内に標準的に搭載されているＤＣ１２Ｖ／２４Ｖの車内用電源ソケット、いわゆるシガーソケットに接続して利用可能な車載対応の電気機器を接続するためのケーブルであって、車載対応の電気機器に接続されるＤＣプラグ１４１Ａを一端に備え、シガープラグ１４２を介して上記第４のＤＣ出力端子３４に外部接続される。
【００６８】
図１０の（Ｂ）に示す第２のシガープラグケーブル１４０Ｂは、ＯＢＤ（On-Board Diagnostic system）システムに対応した車両のメモリバック用のケーブルであって、ＯＢＤ２コネクタ１４１Ｂを一端に備え、シガープラグ１４２を介して上記第４のＤＣ出力端子３４に外部接続される。
【００６９】
この車両用補助給電装置１００における上記制御回路部４は、上記第４のＤＣ出力端子３４を構成しているにシガーソケットに第１のシガープラグケーブル１４０Ａ又は第２のシガープラグケーブル１４０Ｂがシガープラグ１４２を介して外部接続され、シガープラグケーブルを介して外部機器が外部接続された状態された状態で、ユーザが電源スイッチ４１を押して電源ＯＮにすると、電源ＯＮを検知して上記表示制御部により充電量表示部５１の動作を制御し、上記充電量表示部５１を緑色点灯状態として電源ＯＮを表示するとともに、上記出力制御部により上記出力回路部３の動作を制御して、ＤＣ１２Ｖの外部機器駆動用の電源を上記第４のＤＣ出力端子３２からシガープラグケーブルを介して外部機器に供給する。
【００７０】
すなわち、この車両用補助給電装置１００は、上記第４のＤＣ出力端子３４に外部接続される第１のシガーゲーブル１４０Ａを介して車載対応の電気機器を駆動するポータブル電源として機能する。
【００７１】
また、この車両用補助給電装置１００は、上記第４のＤＣ出力端子３４に外部接続される第２のシガーゲーブル１４０Ａを介してＯＢＤ（On-Board Diagnostic system）システムに対応した車両のメモリバックアップ用のポータブル電源として機能する。
【００７２】
ここで、ＯＢＤ（On-Board Diagnostic system）システムは、自動車に搭載されるコンピュータが行う自己故障診断機能であって、使用過程にある自動車の排出ガス浄化装置の機能点検を容易にしている。ＯＢＤ２では、その点検コネクタや通信プロトコル、故障診断コード等が標準化されている。
【００７３】
ＯＢＤ（On-Board Diagnostic system）システムを搭載した車両では、各種診断履歴情報がメモリに保存されており、搭載バッテリを交換する際に、メモリ上の情報を喪失することのないように、メモリにバックアップ電源を供給しておく必要がある。
【００７４】
すなわち、この車両用補助給電装置１００は、ジャンプスタータとしての機能を有し、しかも、バッテリ駆動型のノートＰＣやその付帯機器などの情報機器、シガーソケットに接続して利用可能な車載対応の電気機器、携帯電話やＵＳＢで給電可能な携帯音楽プレーヤ等の使用を可能にするポータブル電源としての機能を有し、さらに、ＯＢＤ（On-Board Diagnostic system）システムに対応した車両のメモリバックアップ用のポータブル電源として機能する小型軽量で携帯性に優れ、使い勝手のよい車両用補助給電装置となっている。

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【００７５】
さらに、この車両用補助給電装置１００は、上述の如きジャンプスタータやポータブル電源として機能するばかりでなく、非常時に使用する警告表示灯や照明灯として機能する。

【００７６】
すなわち、この車両用補助給電装置１００における上記制御回路部４は、電源ＯＮの状態でライトセレクトスイッチ４３が押されたことを検知して、表示制御部により充電量表示部５１及び一対の非常用警告灯５３Ａ，５３Ｂを次のように制御する。

【００７７】
上記制御回路部４は、上記ライトセレクトスイッチ４３が１回押されたことを検知すると、上記非常用警告灯５３Ａとして備えられた赤色ＬＥＤを非常灯として点灯させ、上記ライトセレクトスイッチ４３が２回押されたことを検知すると、上記非常用警告灯５３Ｂとして備えられた白色ＬＥＤを点灯させ正面ライトとして機能させ、上記ライトセレクトスイッチ４３が３回押されたことを検知すると、上記一対の非常用警告灯５３Ａ，５３Ｂを交互に、すなわち、赤白交互に点滅させ、そして、上記ライトセレクトスイッチ４３が４回押されたことを検知すると、上記一対の非常用警告灯５３Ａ，５３Ｂを消灯させる。また、上記制御回路部４は、上記ライトセレクトスイッチ４３が３秒以上長押されたことを検知すると、上記充電量表示部５１を駆動して、バッテリの充電量に応じた点灯状態とする。

【００７８】
また、上記制御回路部４は、上記サイドライト・オン／オフ・スイッチ４４の押圧操作に応じて表示制御部により一対の側面照明灯５４Ａ，５４Ｂの動作を制御し、上記サイドライト・オン／オフ・スイッチ４４が押されたことを検知すると、図１１に示すように、上記一対の側面照明灯５４Ａ，５４Ｂを点灯させ、上記サイドライト・オン／オフ・スイッチ４４が再度押されたことを検知すると上記一対の側面照明灯５４Ａ，５４Ｂを消灯させる。

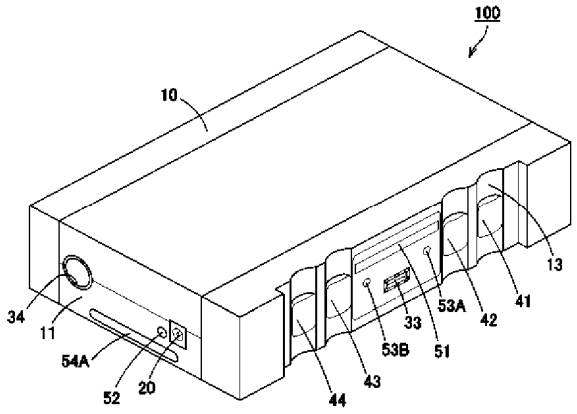
【００７９】
さらに、上記制御回路部４は、上記リチウムイオン蓄電池２のバッテリ電圧を常時監視しており、バッテリ電圧が８．２Ｖまで低下した場合にバッテリロー表示灯５２を点灯して、過放電状態であることを警告する機能を有している。

【符号の説明】

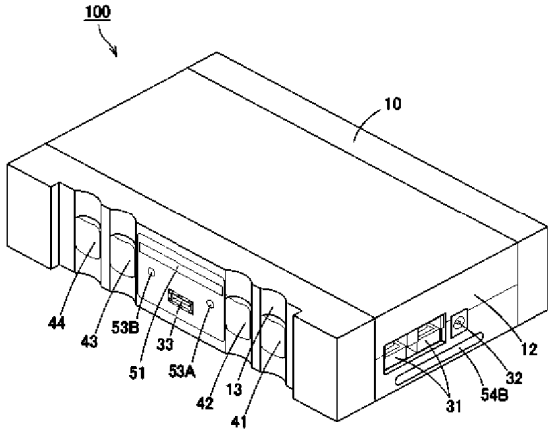
【００８０】
１　充電回路部、２　リチウムイオン蓄電池、３　出力回路部、４　制御回路部、１０　筐体、１１　左側面壁、１２　右側面壁、１３　正面壁、２０　ＤＣ入力端子、３１　第１のＤＣ出力端子、３２　第２のＤＣ出力端子、３３　第３のＤＣ出力端子、３４　第４のＤＣ出力端子、４１　電源スイッチ、４２　ジャンプスタートスイッチ、４３　ライトセレクトスイッチ、４４　サイドライト・オン／オフ・スイッチ、５１　充電量表示部、５２　バッテリロー表示灯、５３Ａ，５３Ｂ　非常用警告灯、５４Ａ，５４Ｂ　側面照明灯、１００　車両用補助給電装置、１１０Ａ　ＡＣアダプタケーブル、１１０Ｂ　シガープラグケーブル、１１１Ａ　ＡＣアダプタ、１１２　ＤＣプラグ、１１１Ｂ　シガープラグ、１２１Ａ、１２１Ｂ　接続クリップ、１２２　プラグ、１２０　ブースタケーブル、１３０　ＵＳＢケーブル、１４０Ａ　第１のシガープラグケーブル、１４０Ｂ　第２のシガープラグケーブル、１４１Ａ　ＤＣプラグ、１４１Ｂ　ＯＢＤ２コネクタ、１４２　シガープラグ、２００　車載バッテリ、３００　ＵＳＢ機器

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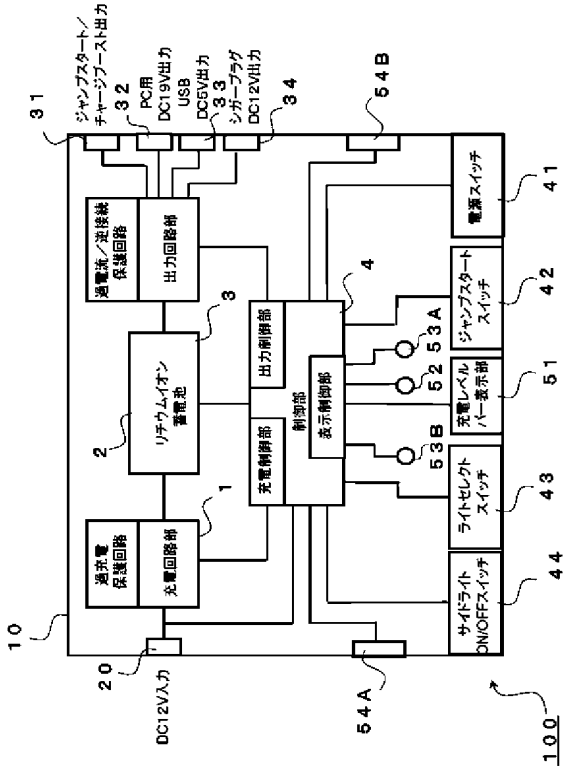
【図１】



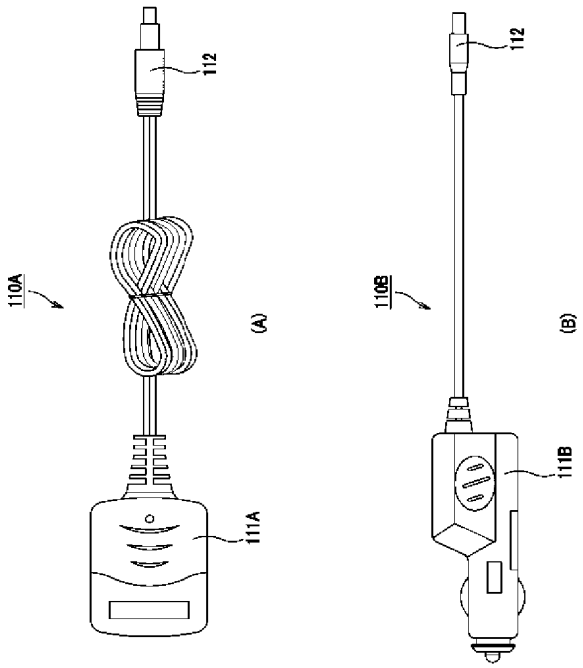
【図２】



【図３】

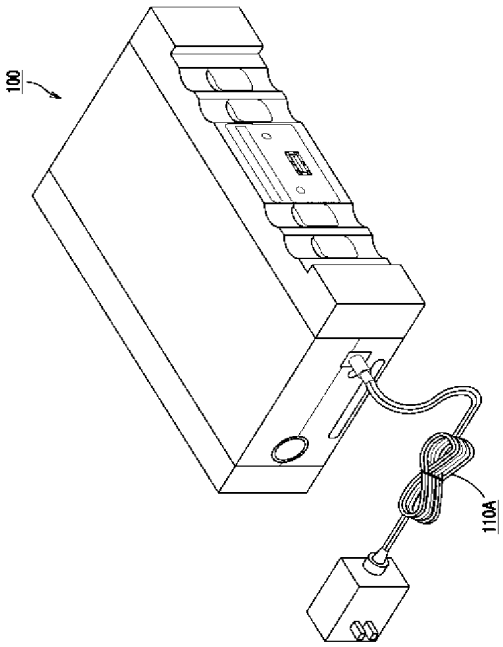


【図４】

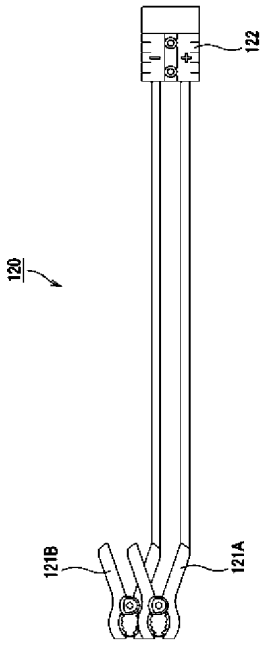


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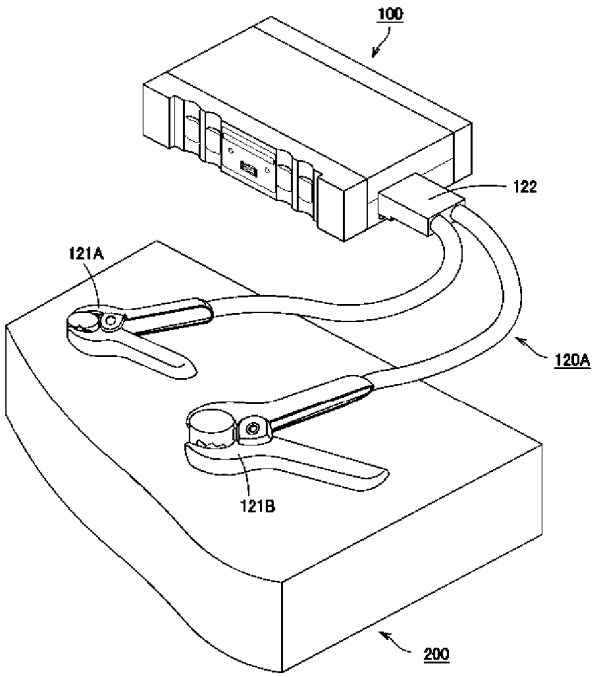
【図５】


100
110A

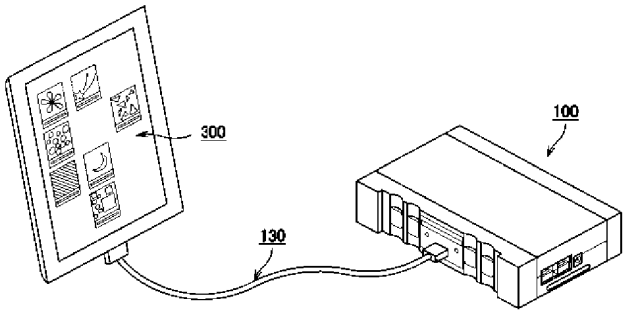
【図７】


122
120
121B
121A

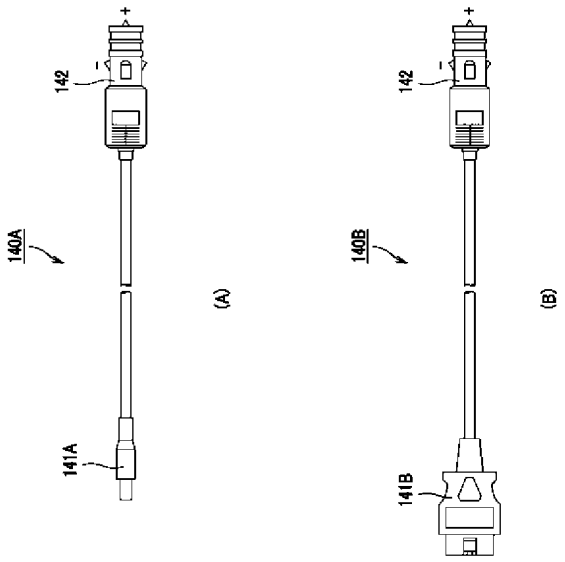
【図８】


100
122
121A
120A
121B
200

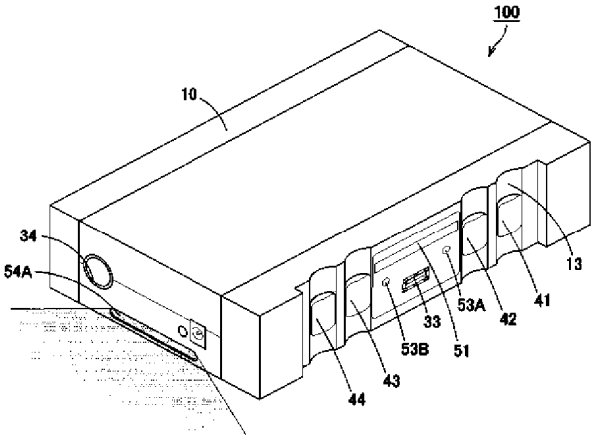
【図９】


300
100
130

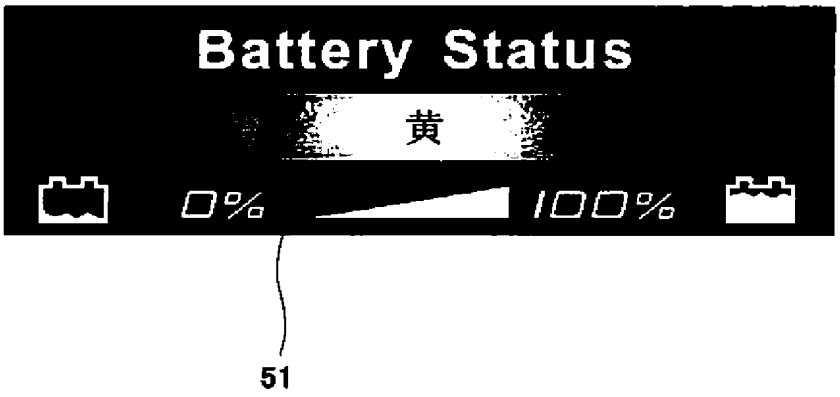
【図１０】


142
140A
141A
(A)
142
140B
141B
(B)

【図１１】


100
10
34
54A
13
41
42
53A
33
53B
51
43
44

【図６】


Battery Status
黄
0%
100%
51

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IPR2025-00885

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SHENZHEN MEDIATEK TONG TECHNOLOGY CO., LTD.
Petitioner,

v.

THE NOCO COMPANY,
Patent Owner,

U.S. Patent No. 9,007,015

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 9,007,015 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42, ET SEQ.

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Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

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1[C] "a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs" 11

1[D] "a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive

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1[E] "a power switch connected between said internal supply and said output port" 13

1[F] "a microcontroller configured to receive inputs signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch . . ." 14

1[G] ". . . such that such power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs" 15

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1[F] "a microcontroller configured to receive inputs signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch . . ." 43

1[G] ". . . such that such power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs" 45

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EX1014	U.S. Patent No. 3,267,452 to Wolf
EX1015	U.S. Patent No. 5,793,185 to Prelec
EX1016	*The NOCO Company, Inc. v. Shenzhen Lianfa Tong Technology Co. Ltd., et al.,* Case No. 1:19-cv-01855, (N.D. Ohio) First Amended Complaint for Patent Infringement
EX1017	E-flite EC Connector Assembly Instructions (2008)

EX1018	U.S. Patent No. 7,095,339 to Peng
EX1019	Datasheet for LM7805 Voltage Regulator from Fairchild Semiconductor

I. Introduction

The '015 Patent, having a priority date of July 3, 2014, simply discloses and claims a portable device for jump starting the battery of a vehicle engine. (EX1001 at Abstract). The '015 Patent acknowledges that numerous such devices were known, but asserts that no devices solved the problems of jumper cable clamps inadvertently touching when the devices were connected to a charged battery, or when the cables were connected in reverse polarity. (*Id.* at 1:16-23). Thus the claims each include a sensor for detecting the presence of a battery, a sensor for detecting whether the cables are connected in reverse polarity, and a microcontroller and switch to only allow power to be supplied when the device is correctly connected. (*Id.* at 8:4-37). In fact, as demonstrated by the prior art set forth in this petition, all of those components, alone and in combination, were known and used long before the '015 Patent. The dependent claims add common and well-known elements such as USB ports, LED indicators, and lithium ion batteries, all of which were known to be used in connection with jump starters. (*Id.* at 8:38-10:22).

None of the four references relied upon in this petition were considered during prosecution of the claims of the '015 Patent. Had they been, none of the claims would have issued. Thus, Shenzhen Mediatek Tong Technology Co., Ltd. ("Petitioner") requests *inter partes* review of claims 1-3, 5, 8-17, 19-21, and 23 of U.S. Patent No. 9,007,015 ("the '015 patent") (EX1001).

II. Identification of challenge (37 C.F.R. § 42.104(b))

Petitioner requests review of 1-3, 5, 8-17, 19-21, and 23 on the following grounds:

Ground	Claims	References	Statutory Basis
1	1, 5, 8-9, 17, 19-20	Zhang	§§102/103
2	2-3, 10, 12-16, 21, 23	Zhang, Xinfang	§103
3	11	Zhang, USB Charging Specification	§103
4	1, 8, 9, 17, 19	Richardson	§ 102
5	2, 3, 10, 12-15, 21, 23	Richardson, Xinfang	§ 103

The '015 Patent was filed as a continuation of and claims priority to Application No. PCT/US2014/045434, filed on July 3, 2014. (EX1001). Each of the following prior art documents applied in the grounds of unpatentability qualify as prior art before the earliest possible priority date, July 3, 2014:

- Chinese Patent No. 202696190 (Zhang)
- U.S. Patent No. 9,506,446 (Xinfang)
- USB Battery Charging Specification Version 1.2 (USB Charging Specification)

- U.S. Patent Pub. No. 2009/0174362 (Richardson)

Zhang, Richardson, and the USB Charging Specification are prior art under at least 35 U.S.C. §102(a)(1), as each has a publication date before July 3, 2014. Xinfang is prior art under at least 35 U.S.C. §102(a)(2), having an effective filing date before July 3, 2014.

III. The '015 Patent

A. Overview

The'015 Patent contains one independent claim (claim 1) and 22 dependent claims. (EX1001 at 8:4-10:22). Generally, the '015 Patent discloses a "handheld device for jump starting a vehicle engine and includes a rechargeable lithium ion battery pack and a microcontroller." (*Id.* at Abstract). The '015 Patent purports to offer an improved vehicle jump start device that overcomes shortcomings in complexity, cost, or potential for malfunction in earlier designs. (*Id.* at 3:7-12). Specifically, the '015 Patent discloses and claims two separate sensors, *i.e.*, a "vehicle battery isolation sensor" and a "reverse polarity sensor," as well as an "internal power supply," an "output port," a "power switch," and a "microcontroller." (*Id.* at Abstract, claim 1). More specifically, the "car battery reverse sensor 10 monitors the polarity of the vehicle battery 72 when the handheld battery booster device is connected to the vehicle's electric system," while the "car battery isolation sensor 12 detects whether or not a vehicle battery 72 is connected to the booster

device, and prevents the lithium ion battery pack from being connected to the output terminals of the booster device unless there is a good (e.g. chargeable) battery connected to the output terminals." (*Id.* at 4:20-31). The '015 discloses that the power switch is connected between the internal power supply and the output port. (*Id.* at 3:26-27). And the microcontroller receives signals from both the vehicle battery isolation sensor and the reverse polarity sensor, and controls the power switch to "electrically switch the handheld battery booster lithium ion battery to the vehicle's electric systems only when the vehicle battery is determined . . . to be present . . . and connected with the correct polarity[.]" (*Id.* at 4:32-48).

The '015 Patent also discloses additional features and limitations in dependent claims, including limiting the power source to a lithium ion battery or lithium ion battery pack (claims 2 and 3), using an optocoupler for the vehicle battery isolation sensor and reverse polarity sensor (claim 5), adding USB input and output ports (claims 10-11), including flashlights and LED indicators (claims 12-17), including a manual override switch (claims 19-20), and including a specially shaped output port (claims 21 and 23). (E.g., EX1001 at 8:38-10:22).

B. The prosecution history

The '015 Patent issued from U.S. Patent Application No. 14/325,938 ("'938 application"), which was filed on July 8, 2014. (EX1001 at 1). The '938 application

is a continuation of Application No. PCT/US2014/045434, which was filed on July 3, 2014. (*Id*).

Initially, the Office allowed claims 1-23, but rejected claims 24-26 as being anticipated by U.S. Patent Pub. No. 2012/0091944 (Rogers), U.S. Patent Pub. No. 2007/0285049 (Krieger), and U.S. Patent No. 8,172,603 (Richardet). (EX1002 at 113). Applicant responded by cancelling claims 24-26. (*See id*. at 108).

However, in a second office action, the Office withdrew its allowance of claims 1-23, and rejected claims 1, 4-6, 8-9, 12-18 as being anticipated by U.S. Patent Pub. No. 2005/0110467 (Thomason). (*Id*. at 44). Furthermore, the Office rejected claims 2, 3, 10, and 11 as unpatentable over Thomason in view of U.S. Patent Pub. No. 2013/0241488 (Dao), claims 7, 19-20 over Thomason in view of U.S. Patent. No. 6,362,599 (Turner), and claims 21-23 are rejected over Thomason in view of U.S. Patent Pub. No. 2007/0285049 (Krieger). (*Id.*).

Applicant responded by amending claim 1as follows:

> 1. (Currently amended) Apparatus for jump starting a vehicle engine, comprising:
>
> an internal power supply;
>
> an output port having positive and negative polarity outputs;
>
> a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs;
>
> a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to

> detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are properly connected with said positive and negative polarity outputs of said output port;
>
> a power [[FET]] switch connected between said internal power supply and said output port; and
>
> a microcontroller configured to receive input signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power [[FET]] switch, such that said power [[FET]] switch is turned on to ~~connect~~ cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs.

(EX1002 at 29).

Based on those amendments and arguments, the Examiner allowed claims 1-23, and the '015 Patent issued on April 14, 2015. (EX1002 at 7).

C. Level of ordinary skill in the art

Based on the disclosure of the '015 Patent, a person having ordinary skill in the art at the relevant time would have had a minimum of a bachelor's degree in electrical engineering, or its equivalent, and two years of experience in studying or designing battery charging systems.

D. Claim construction

In an IPR filed after November 13, 2018, the claim's will be construed under the same standard as applied by Federal Courts and articulated by *Phillips*, *i.e.*, the "words of a claim are generally given their ordinary and customary meaning." *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005)**Error! Bookmark not defined.**. For purposes of this proceeding only, in analyzing the claims in the prior art references, Petitioner has given the claims their ordinary and customary meaning as understood by one of ordinary skill in the art and the prosecution history of the '015 Patent.[1] Should any of those terms be construed in this proceeding in another manner, Petition reserves the right to supplement its positions in that regard.

IV. Ground 1 – Claims 1, 5, 8-9, 17, 19-20 are anticipated or rendered obvious over Zhang

A. Overview of Zhang

Chinese Patent No. 202696190 (EX1005) was published in China on January 23, 2013, and thus constitutes prior art under 35 U.S.C. §102(a)(1). A certified

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[1] As set forth in more detail below, for the term "output port," Petitioner has recognized the apparent construction given that term by Patent Owner in related litigation, and analyzed the term under both that more expansive interpretation, and its ordinary and customary meaning.

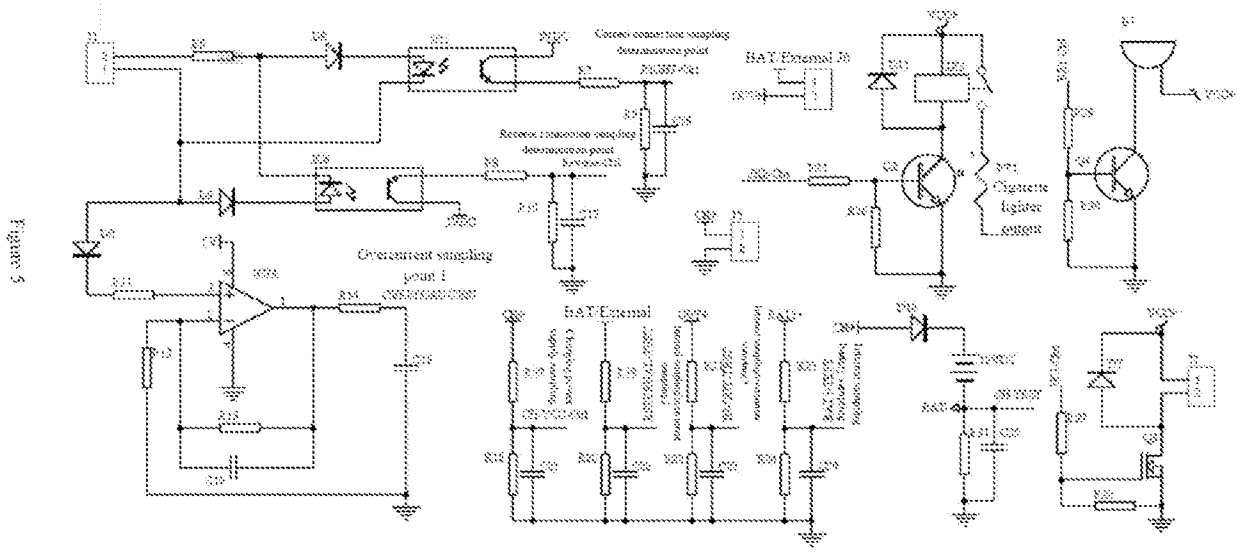
translation of EX1005 is submitted as EX1006 and will be referred to as "Zhang." For ease of explanation, the discussion herein will refer to this English-language translation. The certification of translation is submitted as EX1007.

Zhang discloses a portable, smart jump starter with a built-in voice prompt function and a battery pack. (E.g., EX1006 at Abstract). The battery pack is connected to an output power clip through a change-over switch and DC contactor. (E.g., EX1006 at Abstract, ¶¶ 0006, 0014, 0060.) Zhang discloses that its output power clip contains both anode and cathode power clips. (E.g., EX1006 at ¶¶ 0019, 0058, 0060, Figure 1).

Zhang discloses that the jump starter has shutdown protection if the power clip is erroneously connected in reverse polarity or to the wrong voltage, and ensures correct connection for the power clip to an external battery. (E.g., EX1006 at ¶¶ 0020-0028). Specifically, Zhang discloses that voltage at the terminals of the external battery "is sampled in two ways, where one way is connected to the input terminal of the DC contactor, so that the microcontroller can detect the effective voltage value within the range of the 12 V gear at the 'BAT+/External' point. The other way is sampled using the small teeth of the power clip. The internal conductor wire of the power clip wire is connected to the 'J1' port of the control board, and after the correct connection signal is converted by R5, D8 and IC5, the external correct connection signal 'RIGHT-Ctrl' is transmitted to the P13 port of the

microcontroller." (EX1006 at ¶0050). Zhang also discloses a change-over switch to accommodate 12V or 24V vehicle batteries. (EX1006 at ¶0043). If there is mismatch between the detected vehicle voltage and the current voltage gear position, the DC contactor (switch) will not be turned on. (*Id.* at ¶0046).

Zhang further discloses "reverse polarity connection protection," where "after the reverse connection signal is converted by D9, IC6 and R5, the external reverse connection signal 'Reverse-Ctrl' is transmitted to the P12 port of the microcontroller. The microcontroller determines that the jump starter has been changed over to the 12 V gear, and at the same time, detects that the external battery is connected in reverse polarity. At this time, the DC contactor will maintain its disconnected state . . ." (EX1006 ¶0051; *see also* EX1006 ¶¶0060-0061, Figure 5).



B. Zhang anticipates or renders obvious each and every element of claim 1

1[P] "apparatus for jump starting a vehicle engine"

Zhang discloses an apparatus for jump starting a vehicle engine. "The present utility model involves a jump starter, particularly involving a smart jump starter with a built-in voice prompt function." (EX1006 at Abstract, ¶0001-0003, Figures 1-5; EX1003 at ¶50).

1[A] "an internal power supply"

Zhang's jump starter includes an internal power supply (i.e., the "battery pack.") (EX1006 at Abstract, ¶¶0005-006, 0014-0015, Figure 1; EX1003 at ¶51).

1[B] "an output port having positive and negative polarity outputs"

In its First Amended Complaint against Petitioner, Patent Owner contends that this limitation is met by a jumper cable with red (positive) and black (negative) clamps. (EX1016 at ¶24). Zhang has an identical disclosure, which it calls an "output power clip" that comprises both "anode and cathode power clips." (EX1006 at Abstract, ¶¶0006, 0014, 0019, 0051, 0056, 0058, 0060; EX1003 at ¶52). Thus, according to Patent Owner's construction of this limitation, Zhang discloses an output port having positive and negative polarity outputs. (*Id.*).

While Zhang does not explicitly discuss its output power clip being plugged into the jump starter, a person of ordinary skill in the art would have understood that the output power clip has to be wired into the jump starter in a similar way. (EX1003

at ¶53). For example, the '015 Patent discloses a "jumper cable device" that has "a plug configured to plug into an output port of a handheld battery charger booster device having an internal power supply; a pair of cables integrated with the plug at one respective end." (EX1001 at 3:40-46). Therefore, if the Board disagrees with the Patent Owner's interpretation of this limitation, Petitioner contends that Zhang inherently discloses an output port having positive and negative polarity outputs. (EX1003 at ¶53). Output ports having positive and negative polarity outputs were also widely available long before Zhang. (*Id.*). For example, standard EC connectors with positive and negative polarity outputs where a jumper cable device can be plugged in were widely available since at least 2008. (EX1017).

1[C] "a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs"

Zhang discloses that the vehicle battery is sampled to determine that a vehicle battery voltage within range is detected. (EX1006 at ¶ 0050; *see also* ¶ 0060 and Fig. 5; EX1003 at ¶54). In so doing, Zhang discloses that its device detects the presence of a vehicle battery. (EX1003 at ¶54).

In particular, Zhang discloses that the circuitry comprising either (i) R5, D8, and IC5, or (ii) R19, R20, and C22, is connected in circuit with the positive and negative polarity outputs of a vehicle battery, and detects the voltage (i.e., the presence) of the vehicle battery. Zhang discloses that the vehicle battery is sampled

to determine that a vehicle battery voltage within range is detected. (EX1003 at ¶54). "[T]he voltage at the two terminals of the 12 V battery is sampled in two ways, where one way is connected to the input terminal of the DC contactor, so that the microcontroller can detect the effective voltage value within the range of the 12 V gear at the 'BAT+/External' point. The other way is sampled using the small teeth of the power clip. The internal conductor wire of the power clip wire is connected to the 'J1' port of the control board, and after the correct connection signal is converted by R5, D8 and IC5, the external correct connection signal 'RIGHT-Ctrl' is transmitted to the P13 port of the microcontroller." (EX1006 at ¶0050; *see also* ¶0060, 0061, and Fig. 5).

Zhang also discloses a change-over switch to accommodate 12V or 24V vehicle batteries. (EX1006 at ¶0043). If there is mismatch between the detected vehicle voltage and the current voltage gear position, the DC contactor (switch) will not be turned on. (*Id.* at ¶0046).

Zhang further describes several scenarios when there is no vehicle battery detected: (1) there is a short-circuit and no battery is connected between the power clips (EX1006 at ¶0057); (2) when the power clips are disconnected (*Id.* at ¶0060); and (3) the external vehicle battery voltage is too low (*e.g.*, vehicle voltage is 15.5V in a 24V gear connection). (*Id.* at ¶0055).

1[D] "a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect

polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are property connected with said positive and negative polarity outputs of said output port"

This element of the '015 Patent describes how a polarity detection circuit performs the function of ensuring the proper connection (i.e., positive connected to positive, and negative connected to negative) between the jumper cables and the terminals of the battery that requires a jump start. (EX1003 at ¶55.) Similarly, one of the main functions disclosed in Zhang is "shutdown protection and prompt when the output power clip is connected erroneously in reverse polarity." (EX1006 at ¶0025). To accomplish this function, Zhang discloses a circuitry comprising R5, D9, and IC6, which are connected in circuit with the positive and negative polarity outputs of the power clip and which detect the polarity of a vehicle battery and provide an output signal indicating whether the jump starter is properly connected. (EX1006 at ¶¶0051, 00060; EX1003 at ¶¶55-56).

1[E] "a power switch connected between said internal supply and said output port"

Zhang discloses a power switch (e.g., a DC contactor) connected between the internal power supply (e.g., the battery pack) and its output port (e.g., the power clip). (EX1003 at ¶57). For example, Zhang discloses that "[t]his jump starter utilizes a high-power DC contactor as an automatic control electronic switch and it controls the on and off states through a circuit." (EX1006 ¶0017; EX1003 at ¶57).

The microcontroller maintains the DC contactor in an off position until both a chargeable battery and no reverse polarity is detected. (EX1006 at ¶¶0050-51; EX1003 at ¶57. The power switch will only be turned on when the microcontroller receives both the "RIGHT-Ctrl" and "Reverse-Ctrl" signals from the vehicle isolation sensor and reverse polarity sensor. (*Id.*) Further, the battery pack is connected to an output power clip through a change-over switch and DC contactor. (EX1006 at Abstract, ¶¶ 0006, 0014, 0060; EX1003 at ¶57).

1[F] "a microcontroller configured to receive inputs signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch . . ."

Zhang discloses a microcontroller that receives input signals from the circuitry comprising R5, D8, and IC5 (i.e., the vehicle isolation sensor) and the circuitry comprising R5, D9, and IC6 (i.e., the reverse polarity sensor). (EX1006 at 0050-0052; EX1003 at ¶58). That microcontroller also provides an output signal to the DC contactor. (*Id.)* For example, Zhang discloses that "after the correct connection signal is converted by R5, D8 and IC5, the external correct connection signal 'RIGHT-Ctrl' is transmitted to the P13 port of the microcontroller . . . At this time, the microcontroller once again outputs a high level to the control circuit of the DC contactor for it to carry out pull-in and conduction." (EX1006 at ¶0050). Similarly, Zhang discloses that "after the reverse connection signal is converted by D9, IC6 and R5, the external reverse connection signal 'Reverse-Ctrl' is transmitted

to the P12 port of the microcontroller. The microcontroller determines that the jump starter has been changed over to the 12 V gear, and at the same time, detects that the external battery is connected in reverse polarity. At this time, the DC contactor will maintain its disconnected state . . ." (EX1006 at ¶0051).

1[G] ". . . such that such power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs"

Zhang discloses that the main functions of its jump starter include ensuring correct connection of the power clip, shutdown protection when the power clip is connected erroneously in reverse polarity, and shutdown protection when the power clip is connected to the wrong voltage. (EX1006 at ¶¶0020-0028; EX1003 at ¶59). For example, Zhang discloses that its microcontroller detects if there is a safe connection to the vehicle battery, and maintains the DC contactor (e.g., the switch) in the disconnected position unless it determines the battery is safely connected. (EX1006 at ¶0050; EX1003 at ¶59). The microcontroller also maintains the DC contactor in the disconnected position if the vehicle battery is connected in reverse polarity. (EX1006 at ¶0051; EX1003 at ¶59). Zhang's microcontroller will only turn

on the DC connector if it receives both the "RIGHT-Ctrl" and "Reverse-Ctrl" signals from the circuitry comprising the claimed vehicle isolation sensor and reverse polarity sensor, respectively. (EX1003 at ¶59). It will not turn on the switch if either a vehicle battery at the output port is not present, or there is improper polarity connection between the vehicle battery and the output port of the jump starter. That is, the power switch (e.g., the DC contactor) is turned on to cause the internal power supply (e.g. the battery pack) to be connected to the output port (e.g., the power clip) only when signals indicate the presence of a vehicle battery and proper polarity connection of positive and negative terminals of the vehicle battery. (EX1003 at ¶59).

C. Claim 5

Zhang discloses the use of optically coupled isolator phototransistors in connection with the circuitry that senses the presence of a vehicle battery (e.g., the circuitry comprising R5, D8, and IC5) and the circuitry that senses whether the power clip has been connected in reverse polarity (e.g., the circuitry comprising R5, D9, and IC6). (EX1003 at ¶61). For example, Zhang discloses an embodiment in which IC5 and IC6 are a "PC817 optical coupler," which a person of ordinary skill would understand to be an optically coupled isolator transistor. (EX1006 at ¶0019, Fig. 5; EX1003 at ¶61).

D. Claim 8

Zhang discloses that the microcontroller detects when the voltage of the internal battery pack is lower than a predetermined voltage, in which case the microcontroller disconnects the jump starter's power clip automatically. (EX1006 at ¶¶0023, 0046; EX1003 at ¶63).

For example, resistors R23 and R24, along with capacitor C20, form a circuit that measures the level of the internal battery voltage. (EX1006 at Figure 5; EX1003 at ¶64). In that circuit, the BAT1+ signal comes from the internal battery output terminal. (EX1006 at Figure 5; EX1003 at ¶64). The resistors R23 and R24 form a standard voltage division circuit to scale the internal battery voltage to a level compatible with the microcontroller input, and C20 acts to average the signal and reduce the effects of noise. (EX1003 at ¶64). The voltage signal generated between R23 and R24 is directly proportional to the internal battery voltage and this signal, BAT1-TEST, is sent to the microcontroller so it can be sampled and the microcontroller thus has a measure of the internal battery voltage. (EX1006 at Figure 5; EX1003 at ¶64). The BAT1-TEST signal is connected to pin 34 of the microcontroller, which can be configured to send the BAT-TEST signal to an internal analog-to-digital converter that allows the microcontroller to determine the internal battery voltage. (EX1006 at Figure 3; EX1003 at ¶ 64).

Thus, Zhang discloses a voltage measurement circuit configured to measure the output voltage of the internal power supply (e.g., the battery pack) and to provide a voltage measurement signal to the microcontroller.

E. Claim 9

Zhang describes that "[t]he voltage of battery BAT+ passes through diode D4 and is added into the input terminal of the three-terminal integrated voltage regulator 7805 so that the three pins can provide a stable output of 5 V DC voltage to supply power to the CPU and other circuits." (EX1006 at ¶0043). Further, Figure 2 demonstrates that the internal battery signal, BAT1+, is input through diode D4 to the pin 1 input terminal of the 7805 voltage regulator, and pin 3 of the 7805 voltage regulator provides the 5 V DC output. (EX1006 at Figure 2; EX1003 at ¶¶66-67). The capacitors filter noise and diode D5 prevents the output of the regulator from being at a higher level than the input. (*Id.*) This type of voltage regulation circuit, and specifically the 7805 device, is used in a very large number of applications where a stable voltage is needed to power other circuit elements. (EX1003 at ¶67). The 5 V DC is used throughout the circuit, including to power IC3. (EX1006 at Figure 4; EX1003 at ¶67).

Thus, Zhang discloses a voltage regulator configured to convert output voltage of the internal power supply (e.g., the battery pack) to a voltage level appropriate to provide operating power to internal components of the apparatus.

F. Claim 17

Zhang's "shutdown protection" includes lighting up "reverse connection indicator LED7" and flashing an error message on the "Nixie tube" when the output power clip is connected in reverse polarity. (EX1006 at ¶0025; EX1003 at ¶69).

G. Claim 19

Zhang discloses a "manual force start": "When there is no external battery voltage input or the input voltage signal is too low, and the jump starter is unable to activate automatic identification, it can be manually determined. After the voltage is connected correctly and reliably, press the force start button to facilitate the jump starter to forcefully activate pull-in and conduction." (EX1006 at ¶0007, ¶0030; EX1003 at ¶71).

Moreover, Zhang describes a force start switch connected to J3. (EX1006 at ¶0058; EX1003 at ¶71). It would be obvious to a person of ordinary skill in the art that a simple bush button type of switch could be connected to the microcontroller in a manner that allowed the microcontroller to detect when the switch is closed so that the force start process could be initiated. (EX1003 at ¶71).

H. Claim 20

Zhang discloses that, after the force start button is pressed, there is a warning voice message and a 10 second countdown, during which the user must continue to press the button. (EX1006 at ¶0030; EX1003 at ¶73). "This ensures that the user has

sufficient time to re-verify the safety of the connection." (EX1006 at ¶0030). A person of ordinary skill in the art would find it obvious to implement this function. (EX1003 at ¶74). A switch can be connected to a microcontroller input and the microcontroller can sense the voltage at the input; when the voltage corresponding to a user activating the switch is sensed, the microcontroller can confirm the switch is being held in this position for a preset time, and then after a delay the microcontroller can send a signal to the power switch to connect the charger internal battery to the vehicle battery. (EX1003 at ¶74). This type of function is and was very common and would have been known to one skilled in the art before the '015 Patent. (EX1003 at ¶74).

V. Ground 2: Claims 2-3, 10, 12-16, 21 and 23 are rendered obvious by Zhang in view of Xinfang

A. Overview of Xinfang

U.S. Patent No. 9,506,446 (EX1008) claims priority to U.S. Patent Application No. 14/069,262, which was filed on October 31, 2013, and thus constitutes prior art under 35 U.S.C. § 102(a)(2). EX1008 will be referred to herein as "Xinfang."

Like Zhang, Xinfang also discloses a portable jump starter, describing a "portable power bank system" that is "small enough to be carried in a pocket by a user." (EX1008 at 9:1-8; EX1003 at ¶75). Xinfang discloses that the system incorporates additional features such as USB charging ports for devices like mobile

phones. (E.g., EX1008 at 4:59-5:3, EX1003 at ¶75). Xinfang also discloses the use of lithium ion as the internal power source for the portable jump starter. (E.g., EX1008 at 1:67-2:1, 5:12-27, EX1003 at ¶75).

B. The rationale to combine Zhang and Xinfang

As evidenced by Xinfang, it was well known in the art to use lithium ion batteries within devices like portable jump starters. (EX1003 at ¶76). In light of the teachings of Xinfang and the general knowledge of a person of ordinary skill in the art, such a person of ordinary skill would have found it obvious to incorporate a lithium ion battery into Zhang's jump starter. (EX1003 at ¶76). Such a replacement would improve Zhang's battery pack, as lithium batteries were known to hold a higher charge. (EX1003 at ¶76). Lithium ion batteries as disclosed in Xinfang also provide the advantage of compactness and were widely used at the time of the priority date of the '015 Patent. (EX1003 at ¶76). Additional properties of lithium ion batteries that were well known at the time of the priority date of the '015 Patent include the voltage and current available from each cell, and performance in various environmental conditions. (EX1003 at ¶76). Thus, the results of using a lithium ion battery would have been predictable and advantageous. (EX1003 at ¶76). Where a technique is used to improve a similar device, the Supreme Court has held that a person of ordinary skill would have recognized that the technique could "improve

similar devices in the same way." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007).

Furthermore, as evidenced by Xinfang, USB charging technology was well known at the time of the priority date of the '015 Patent. (EX1003 at ¶77; *see also* USB Charging Specification, EX1009). In light of this well known technology, it would have been obvious for a person of ordinary skill to have combined that known USB technology, such as the USB port of Xinfang, with the battery jump starter of Zhang to allow the device to offer a standardized charging interface for charging other devices without requiring specialized plugs and USB charging ports were widely known at the time of the claimed invention. (EX1008 at 4:59-62; EX1003 at ¶77). Xinfang's USB port is described for the same type of jump starting device as Zhang, and USB charging devices were widely known and used at the time of the priority date. (EX1003 at ¶77). Furthermore, the USB open standard that describes characteristics such as charging voltage and current demonstrate the predictable performance of using a USB port within Zhang's jump starter. (EX1003 at ¶77).

Additionally, as evidenced by Xinfang, LED flashlights were well known at the time of the priority date of the '015 Patent. (EX1003 at ¶77). A person of ordinary skill would have been motivated to combine the LED flashlight of Xinfang with Zhang as it would allow the user of the battery jump starter to more easily observe

connectors in the vehicle in situations where ambient light was insufficient. (EX1008 at 7:12-18; EX1003 at ¶77).

C. Claims 2 and 3

Xinfang discloses the use of an internal power supply comprising a lithium ion battery within its jump starter. (E.g., EX1008 at 1:67-2:1 ("The battery may comprise a lithium iron phosphate battery cell or a lithium cobalt oxide battery cell."), *see also* 2:47-51, 5:13-27, claims 4,7; EX1003 at ¶79). Xinfang further discloses the use of a pack of multiple lithium ion batteries. (EX1008 at 5:9-11 ("The battery cell 42 may have a multi-cell structure. In an embodiment of the present invention, the battery cell 42 has four battery cells."); EX1003 at ¶79).

By the priority date of the '015 Patent, the use of lithium ion batteries had become prevalent along with the increasing popularity of portable devices such as smart phones and tablets. (EX1003 at ¶80). Thus, it would have been obvious to one of skill in the art to combine the teachings of Zhang with those of Xinfang to include a lithium ion battery and/or multiple lithium battery packs within Zhang's jump starter, as this would result in a smaller, more portable product, given the smaller size to energy capacity of lithium ion batteries. (EX1003 at ¶80).

D. Claim 10

Xinfang explicitly discloses that its portable jump starter can include USB output ports. (EX1008 at 4:59-62 ("The USB output module 36 is connectable via a

USB cable to support USB charging of electronic devices where the battery module 16 provides power to the electronic devices."), *see also* Figure 3, 2:16-32, 4:36-46, 6:25-34, claims 12, 21-22, 25; EX1003 at ¶82).

As discussed earlier, USB charging technology was well known at the time of the priority date of the '015 Patent. (EX1003 at ¶77; *see also* USB Charging Specification, EX1009). In light of this well-known technology, it would have been obvious for a person of ordinary skill to have combined that known USB technology, such as the USB port of Xinfang, with the battery jump starter of Zhang to allow the device to offer a standardized charging interface for charging other devices without requiring specialized plugs and USB charging ports were widely known at the time of the claimed invention. (EX1008 at 4:59-62; EX1003 at ¶77). Xinfang's USB port is described for the same type of jump starting device as Zhang, and USB charging devices were widely known and used at the time of the priority date. (EX1003 at ¶77). It would have been obvious to a person of ordinary skill in the art to utilize USB output ports such as those disclosed in Xingfang within the portable jump starter disclosed in Zhang. (EX1003 at ¶¶77, 82).

E. Claims 12-14

Dependent claims 12 -14 add the limitations of an LED flashlight that can provide a source of light and a visual alarm indicating an emergency situation.

Xingfang discloses a portable jump starter that utilizes a flashlight circuit configured to provide a source of light to a user. (E.g., EX1008 at 1:45-47 ("The present invention according to an embodiment provides a mobile power bank, vehicle ignition system jump starter, and a flashlight."), *see also* 4:24-25 ("The second plate 24 may be provided with a master control button 26 and a flashlight 28."), *see also* Figure 3, 6:45-55, 8:34-67, claim 21); EX1003 at ¶84). Xinfang also discloses the use of flashlight to provide a S.O.S. signal in an emergency situation. (EX1008 at 8:37-44 ("After turning on the flashlight 28, if the control module 58 detects that the master control button 26 is activated, it may control the flashlight in multiple illumination modes, such as a constant light mode, flashing strobe light mode, and flashing S.O.S. (three sequential short flashes, followed by three sequential long flashes, followed again by three sequential short flashes) signal light mode."); EX1003 at ¶85).

Furthermore, Xinfang discloses extensive use of LEDs for indicators, including flashing LED lights. (E.g., EX1008 at 7:12-18 ("For example, when the power test circuit 64 detects battery voltage of the battery module 16 is lower than about 10.8V, the control module 58 may control the LED indicator module 32 to stop all LED's from lighting up. When the detected battery voltage is greater than about 12.6V, the control module may control the LED indicator module 32 so that one LED is lit and another LED is flashing."), Figure 3, 2:16-32, 4:36-51, 7:4-33,

8:17-24, claim 22; EX1003 at ¶87). Xinfang also discloses using the flashlight in emergency situations, such as flashing S.O.S. mode. (EX1008 at 8:37-44).

A person of ordinary skill would have found it obvious to combine the disclosures of Xinfang regarding LEDs and flashlights within a jump starter with Zhang's disclosure of a jump starter. (EX1003 at ¶88).

F. Claims 15 and 16

Zhang discloses a voice prompt and photoelectric indicators for safety prompts regarding low battery voltage warning. (E.g., EX1006 at ¶0007 ("At the same time, the corresponding voice prompt and photoelectric indicators are added to the safety prompts regarding selection of charging gear position, low battery voltage warning, output overcurrent protection, clip output short circuit protection, manual force start and other areas."); EX1003 at ¶90). Similarly, Xinfang discloses a portable jump starter with a plurality of visual indicators configured to display remaining capacity status of said internal power supply. (EX1008 at 7:12-18 ("For example, when the power test circuit 64 detects battery voltage of the battery module 16 is lower than about 10.8V, the control module 58 may control the LED indicator module 32 to stop all LED's from lighting up. When the detected battery voltage is greater than about 12.6V, the control module may control the LED indicator module 32 so that one LED is lit and another LED is flashing."); EX1003 at ¶91). It would have been obvious to one of ordinary skill to combine the teachings of Zhang with

those of Xinfang to include a plurality of visual indicators configured to display remaining capacity status of the internal battery so that the user can timely recharge the jump starter. (EX1003 at ¶92). The use of LEDs as a visual indicator of internal battery status was in widespread use in devices such as cell phones, detachable batteries for powering tools, and numerous prior art patents deal with this technology. (EX1003 at ¶92). For example, U.S. Patent No. 5,496,658, entitled "Storage Battery State-of-Charge Indictor," issued on March 5, 1996, describes LED indictors to display the charge status of a device with an internal battery. (EX1011; EX1003 at ¶92). Furthermore, such visual indicators would have been less expensive and easier to implement than a voice prompt, and visual indicators are superior to the voice prompt in situations where the ambient noise is high, such as next to a busy highway. (EX1003 at ¶92).

Moreover, Zhang discloses a plurality of visual indicators which comprise a plurality of LEDs providing output light of different colors. (EX1003 at ¶94). "The output terminal of the said CPU master control circuit is also connected to the display circuit. This display circuit comprises a LED Nixie tube display and LED indicator lights of different colors." (EX1006 at ¶0006, 0015, Claim 3, Figure 3). In Figure 3, Zhang discloses circuitry with multiple LED indicators; in the bottom left of the figure, LED1, LED2, LED3, LED4, LED5, LED6, and LED7 are shown. (EX1003 at ¶95).

G. Claim 21

Zhang discloses an "output power clip" that comprises both "anode and cathode power clips." (EX1006 at Abstract, ¶¶ 0006, 0014, 0019, 0051, 0056, 0058, 0060; EX1003 at ¶48). Similarly, Xinfang discloses a "vehicle ignition cable having a first end coupleable to the ignition output port and a second end coupleable to terminals of a vehicle battery." (EX1008 at 2:40-43; EX1003 at ¶98). Moreover, Xinfang discloses that "the user of the vehicle may unplug the vehicle ignition cable from the vehicle battery." (EX1008 at 5:67-6:3). It would have been obvious to one of ordinary skill in the art to combine either Xinfang's or Zhang's jumper cables and Xinfang's explicit recitation of an end coupleable to the output port (i.e., a plug) with Zhang's portable jump starter to provide a connection to the vehicle battery. (EX1003 at ¶98).

H. Claim 23

Xinfang discloses an output port 46 that contains a top portion and bottom portion that are shaped differently, where the top portion has a circular portion with flat side and the bottom portion is substantially circular so that an ignition cable will fit into the output port only in one specific orientation. (EX1008 at Fig. 2; EX1003 at ¶100). This is illustrated further in Figure 2 below.

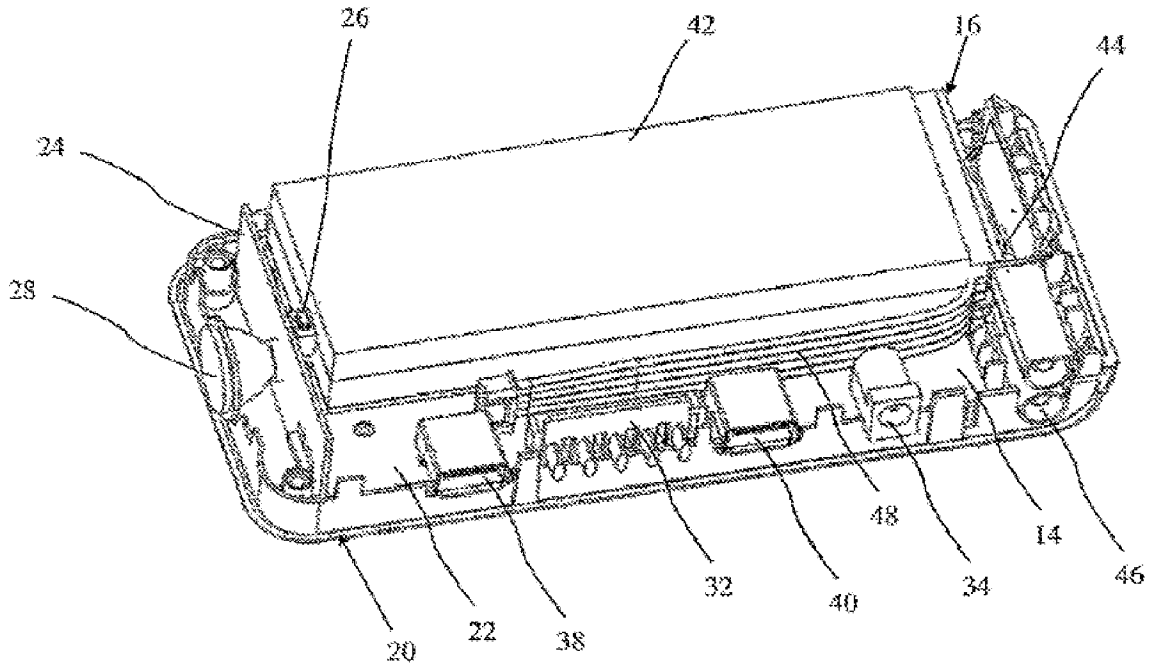


FIG. 2

It would have been obvious to one of skill in the art to combine this output port of Xinfang into Zhang's jump starter so that a user could only place the jumper cable plug into the port in the correct orientation, limiting the chance of connecting the cables with incorrect parity, resulting in a safer product. (EX1003 at ¶101).

VI. Ground 3: Claim 11 is rendered obvious by Zhang in view of USB Charging Specification

The USB Charging Specification was introduced by The USB Implementers Forum, Inc., the cooperative organization that created the USB ("Universal Serial Bus") technologies. (EX1009 at 2; EX1003 at ¶102). The USB Charging Specification governs the technologies that allow a portable device to use a USB cable to charge from either a personal computer or from a USB charger. (*Id.* at 12;

EX1003 at ¶102). The battery charging specification was first released on March 8, 2007. (EX1009 at 4). By the time of the '015 Patent, charging thorough a USB port had become prevalent for smartphones and other portable devices, and was widely known to persons of ordinary skill in the art. (EX1003 at ¶102).

It would have been obvious to one of skill in the art to modify Zhang's jump starter with a widely known and available USB charging port at the time of the claimed invention of the '015 Patent. (EX1003 at ¶103). This would allow the device to offer a standardized charging interface for both charging other devices and for charging the internal battery itself without requiring specialized plugs. (*Id.*). Furthermore, it would allow the device to be used with any power source compatible with a USB connection for providing power. (*Id.*). Furthermore, allowing USB charging creates additional mobility for a portable jump starter. (*Id.*)

VII. Ground 4: Claims 1, 8, 9, 17, and 19 are anticipated by Richardson

A. Overview of Richardson

U.S. Patent Application Publication No. 2009/0174362 (EX1010) claims priority to Provisional application No. 61/018,715, filed on January 3, 2008, over 6 years prior to the July 8, 2014 priority date of the '015 Patent, and thus constituted prior art under U.S. 35 U.S.C. §102(a)(1). EX1010 will hereinafter be referred to as "Richardson."

Richardson discloses a "method and apparatus for providing supplemental power to an engine." (EX1010). Specifically, Richardson discloses to "provide[] supplemental power to an engine" via "a pair of conductive leads for connecting the supplemental power to an engine electrical system, a batter[y], a relay connected to the conductive leads, a shunt cable connecting the batter[y] to the relay and a processor for controlling the relay to selectively apply electrical power to the engine electrical system." (*Id.* at Abstract). Importantly, Richardson also discloses "safety features to reduce the risk of injury to the operator and damage to the apparatus and/or engine electrical systems." (*Id.*). And, similar to the '015 Patent, Richardson discloses two separate safety features, (1) a "reverse voltage sensor 24 [which] monitors the polarity of the jumper cables on line 26 which are connected to the vehicle's electrical system 28," (*Id.* at ¶0012; *see also* ¶0006 ("[f]or safety purposes, only if proper polarity is detected can the system operate")), and (2) a "vehicle voltage sensor 30 [which] monitors the voltage on line 37 (voltage of the vehicle)." (*Id.* at ¶0016). Richardson also discloses a microcontroller that checks the status of all sensors including the reverse polarity sensor and vehicle voltage sensor prior to operation. (*Id.* at ¶0012).

B. Richardson anticipates every element of claim 1

1[P] "apparatus for jump starting a vehicle engine"

Richardson discloses an apparatus for jump starting a vehicle engine. "The present invention relates to a portable power source for a motor vehicle, and more particularly, to a method and apparatus to provide supplemental power to start internal combustion and turbine engines." (EX1010 at ¶0001; EX1003 at ¶107).

1[A] "an internal power supply"

Richardson's jump starter includes an internal power supply, *i.e.*, the "one or more jump starter batteries 22.". (EX1010 at ¶0012; EX1003 at ¶108). For example, Richardson explicitly teaches an invention that "includes an internal battery . . . to provide the power to the battery of the vehicle to be jump started." (EX1010 at ¶0006).

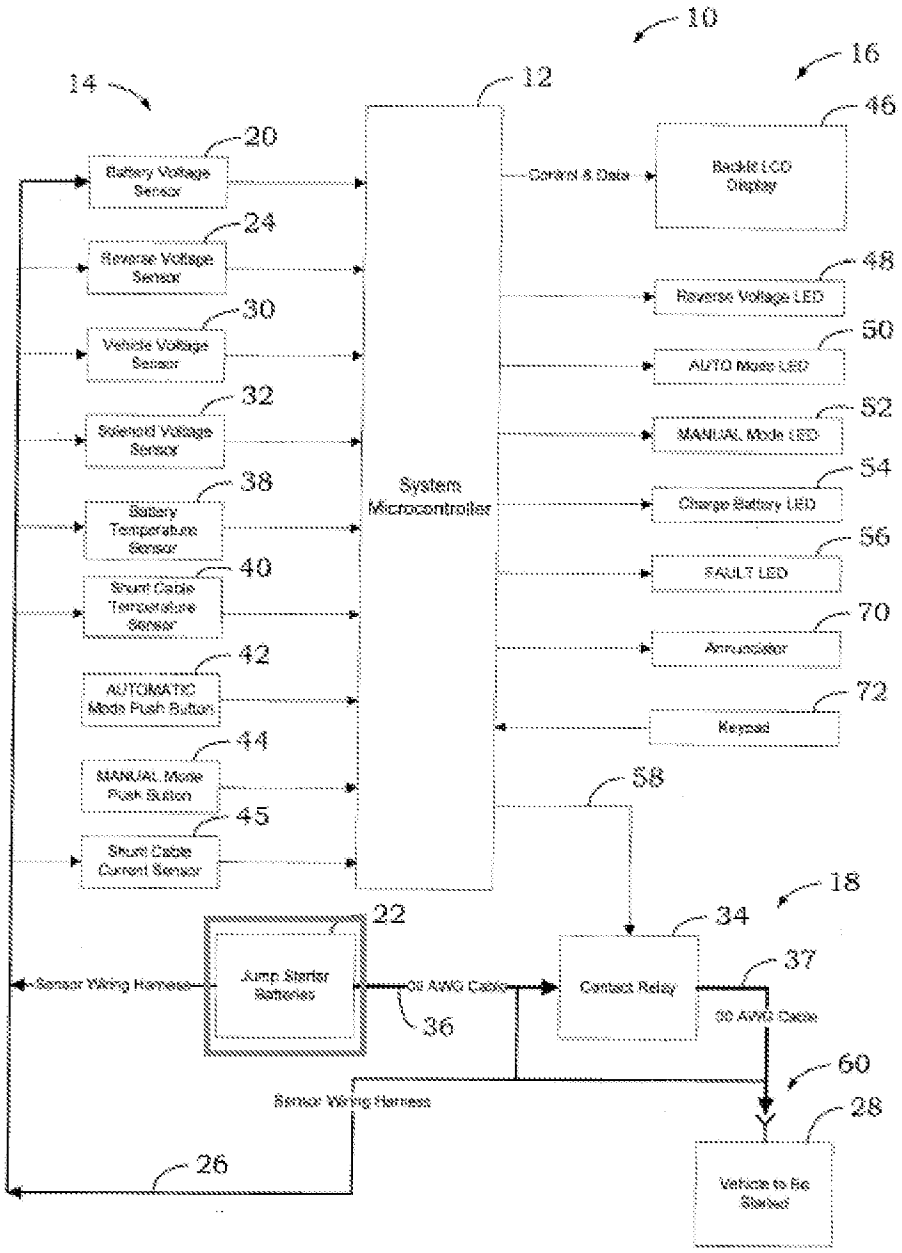


Fig. 1

(EX1010 at Fig. 1 (denoting Jump Starter Batteries as 22); EX1003 at ¶108).

1[B] "an output port having positive and negative polarity outputs"

As discussed above, Patent Owner contends that this limitation is met by a jumper cable with red (positive) and black (negative) clamps. (EX1016 at ¶24). Similarly, Richardson discloses "a pair of conductive leads for connecting the supplemental power to an engine electrical system." (EX1010 at Abstract, ¶0020 ("[O]nce jumper cables 60 have been connected to the vehicle to be started"); EX1003 at ¶109)). Furthermore, Richardson discloses that the jumper cables have a positive and negative polarity. (EX1010 at ¶0012 ("A reverse voltage sensor 24 monitors the polarity of the jumper cables on line 26")). Figure 2C also illustrates that the jumper cables include a "red clamp" and a "black clamp," labeled 60, which connect to the vehicle 28:

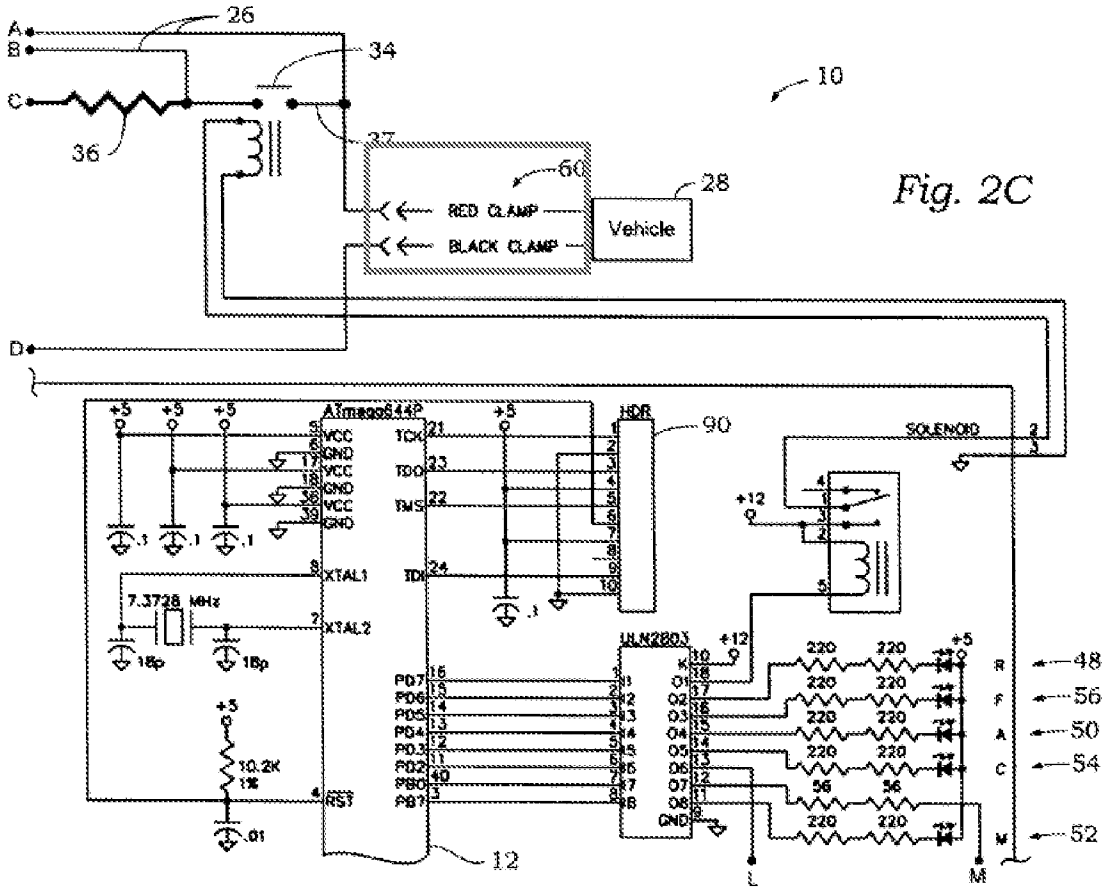


Fig. 2C

Thus, Richardson discloses an output port having positive and negative polarity outputs in the same manner as defined by Patent Owner, *i.e.*, jumper cables with a red (positive) and black (negative) clamp. (EX1003 at ¶111).

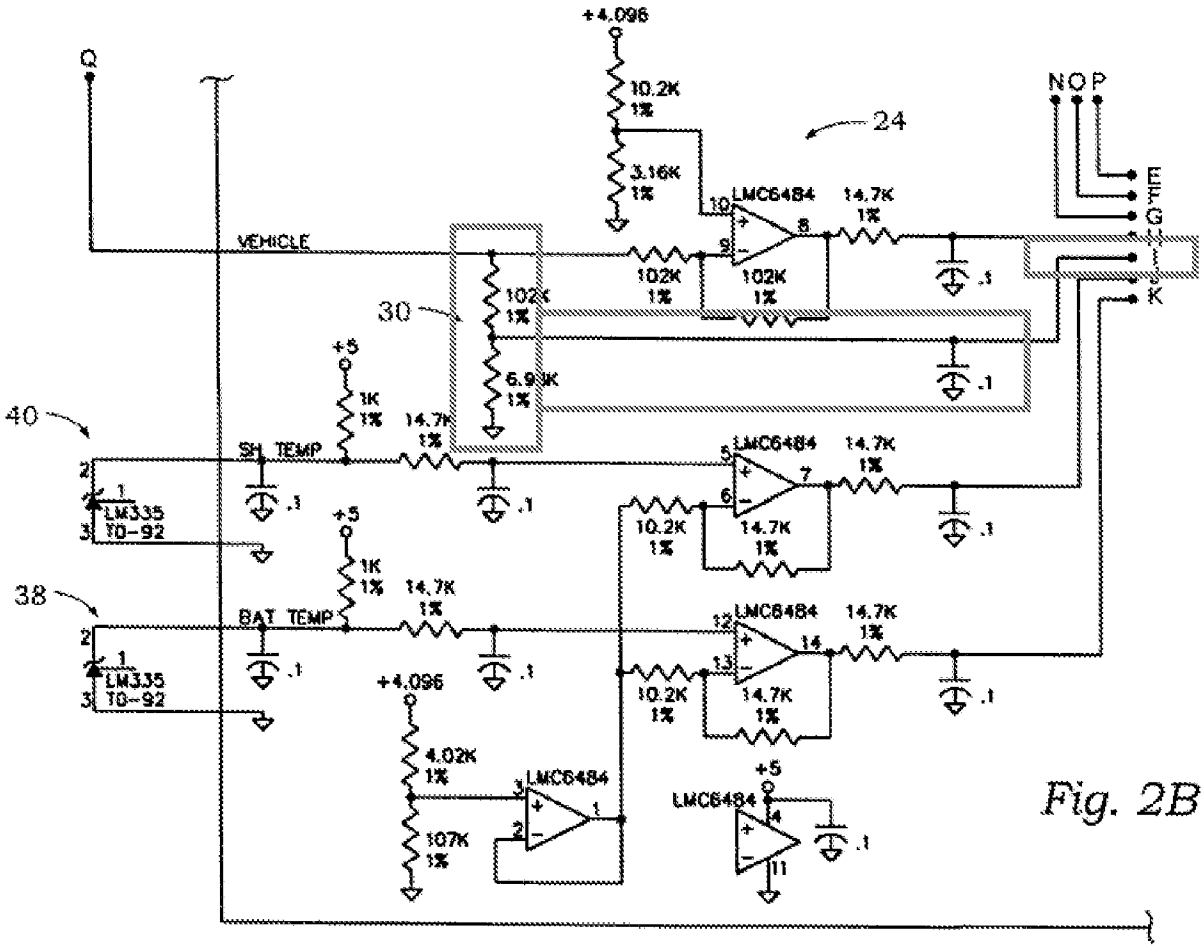
Richardson also discloses that a "Jumper Cable unplugged" error message is displayed if a jumper cable is disconnected or unplugged from the starter system. (EX1010 at ¶0033). And Figure 2C appears to depict a jumper cable plugged into the jump starter. The '015 Patent discloses a "jumper cable device" that has "a plug configured to plug into an output port of a handheld battery charger booster device having an internal power supply; a pair of cables integrated with the plug at one

respective end." (EX1001 at 3:40-46). Therefore, if the Board disagrees with the Patent Owner's interpretation of this limitation, Petitioner contends that Richardson inherently discloses an output port having positive and negative polarity outputs. (EX1003 at ¶111). Output ports having positive and negative polarity outputs were also widely available at the time of Richardson. (*Id.*). For example, standard EC connectors with positive and negative polarity outputs where a jumper cable device can be plugged in were widely available since at least 2008. (EX1017).

1[C] "a vehicle battery isolation sensor connected in circuit with said positive and negative polarity outputs, configured to detect presence of a vehicle battery connected between said positive and negative polarity outputs"

Richardson discloses that "[a] vehicle voltage sensor 30 monitors the voltage on line 37 (voltage of the vehicle)." (EX1010 at ¶0012; EX1003 at ¶112). As is shown above in Figure 2C, line 37 is connected to the vehicle battery 28 via red clamp and black clamp 60. Furthermore, Richardson discloses that the voltage sensor 30 detects whether the jumper cables are connected to the vehicle battery. (EX1010 at ¶0033 ("If the system detects an increase in the difference between the measured jump starter battery voltage 20 and the voltage measured 30 across the contact relay 34 indicating that one of the jumper cables has been disconnected 302 from the vehicle's battery system or starter system 28 then a jumper cable unplugged error count is incremented 304.")) Vehicle voltage sensor 30 consists of two resistors

and a capacitor, and the signal from this sensor is sent to the microcontroller via line I, as shown in Figure 2B.



(EX1010 at Fig. 2B; EX1003 at ¶112). These resistors are connected to vehicle battery 28 via line Q, which as shown in Figure 2A connects directly to line A, which in turn provides an output signal via line I to microprocessor 12, as shown in Figure 2C. (EX1010 at Figs 2A and 2C; EX1003 at ¶112).

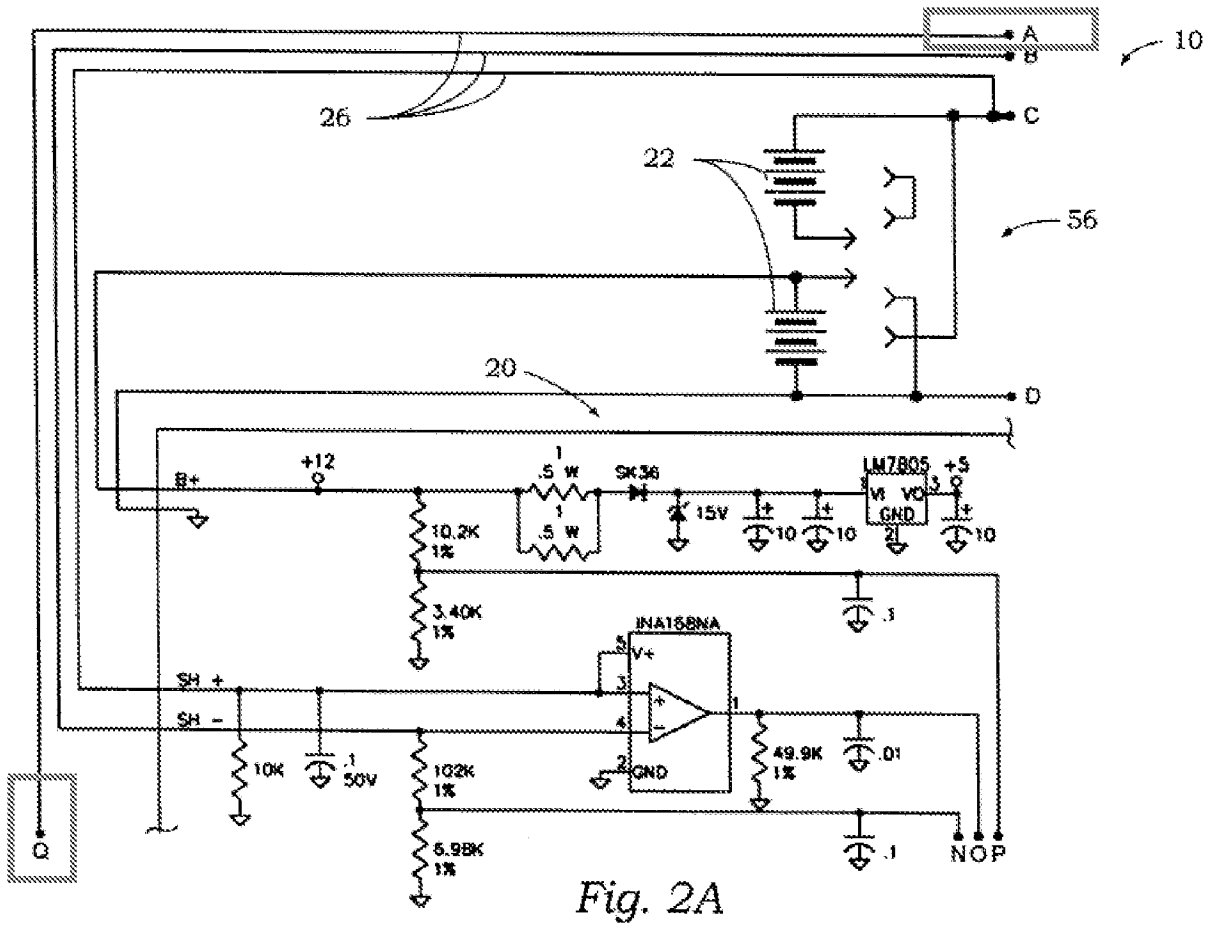


Fig. 2A

(EX1010 at Fig. 2A).

Furthermore, voltage sensor 30 is isolated from the jump starter batteries 22, which are connected to line C. (EX1010 at Fig. 2A; EX1003 at ¶114). Line C connects to shunt cable 36, which is isolated from the output port consisting of red clamp and black clamp 60 (and thus vehicle 28) by contact relay 34. (EX1010 at Fig. 2C; EX1003 at ¶114). Figure 1 also clearly shows that contact relay 34 is placed between jump starter batteries 22 and vehicle 28. (EX1003 at ¶114).

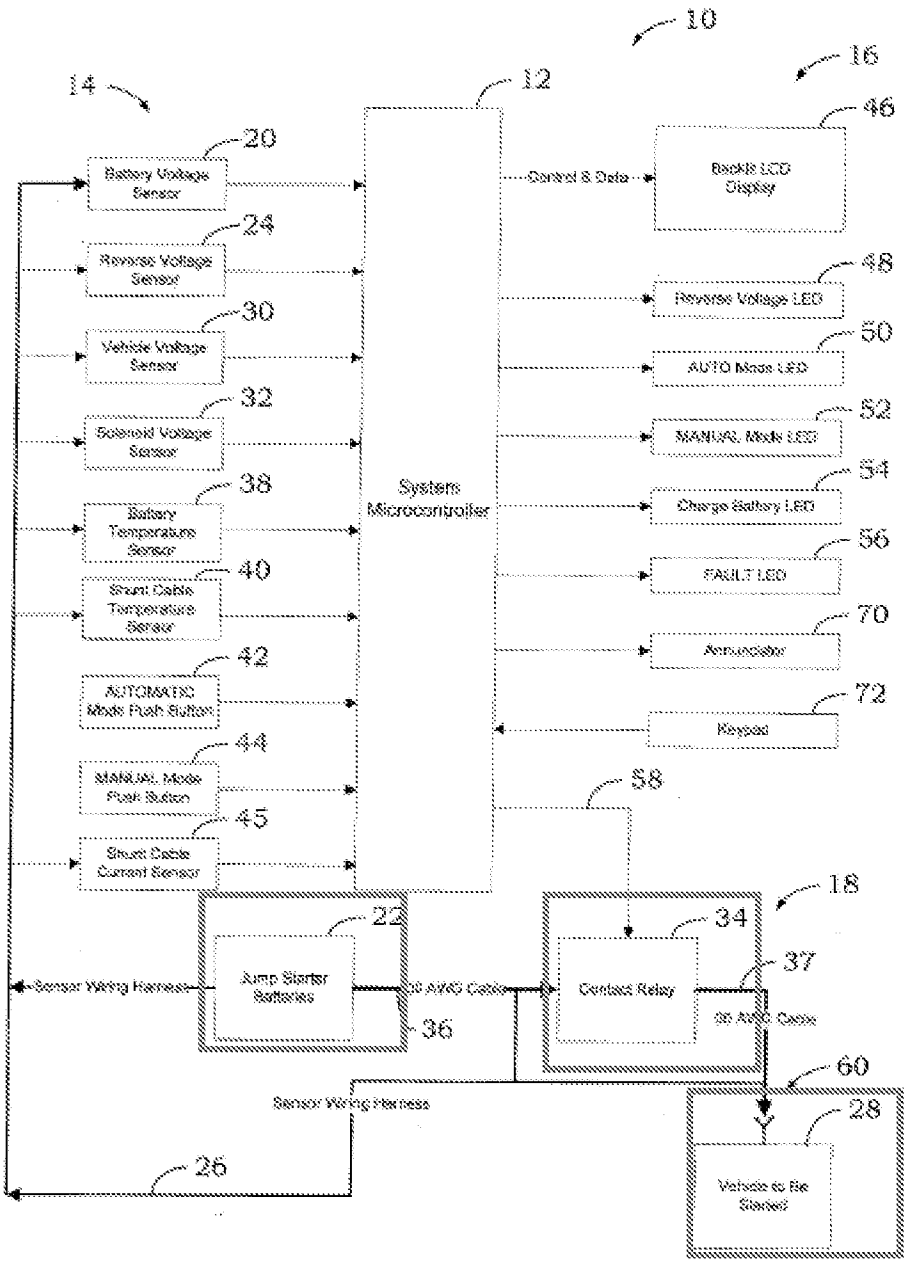


Fig. 1

(EX1010 at Fig. 1). Thus, Richardson discloses a vehicle battery isolation sensor, *i.e.*, the voltage sensor 30, which is connected in circuit with the positive and

negative outputs, shown as plugged in red clamp and black clamp in Figure 2C, and which detects the presence of a vehicle battery. (EX1003 at ¶115).

1[D] "a reverse polarity sensor connected in circuit with said positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between said positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are property connected with said positive and negative polarity outputs of said output port"

Richardson discloses "[a] reverse voltage sensor 24 [that] monitors the polarity of the jumper cables on line 26 which are connected to the vehicle's electrical system 28." (EX1010 at ¶0012; *see also* EX1010 at ¶0020 ("once jumper cables 60 have been connected to the vehicle to be started 28, the voltage is measured by reverse voltage sensor 24 to determine if the cables have been properly connected to the vehicle 214"); EX 1003 at ¶116). Reverse voltage sensor 24 consists of 5 resistors connected in sequence, a capacitor, and further connected to component LMC6484, an operational amplifier, which is connected to line Q and which provides an output signal on line H. (EX1010 at Fig. 2B; EX1003 at ¶116).

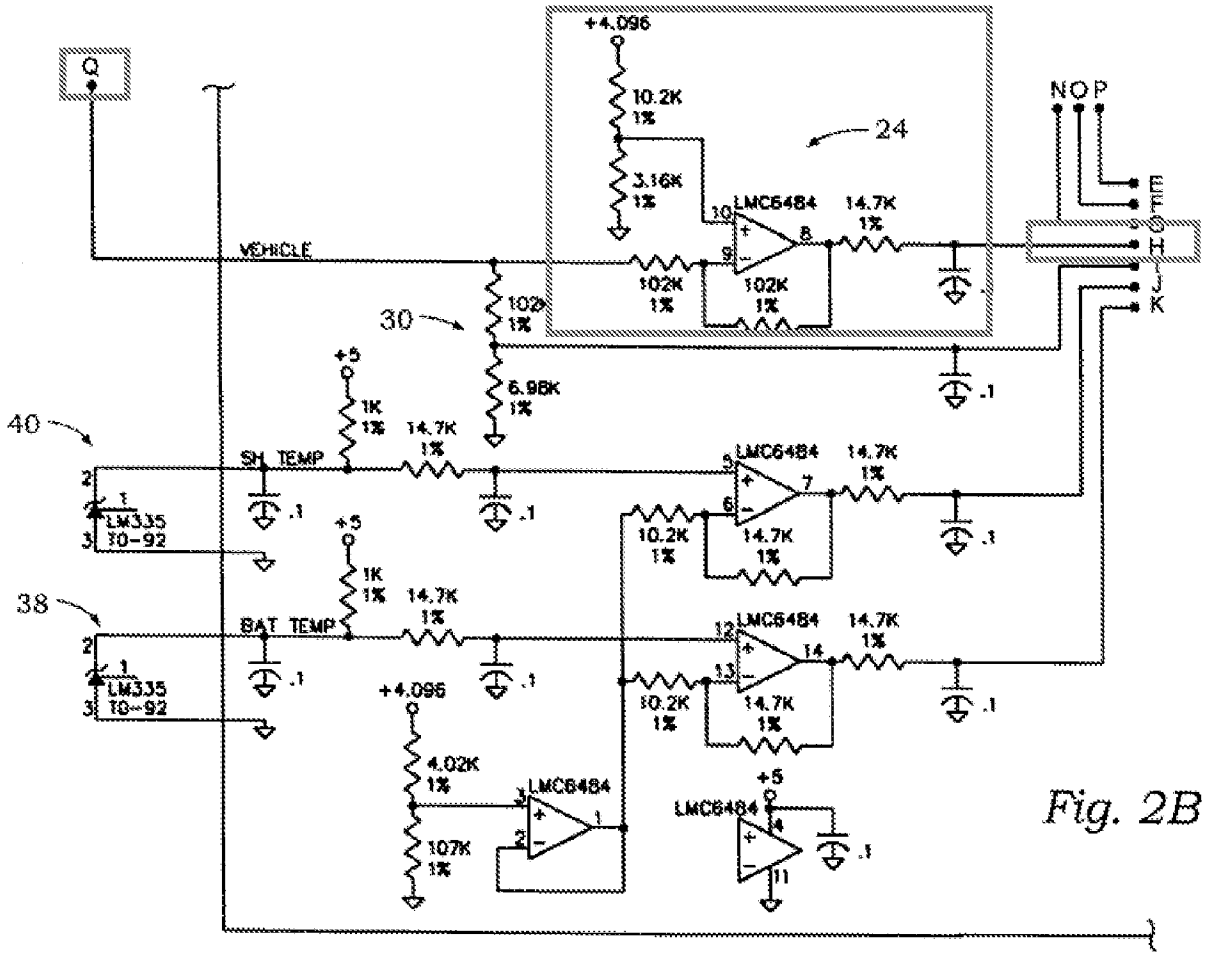


Fig. 2B

(Again, as discussed above in relation to the vehicle battery isolation sensor, line Q is connected directly to line A as shown in Figure 2A, and line A is connected to the positive and negative polarity output port, shown as plugged in red clamp and black clamp 60 in Figure 2C. (EX1003 at ¶116). Thus, the reverse voltage sensor 24 is connected in circuit with said positive and negative polarity outputs. Furthermore, it provides an output signal to the microprocessor 12 on line H, which indicates whether positive and negative terminals of the vehicle battery are property connected with the positive and negative polarity outputs of the output port. (EX1010 at ¶0014

("A reverse voltage LED 48 is illuminated when the microprocessor 12 determines that a reverse voltage jumper cable voltage is detected by reverse voltage sensor 24."); EX1003 at ¶116). Importantly, the circuitry that forms reverse voltage sensor 24 is separate and distinct from the circuity forming vehicle voltage sensor 30. (EX1010 at Fig. 2B; *see also* EX1003 at ¶116). Furthermore, reverse voltage sensor 24 and vehicle voltage sensor 30 produce separate and distinct signals that are transmitted to microprocessor 12 on separate and distinct lines H and I, respectively. (EX1010 at 2B; *see also* EX1003 at ¶116). Thus, Richardson discloses a reverse polarity sensor that is connected in circuit with the positive and negative polarity outputs, configured to detect polarity of a vehicle battery connected between the positive and negative polarity outputs and to provide an output signal indicating whether positive and negative terminals of said vehicle battery are property connected with the positive and negative polarity outputs of the output port.

1[E] "a power switch connected between said internal power supply and said output port"

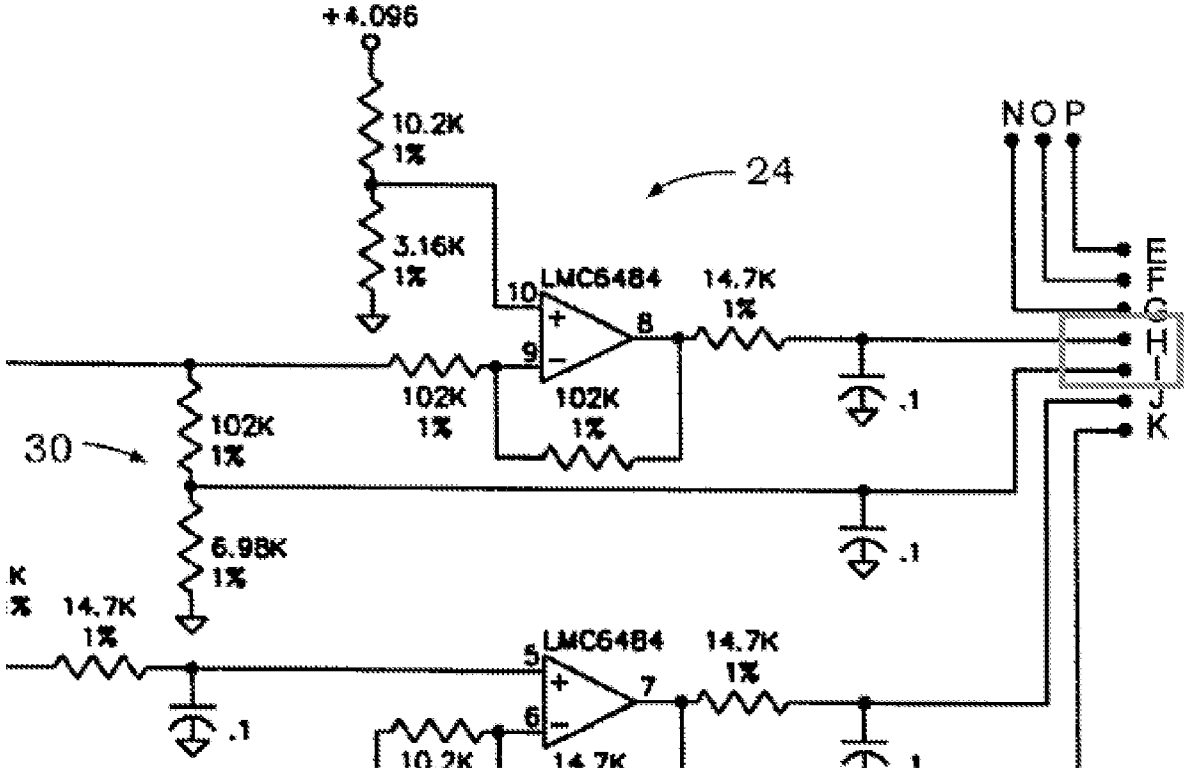
Richardson discloses "contact relay 34," which when closed connects the internal batteries to the vehicle. (EX1010 at ¶0014 ("When jump starter operation has been successfully initiated, the contact relay 34 is closed and the jump starter batteries 22 are connected to the starter system or batteries of the vehicle to be started 28.")). Furthermore, Figure 2C shows that contact relay 34 is connected on one side to shunt cable 36, which is connected to line C, which is shown in Figure 2A

connected to jump starter batteries 22. (EX1010 at Fig. 2A and 2C; EX 1003 at ¶117). The other side of contact relay 34 connects to line 37, which is connected directly to the output port, shown as plugged in red clamp and black clamp 60. (EX1010 at Fig. 2C; EX1003 at ¶117). This is further shown in Figure 1, which shows contact relay 34 connected between the jump starter batteries and the 00 AWG cable line 37. (EX1010 at Fig. 1; EX1003 at ¶117). Thus, Richardson discloses a power switch connected between the internal power supply and the output port. (EX1003 at ¶117).

1[F] "a microcontroller configured to receive inputs signals from said vehicle isolation sensor and said reverse polarity sensor, and to provide an output signal to said power switch . . ."

Richardson discloses a microcontroller that receives input signals from the vehicle battery isolation sensor, *i.e.*, vehicle voltage sensor 30, and the reverse polarity sensor, *i.e.*, reverse voltage sensor 24, and which provides an output signal to the power switch, *i.e.*, contact relay 34. (EX1003 at ¶118). For example, Richardson discloses "a programable microprocessor 12 which receives inputs 14 and produces information outputs 16 and control outputs 18." (EX1010 at ¶0011; EX1003 at ¶ 118). Richardson uses the terms microprocessor and microcontroller interchangeably throughout the specification. (*See, e.g.* EX1010 at ¶0015 and Figure 1). As shown in Figure 1, inputs 14 include input signals from reverse voltage sensor 24 and vehicle voltage sensor 30, and outputs 18 and 58 which is directed to contact

relay. (EX1003 at ¶118; EX1010 at Fig. 1, ¶0014 ("A reverse LED 48 is illuminated when the microprocessor 12 determines that a reverse voltage jumper cable voltage is detected by reverse polarity sensor 24 . . . A fault LED 56 is turned on any time the microprocessor 12 detects and operation, sensor or internal fault . . . A contact relay control output 58 operates the contact relay 34. When the jump starter operation has been successfully initiated, the contact relay 34 is closed")). Furthermore, as discussed above, Figure 2C shows that line H carries a signal from reverse voltage sensor 24 and that line I carries a signal from vehicle voltage sensor 30.



(EX1010 at Fig. 2C). Figure 2D shows an image of the inputs to microcontroller 12 which includes inputs H and I.

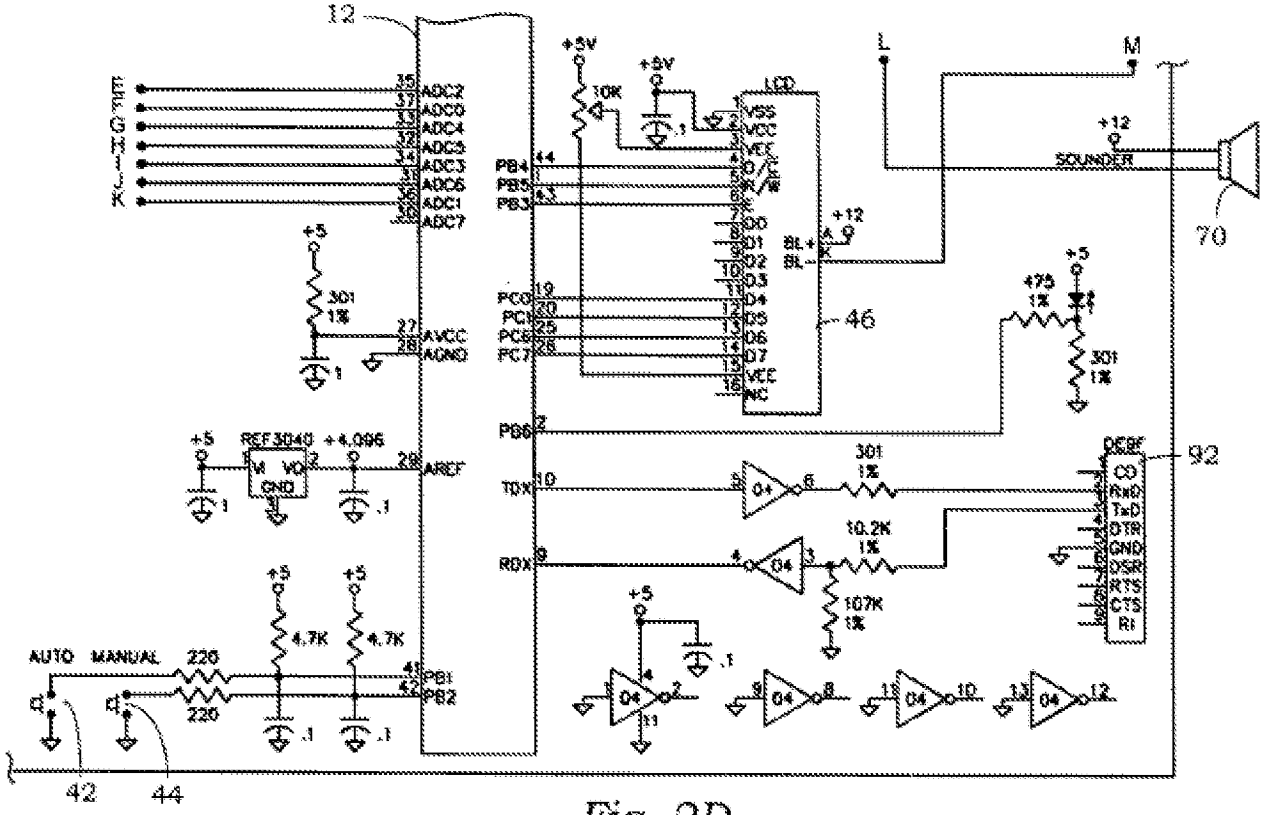


Fig. 2D

(EX1010 at Fig. 2D; EX1003 at ¶118). Thus, Richardson discloses a microcontroller that is configured to receive signals from the vehicle battery isolation sensor and the reverse polarity sensor and which provide an output signal to the power switch. (EX1003 at ¶118).

1[G] ". . . such that such power switch is turned on to cause said internal power supply to be connected to said output port in response to signals from said sensors indicating the presence of a vehicle battery at said output port and proper polarity connection of positive and negative terminals of said vehicle

battery with said positive and negative outputs, and is not turned on when signals from said sensors indicate either the absence of a vehicle battery at said output port or improper polarity connection of positive and negative terminals of said vehicle battery with said positive and negative polarity outputs"

Richardson discloses that the microcontroller 12 receives signals from the vehicle voltage sensor 30 and the reverse voltage sensor 24 and that it generates a control signal 58 that controls the contact relay 34 to connect the jump starter batteries 22 to the vehicle to be started 28. (EX1003 at ¶119). Richardson also discloses that the microcontroller only closes relay 34 if the reverse polarity sensor 24 and vehicle voltage sensor 30 indicates the presence of a vehicle battery connected with proper polarity. (EX1003 at ¶119).

For example, Richardson states that "when the jump starter 10 is initially powered on 200, the microprocessor initializes the hardware . . . . then performs a self-test operation 208 where . . . all sensors 20, 24, 30, 32, 38, 40 . . . are tested." (EX1010 at ¶0015; EX1003 at ¶119). Furthermore, once the self-test is completed an interrupt service routine (ISR) is started. Provided that the microcontroller does not receive any signals from the sensors, the process continues to the steps shown in Figures 3-8 where several checks are performed prior to the microcontroller sending a signal to close the power switch and thus jump start the vehicle. At step 406 the shunt calibration flag is checked, and if the calibration flag is set, the starter contact relay is closed at step 408. (EX1010 at Fig. 4; EX1003 at ¶119). However, if the flag

is not set, the relay is not closed and the process proceeds to step 212 and then to step 214 where the polarity connection to the vehicle battery is tested. (EX1010 at Fig. 3; *see also* ¶ 0020 ("If the system does not detect a battery charging voltage 212 . . . the voltage is measured by the reverse voltage sensor to determine if the cables have been properly connected to the vehicle 214. If the voltage measured is significantly less than the voltage of the system batteries 22, then a reverse polarity connection . . . is determined"); EX1003 at ¶119)).

Furthermore, Richardson also discloses that at step 252 a vehicle battery presence test is conducted. (EX1010 at Fig. 5; EX1003 at ¶119). For example, vehicle voltage sensor 30 "monitors the voltage on line 37 (voltage of the vehicle)" for detecting the voltage of the vehicle to be started. (EX1010 at ¶0012; EX1003 at ¶119). "If one of the push buttons 42 or 44 has been selected, the system will compare the operator-configured starter voltage against the voltage of the vehicle to be started 28. . . If the difference between the voltage selected and the voltage measured is not within a predetermined range and tolerance 252 . . . further operation is prohibited until the correct voltage is selected 256 at which point processing returns to the main processing loop 210." (EX1010 at ¶0026). The process of measuring the vehicle battery voltage necessarily entails detecting the presence of a vehicle battery connected to the positive and negative output ports, because reading a sufficiently low voltage would indicate either the absence of a vehicle battery or a

battery with a voltage below a required threshold for detection. (EX1003 at ¶119). Only after the reverse polarity and battery presence tests have been conducted at steps 214 and 252 does the process proceed to step 268 where microcontroller 12 sends a signal to close contact relay 34. (*See* EX1010 at Fig. 3, Fig. 6; *see also* EX1010 at ¶¶0014 and 0027; EX1003 at ¶119).

Thus, Richardson discloses that the microcontroller receives signals from both the vehicle voltage sensor 30 (a vehicle battery isolation sensor) and reverse voltage sensor 24 (a reverse polarity sensor) and the microcontroller 12 only sends a signal to close the contact relay 34 (the power switch) if the received signals indicate both the presence of a vehicle battery and a proper polarity connection to the vehicle battery terminals. (EX1003 at ¶119).

C. Claim 8

Richardson discloses a voltage measurement circuit configured to measure output voltage of said internal power supply and to provide a voltage measurement signal to said microcontroller as set forth in Claim 8. For example, Richardson discloses "[a] battery voltage sensor 20 monitors the voltage level of one or more jump starter batteries 22." (Ex. 1010 at ¶0016). The battery voltage sensor 20 provides a voltage measurement signal to the microcontroller 12 depicted in FIG. 1. (EX1010 at Fig. 1; EX1003 at ¶¶121-122).

D. Claim 9

Richardson discloses "a voltage regulator configured to convert output voltage of said internal power supply to a voltage level appropriate to provide operating power to internal components of the apparatus," as required by Claim 9.

Richardson discloses a voltage regulator shown as "LM7805" in FIG. 2A below. (EX1010 at Fig. 2A; EX1003 at ¶124). LM7805 is a commonly used five-volt regulator that provides power to the internal components (microcontroller, operational amplifiers, etc.) of the apparatus. (EX1003 at ¶¶124-126). An exemplary datasheet of an LM7805 voltage regulator from Fairchild Semiconductor Corporation has a 2006 copyright date, which is before the priority date of the '015 patent. (*Id.* at ¶125; EX1019). The voltage regulator LM7805 is connected with several other components and provides +5 volts to the terminal labeled "+5", a voltage level appropriate to provide operating power to internal components of the apparatus. (*Id.*) As is customary in circuit diagrams, power supply leads are often not shown, but other +5 connections appear in Figures 2C and 2D. These are supplied by the LM7805 of FIG. 2A. (*Id.*)

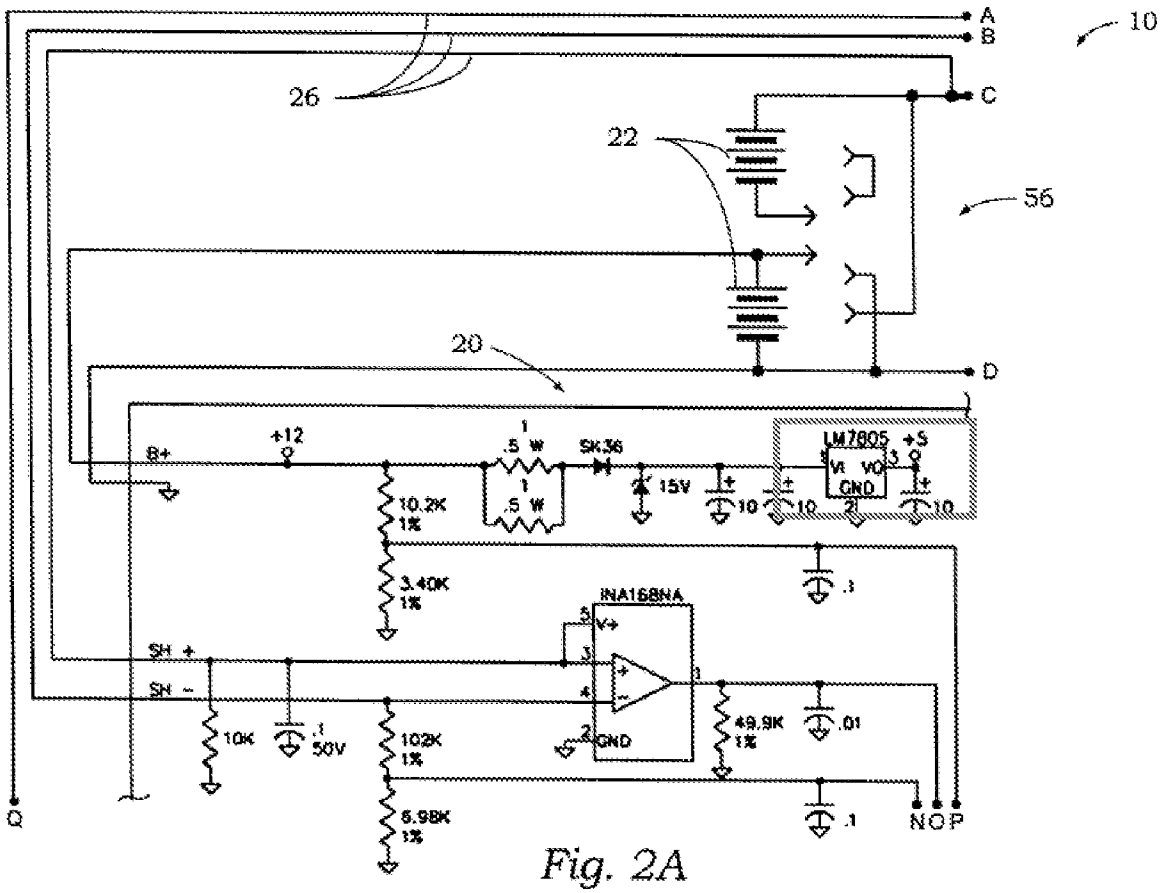


Fig. 2A

(EX1010 at Figure 2A; EX1003 at ¶124).

A voltage regulator stabilizes the DC voltages used by processors and other elements in electronic devices. (EX1003at ¶126). Without a voltage regulator, the voltage variation from the internal battery could impair operation of the electronics in the device. (*Id.*) Therefore, almost every electronic device nowadays includes a voltage regulator. (*Id.*) A person of ordinary skill in the art would have known to use a voltage regulator to stabilize the power supplied to the microcontroller and other internal components. (*Id.*)

E. Claim 17

Richardson discloses a "reverse voltage LED 48 [which] is illuminated when the microprocessor determines that a reverse voltage jumper cable voltage is detected by reverse voltage sensor." (EX1010 at ¶0014; EX1003 at ¶128). Therefore, Richardson discloses all the elements of claim 17. (EX1003 at ¶128).

F. Claim 19

Richardson discloses an override switch to enable a user to connect jump starter power to said output port when the vehicle battery isolation sensor is unable to detect the presence of a vehicle battery. (EX1003 at ¶130). For example, Richardson discloses that "[i]f in manual mode, the jump starter 10 may be used when the battery voltage of the vehicle is below 10 volts, or if the vehicle's battery is not connected." (EX1010 at ¶0041). Manual mode is activated by "manual 44 pushbutton input." (EX1010 at ¶0013). Thus, Richardson discloses all of the elements of claim 19. (EX1003 at ¶130).

VIII. Ground 5: Claims 2-3, 10, 12-15, 21, 23 are rendered obvious by Richardson in view of Xinfang

A. Rationale to Combine Richardson and Xinfang

For similar reasons discussed above in relation to Ground 2, it would have been obvious to one of skill in the art to combine Richardson with Xinfang. (EX1003 at ¶¶131-133). Richardson discloses a portable jump starter. (EX1010 at ¶0001). Xinfang also discloses a portable jump starter that is "small enough to be

carried in a pocket by a user." (EX1008 at 9:1-8; EX1003 at ¶131). Further, Xinfang discloses that the system incorporates additional features such as USB charging ports for devices like mobile phones. (E.g., EX1008 at 4:59-5:3; EX1003 at ¶131). And Xinfang discloses the use of lithium ion batteries as the internal power source for the portable jump starter. (E.g., EX1008 at 1:67-2:1, 5:12-27; EX1003 at ¶131-132).

A person of ordinary skill would have looked to known lithium ion batteries (such as disclosed in Xinfang) to use within Richardson's jump starter, as doing so would merely replace Richardson's rechargeable battery with another type a battery that holds a higher charge, and lithium ion batteries were widely known at the time of the priority date of the '015 Patent. (EX1003 at ¶132). Lithium ion batteries as disclosed in Xinfang provide the advantage of compactness and were widely used at the time of the priority date of the '015 Patent, as described in additional detail above in relation to Ground 2. (*Id.*)

Additionally, a person of ordinary skill would have looked to combine known USB technologies, such as the USB port of Xinfang, with the battery jump starter of Richardson to allow the device to offer a standardized charging interface for charging other devices without requiring specialized plugs and USB charging ports were widely known at the priority date time of the '015 Patent. (EX1008 at 4:59-62; EX1003 at ¶133). The USB port of Xinfang is described for the same type of jump starting device as Richardson, and with the wide proliferation of USB charging

devices at the time of the invention and the predictable performance established by the USB open standard that describes characteristics such as charging voltage and current, combining Xinfang's USB port with Richardson's jump starting device would have been obvious to any person of ordinary skill. (EX1003 at ¶133). Additionally, a person of ordinary skill would have been motivated to combine the LED flashlight of Xinfang with Richardson as it provides a portable battery jump starter the ability to better observe connectors in the vehicle and LED flashlights were widely known at the time of the priority date of the '015 Patent. (EX1008 at 7:12-18). Furthermore, one of skill in the art would have been motivated to combine the plurality of battery charge indicators configured to display the remaining capacity of the internal battery of Xinfang with the battery charge LED of Richardson as it would provide the user with notice of the charge state so they could timely recharge the jump starter. (EX1003 at ¶133).

B. Claims 2 and 3

As discussed above, Xinfang discloses the use of an internal power supply comprising a lithium ion battery within its jump starter. (E.g., EX1008 at 1:67-2:1 ("The battery may comprise a lithium iron phosphate battery cell or a lithium cobalt oxide battery cell."), *see also* 2:47-51, 5:13-27, claims 4,7). It would have been obvious to one of skill in the art to combine the lithium ion battery packs disclosed

in Xinfang with Richardson as this would result in a smaller, more portable product, given the smaller size to energy capacity of lithium ion batteries. (EX1003 at ¶135).

C. Claim 10

As discussed above, Xinfang's USB port is described for the same type of jump starting device as Richardson, and USB charging devices were widely known and used at the time of the priority date. (EX1003 at ¶137). It would have been obvious to one of skill in the art to combine the USB ports disclosed in Xinfang with Richardson since these ports were widely known at the time. (EX1003 at ¶137).

D. Claims 12-14

For the same reasons as discussed above in regards to Ground 2, it would have been obvious to one of skill in the art to combine the LED flashlight circuits disclosed in Xinfang with the invention disclosed by Richardson as it provides a portable battery jump starter the ability to better observe connectors in the vehicle and LED flashlights were widely known at the time of the priority date of the '015 Patent. (EX1003 at ¶¶139-141).

E. Claim 15

Richardson discloses an LED which indicates a remaining battery capacity of the internal power supply. (EX1010 at ¶0014 ("If the voltage level of the jump starter batteries 22 drop below a value of twenty percent of the normal level, a charge battery LED 54 is illuminated.")). For similar reasons as addressed above in regard

to Ground 2, It would have been obvious to one of ordinary skill to combine the teachings of Richardson with those of Xinfang to include a plurality of visual indicators configured to display remaining capacity status of the internal battery so that the user can timely recharge the jump starter. (EX1003 at ¶¶143-144).

F. Claim 21 and 23

Richardson discloses a jumper cable device that is plugged into the starter system. (EX1010 at ¶0033). Xinfang also discloses a "vehicle ignition cable having a first end coupleable to the ignition output port and a second end coupleable to terminals of a vehicle battery." (EX1008 at 2:40-43; EX1003 at ¶146). Moreover, Xinfang discloses that "the user of the vehicle may unplug the vehicle ignition cable from the vehicle battery." (EX1008 at 5:67-6:3; EX1003 at ¶146). Finally, Xinfang also discloses output port 46 that contains a top portion and bottom portion that are shaped differently, where the top portion has a circular portion with flat side and the bottom portion is substantially circular so that an ignition cable will fit into the output port only in one specific orientation. (EX1008 at Fig. 2; EX1003 at ¶148). It would have been obvious to one of ordinary skill in the art to combine Xinfang's jumper cables and Xinfang's explicit recitation of an end coupleable to the output port (*i.e.*, a plug) with Richardson to provide a connection to the vehicle battery that is only couplable in the correct orientation. (EX1003 at ¶148).

IX. Conclusion

Claims 1-3, 5, 8-17, 19-21, and 23 of the '015 Patent are unpatentable over the prior art pursuant to Grounds 1-5 set forth above. Accordingly, Petitioner respectfully requests *inter partes* review of claims 1-3, 5, 8-17, 19-21, and 23. The grounds raised herein are meaningfully distinct and not redundant because the primary references relied upon, Zhang and Richardson, have materially different teachings with respect to the challenged claims. Ground 1 asserts unpatentability based upon anticipation and obviousness, Grounds 2-3 and 5 assert unpatentability based only upon obviousness, and Ground 4 asserts unpatentability based only upon anticipation. Grounds 1-3 each involve Zhang as the primary reference and have no overlapping claims. Grounds 4 and 5 have some overlapping claims with Grounds 1 and 2 but involves the materially distinct Richardson as the primary reference.

X. Grounds for Standing (37 C.F.R. § 42.104(a))

The undersigned and Shenzhen Mediateek Tong certify that the '015 Patent is available for *inter partes* review. Shenzhen Mediatek Tong certifies that it is not barred or estopped from requesting this *inter partes* review on the grounds identified herein. Petitioner waived service of the summons and complaint, establishing an effective service date of April 2, 2020, which the assignee of the '015 Patent, NOCO, filed with court on April 10, 2020. This petition is being filed within one year of service on Petitioner.

XI. Mandatory Notices (37 C.F.R § 42.8)

A. Real Party-In-Interest

Shenzhen Mediatek Tong Technology Co., Ltd. is the real party-in-interest.

B. Related Matters

The '015 Patent is the subject of the following civil actions:

The NOCO Company v. Shenzhen Mediatek Tong Technology Co. Ltd. et al., Case No. 1:19-cv-01855 (N.D. Ohio); *The NOCO Company v. Nekteck, Inc.*, Case No. 2:20-cv-01356 (S.D. Ohio); *The NOCO Company v. Medcursor, Inc.*, Case No. 2:20-cv-01358 (S.D. Ohio); *The NOCO Company v. Deltona Transformer Corporation*, Case No. 6:20-cv-00050 (M.D. Fla.); *The NOCO Company v. Sunvalleytek International, Inc.*, Case No. 5:19-cv-04907 (N.D. Cal.); *The NOCO Company v. TII Trading Inc., et al.*, Case No. 2:19-cv-07127 (C.D. Cal.); *The NOCO Company v. SmarTech Products, Inc.*, Case No. 1:18-cv-2789 (N.D. Ohio); *The NOCO Company v. Shenzhen Valuelink E-Commerce Co., Ltd.*, Case No. 1:17-cv-02210 (N.D. Ohio); *The NOCO Company v. Shenzhen ChangXinYang Technology Co. Ltd.*, Case No. 1:17-cv-02209 (N.D. Ohio).

C. Lead and Back-Up Counsel (37 C.F.R. § 42.8(b)(3))

Petitioner appoints Justin B. Kimble (Reg. No. 58,591) as its lead counsel and Jerry Tice (Reg. No. 73, 582) as its back-up counsel, all at the address: Bragalone

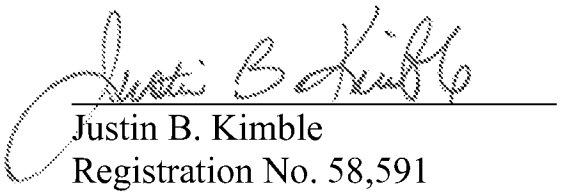
Conroy PC, 2200 Ross Avenue, Suite 4500W, Dallas, Texas 75201, phone number (214) 785-6670 and facsimile (214) 785-6680.

D. Service Information

Petitioner consents to electronic service by email at the email addresses: JKimble-IPR@bcpc-law.com and jtice@bcpc-law.com.

Dated: July 29, 2020

Respectfully submitted,



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Dallas, TX 75201
Phone: (214) 785-6670
Email: JKimble-IPR@bcpc-law.com

CERTIFICATE OF SERVICE ON PATENT OWNER

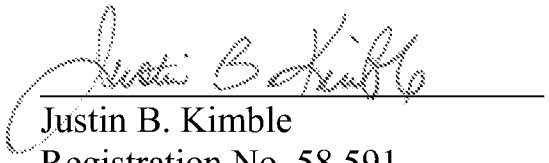
Pursuant to 37 C.F.R. § 42.6(e), the undersigned certifies that on July 29, 2020, a complete and entire copy of this Petition for *Inter Partes* Review of U.S. Patent No. 9,007,015, Petitioner's Power of Attorney, and all associated exhibits, were served via Federal Express, to the Patent Owner by serving the correspondence address of record for U.S. Patent No. 9,007,015:

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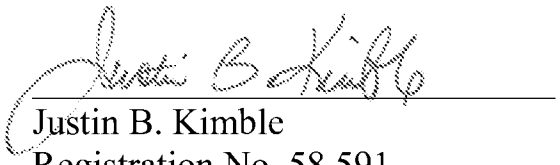
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CERTIFICATE OF COMPLIANCE

As required by 37 C.F.R. § 42.24(a), the undersigned hereby certifies that the foregoing Petition for *Inter Partes* Review contains 11,490 words, excluding those portions identified in 37 C.F.R. § 42.24(a)(1), as measured by the word-processing system used to prepare this paper.



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Espacenet

JP2012169161A CYLINDRICAL NONAQUEOUS ELECTROLYTE BATTERY AND METHOD FOR MANUFACTURING THE SAME

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Classifications:
IPC ***H01M10/052; H01M10/0566; H01M10/0587; H01M2/26;***

CPC Y02E60/10 (EP);

Priorities: JP2011029481A 2011-02-15

Application: JP2012169161A·2011-02-15

Publication: JP2012169161A·2012-09-06

Published as: JP2012169161A

CYLINDRICAL NONAQUEOUS ELECTROLYTE BATTERY AND METHOD FOR MANUFACTURING THE SAME

Abstract

PROBLEM TO BE SOLVED: To provide a method for manufacturing a cylindrical nonaqueous electrolyte battery, which can prevent weaving caused when winding an electrode group and can prevent cut of an electrode plate.SOLUTION: This manufacturing method includes winding a first electrode plate 21 to which a first electrode lead 210 is connected, a separator 27 and a second electrode plate 22 to which a second electrode lead 710 is connected. The first electrode lead 210 has a plate-like part and a round bar part. The plate-like part has a slip prevention structure formed therein for lowering sliding properties between the plate-like part and the separator 27. The manufacturing method also includes: protruding a peripheral part of the separator 27 from the first electrode plate 21 and the second electrode plate 22 in a width direction of the first electrode plate 21 and the second electrode plate 22 and positioning the round bar part to the outside of the peripheral part of the separator 27; and winding the first electrode plate 21, the separator 27 and the second electrode plate 22 while overlapping the peripheral part of the separator 27 on the slip prevention structure.

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2012-169161
(P2012-169161A)
(43)公開日　平成24年9月6日(2012.9.6)

(51)Int.Cl.		F I		テーマコード（参考）
H01M 10/0587	(2010.01)	H01M 10/00	118	5H029
H01M 2/26	(2006.01)	H01M 2/26	A	5H043
H01M 10/052	(2010.01)	H01M 10/00	102	
H01M 10/0566	(2010.01)	H01M 10/00	111	

審査請求 未請求　請求項の数 6　OL　（全 20 頁）

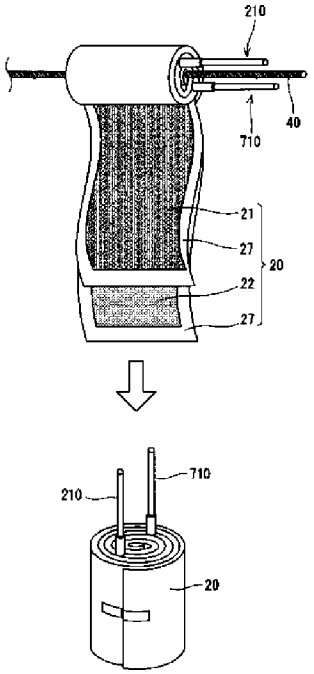
(21)出願番号　特願2011-29481 (P2011-29481)
(22)出願日　平成23年2月15日 (2011.2.15)

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(54)【発明の名称】円筒型非水電解液電池及びその製造方法

(57)【要約】　（修正有）
【課題】電極群を巻回する際の巻きずれ及び電極板の切れを防止できる円筒型非水電解液電池の製造方法を提供する。
【解決手段】第一電極リード２１０が接続された第一電極板２１、セパレータ２７及び第二電極リード７１０が接続された第二電極板２２を巻回する。第一電極リード２１０は、板状部と丸棒部とを有する。板状部には、当該板状部とセパレータ２７との間の摺動性を低下させるための滑り止め構造が形成されている。第一電極板２１及び第二電極板２２の幅方向に関して、セパレータ２７の周縁部を第一電極板２１及び第二電極板２２から突出させ、丸棒部をセパレータ２７の周縁部の外に位置させる。セパレータ２７の周縁部と滑り止め構造とを重ねつつ、第一電極板２１、セパレータ２７及び第二電極板２２を巻回する。
【選択図】図６



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【特許請求の範囲】
【請求項１】
リチウムイオンを吸蔵及び放出しうる第一活物質を含む第一電極板と、リチウムイオンを吸蔵及び放出しうる第二活物質を含み、前記第一電極板の極性と反対の極性を有する第二電極板と、前記第一電極板及び前記第二電極板よりも幅広のセパレータとを準備する工程と、
前記第一電極板及び前記第二電極板に第一電極リード及び第二電極リードをそれぞれ電気的に接続する工程と、
前記第一電極板及び前記第二電極板の幅方向に関して前記セパレータの周縁部が前記第一電極板及び前記第二電極板から突出し、前記第一電極板からの前記第一電極リードの突出方向が前記第二電極板からの前記第二電極リードの突出方向に一致するように、前記第一電極板、前記セパレータ及び前記第二電極板の相対的な位置関係を定める工程と、
巻かれた電極群を形成するように、前記第一電極板、前記セパレータ及び前記第二電極板を巻回する工程と、
前記第一電極リード及び前記第二電極リードが封口体を通じて円筒状の電池ケースの外部に延びるように、前記電極群を前記電池ケースに入れて前記電池ケースの開口部を前記封口体で閉じる工程と、を含み、
前記第一電極リードは、前記第一電極板に固定された板状部と、前記板状部と一体に形成された丸棒部とを有し、前記板状部の厚さ方向に関する前記第一電極リードの寸法が前記板状部と前記丸棒部との境界で不連続に変化しており、
前記板状部には、当該板状部と前記セパレータとの間の摺動性を低下させるための滑り止め構造が前記境界に隣接した位置に形成されており、
前記幅方向に関して前記丸棒部を前記セパレータの前記周縁部の外に位置させ、かつ、前記セパレータの前記周縁部を前記滑り止め構造に重ねつつ、前記巻回工程を実施する、円筒型非水電解液電池の製造方法。
【請求項２】
前記滑り止め構造が、前記板状部の表面及び裏面に形成されている、請求項１に記載の円筒型非水電解液電池の製造方法。
【請求項３】
前記滑り止め構造は、前記セパレータの外縁に平行な方向に沿って前記板状部の表面及び／又は裏面に形成された溝を含む、請求項１又は２に記載の円筒型非水電解液電池の製造方法。
【請求項４】
前記滑り止め構造は、前記板状部の表面及び／又は裏面に形成された凹凸を含む、請求項１又は２に記載の円筒型非水電解液電池の製造方法。
【請求項５】
前記第一電極板がその長手方向に関して一端及び他端を有し、
前記一端を前記長手方向に関する０％の位置、前記他端を前記長手方向に関する１００％の位置と定義したとき、
前記第一電極リードが前記長手方向に関して１０～３０％の範囲に位置するように、前記第一電極板に前記第一電極リードを接続する、請求項１～４のいずれか１項に記載の円筒型非水電解液電池の製造方法。
【請求項６】
リチウムイオンを吸蔵及び放出しうる第一活物質を含む第一電極板と、リチウムイオンを吸蔵及び放出しうる第二活物質を含み、前記第一電極板の極性と反対の極性を有する第二電極板と、前記第一電極板及び前記第二電極板よりも幅広のセパレータとを有する、巻かれた電極群と、
前記電極群を収容している円筒状の電池ケースと、
前記電池ケースの開口部を閉じている封口体と、
前記第一電極板に電気的に接続され、前記封口体を通じて円筒状の電池ケースの外部に

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延びている第一電極リードと、
前記第二電極板に電気的に接続され、前記封口体を通じて円筒状の電池ケースの外部に延びている第二電極リードと、を備え、
前記第一電極リードは、前記第一電極板に固定された板状部と、前記板状部と一体に形成された丸棒部とを有し、前記板状部の厚さ方向に関する前記第一電極リードの寸法が前記板状部と前記丸棒部との境界で不連続に変化しており、
前記板状部には、当該板状部と前記セパレータとの間の摺動性を低下させるための滑り止め構造が前記境界に隣接した位置に形成されており、
前記第一電極板及び前記第二電極板の幅方向に関して前記セパレータの周縁部が前記第一電極板及び前記第二電極板から突出し、
前記幅方向に関して前記丸棒部が前記セパレータの前記周縁部の外に位置し、かつ、前記セパレータの前記周縁部が前記滑り止め構造に重なっている、円筒型非水電解液電池。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、円筒型非水電解液電池及びその製造方法に関する。
【背景技術】
【０００２】
二次電池は、ノート型パソコンを始めとした様々なポータブル機器に使用されている。携帯性の向上、駆動時間の延長及び駆動の安定化の観点から、ポータブル機器向けの二次電池には、軽量化、エネルギー密度の向上及び信頼性の向上が求められる。
【０００３】
ポータブル機器向けの二次電池として、リチウムイオン二次電池が挙げられる。電極群を収容するための容器として、アルミニウム箔製の容器、及び金属製の角型容器が広く使用されている。
【０００４】
一方、エネルギー分野向けの二次電池には、金属製の円筒状容器が広く使用されている。金属製の円筒状容器を用いた二次電池は、一般的には、容器内に電極群を収容し、容器の開口部を封口板により封口することにより製造される。電極群に接続された２つのリード端子は、容器及び封口板にそれぞれ溶接される。封口板の構造は、比較的複雑で値段も高い。また、リードの溶接工程も面倒である。そこで、特許文献１の構造の電池が提案されている。
【０００５】
特許文献１には、図９に示すような円筒型非水電解液電池８８０が開示されている。円筒型非水電解液電池８８０は、電極群８２０、正極リード８１０、負極リード９１０、電池ケース８６０及び封口体８７０を備えている。電極群８２０は電池ケース８６０に収容されている。正極リード８１０及び負極リード９１０は丸棒部８１２及び９１２をそれぞれ有する。封口体８７０はゴム製であり、丸棒部８１２及び９１２を支持しながら電池ケース８６０の開口部を封口している。
【先行技術文献】
【特許文献】
【０００６】
【特許文献１】特開平１０－３０８２０６号公報
【発明の概要】
【発明が解決しようとする課題】
【０００７】
本発明の発明者らが、特許文献１に記載された円筒型非水電解液電池を作製したところ、次の不具合が生じた。具体的には、電極群を巻回するときに巻きずれが生じたり、正極板及び負極板が切れたりした。このような不具合は、電極群とリードとの相互干渉によるものと考えられる。

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【０００８】
本発明は上記従来の課題を鑑みてなされたもので、巻きずれ及び電極板の切れを防止できる円筒型非水電解液電池の製造方法と、当該製造方法によって製造された円筒型非水電解液電池を提供することを目的とする。
【課題を解決するための手段】
【０００９】
上記課題を解決するために、本発明は、
リチウムイオンを吸蔵及び放出しうる第一活物質を含む第一電極板と、リチウムイオンを吸蔵及び放出しうる第二活物質を含み、前記第一電極板の極性と反対の極性を有する第二電極板と、前記第一電極板及び前記第二電極板よりも幅広のセパレータとを準備する工程と、
前記第一電極板及び前記第二電極板に第一電極リード及び第二電極リードをそれぞれ電気的に接続する工程と、
前記第一電極板及び前記第二電極板の幅方向に関して前記セパレータの周縁部が前記第一電極板及び前記第二電極板から突出し、前記第一電極板からの前記第一電極リードの突出方向が前記第二電極板からの前記第二電極リードの突出方向に一致するように、前記第一電極板、前記セパレータ及び前記第二電極板の相対的な位置関係を定める工程と、
巻かれた電極群を形成するように、前記第一電極板、前記セパレータ及び前記第二電極板を巻回する工程と、
前記第一電極リード及び前記第二電極リードが封口体を通じて円筒状の電池ケースの外部に延びるように、前記電極群を前記電池ケースに入れて前記電池ケースの開口部を前記封口体で閉じる工程と、を含み、
前記第一電極リードは、前記第一電極板に固定された板状部と、前記板状部と一体に形成された丸棒部とを有し、前記板状部の厚さ方向に関する前記第一電極リードの寸法が前記板状部と前記丸棒部との境界で不連続に変化しており、
前記板状部には、当該板状部と前記セパレータとの間の摺動性を低下させるための滑り止め構造が前記境界に隣接した位置に形成されており、
前記幅方向に関して前記丸棒部を前記セパレータの前記周縁部の外に位置させ、かつ、前記セパレータの前記周縁部を前記滑り止め構造に重ねつつ、前記巻回工程を実施する、円筒型非水電解液電池の製造方法を提供する。
【００１０】
他の側面において、本発明は、
リチウムイオンを吸蔵及び放出しうる第一活物質を含む第一電極板と、リチウムイオンを吸蔵及び放出しうる第二活物質を含み、前記第一電極板の極性と反対の極性を有する第二電極板と、前記第一電極板及び前記第二電極板よりも幅広のセパレータとを有する、巻かれた電極群と、
前記電極群を収容している円筒状の電池ケースと、
前記電池ケースの開口部を閉じている封口体と、
前記第一電極板に電気的に接続され、前記封口体を通じて円筒状の電池ケースの外部に延びている第一電極リードと、
前記第二電極板に電気的に接続され、前記封口体を通じて円筒状の電池ケースの外部に延びている第二電極リードと、を備え、
前記第一電極リードは、前記第一電極板に固定された板状部と、前記板状部と一体に形成された丸棒部とを有し、前記板状部の厚さ方向に関する前記第一電極リードの寸法が前記板状部と前記丸棒部との境界で不連続に変化しており、
前記板状部には、当該板状部と前記セパレータとの間の摺動性を低下させるための滑り止め構造が前記境界に隣接した位置に形成されており、
前記第一電極板及び前記第二電極板の幅方向に関して前記セパレータの周縁部が前記第一電極板及び前記第二電極板から突出し、
前記幅方向に関して前記丸棒部が前記セパレータの前記周縁部の外に位置し、かつ、前

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記セパレータの前記周縁部が前記滑り止め構造に重なっている、円筒型非水電解液電池を提供する。

【００１１】

第一電極板が正極板のとき、第一電極リードが正極リードに相当し、第一活物質が正極活物質に相当し、第二電極板が負極板に相当し、第二電極リードが負極リードに相当し、第二活物質が負極活物質に相当する。第一電極板が負極板のとき、第一電極リードが負極リードに相当し、第一活物質が負極活物質に相当し、第二電極板が正極板に相当し、第二電極リードが正極リードに相当し、第二活物質が正極活物質に相当する。

【発明の効果】

【００１２】

本発明によれば、第一電極リードの寸法が板状部と丸棒部との境界で不連続に変化している。第一電極リードの板状部には、当該板状部とセパレータとの間の摺動性を低下させるための滑り止め構造が形成されている。幅方向に関して丸棒部をセパレータの周縁部の外に位置させ、かつ、セパレータの周縁部を滑り止め構造に重ねつつ、巻回工程を実施する。このようにすれば、セパレータの周縁部が第一電極リードから過度な荷重を受けたり、第一電極リードの表面を滑ったりすることを防止できる。そのため、電極群に過度な応力が加わることも防止できる。本発明によれば、巻きずれ及び電極板の切れを防止できる。また、本発明によれば、外部の振動などによる巻きずれが生じ難い電極群を有する円筒型非水電解液電池を提供することができる。

【図面の簡単な説明】

【００１３】

【図１】本発明の実施形態に係る円筒型非水電解液電池の断面図
【図２】図１に示す電池の電極群の分解斜視図
【図３Ａ】電極リードの製造方法を説明するためのフロー図（斜視）
【図３Ｂ】電極リードの製造方法を説明するためのフロー図（断面）
【図３Ｃ】滑り止め構造として凹凸が形成された電極リードの平面図
【図３Ｄ】滑り止め構造としてローレットが形成された電極リードの平面図
【図４Ａ】正極側のリード取付工程を説明するための斜視図
【図４Ｂ】負極側のリード取付工程を説明するための斜視図
【図４Ｃ】リード取付工程を説明するための、正極リード周辺の拡大斜視図
【図４Ｄ】リード取付工程を説明するための、負極リード周辺の拡大斜視図
【図５Ａ】積層工程を説明するための斜視図
【図５Ｂ】積層工程を説明するための、正極リード周辺の拡大斜視図
【図５Ｃ】積層工程を説明するための、負極リード周辺の拡大斜視図
【図６】巻回工程を説明するためのフロー図
【図７】収容工程を説明するためのフロー図
【図８】封口工程を説明するためのフロー図
【図９】従来の円筒型非水電解液電池の断面図

【発明を実施するための形態】

【００１４】

以下、図面を参照しつつ本発明の実施形態を説明する。

【００１５】

図１に示すように、本実施形態の円筒型非水電解液電池８０（以下、単に「電池８０」とも記載する）は、円筒状の電池ケース６０、電池ケース６０に収容された電極群２０、及び電池ケース６０の開口部に固定された封口体７０を備えている。電池８０は、典型的には、リチウムイオン二次電池である。

【００１６】

図２に示すように、電極群２０は、正極板２１、負極板２２及び２つのセパレータ２７で構成されている。正極板２１は、正極集電体２３及び正極活物質層２４で構成されている。負極板２２は、負極集電体２５及び負極活物質層２６で構成されている。セパレータ

２７は、それぞれ、正極板２１と負極板２２との間に配置されている。正極板２１には、電力取り出し用の正極リード２１０が電気的に接続されている。負極板２２には、電力取り出し用の負極リード７１０が電気的に接続されている。電極群２０は、渦状に巻かれており、全体として円筒の形を有している。電極群２０の巻回軸に関して、正極リード２１０は、負極リード７１０と向かい合っている。

【００１７】

図１に示すように、封口体７０には、貫通孔７０ａ及び７０ｂが形成されている。正極リード２１０は、貫通孔７０ａの中で封口体７０に保持されるように封口体７０の貫通孔７０ａに挿し込まれている。同様に、負極リード７１０は、貫通孔７０ｂの中で封口体７０に保持されるように封口体７０の貫通孔７０ｂに挿し込まれている。つまり、正極リード２１０及び負極リード７１０は、それぞれ、貫通孔７０ａ及び７０ｂを通って電池ケース６０の外部まで延びている。本実施形態では、電池ケース６０の高さ方向に関して、正極リード２１０の長さが、負極リード７１０の長さに一致している。

【００１８】

電池ケース６０の側部には、電池ケース６０の高さ方向に関して封口体７０の上面７０ｐと封口体７０の下面７０ｑとの間において、電極群２０の中心軸に向かう方向に突出しているかしめ部６０ａが設けられている。かしめ部６０ａは、円環の形状を有するように電池ケース６０の周方向に沿って形成されている。この構成によれば、封口体７０に対して、周方向に均一な圧縮荷重を付与できる。電池ケース６０の開口部には、Ｕ字状に曲げられたかしめ部６０ｂが設けられている。かしめ部６０ｂは、封口体７０の上面に接しており、これにより、電池ケース６０の中に押し込む方向の荷重を封口体７０に付与している。

【００１９】

なお、電池ケース６０の底部の空間、すなわち、電池ケース６０の底部と電極群２０との間に絶縁シートなどの他の部材が設けられていてもよい。同様に、封口体７０の下面７０ｑと電極群２０との間に絶縁シートなどの他の部材が設けられていてもよい。

【００２０】

次に、図１に示す電池８０の製造方法を説明する。

【００２１】

［部材準備工程］

まず、電池８０を構成する各部材を準備する。

【００２２】

（電極リード）

本実施形態では、図３Ａに示すように、ワークピース１０を加工することにより正極リード２１０を作製する。ワークピース１０として、既存の電極リードを使用できる。ワークピース１０は、板状部１１と、丸棒部１２と、先端部１３と、隆起部１４とを有する。

【００２３】

板状部１１は、帯状の形状を有する。図３Ａにおいて、板状部１１の長手方向は、ｘ方向に平行である。丸棒部１２は、円柱の形状を有する。丸棒部１２は、板状部１１に一体に形成されている。先端部１３は、線状の形状を有する。先端部１３は、板状部１１の反対側で丸棒部１２に溶接されている。

【００２４】

図３Ｂに示すように、隆起部１４は、板状部１１の厚さ方向（図３Ｂに示すｙ方向）に関するワークピース１０の寸法を、板状部１１と丸棒部１２との境界近傍領域において連続に変化させるように設けられている。

【００２５】

まず、ワークピース１０の隆起部１４を除去する。隆起部１４を除去する方法は限定されない。例えば、ヤスリで隆起部１４を削り取ればよい。隆起部１４を除去した後、板状部１１の厚さ方向に関するワークピース１１０の寸法は、板状部１１と丸棒部１２との境界で不連続に変化している。つまり、板状部１１の厚さd_1及び丸棒部１２の直径d_2は、

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それぞれ、一定であり、丸棒部１２の直径d_2は、板状部の厚さd_1よりも大きい。丸棒部１２は、例えば、板状部１１の厚さの２～１０倍の直径を有している。板状部１１の厚さd_1は、例えば、０．２～０．５ｍｍである。丸棒部１２の直径d_2は、例えば、０．４～５ｍｍである。ワークピース１１０の板状部１１及び丸棒部１２の各構造は、正極リード２１０に反映される。

【００２６】

次に、板状部１１に溝１１ａを形成する。溝１１ａは、板状部１１の幅方向（図３Ａに示すｚ方向）に延びている。幅方向とは、板状部１１の長手方向及び厚さ方向に直交する方向である。溝１１ａは、板状部１１の長手方向の摺動性を低下させる、すなわち、摩擦係数を高めるように作用する滑り止め構造を構成する。本実施形態では、溝１１ａを、板状部１１における、板状部１１と丸棒部１２との境界に隣接した位置に形成する。また、本実施形態では、溝１１ａを、板状部１１の表面及び裏面に形成する。このようにして、正極リード２１０を作製する。

【００２７】

なお、本実施形態では、複数の溝１１ａを形成している。しかし、溝１１ａは、１つの溝であってもよい。また、溝１１ａの具体的な寸法は限定されない。例えば、溝１１ａの深さは０．０５～０．１ｍｍとすればよい。また、溝１１ａは、幅方向全体に形成することが好ましい。つまり、溝１１ａの一端が板状部１１の一方の側面に位置し、溝１１ａの他端が板状部１１の他方の側面に位置していてもよい。このようにすれば、板状部１１の側面によってもセパレータ２７を捕らえることができる。

【００２８】

また、単一の工程で、隆起部１４の除去と、溝１１ａの形成とを実施してもよい。例えば、隆起部１４にヤスリを接触させ、ヤスリを幅方向に動かすことにより、隆起部１４の除去と、溝１１ａの形成の双方を実施できる。このようにすれば、単一の工程でワークピース１０から正極リード２１０が得られる。したがって、加工コストを抑制できる。

【００２９】

また、ワークピース１０としては、市販の電極リードを用いればよい。また、本実施形態では、ワークピース１０を加工して正極リード２１０を作製しているが、本発明はこれに限定されない。例えば、原材料から直接正極リード２１０を作製してもよい。具体的には、まず、丸棒部１２の直径と同じ直径を有する線材を準備する。次に、線材を適切な長さに切断する。次に、板状部１１が形成されるように、切断された線材をプレス加工する。次に、プレス加工によってできた隆起部１４を研削、研磨などの加工方法で除去する。最後に、先端部１３を丸棒部１２に溶接すればよい。

【００３０】

また、本実施形態では、溝１１ａにより滑り止め構造を構成している。溝１１ａによる滑り止め構造は、板状部１１の長手方向の摺動性を低下させる点で優れている。しかし、他の態様で滑り止め構造を構成してもよい。例えば、凹凸、ローレット、突起又はノッチにより滑り止め構造を構成してもよい。図３Ｃに示すような、凹凸１１ｂにより構成された滑り止め構造は、板状部１１の厚さ方向に垂直な全ての方向の摺動性を低下させる点で優れている。凹凸１１ｂは、例えば、板状部１１の表面を粗すことで形成できる。なお、図３Ｃでは、凹凸１１ｂは目視可能な大きさの凹凸であるが、凹凸１１ｂは、目視できない粗面であってもよい。また、図３Ｄに示すような、ローレット１１ｃにより構成された滑り止め構造も、凹凸１１ｂにより構成された滑り止め構造と同様の点で優れている。ローレット１１ｃは、例えば、板状部１１における滑り止め構造を形成すべき部分に対してダイスを強く押し当てることにより、当該部分を塑性変形させることで形成できる。また、突起により構成された滑り止め構造も、板状部１１の摺動性を低下させる点で優れている。また、ノッチにより滑り止め構造は、セパレータ２７の破損を抑制しつつ板状部１１の摺動性を低下させる点で優れている。

【００３１】

本実施形態において、負極リード７１０は、正極リード２１０と同じ構造を有している

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。そのため、負極リード７１０も正極リード２１０と同じ方法で作製できる。図３Ａ及び図３Ｂに示すように、リード作製工程では、ワークピース５１０から隆起部５１４を除去する。隆起部５１４が除去されたワークピース６１０に溝５１１ａを形成することにより負極リード７１０が得られる。負極リード５１０は、板状部５１１、丸棒部５１２及び先端部５１３を有する。板状部５１１の表面及び／又は裏面には、滑り止め構造としての溝５１１ａが形成されている。

【００３２】

正極リード２１０及び負極リード７１０の材料としては、例えば、アルミニウム、アルミニウム合金、ニッケル、ニッケル合金、銅、銅合金、ステンレスが挙げられる。負極リード７１０は、正極リード２１０と同じ材料でできていてもよいし、異なる材料でできていてもよい。正極リード２１０において、板状部１１及び丸棒部１２は、基本的には、同じ材料でできている。先端部１３は、板状部１１及び丸棒部１２と同じ材料でできていてもよいし、異なる材料でできていてもよい。このことは、負極リード７１０についても同じである。

【００３３】

（正極板）

まず、正極活物質及び任意の材料を混練することにより正極合剤を作製する。任意の材料には、溶媒、導電助剤、結着剤などが含まれる。次に、正極合剤を正極集電体２３に塗布する。塗布された正極合剤を乾燥させることにより、正極集電体２３の上に正極活物質層２４が形成される。次に、所定の厚さの正極板２１が形成されるように、正極集電体２３及び正極活物質層２４を圧延する。その後、正極板２１を所定の寸法に切断する。これにより、帯状の正極板２１が得られる。なお、正極集電体２３の両面に正極合剤を塗布してもよいし、正極集電体２３の片面に正極合剤を塗布してもよい。

【００３４】

正極集電体２３は、導電性を有するシート状の部材であり、典型的には金属箔で構成されている。金属箔に代えて、多数の孔を有する部材（金属メッシュ、パンチングメタル、エキスパンドメタル）も使用できる。正極集電体２３の材料としては、アルミニウム、アルミニウム合金などの金属が挙げられる。

【００３５】

正極活物質としては、リチウムイオンを吸蔵及び放出しうる材料を使用できる。このような正極活物質としては、二酸化マンガン（MnO_2）、リチウムマンガン複合酸化物（例えば$Li_xMn_2O_4$又はLi_xMnO_2）、リチウムニッケル複合酸化物（例えばLi_xNiO_2）、リチウムコバルト複合酸化物（例えばLi_xCoO_2）、リチウムニッケルコバルト複合酸化物（例えば$LiNi_{1-y}Co_yO_2$）、リチウムマンガンコバルト複合酸化物（例えば$Li_xMn_yCo_{1-y}O_2$）、スピネル型リチウムマンガンニッケル複合酸化物（$Li_xMn_{2-y}Ni_yO_4$）、オリビン構造を有するリチウムリン酸化物（Li_xFePO_4）などの酸化物が挙げられる。上記化学式の「ｘ」及び「ｙ」は、それぞれ、０～１の範囲の値をとりうる。好ましい正極活物質としては、リチウムマンガン複合酸化物、リチウムニッケル複合酸化物、リチウムコバルト複合酸化物、リチウムニッケルコバルト複合酸化物、スピネル型リチウムマンガンニッケル複合酸化物、リチウムマンガンコバルト複合酸化物、リチウムリン酸鉄が挙げられる。これらは、金属リチウムの電位に対して例えば３．０Ｖ以上５．０Ｖ以下の充放電電位を有する。

【００３６】

導電助剤としては、アセチレンブラック、カーボンブラック、黒鉛などの炭素材料を使用できる。結着剤としては、ポリテトラフルオロエチレン（ＰＴＦＥ）、ポリフッ化ビニリデン（ＰＶｄＦ）、カルボキシメチルセルロース（ＣＭＣ）、フッ素ゴム、スチレンブタジエンゴム（ＳＢＲ）などの樹脂材料を使用できる。

【００３７】

（負極板）

まず、負極活物質及び任意の材料を混練することにより負極合剤を作製する。任意の材

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料には、溶媒、導電助剤、結着剤などが含まれる。次に、負極合剤を負極集電体２５に塗布する。塗布された負極合剤を乾燥させることにより、負極集電体２５の上に負極活物質層２６が形成される。次に、所定の厚さの負極板２２が形成されるように、負極集電体２５及び負極活物質層２６をプレスする。その後、負極板２２を所定の寸法に切断する。これにより、帯状の負極板２２が得られる。なお、負極集電体２５の両面に負極合剤を塗布してもよいし、負極集電体２５の片面に負極合剤を塗布してもよい。

【００３８】

負極集電体２５も、導電性を有するシート状の部材であり、典型的には金属箔で構成されている。金属箔に代えて、多数の孔を有する部材（金属メッシュ、パンチングメタル、エキスパンドメタル）も使用できる。負極集電体２５の材料としては、ニッケル、ニッケル合金、銅、銅合金、アルミニウム、アルミニウム合金などの金属が挙げられる。

【００３９】

負極活物質としては、リチウムイオンを吸蔵及び放出しうる材料を使用できる。好ましい負極活物質としては、例えば、金属リチウム、リチウム合金、リチウムチタン複合酸化物（例えば$Li_4Ti_5O_{12}$）、リチウムイオンを吸蔵及び放出しうる炭素材料、リチウムと合金を形成しうる材料（いわゆる合金系活物質）などが挙げられる。炭素材料としては、グラファイトが挙げられる。合金系活物質としては、スズ、スズ合金、シリコン及びシリコン合金が挙げられる。充放電効率及びサイクル寿命の観点から、炭素材料又はリチウムチタン複合酸化物を好適に使用できる。

【００４０】

なお、負極板２２が有する負極活物質の電位が金属リチウムの電位よりも１．０Ｖ以上高い場合は、負極集電体２５の材料としてアルミニウム又はアルミニウム合金を用いることが好ましい。これにより、電池ケース６０の材料として、後述の理由で好適なアルミニウム又はアルミニウム合金を用いることができる。すなわち、アルミニウム又はアルミニウム合金で構成された電池ケース６０に負極板が触れると、電池ケース６０の溶出することがあるが、このような負極板２２によれば、電池ケース６０の溶出を防ぐことができる。

【００４１】

金属リチウムの電位に対して１．０Ｖ以上高い電位を有する負極活物質として、リチウムとチタンとを含む複合酸化物が挙げられる。具体的には、化学式$Li_{4+x}Ti_5O_{12}$（$0 \leqq x \leqq 3$）で表され、スピネル型構造を有するチタン酸リチウムが挙げられる。チタン酸リチウムを負極板２２に使用すると、負極板２２の柔軟性は損なわれることがある。柔軟性に乏しい電極板は、巻回時に切れやすい。したがって、チタン酸リチウムを負極活物質として使用する場合、本実施形態の方法が特に推奨される。

【００４２】

負極板２２の結着剤及び導電助剤としては、正極板２１と同じものを使用できる。

【００４３】

（セパレータ）

本実施形態では、正極板２１及び負極板２２よりも幅広である帯状の２つのセパレータ２７を準備する。すなわち、セパレータ２７の短辺は、正極板２１の短辺及び負極板２２の短辺よりも長い。また、本実施形態では、セパレータ２７の長辺は、正極板２１の長辺及び負極板２２の長辺よりも長い。

【００４４】

セパレータ２７としては、例えば、多孔質フィルム、不織布などが挙げられる。多孔質フィルムとしては、ポリエチレン又はポリプロピレンでできたものなどが挙げられる。不織布としては、セルロース又はポリビニルアルコール（ＰＶＡ）でできたものなどが挙げられる。

【００４５】

（非水電解質）

本実施形態では、電解質と有機溶媒とを含む液状の非水電解質を準備する。有機溶媒と

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しては、エチレンカーボネート（ＥＣ）、プロピレンカーボネート（ＰＣ）、ビニレンカーボネート（ＶＣ）などの環状カーボネートが挙げられる。また、ジメチルカーボネート（ＤＭＣ）、メチルエチルカーボネート（ＭＥＣ）、ジエチルカーボネート（ＤＥＣ）などの鎖状カーボネート、テトラヒドロフラン（ＴＨＦ）、２メチルテトラヒドロフラン（２ＭｅＴＨＦ）などの環状エーテル、ジメトキシエタン（ＤＭＥ）などの鎖状エーテル、アセトニトリル（ＡＮ）、スルホラン（ＳＬ）などを使用してもよい。これらの有機溶媒は、単独又は２種以上の混合物の形態で使用できる。

【００４６】

電解質としては、過塩素酸リチウム（$LiClO_4$）、六フッ化リン酸リチウム（$LiPF_6$）、四フッ化ホウ酸リチウム（$LiBF_4$）などのリチウム塩が挙げられる。化学的安定性と高誘電率化の観点から、六フッ化リン酸リチウム（$LiPF_6$）を主たる電解質として用いることが好ましい。「主たる電解質」とは、モル比にて最も多く含まれた電解質を意味する。電解質は、有機溶媒に対して、例えば０．５～２．０ｍｏｌ／Ｌの濃度で溶解している。

【００４７】

（電池ケース）

本実施形態では、底部と開口部とを有する円筒形の電池ケース６０を準備する。電池ケース６０の材料としては、軽量で、加工性に優れる金属材料が好ましい。また、後述のように封口体７０をかしめるために、かしめ強度を高め易い金属材料の中から選択することが好ましい。軽量で加工性に優れた金属材料としては、アルミニウム及びアルミニウム合金などが挙げられる。かしめ強度を高め易い金属材料としては、Ｃｕ、Ｍｎ、Ｓｉなどの元素を微量添加したアルミニウム合金が挙げられる。もちろん、ステンレスなどの他の金属材料も使用できる。

【００４８】

（封口体）

本実施形態では、弾性材料（エラストマー）により構成された円柱状の封口体７０を準備する。封口体７０には貫通孔７０ａ及び７０ｂが設けられている。封口体７０の材料としては、例えば、エチレンプロピレンジエンゴム（ＥＰＤＭ）、イソブチレンイソプレンゴム（ＩＩＲ）、ブタジエンスチレンゴム（ＳＢＲ）が挙げられる。貫通孔７０ａ及び７０ｂの内径は、例えば、０．２～４．９ｍｍである。

【００４９】

以上の部材を準備した後に、下記の工程により電池８０を組み立てる。

【００５０】

［リード取付工程］

まず、図４Ａに示すように、正極板２１に正極リード２１０を電気的に接続する。具体的には、正極集電体２３に正極リード２１０の板状部１１を溶接によって固定する。溶接の方法としては、抵抗溶接、超音波溶接などが挙げられる。正極板２１と同様の方法で、図４Ｂに示すように、負極板２２に負極リード７１０を電気的に接続する。

【００５１】

本実施形態では、正極リード２１０の溝１１ａが、正極板２１に重なり合わないように、正極リード２１０と正極板２１とを接続する（図４Ｃ参照）。すなわち、正極板２１の幅方向に関して板状部１１の一部が正極板２１から突出するように正極リード２１０を正極板２１に接続する。板状部１１には、正極板２１から突出した部分にのみ溝１１ａ（滑り止め構造）が形成されている。同様に、負極リード７１０の溝５１１ａが、負極板２２に重なり合わないように、負極リード７１０と負極板２２とを接続する（図４Ｄ参照）。負極板２２及び負極リード７１０にも正極板２１及び正極リード２１０と同じ位置関係が採用されている。

【００５２】

また、本実施形態では、正極板２１の長手方向（図４Ｃに示すｚ方向）の一端を０％の位置、他端を１００％の位置と定義したとき、正極リード２１０が正極板２１の長手方向

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に関して１０～３０％の範囲に位置するように、正極リード２１０を正極板２１に接続する。同様に、負極板２２の長手方向（図４Ｄに示すｚ方向）の一端を０％の位置、他端を１００％の位置と定義したとき、負極リード７１０が負極板２２の長手方向に関して１０～３０％の範囲に位置するように、負極リード７１０を負極板２２に接続する。これにより、後述の巻回工程後に、正極リード２１０及び負極リード７１０が適切な位置に配置される。

【００５３】

［積層工程］

次に、図５Ａに示すように、正極板２１、１対のセパレータ２７及び負極板２２の相対的な位置関係を定める。具体的には、セパレータ２７、負極板２２、セパレータ２７、正極板２１の順にこれらを配置する。このようにして、電極群２０、正極リード２１０及び負極リード７１０を有する積層体３０を形成する。

【００５４】

積層工程では、以下の関係を満たすように各部材の相対的な位置を調節する。すなわち、図５Ｂ及び図５Ｃに示すように、正極板２１及び負極板２２の幅方向（図５Ｂ及び図５Ｃに示すｘ方向）に関して、セパレータ２７の周縁部２７ａが、正極板２１及び負極板２２から突出している。正極板２１からの正極リード２１０の突出方向（図５Ｂ及び図５Ｃに示すｘ方向）は、負極板２２からの負極リード７１０の突出方向に一致している。正極板２１及び負極板２２の幅方向に関して、丸棒部１２の全部及び丸棒部５１２の全部が、周縁部２７ａの外に位置している。正極リード２１０の溝１１ａは、セパレータ２７の周縁部２７ａに重なっている。負極リード７１０の溝５１１ａも、セパレータ２７の周縁部２７ａに重なっている。厳密には、溝１１ａは周縁部２７ａのみと重なり合っている。同様に、溝５１１ａは周縁部２７ａのみと重なり合っている。

【００５５】

なお、本実施形態では、溝１１ａが板状部１１と丸棒部１２との境界に隣接した位置に形成されている。板状部１１と丸棒部１２との境界に隣接した位置とは、詳細には、板状部１１と丸棒部１２との境界からその境界に最も近い正極板２１の外縁までの領域に含まれた位置、又は、板状部１１と丸棒部１２との境界からその境界に最も近い負極板２２の外縁までの領域に含まれた位置を意味する。より詳細には、板状部１１と丸棒部１２との境界に隣接した位置とは、板状部１１と丸棒部１２との境界からその境界に最も近い正極板２１の外縁までの領域に含まれ、かつ、板状部１１と丸棒部１２との境界からその境界に最も近い負極板２２の外縁までの領域に含まれた位置を意味する。

【００５６】

［巻回工程］

次に、図６に示すように、積層体３０を巻回する。具体的には、まず、巻芯４０の軸方向が積層体３０の短手方向に沿うように、積層体３０の端部に巻芯４０を接続する。次に、セパレータ２７の周縁部２７ａを溝１１ａ及び５１１ａに重ねつつ、巻芯４０を軸にして積層体３０を巻回する。これにより、巻かれた電極群２０が得られる。

【００５７】

比較の形態として、正極リード及び負極リードとして、図３Ａのワークピース１０のような、隆起部を有する電極リードを用い、隆起部がセパレータに接触するように積層体を作製した場合を想定する。このような積層体を巻回すると、隆起部の外周側に巻回されたセパレータが巻回軸に平行な方向にずれ易い。したがって、巻きずれが生じたり、正極板及び負極板がねじれたり、正極板及び負極板の強度が弱い箇所が切れたりする。

【００５８】

これに対し、本実施形態によれば、板状部１１の厚さ方向に関する正極リード２１０の寸法は、板状部１１と丸棒部１２との境界で不連続に変化している。さらに、本実施形態では、正極板２１の幅方向に関して、丸棒部１２が、セパレータ２７の周縁部２７ａの外に位置する。したがって、積層体３０を巻回するときに丸棒部１２がセパレータ２７に接しない。すなわち、本実施形態では、セパレータ２７が巻回軸に平行な方向にずれる要因

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が取り除かれている。正極板２１、負極板２２及びセパレータ２７は、巻回軸に平行に保たれる。これにより、積層体３０を巻回するときに巻きずれ並びに正極板２１及び負極板２２の切れを防止できる。

【００５９】

さらに、本実施形態では、正極リード２１０の溝１１ａがセパレータ２７の周縁部２７ａに重なっている。溝１１ａは、セパレータ２７の外縁に平行な方向に延びている。これにより、セパレータ２７と正極リード２１０との間の摺動性を低下させることができる。特に、巻回軸に平行な方向に関して、セパレータ２７を滑りにくくすることができる。したがって、積層体３０を巻回するときに巻きずれ並びに正極板２１及び負極板２２の切れをより効果的に防止できる。

【００６０】

また、溝１１ａは、セパレータ２７の周縁部２７ａのみと重なっている。したがって、セパレータ２７が、正極リード２１０の溝１１ａと正極板２１との間に挟まれることがない。これにより、積層体３０を巻回するときに、溝１１ａからセパレータ２７に過剰な圧力が加わることを防止できる。したがって、積層体３０を巻回するときに、セパレータ２７が破れ難い。これにより、セパレータ２７が破れることによって生じる電気的短絡を防ぐことができる。

【００６１】

なお、本実施形態では、溝１１ａが板状部１１の表面及び裏面に形成されているので、セパレータ２７の滑りをより確実に防止できる。ただし、板状部１１の片面にのみ溝１１ａを形成しても、巻きずれ並びに正極板２１及び負極板２２の切れの防止効果を得ることができる。

【００６２】

本実施形態において、負極リード７１０は正極リード２１０と同じ構造を有しており、負極リード７１０とセパレータ２７との位置関係も正極リード２１０とセパレータ２７との位置関係と同じように設定されている。したがって、上述した効果は、負極リード７１０についても得られる。

【００６３】

本実施形態では、正極リード２１０及び負極リード７１０の両方がセパレータ２７の滑りを防止するための構成を有している。しかし、正極リード２１０と負極リード７１０のいずれか一方のみを上記のように構成しても、巻きずれ並びに正極板２１及び負極板２２の切れを防止できる。

【００６４】

一般的な円筒型二次電池では、リードの厚みは１００μｍ程度なので、リードに起因した巻きずれ及び電極板の切れは起こり難い。

【００６５】

これに対し、図９を参照して説明した電池８８０では、正極板の中間部に正極リードが固定されている。同様に、負極板の中間部に負極リードが固定されている。すなわち、電極群を巻回したとき、正極リード及び負極リードが電極群に巻き込まれる。そのため、巻きずれ並びに正極板及び負極板の切れが本質的に発生し易い。本実施形態では、上記したような構成を採用しているので、正極リード２１０及び負極リード７１０が電極群２０に巻き込まれたとしても、巻きずれ並びに正極板２１及び負極板２２の切れを防止できる。

【００６６】

［収容工程］

次に、図７に示すように、電極群２０を電池ケース６０に収容する。電極群２０を電池ケース６０に収容したら、非水電解液（図示せず）を電池ケース６０に注入する。

【００６７】

［封口工程］

次に、図８に示すように、電池ケース６０の開口部を封口体７０により封口する。具体的には、正極リード２１０及び負極リード７１０が封口体７０に設けられた貫通孔７０ａ

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及び７０ｂからそれぞれ電池ケース６０の外部に延びるように封口する。本実施形態では、丸棒部１２及び丸棒部５１２が、貫通孔７０ａ及び７０ｂの中で封口体７０から押圧力を受けて支持される。

【００６８】

次に、電池ケース６０をかしめて、封口体７０を固定する。具体的には、電池ケース６０に、かしめ部６０ａと、かしめ部６０ｂとを形成する。かしめ部６０ａは、電池ケース６０の側面を中心方向に向かって凹ませて形成する。また、かしめ部６０ｂは、電池ケース６０の開口側の端部を、中心方向に向かうＵ字状に折り曲げて形成する。

【００６９】

封口体７０の具体的な寸法は限定されないが、封口体７０の直径は、封口体７０が電池ケース６０の開口部を密閉するように、電池ケース６０の内径よりもある程度大きいことが好ましい。また、封口体７０が有する貫通孔７０ａ及び７０ｂの内径は、封口体７０と丸棒部１２及び丸棒部５１２とが密着するように、丸棒部１２及び丸棒部５１２の直径よりもある程度小さいことが好ましい。

【００７０】

このようにして作製された電池８０は、外部の振動などによる電極群２０における巻きずれが発生し難い。したがって、電池８０の信頼性は高い。また、電池８０は、電極群２０に接触すると巻きずれを引き起こす隆起部を省略できる。また、隆起部を省略すると、正極リード２１０の板状部１１と丸棒部１２との境界がセパレータ２７の長辺に一致するように、正極リード２１０とセパレータ２７との位置関係を設定することもできる。負極リード７１０とセパレータ２７との位置関係も同様に設定することができる。したがって、本実施形態によれば、電池８０を、小型化できる（すなわち、高エネルギー密度化できる）。

【実施例】

【００７１】

（実施例）

まず、正極リード、負極リード、正極板、負極板、及びセパレータを準備した。

【００７２】

正極リードを図３Ａを参照して説明した方法で作製した。まず、ワークピースとして、コンデンサ用リード（ニューセントラル社製Ｌ３Ｗ２０３２８ＦＷＰＳ）を準備した。次に、このワークピースの隆起部をやすりで削り取った。次に、ワークピースの板状部における丸棒部側の端部２ｍｍの領域の表面及び裏面をやすりで削った。これにより、幅方向（図３Ａに示すｚ方向）に延びる溝を形成した。このようにして正極リードを作製した。また、同様にして負極リードを作製した。

【００７３】

正極板は、下記のように作製した。まず、正極活物質と、導電助剤と、結着剤と、溶媒とを、双腕式練合機で撹拌、混練して、正極合剤を作製した。正極活物質としては、コバルト酸リチウムを用いた。導電助剤としては、正極活物質１００重量部に対して２重量部のアセチレンブラックを用いた。結着剤としては、正極活物質１００重量部に対して２重量部のポリフッ化ビニリデンを用いた。溶媒としては、正極合剤の固形分濃度を５０％程度にするのに適量のＮ－メチル－２－ピロリドンを用いた。

【００７４】

次に、厚さ１５μｍのアルミニウム箔でできた正極集電体の表面及び裏面に上記の正極合剤を塗布した。塗布した正極合剤を乾燥させ、正極集電体の上に正極活物質層を形成した。その後、正極集電体及び正極活物質層を圧延し、得られた正極板を所定の寸法に切断した。このようにして、幅４２ｍｍ、長さ５８０ｍｍ、片面側の正極活物質層の厚さが５０μｍの正極板を作製した。なお、この幅は、円筒型電池の正極板の幅の規定値である。

【００７５】

負極板は、下記のように作製した。まず、負極活物質と、導電助剤と、結着剤と、溶媒とを、双腕式練合機で撹拌、混練して、負極合剤を作製した。負極活物質としては、リチ

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ウムチタン複合酸化物（$Li_4Ti_5O_{12}$）を用いた。導電助剤としては、負極活物質１００重量部に対して４重量部の気相成長法炭素繊維（ＶＧＣＦ：Vapor Grown Carbon Fiber）を用いた。結着剤としては、負極活物質１００重量部に対して５重量部のポリフッ化ビニリデンを用いた。溶媒としては、負極合剤の固形分濃度を５０％程度にするのに適量のＮ－メチル－２－ピロリドンを用いた。

【００７６】

次に、厚さ１５μｍのアルミニウム箔でできた負極集電体の表面及び裏面に上記の負極合剤を塗布した。塗布した負極合剤を乾燥させ、負極集電体の上に負極活物質層を形成した。その後、負極集電体及び負極活物質層を圧延し、得られた負極板を所定の寸法に切断した。このようにして、幅４０ｍｍ、長さ５４０ｍｍ、片面側の負極合剤層の厚さが１００μｍの負極板を作製した。なお、この幅は、円筒型電池の負極板の幅の規定値である。

【００７７】

セパレータとしては、厚さ２５μｍ、幅４４ｍｍ、長さ６００ｍｍの寸法を有するセルロースフィルム（ニッポン高度紙工業社製）を用いた。

【００７８】

次に、正極リードを正極集電体に溶接した。具体的には、正極板の長手方向（図４Ａのｚ方向）の一端から他端に向かって１１０ｍｍの位置に正極リードを溶接した。丸棒部と板状部との境界が正極板の長辺の外に（すなわち図４Ｃのｘの正方向に）１ｍｍ突出するように正極リードと正極板との位置関係を設定した。

【００７９】

次に、負極リードを負極集電体に溶接した。具体的には、負極板の長手方向（図４Ｂのｚ方向）の一端から他端に向かって９５ｍｍの位置に負極リードを溶接した。丸棒部と板状部との境界が負極板の長辺の外に（すなわち図４Ｄのｘの正方向に）２ｍｍ突出するように負極リードと負極板との位置関係を設定した。

【００８０】

溶接には、超音波溶着機（日本エマソン社製メタルウェルダ２０００ｅａ型）を用いた。また、ウェルドタイムは０．１秒に、振幅は８０％に、それぞれ設定した。

【００８１】

次に、セパレータ、負極板、セパレータ及び正極板の順にこれらを配置し、電極群、正極リード及び負極リードを有する積層体を形成した。セパレータの幅方向（図５Ａに示すｘ方向）に関して、２つのセパレータが負極板の外に２ｍｍ突出するように２つのセパレータと負極板との位置関係を設定した。同様に、セパレータの幅方向に関して、２つのセパレータが正極板の外に１ｍｍ突出するように２つのセパレータと正極板との位置関係を設定した。すなわち、本実施例では、正極リードにおける丸棒部と板状部との境界、負極リードにおける丸棒部と板状部との境界、および２つのセパレータの長辺が一致するように、正極板、負極板、および２つのセパレータの位置関係を設定した。

【００８２】

次に、積層体の長手方向の一端に巻芯を取り付けた。そして、巻回機を用いて１０Ｎ程度の張力をかけながら積層体を巻回し、巻かれた電極群を得た。最後に、電極群の最外周を粘着テープで固定した。

【００８３】

（比較例）

正極リード及び負極リードとして図３Ａの電極リードが有するような隆起部を有するコンデンサ用リード（ニューセントラル社製Ｌ３Ｗ２０３２８ＦＷＰＳ）を用いた。また、隆起部とセパレータとが重なるように積層体を作製した。それ以外は実施例と同様にして電極群を作製した。

【００８４】

［評価］

実施例の電極群と比較例の電極群とを目視により比較した。実施例の電極群には、巻きずれ並びに正極板及び負極板の切れが発生していなかった。一方、比較例の電極群には、

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巻きずれ並びに正極板及び負極板の切れが発生していた。

【産業上の利用可能性】

【００８５】

本発明は、エネルギー分野向けの二次電池、例えば、一般家庭用の二次電池に適用できる。

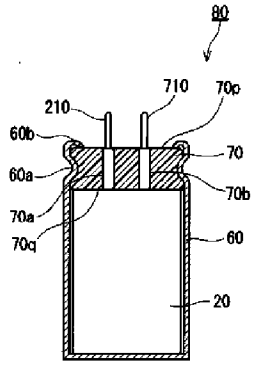
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【００８６】

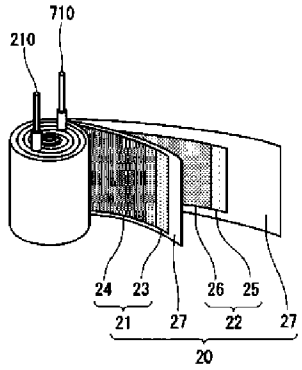
１０，５１０，１１０，６１０　ワークピース
１１，５１１　板状部
１１ａ，５１１ａ　溝（滑り止め構造）
１１ｂ　凹凸（滑り止め構造）
１１ｃ　ローレット（滑り止め構造）
１２，５１２　丸棒部
１３，５１３　先端部
１４，５１４　隆起部
２０　電極群
２１　正極板
２２　負極板
２３　正極集電体
２４　正極活物質層
２５　負極集電体
２６　負極活物質層
２７　セパレータ
２７ａ　周縁部
３０　積層体
４０　巻芯
６０　電池ケース
６０ａ，６０ｂ　かしめ部
７０　封口体
７０ａ，７０ｂ　貫通孔
７０ｐ　上面
７０ｑ　下面
８０　円筒型非水電解液電池
２１０　正極リード
７１０　負極リード

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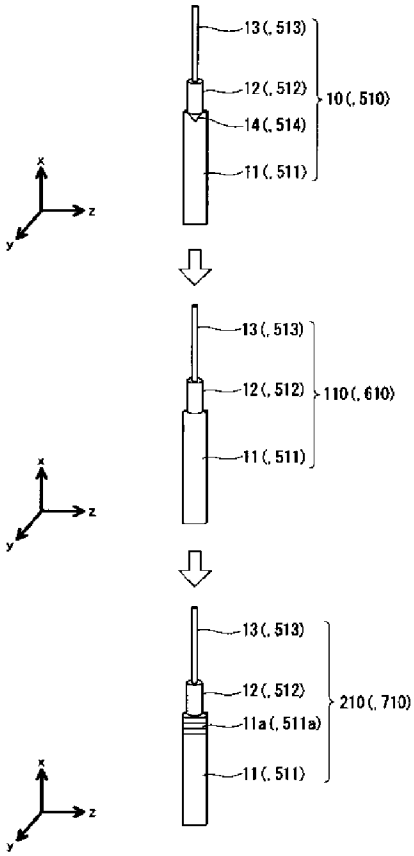
【図１】



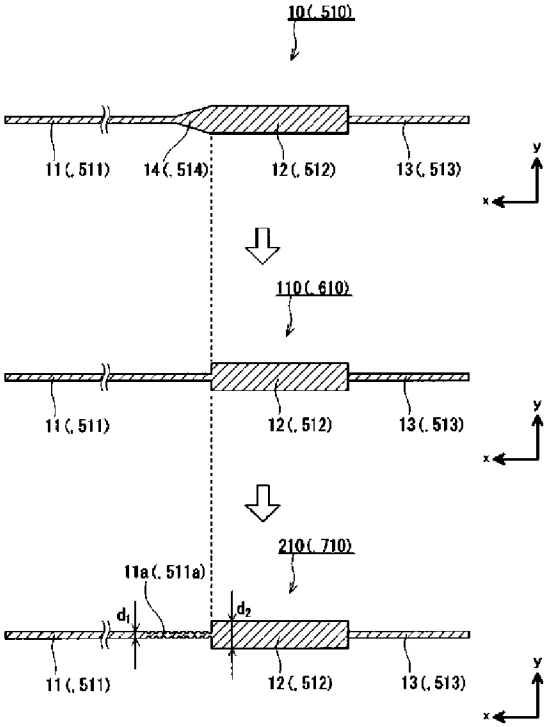
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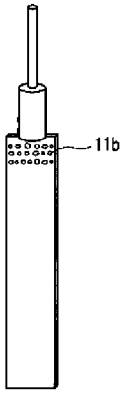
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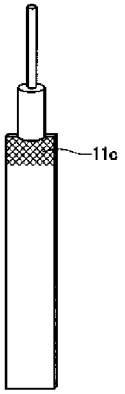
【図３Ｂ】



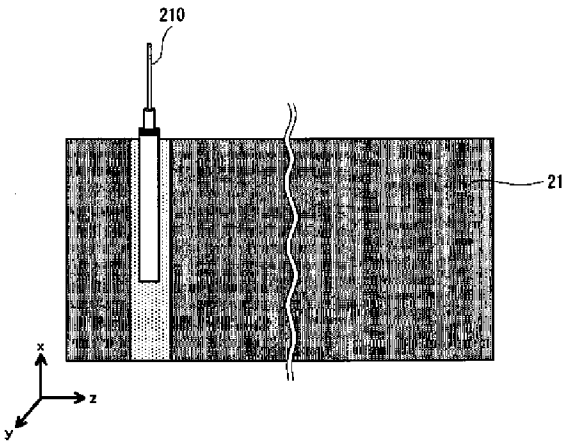
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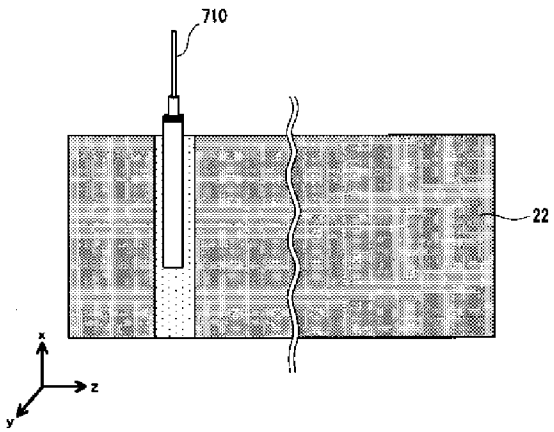
【図３Ｄ】



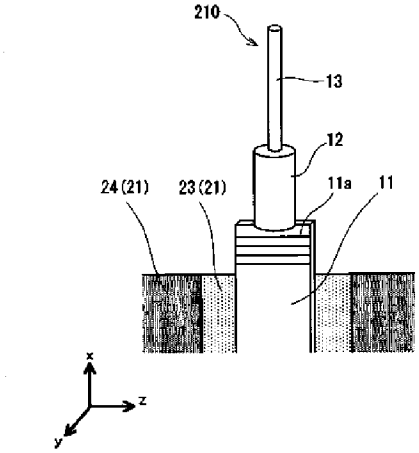
【図４Ａ】



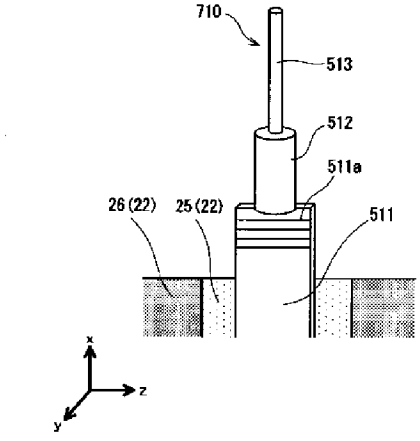
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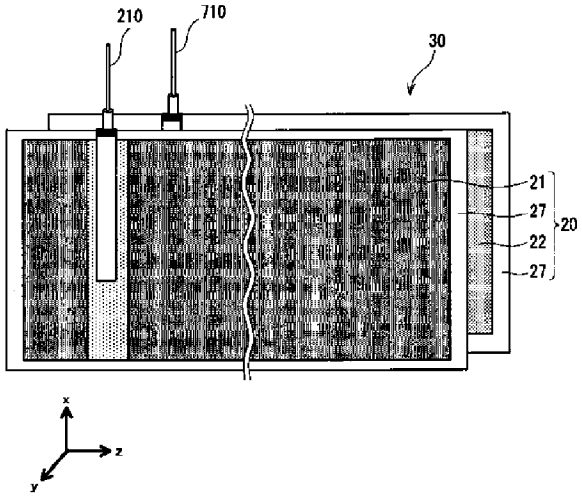
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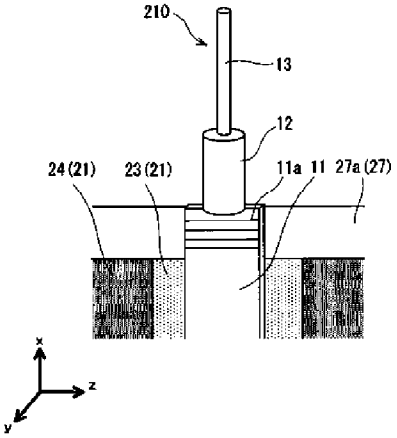
【図４Ｄ】



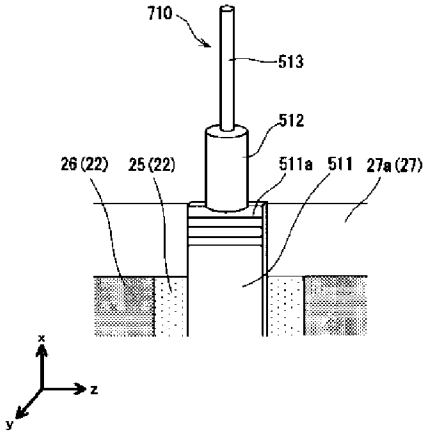
【図５Ａ】



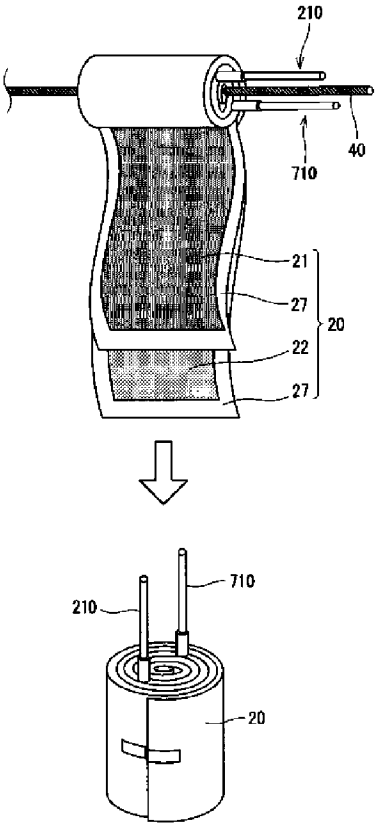
【図５Ｂ】



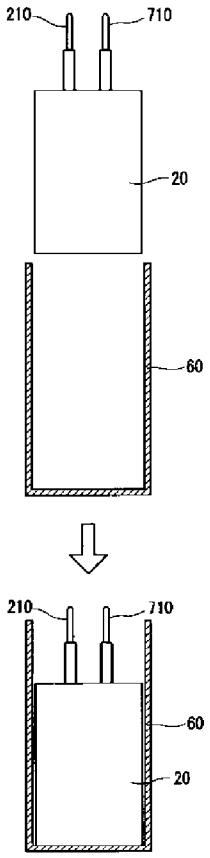
【図５Ｃ】



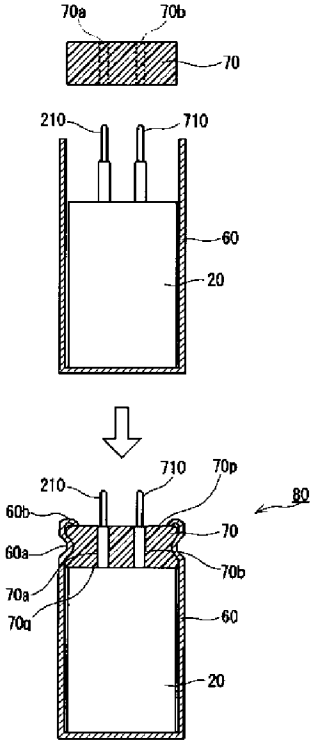
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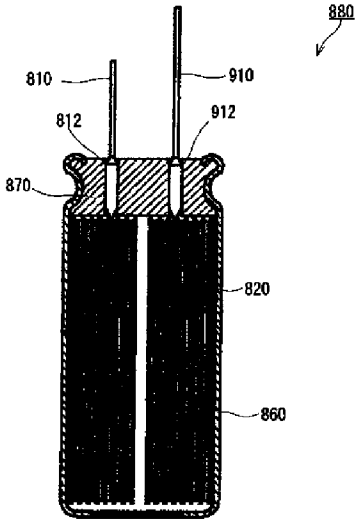
【図７】


210
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【図８】


70a
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210
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70p
80
60b
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60a
70b
70a
70q
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【図９】


880
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フロントページの続き

Ｆターム(参考) 5H029 AJ14 AK01 AK02 AK03 AL03 AL06 AL11 AL12 AM02 AM03
AM04 BJ02 BJ14 CJ07 DJ04 DJ05 DJ14 HJ04 HJ12
5H043 AA20 BA19 CA03 CA12 CB04 CB09 EA02 EA22 EA60 HA33E
JA01E JA03E JA11E JA13E LA02E

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Espacenet

JP2001069673A POWER SUPPLY FOR VEHICLE

Applicants: HITACHI LTD

Inventors: SAITO HIROYUKI

Classifications:

IPC ***B60R16/02; B60R16/04; F02D45/00; F02N11/08; H02G3/16; H02J7/00;*** (IPC1-7): B60R16/02; F02D45/00; F02N11/08; H02G3/16; H02J7/00;

Priorities: JP24475299A 1999-08-31

Application: JP2001069673A·1999-08-31

Publication: JP2001069673A·2001-03-16

Published as: JP2001069673A

POWER SUPPLY FOR VEHICLE

Abstract

PROBLEM TO BE SOLVED: To omit a harness for connection between a fuse relay box and a battery by placing an electric circuit unit at the upper part of a battery fixing means and connecting only the positive-pole terminal of the battery to the electric circuit unit. SOLUTION: To secure a battery 123 on a vehicle body, a frame 118 is put over the top of the battery 123, and the battery is installed on the vehicle body with stays 121 and 122 and tightened with nuts 119 and 120. A fuse relay box 103 of an electric circuit units fastened to and secured on the upper part of the frame 118 as a battery fixing means by a means such as an adhesive. A booster cable is connected only to the positive-pole terminal of the battery 123, and an insulating protective cover 107 is secured detachably on the fuse relay box 103 so as to cover the positive-pole terminal.

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号
特開2001－69673
（P2001－69673A）
(43)公開日　平成13年３月16日(2001.3.16)

(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード（参考）
Ｈ０２Ｊ　7/00		Ｈ０２Ｊ　7/00	Ｐ	
	３０１		３０１Ｂ	
Ｂ６０Ｒ　16/02	６１０	Ｂ６０Ｒ　16/02	６１０Ｚ	
16/04		16/04	Ｃ	
Ｆ０２Ｄ　45/00	３９５	Ｆ０２Ｄ　45/00	３９５Ａ	

審査請求　未請求　請求項の数２　ＯＬ　（全　５　頁）　最終頁に続く

(21)出願番号　特願平11－244752

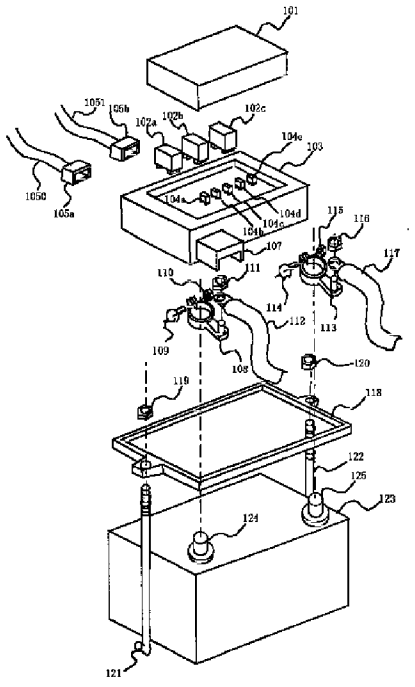
(22)出願日　平成11年８月31日(1999.8.31)

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(54)【発明の名称】　車両用電源装置

(57)【要約】
【課題】車両用バッテリに積み重ねて搭載されるヒューズ・リレーボックスに関し、バッテリの大きさに依存せず、ジャンパスタートが可能なヒューズ・リレーボックスを構成することが可能な車両用電源装置の構造を提供する。
【解決手段】バッテリを固定するフレームにヒューズ・リレーボックスを取り付け、バッテリの大きさ毎にフレームを用意して、ヒューズ・リレーボックスは標準化されたものを組み合わせることにより、バッテリの大きさに依存しないヒューズ・リレーボックスを構成する。ヒューズ・リレーボックスに、バッテリ（＋）端子保護カバーを設けておき、ジャンパスタート時には、カバーを取り外すことにより、バッテリ（＋）ターミナルにブースターケーブルを接続して、ジャンプスタートが可能となる。

図　1



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【特許請求の範囲】
【請求項１】　自動車の電気負荷に電源を供給する電源供給装置において、バッテリを車体に固定するバッテリ固定手段と、ヒューズおよび電源供給用リレーを備えた電気回路ユニットとを、分離可能なまま一体化して構成し、前記バッテリ固定手段の上部に前記電気回路ユニットを配置して、バッテリの正極端子のみ前記電気回路ユニットに接続することを特徴とする、車両用電源装置。
【請求項２】　請求項１に記載の車両用電源装置において、バッテリ正極端子に接続用端子を取り付け、該接続用端子にスタータモータ電源供給用電源線と前記電気回路ユニットへ電源を供給するための導電部材とを締結し、該接続用端子を含んだ正電位を有する部分の車体短絡保護用絶縁手段を設け、該車体短絡保護用絶縁手段を脱着可能な構成とし、ジャンパスタート時には該車体短絡保護用絶縁手段を取り外してジャンパスタートを実行する構成としたことを特徴とする、車両用電源装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、自動車の電気負荷に電源を供給する電源供給装置の構造に係わり、特にバッテリに積み重ねて取り付けられるヒューズ・リレーボックスの構造に関する。
【０００２】
【従来の技術】自動車電装負荷（例えばヘッドランプやスタータモータ等）は、自動車のバッテリないしオルタネータからの電源供給をうけ、負荷への給電や電源遮断はリレーや半導体スイッチング素子によって制御されている。また、上記電装負荷の短絡故障または車両配線の短絡事故などによる電線過熱を防止するため、バッテリと負荷との間にヒューズが通常設けられている。リレーおよびヒューズは、ヒューズ・リレーボックスに一括して搭載され、ヒューズ・リレーボックスは通常バッテリの近傍に設置されている。
【０００３】本ヒューズ・リレーボックスを小型化するために、特開平１０－２６４７４０号では、バッテリを取り囲む筐体とヒューズ・リレーボックスとを一体化して構成し、ヒューズ・リレーボックスを小型化する構成方法を提案している。さらに、バッテリ逆接時の電子機器の破壊を防止するためのバッテリの逆接防止構造も併せて提案している。
【０００４】
【発明が解決しようとする課題】上記発明では、バッテリとヒューズ・リレーボックスが一体化して構成されるため、電気負荷のオフし忘れなどによるバッテリ放電時に車両外部から電力を給電してエンジンを始動させるためのジャンパスタートに対する配慮が欠けており、ジャンパスタートが不可能な構成となっている。
【０００５】また、同一車種においても、寒冷地仕様や仕向地（日本および米国等）の違いなどでバッテリサイズが異なることがあるが、この点についても配慮が欠けており、バッテリの大きさ毎にヒューズ・リレーボックスを設定しなければならない煩わしさがあった。
【０００６】しかるに、本発明の目的は、車両用バッテリに積み重ねて搭載されるヒューズ・リレーボックスに関し、ジャンパスタートが可能かつバッテリの大きさに依らずに該ヒューズ・リレーボックスを構成することが可能な車両用電源装置を提供することにある。
【０００７】
【課題を解決するための手段】バッテリを車体に取り付けるためのステーは、バッテリ上部に組み付けられるフレームにねじ留めされ、該フレームにヒューズ・リレーボックスが固定される構造とする。バッテリの大きさ毎にフレームを用意し、ヒューズ・リレーボックスは標準化されたものを組み合わせることにより、バッテリの大きさに依存しないヒューズ・リレーボックスが構成できる。
【０００８】バッテリとヒューズ・リレーボックスとの電気的な接続は、以下のような構成とする。バッテリ（＋）ターミナルにボルト・ナット式端子を予め固定しておき、本ボルト・ナット式端子の反対部分にスタッドボルトを備え、該スタッドボルトにヒューズ・リレーボックスのバスバーとスタータモータ電源供給用電源線のタブを共締めする。バッテリ（－）ターミナルにボルト・ナット式端子を予め固定しておき、本ボルト・ナット式端子の反対部分にスタッドボルトを備え、該スタッドボルトにグランド線のタブを共締めする。バッテリ（＋）ターミナルは、ヒューズ・リレーボックス筐体に固定される絶縁保護カバーによってボディとの絶縁が保たれている。
【０００９】ジャンパスタート時は、該保護バッテリ（＋）ターミナル部材を取り外すことにより、バッテリ（＋）ターミナルにブースターケーブルを接続することが可能となる。
【００１０】
【発明の実施の形態】本発明の一実施例を、図面を用いて説明する。図１に、本発明の車両用電源装置の構造俯瞰図を示す。バッテリ１２３は、（＋）端子１２４および（－）端子１２５を備えている。バッテリ１２３を車体（図示せず）に固定するため、フレーム１１８をバッテリ１２３の上部からかぶせて、ステー１２１および１２２で車体に取り付け、ナット１１９および１２０で締め付ける。バッテリ１２３には、（＋）端子側に端子１０８が、（－）端子側に端子１１３が、それぞれ固定されている。端子１０８は、ボルト１０９およびナット１１０を締めて固定され、端子１１３は、ボルト１１４およびナット１１５を締めて固定される。端子１０８は、スタータモータへの電源供給線１１２およびヒューズ・リレーボックス内部のバスバー（図２にて説明する）を固定するためのスタッドボルトを備えており、前記電源

供給線およびバスバーをスタッドボルトに通した後で、ナット１１１によって締結・固定される。端子１２２は、グランド線１１７を固定するためのスタッドボルトを備えており、前記グランド線をスタッドボルトに通した後で、ナット１１６によって締結・固定される。

【００１１】ヒューズ・リレーボックス１０３は、フレーム１１８に固定されるが、その固定方法として、スナップフィットや接着剤による固定が可能であるが、他の固定方法でも良い。ヒューズ・リレーボックス１０３に脱着可能で固定される絶縁保護カバー１０７は、バッテリ（＋）ターミナルとボディ（車体）との絶縁を保つために設けられている。ジャンパスタート時は、前記カバーをはずして、バッテリ（＋）端子にブースターケーブルを接続する。本実施例では、ヒューズ・リレーボックス１０３には、ヒューズ１０４ａ、１０４ｂ、１０４ｃ、１０４ｄ、１０４ｅおよびリレー１０２ａ、１０２ｂ、１０２ｃが搭載されている。ヒューズ・リレーボックス１０３に接続される車両ハーネス１０５０および１０５１は、それぞれコネクタ１０５ａおよび１０５ｂを介して接続される。本実施例では、バッテリターミナルの反対側にコネクタが設定されているが、コネクタの場所は特に問わない。リレーおよびヒューズを物理的に保護するためのカバー１０１が、ヒューズ・リレーボックス１０３に取り付けられる。

【００１２】図２に、前記ヒューズ・リレーボックス１０３の断面図を示す。本図により、前記ヒューズ・リレーボックス１０３の詳細構造を説明する。

【００１３】カバー２０１は、ヒューズ２０４およびリレー２０２、２０３を保護するために設けられている。ヒューズ・リレーボックス１０３は、上下二分割の構造となっており、アッパーケース２０５およびロワーケース２０６から構成される。ロワーケース２０６は、車両ハーネス側のコネクタのハウジングも兼ねており、コネクタ端子２１６および２１８が突き出ている。リレー２０２、２０３およびヒューズ２０４の端子は、それぞれメスーメス端子２０７１、２０８１、２０９、２１０、２１１、２１２でもって、メタルフレット２１４に接続されている。前記コネクタ端子２１６および２１８は、ヒューズ・リレーボックス内でメタルフレットを形成しており、本実施例では、絶縁部材２１３、２１５、２１７をはさんだ三層構造となっている。メタルフレットの一方は、給電用メタルフレット２２０としてバッテリ（＋）端子２２８に接続されている。各層のメタルフレットの接続は、該ヒューズ・リレーボックスの内部回路（図３で説明）に従う。なお、本構成はメタルフレットを用いたジャンクションボックスに共通な構成である。

【００１４】バッテリ２２９の（＋）端子２２８に固定される端子２３０に、前記給電用メタルフレット２２０とスタータ電源供給線２２５とを締結・固定する。端子２３０のスタッドボルトに、スタータ電源供給線２２５をナット２２３で固定し、さらに給電用メタルフレット２２０をナット２２１およびワッシャ２２２で固定する。

【００１５】バッテリ２２９を車体に固定するフレーム２２７に、ヒューズ・リレーボックスロワケース２０６が固定される。カバー２１９は、ジャンパスタート時に脱着可能な構造となっている。

【００１６】図３に、本実施例のヒューズ・リレーボックスの内部回路構成例を示す。ヒューズ・リレーボックス３０１には、車両ハーネス用コネクタ３０２および３０３が設けられている。コネクタ３０２は、リレー３０９および３１０のスイッチ側（すなわち負荷接続側）ラインが接続される。リレーの各系統毎にそれぞれヒューズ３０４、３０５が設けられ、負荷短絡および電線地絡時のハーネス保護を実現している。このようなリレーの用途として、イグニッションリレー、スタータリレー、アクセサリリレーなどがある。また、リレー３０９よい３１０のコイル制御信号も同様にコネクタ３０２に接続される。コネクタ３０３は、リレー３１１のスイッチ側（すなわち負荷接続側）ラインと、ヒューズ３０７および３０８を介して常時給電されるライン（非スイッチ電源供給ライン）が接続される。リレー３１１の下流にヒューズ３０６が設けられ、負荷短絡および電線地絡時のハーネス保護を実現している。上記非スイッチ電源供給ラインの用途として、例えばコントロールユニットのメモリバックアップ電源やラジオの選局データ等がある。また、リレー３１１のコイル制御信号も同様にコネクタ３０３に接続される。　リレーの給電側ラインおよび非スイッチ電源供給ラインは、まとめてバッテリ３１２の（＋）端子３１３に接続され、一括して電源が供給される。上記とは別に、バッテリ３１２の（＋）端子３１３にはスタータ電源供給線３１５が、バッテリ３１２の（－）端子３１４にはグランド線３１６が、それぞれ独立に接続される。これは、スタータの突入電流および定常電流が他の電気負荷に比べ過大であり、適当な過電流遮断素子が存在しないためである。

【００１７】以上のように、本発明によればヒューズ・リレーボックスとバッテリ間をつなぐハーネスが省略でき、リレーボックスもバッテリの上に設置することができるので、小型化・省スペースな設計が可能となる。

【００１８】

【発明の効果】以上説明したように、本発明によれば、ヒューズ・リレーボックスとバッテリ間をつなぐハーネスが省略でき、リレーボックス設置スペースも省略できる。さらに、ジャンパスタートが可能かつバッテリの大きさに依らないヒューズ・リレーボックスが実現できる効果も期待できる。

【図面の簡単な説明】

【図１】本発明における車両用電源装置の構造俯瞰図。

【図２】本発明におけるヒューズ・リレーボックスの断

面図。

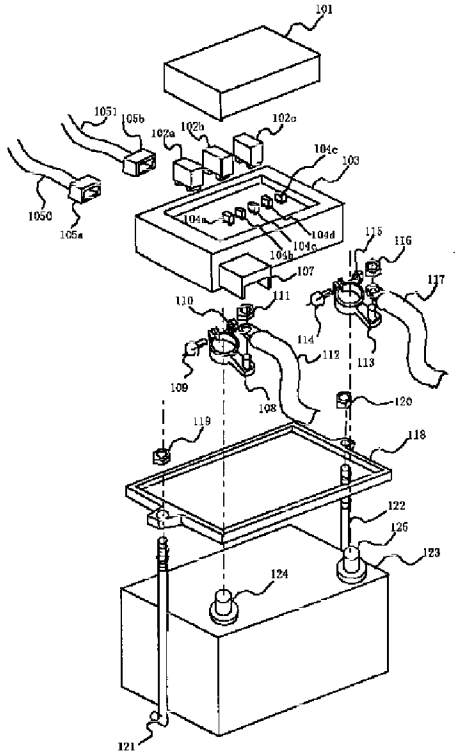
【図３】本発明におけるヒューズ・リレーボックスの内部回路構成図。

【符号の説明】

１０１…カバー、１０２ａ…リレー、１０３…ヒューズ・リレーボックス、１０４ａ…ヒューズ、１０５ａ…コネクタ、１０７…絶縁保護カバー、１０８…端子、１０９…ボルト、１１０…ナット、１１１…ナット、１１２…電源供給線、１１８…フレーム、１１９…ナット、１２１…ステー、１２３…バッテリ、１２４…バッテリ端子。

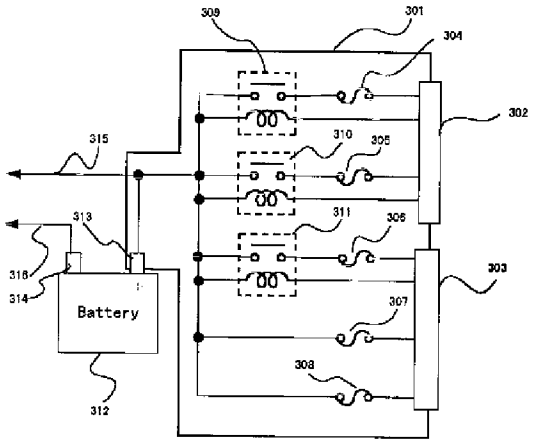
【図１】

図 1

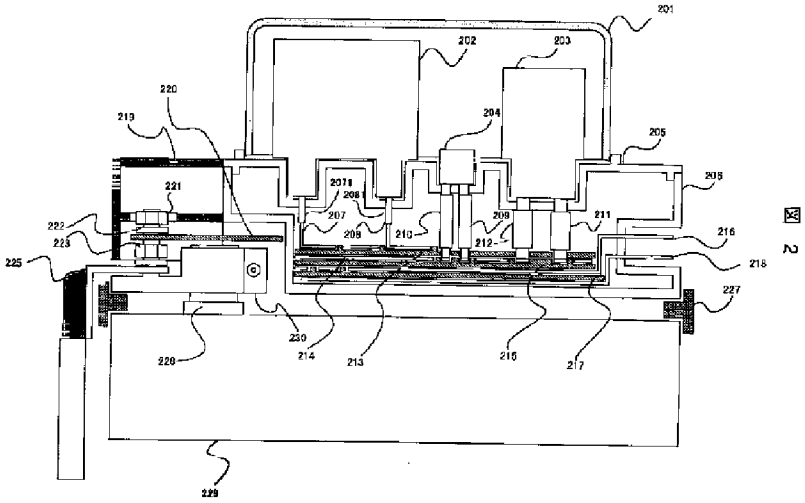


【図３】

図 3



【図２】



フロントページの続き

(51)Int.Cl.[7]	識別記号	ＦＩ		（参考）
Ｆ０２Ｎ　11/08		Ｆ０２Ｎ　11/08	Ｌ	
Ｈ０２Ｇ　 3/16		Ｈ０２Ｇ　 3/16	Ｚ	

Espacenet

JP2012004106A BATTERY PACK CONNECTOR AND COUPLING METHOD THEREOF

Applicants: SAMSUNG SDI CO LTD

Inventors: PARK HAN-GYU

Classifications:
IPC ***H01M2/10; H01M2/20; H01R4/02;***

CPC Y02E60/10 (EP);

Priorities: US201113983807A 2011-01-03; US35698310P 2010-06-21; US98380711A 2011-01-03

Application: JP2011106118A·2011-05-11

Publication: JP2012004106A·2012-01-05

Published as: JP2012004106A;**JP5345175B2**

BATTERY PACK CONNECTOR AND COUPLING METHOD THEREOF

Abstract

PROBLEM TO BE SOLVED: To firmly couple a wire to a battery cell or a protective circuit module in a battery pack connector and a coupling method thereof.SOLUTION: In one embodiment of the present invention, a connecting region includes: a first connecting member electrically connected to a battery cell or a protective circuit module; and a second connecting member formed on the first connecting member and coupled to a wire. The second connecting member has a pair of coupling members upwardly protruding for coupling the wire. Further, a solder may be additionally formed on the first connecting member, the second connecting member, the coupling members and the wire.

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2012-4106
(P2012-4106A)
(43)公開日　平成24年1月5日(2012.1.5)

(51)Int.Cl.			F I			テーマコード（参考）
H01M	***2/20***	***(2006.01)***	H01M	2/20	A	5E085
H01M	***2/10***	***(2006.01)***	H01M	2/10	M	5H040
H01R	***4/02***	***(2006.01)***	H01R	4/02	Z	5H043

審査請求 有　請求項の数 24　ＯＬ　（全 17 頁）

(21)出願番号　特願2011-106118 (P2011-106118)
(22)出願日　平成23年5月11日 (2011.5.11)
(31)優先権主張番号　61/356,983
(32)優先日　平成22年6月21日 (2010.6.21)
(33)優先権主張国　米国 (US)
(31)優先権主張番号　12/983,807
(32)優先日　平成23年1月3日 (2011.1.3)
(33)優先権主張国　米国 (US)

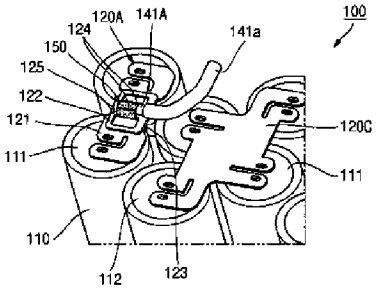
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Ｆターム(参考)　5E085 BB01 BB14 BB26 DD01 DD14 DD18 HH01 HH06 JJ06

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(54)【発明の名称】バッテリーパックのコネクタ及びこれの結合方法

(57)【要約】
【課題】本発明の一実施形態は、バッテリーパックのコネクタ及びこれの結合方法に関し、解決しようとする技術的課題は、バッテリーセルまたは保護回路モジュールにワイヤを堅固に結合することにある。
【解決手段】このために本発明の一実施形態は、バッテリーセルまたは保護回路モジュールに電気的に連結される第１の連結部材と、第１の連結部材上に形成され、ワイヤが結合される第２の連結部材とからなる連結領域を開示する。ここで、第２の連結部材は、ワイヤとの結合のために上部に突出した一対の結合部材を有する。また、第１の連結部材、第２の連結部材、結合部材及びワイヤに半田付けが追加的に形成されてもよい。
【選択図】図４



ADC EX1002
IPR2025-00885

【特許請求の範囲】
【請求項１】
少なくとも一つのバッテリーまたは保護回路モジュールに電気的にワイヤを連結するためのコネクタであって、
前記コネクタは、
第１の面と第２の面を有し、前記少なくとも一つのバッテリーまたは保護回路モジュールに前記第１の面を介して電気的に連結される第１の連結部材と、
前記第１の連結部材に連結される第１の面と第２の面を有する第２の連結部材と、
を含み、
前記第２の連結部材の第１の面は前記第１の連結部材の第２の面に近接して位置し、
前記ワイヤが前記第２の連結部材に電気的に連結されることを特徴とするコネクタ。
【請求項２】
前記ワイヤが前記少なくとも一つのバッテリーまたは保護回路モジュールに前記第２の連結部材及び前記第１の連結部材を介して電気的に連結されるように、少なくとも一つのワイヤ結合部材が前記第２の連結部材の第２の面に形成されることを特徴とする請求項１に記載のコネクタ。
【請求項３】
前記第１の連結部材は、
本体と、
前記少なくとも一つのバッテリーまたは保護回路モジュールの少なくとも一つの端子に連結される大きさで、前記本体から延在されて離隔する少なくとも一つの延長部と、
を含むことを特徴とする請求項１に記載のコネクタ。
【請求項４】
前記本体と前記少なくとも一つの延長部との間に切開部が形成されることを特徴とする請求項３に記載のコネクタ。
【請求項５】
前記本体及び前記少なくとも一つの延長部に溶接溝が形成されることを特徴とする請求項３に記載のコネクタ。
【請求項６】
前記第１及び第２の連結部材は、第１及び第２の側縁部を有し、
前記第１の連結部材の第１の側縁部は前記第２の連結部材の第１の側縁部に連結されることを特徴とする請求項１に記載のコネクタ。
【請求項７】
前記第１の連結部材の第１の側縁部は、
前記第１及び第２の連結部材に一体に連結された連結領域を介して前記第２の連結部材の第１の側縁部に連結されることを特徴とする請求項６に記載のコネクタ。
【請求項８】
前記連結領域は折曲可能な領域であることを特徴とする請求項７に記載のコネクタ。
【請求項９】
前記第１及び第２の連結部材の第２の側縁部と係合する加圧部をさらに含むことを特徴とする請求項６に記載のコネクタ。
【請求項１０】
前記加圧部は、
前記第１の連結部材の第２の側縁部に一体に付着され、
前記第２の連結部材が位置するＣ字形の開口であることを特徴とする請求項９に記載のコネクタ。
【請求項１１】
前記少なくとも一つのワイヤ結合部材は、
ワイヤ収容空間を定義する第１及び第２のワイヤ結合部材を含み、
前記ワイヤが前記ワイヤ収容空間内に位置するとき、

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前記第１及び第２のワイヤ結合部材が前記ワイヤ収容空間に前記ワイヤを収容して維持し、前記第２の連結部材に電気的に連結されるようにすることを特徴とする請求項２に記載のコネクタ。

【請求項１２】

前記ワイヤ収容空間で前記ワイヤを追加的に支持するように、

前記ワイヤ収容空間、前記第１，第２のワイヤ結合部材の前記ワイヤの上に位置した半田付け材料をさらに含むことを特徴とする請求項１１に記載のコネクタ。

【請求項１３】

前記第２の連結部材の第２の表面には、

前記第１及び第２のワイヤ結合部材に近接して位置した一つまたはそれ以上の凹溝が形成されることを特徴とする請求項１２に記載のコネクタ。

【請求項１４】

前記一つまたはそれ以上の凹溝は、前記第２の連結部材の第２の表面から第１の表面まで延在される開口であることを特徴とする請求項１３に記載のコネクタ。

【請求項１５】

前記第１，第２の連結部材は互いに異なる物質で形成されることを特徴とする請求項１に記載のコネクタ。

【請求項１６】

少なくとも一つのバッテリーまたは保護回路モジュールにワイヤを結合する方法であって、

第１及び第２の連結部材が電気的に相互連結され、

前記第２の連結部材の第２の側部が前記第１の連結部材の第２の側部に近接して位置するように、

前記第１の連結部材に対して前記第２の連結部材を位置させる段階と、

前記第１の連結部材を前記少なくとも一つのバッテリーまたは保護回路モジュールに電気的に連結する段階と、

前記ワイヤを前記第２の連結部材に電気的に連結する段階と、

を含むことを特徴とするワイヤの結合方法。

【請求項１７】

前記ワイヤを前記第２の連結部材に電気的に連結する段階において、

前記第２の連結部材の第２の面上に形成されたマウント構造に前記ワイヤを機械的に結合することを特徴とする請求項１６に記載のワイヤの結合方法。

【請求項１８】

前記第１の連結部材は、

前記ワイヤが前記マウント構造に機械的に結合される前に、前記少なくとも一つのバッテリーまたは保護回路モジュールに連結されることを特徴とする請求項１７に記載のワイヤの結合方法。

【請求項１９】

前記第１の連結部材は、

前記ワイヤが前記マウント構造に機械的に結合された後に、前記少なくとも一つのバッテリーまたは保護回路モジュールに連結されることを特徴とする請求項１７に記載のワイヤの結合方法。

【請求項２０】

前記第１の連結部材に対して前記第２の連結部材を位置させる段階では、

前記第２の連結部材の第２の側部が前記第１の連結部材の第２の側部に近接して位置するように、

前記第１及び第２の連結部材に連結された連結領域で、前記第１の連結部材に対して前記第２の連結部材を折曲することを特徴とする請求項１６に記載のワイヤの結合方法。

【請求項２１】

前記第２の連結部材を前記第１の連結部材に近接させて固定することを特徴とする請求

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項１６に記載のワイヤの結合方法。
【請求項２２】
前記第２の連結部材を前記第１の連結部材に近接させて固定する段階では、
前記第１の連結部材の固定部材により正義される空間に、前記第２の連結部材の端部を位置させることを特徴とする請求項２１に記載のワイヤの結合方法。
【請求項２３】
前記マウント構造に前記ワイヤを機械的に結合する段階では、
少なくとも二つの結合部材がワイヤ収容領域に前記ワイヤを収容するように、前記ワイヤ収容領域を定義する前記少なくとも二つの結合部材に前記ワイヤを位置させることを特徴とする請求項１７に記載のワイヤの結合方法。
【請求項２４】
前記ワイヤ及び前記二つの結合部材に半田付け材料をさらに形成することを特徴とする請求項２３に記載のワイヤの結合方法。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、バッテリーパックのコネクタ及びこれの結合方法に関する。
【背景技術】
【０００２】
一般に、ノートパンコン、電動工具、電気自転車または電気スクーターなどの場合、一つのバッテリーセルだけでは電源用途で使用し難い。よって、このような電子機器または電動機器の電源用途で使用されるバッテリーパックとしては、多数のバッテリーセルを直列及び並列に連結して使用している。
【０００３】
また、このようなバッテリーパックには、バッテリーセルの充電及び放電状態を制御し、過充電や過放電により発生する各種危険を防止するために、保護回路モジュールが含まれる。さらに、このような多数のバッテリーセルと保護回路モジュールの間には、充電電流または放電電流を流すための導電性ワイヤが連結される。
【発明の概要】
【発明が解決しようとする課題】
【０００４】
本発明は、バッテリーセルまたは保護回路モジュールにワイヤが堅固に結合されるようにしたバッテリーパックのコネクタ及びこれの結合方法を提供する。
本発明は、バッテリーセルまたは保護回路モジュールにワイヤを迅速且つ安全に結合することができるバッテリーパックのコネクタ及びこれの結合方法を提供する。
【課題を解決するための手段】
【０００５】
本発明の一態様によると、少なくとも一つのバッテリーまたは保護回路モジュールに電気的にワイヤを連結するためのコネクタは、コネクタは、第１の面と第２の面を有し、少なくとも一つのバッテリーまたは保護回路モジュールに第１の面を介して電気的に連結される第１の連結部材と、第１の連結部材に連結される第１の面と第２の面を有する第２の連結部材と、を含み、第２の連結部材の第１の面は第１の連結部材の第２の面に近接して位置し、ワイヤが第２の連結部材に電気的に連結される。
【０００６】
ワイヤが少なくとも一つのバッテリーまたは保護回路モジュールに第２の連結部材及び第１の連結部材を介して電気的に連結されるように、少なくとも一つのワイヤ結合部材が第２の連結部材の第２の面に形成される。
【０００７】
第１の連結部材は、本体と、少なくとも一つのバッテリーまたは保護回路モジュールの少なくとも一つの端子に連結される大きさで、本体から延在されて離隔する少なくとも一

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つの延長部と、を含む。本体と少なくとも一つの延長部との間に切開部が形成される。本体及び少なくとも一つの延長部に溶接溝が形成される。

【０００８】

第１及び第２の連結部材は、第１及び第２の側縁部を有し、第１の連結部材の第１の側縁部は第２の連結部材の第１の側縁部に連結される。第１の連結部材の第１の側縁部は、第１及び第２の連結部材に一体に連結された連結領域を介して第２の連結部材の第１の側縁部に連結される。連結領域は折曲可能な領域である。コネクタは、第１及び第２の連結部材の第２の側縁部と係合する加圧部をさらに含む。加圧部は、第１の連結部材の第２の側縁部に一体に設けられ、第２の連結部材が位置する「Ｃ」字形の開口である。

【０００９】

少なくとも一つのワイヤ結合部材は、ワイヤ収容空間を定義する第１及び第２のワイヤ結合部材を含み、ワイヤがワイヤ収容空間内に位置するとき、第１及び第２のワイヤ結合部材がワイヤ収容空間にワイヤを収容して維持し、第２の連結部材に電気的に連結されるようにする。コネクタは、ワイヤ収容空間でワイヤを追加的に支持するように、ワイヤ収容空間、第１，第２のワイヤ結合部材のワイヤの上に位置した半田付け材料をさらに含む。第２の連結部材の第２の表面には、第１及び第２のワイヤ結合部材に近接して位置した一つまたはそれ以上の凹溝が形成される。一つまたはそれ以上の凹溝は、第２の連結部材の第２の表面から第１の表面まで延在される開口（ｏｐｅｎｉｎｇ）である。

第１，第２の連結部材は互いに異なる物質で形成される。

【００１０】

本発明の一態様によると、少なくとも一つのバッテリーまたは保護回路モジュールにワイヤを結合する方法は、第１及び第２の連結部材が電気的に相互連結され、第２の連結部材の第２の側部が第１の連結部材の第２の側部に近接して位置するように、第１の連結部材に対して第２の連結部材を位置させる段階と、第１の連結部材を少なくとも一つのバッテリーまたは保護回路モジュールに電気的に連結する段階と、ワイヤを第２の連結部材に電気的に連結する段階と、を含む。

【００１１】

ワイヤを第２の連結部材に電気的に連結する段階において、第２の連結部材の第２の面上に形成されたマウント構造にワイヤを機械的に結合する。第１の連結部材は、ワイヤがマウント構造に機械的に結合される前に、少なくとも一つのバッテリーまたは保護回路モジュールに連結される。第１の連結部材は、ワイヤがマウント構造に機械的に結合された後に、少なくとも一つのバッテリーまたは保護回路モジュールに連結される。

【００１２】

第１の連結部材に対して第２の連結部材を位置させる段階では、第２の連結部材の第２の側部が第１の連結部材の第２の側部に近接して位置するように、第１及び第２の連結部材に連結された連結領域で、第１の連結部材に対して第２の連結部材を折曲する。第２の連結部材を第１の連結部材に近接させて固定する。第２の連結部材を第１の連結部材に近接させて固定する段階では、第１の連結部材の固定部材により定義される空間に、第２の連結部材の端部を位置させる。

【００１３】

マウント構造にワイヤを機械的に結合する段階では、少なくとも二つの結合部材がワイヤ収容領域にワイヤを収容するように、ワイヤ収容領域を定義する少なくとも二つの結合部材にワイヤを位置させる。ワイヤ及び二つの結合部材に半田付け材料をさらに形成する。

【発明の効果】

【００１４】

本発明の一実施形態によるバッテリーパックのコネクタには平らな第１の連結部材が形成されて、第１の連結部材がバッテリーセルまたは保護回路モジュールに容易に溶接され、また、第１の連結部材上に第２の連結部材及び一対の結合部材が形成されることで、第２の連結部材及び一対の結合部材にワイヤが容易に結合される。

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本発明の一実施形態によるバッテリーパックのコネクタとワイヤの結合構造は、ワイヤがコネクタに具備された一対の結合部材に結合され、またはワイヤの結合後に半田付けが形成され、またはワイヤの結合後に結合部材がクランプされ、次いで半田付けが形成されることで、コネクタとワイヤの結合構造がより堅固になる。

さらに、このような結合構造によると、ワイヤに大電流が流れて高温になることで半田付けが溶融されても、一対の結合部材にワイヤが結合されているため、コネクタからワイヤが分離されることが防止される。

また、本発明の別の実施形態によるバッテリーパックのコネクタとワイヤの結合方法は、コネクタをバッテリーセルまたは保護回路モジュールに接続し、コネクタに具備された一対の結合部材にワイヤを結合し、またはワイヤ結合後に半田付けを形成し、またはワイヤの結合後に結合部材をクランプし、または結合部材のクランプ後に半田付けを形成することで、コネクタとワイヤの結合時間が短く、結合時間全体の間において危険要素がないため、作業安全性が向上する。

【図面の簡単な説明】

【００１５】

【図１】本発明の一実施形態によるバッテリーパックの概略的な回路を示す回路図である。

【図２】本発明の一実施形態によるバッテリーパックの概略的な構造を示す斜視図である。

【図３】本発明の別の実施形態によるバッテリーパックの概略的な構造を示す斜視図である。

【図４】本発明の一実施形態によるバッテリーパックのコネクタ及びワイヤの結合構造を示す部分斜視図である。

【図５】本発明の別の実施形態によるバッテリーパックのコネクタ及びワイヤの結合構造を示す部分斜視図である。

【図６ａ】本発明の別の実施形態によるコネクタ及びワイヤの結合構造を示す平面図である。

【図６ｂ】図６ａの線６ｂ－６ｂに沿った断面図である。

【図６ｃ】図６ａの線６ｃ－６ｃに沿った断面図である。

【図６ｄ】図６ａの線６ｃ－６ｃに沿った別の断面図である。

【図７ａ】本発明の別の実施形態によるバッテリーパックのコネクタを用いたワイヤの結合方法を順に示す斜視図である。

【図７ｂ】本発明の別の実施形態によるバッテリーパックのコネクタを用いたワイヤの結合方法を順に示す斜視図である。

【図７ｃ】本発明の別の実施形態によるバッテリーパックのコネクタを用いたワイヤの結合方法を順に示す斜視図である。

【図７ｄ】本発明の別の実施形態によるバッテリーパックのコネクタを用いたワイヤの結合方法を順に示す斜視図である。

【図７ｅ】本発明の別の実施形態によるバッテリーパックのコネクタを用いたワイヤの結合方法を順に示す斜視図である。

【図７ｆ】本発明の別の実施形態によるバッテリーパックのコネクタを用いたワイヤの結合方法を順に示す斜視図である。

【発明を実施するための形態】

【００１６】

以下、本発明の属する技術分野における通常の知識を有する者が本発明を容易に実施できるように、本発明の好ましい実施形態を添付の図面を参照して詳細に説明する。

図１は、本発明の一実施形態によるバッテリーパックの概略的な回路を示す回路図である。図２は、本発明の一実施形態によるバッテリーパックの概略的な構造を示す斜視図である。

図１及び図２に示すように、本発明の一実施形態によるバッテリーパック１００は、バ

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ッテリーセル１１０、コネクタ１２０Ａ，１２０Ｂ，１２０Ｃ、保護回路モジュール１３０及びワイヤ１４１Ａ，１４１Ｂを含む。

【００１７】

バッテリーセル１１０は、再充電可能な電池であってもよい。一例として、バッテリーセル１１０は、リチウムイオン電池、リチウムポリマー電池、リチウムイオンポリマー電池及びその等価物のうち選択された何れか一つであってもよいが、ここでその種類を限定するものではない。さらに、バッテリーセル１１０は、円筒型、角型、パウチ型及びその等価物のうち選択された何れか一つであってもよいが、ここでその形態を限定するものではない。

【００１８】

コネクタ１２０Ａ，１２０Ｂ，１２０Ｃは、バッテリーセル１１０を直列または並列に電気的に連結する。図１及び図２には、一例として、コネクタ１２０Ａ，１２０Ｂ，１２０Ｃにより複数のバッテリーセル１１０が５直列２並列形態に連結されたものが示されているが、このような連結形態で本発明が限定されるものでもない。

【００１９】

保護回路モジュール１３０は、バッテリーセル１１０と電気的に連結され、バッテリーセル１１０の充電及び放電を制御する。ここで、保護回路モジュール１３０は、バッテリーセル１１０と電気的に連結するための正極パッド１３１Ａ及び負極パッド１３１Ｂを含む。このような保護回路モジュール１３０には、バッテリーセル１１０が過充電されないように制御するだけでなく、過放電されないように制御する複数の電子素子１３３（集積回路、トランジスタ、抵抗及びコンデンサなど）が実装されている。このような保護回路モジュール１３０には、充電器（図示せず）または負荷（図示せず）との連結のために、コネクタ１３４が設けられてもよい。

【００２０】

ワイヤ１４１Ａ，１４１Ｂは、バッテリーセル１１０と保護回路モジュール１３０を電気的に連結する。ここで、ワイヤ１４１Ａ，１４１Ｂは、それぞれ絶縁被覆１４１ａ，１４１ｂで被覆されている。このようなワイヤは、正極ワイヤ１４１Ａ及び負極ワイヤ１４１Ｂを含む。正極ワイヤ１４１Ａは、バッテリーセル１１０のうち最高電位のバッテリーセル１１０の正極端子１１１に連結されたコネクタ１２０Ａと保護回路モジュール１３０の正極パッド１３１Ａとを連結する。すなわち、正極ワイヤ１４１Ａは、一端がコネクタ１２０Ａに結合、接続、連結または半田付けされ、他端が正極パッド１３１Ａに半田付けされる。負極ワイヤ１４１Ｂは、バッテリーセル１１０のうち最低電位のバッテリーセル１１０の負極端子１１２に連結されたコネクタ１２０Ｂと保護回路モジュール１３０の負極パッド１３１Ｂとを連結する。すなわち、負極ワイヤ１４１Ｂは、一端がコネクタ１２０Ｂに結合、接続、連結または半田付けされ、他端が負極パッド１３１Ｂに半田付けされる。

【００２１】

バッテリーセル１１０のうち最高電位を有するバッテリーセル１１０の正極端子１１１に連結されたコネクタ１２０Ａは、第１の連結部材１２１及び第２の連結部材１２２からなる２層構造を有してもよい。すなわち、第１の連結部材１２１がバッテリーセル１１０の正極端子１１１に溶接され、正極ワイヤ１４１Ａは第２の連結部材１２２に結合、接続、連結または半田付けされる。また、バッテリーセル１１０のうち最低電位を有するバッテリーセル１１０の負極端子１１２に連結されたコネクタ１２０Ｂも、コネクタ１２０Ａと同じ構造を有するので、これについての説明は省略する。

【００２２】

一方、正極ワイヤ１４１Ａまたは負極ワイヤ１４１Ｂが結合されていない他のコネクタ１２０Ｃは、一つの導電層からなる１層構造を有する。勿論、このような一つの導電層からなるコネクタ１２０Ｃがバッテリーセル１１０の正極端子１１１または負極端子１１２に溶接されることで、複数のバッテリーセル１１０を直列及び並列に電気的に連結する。

このような１層構造のコネクタ１２０Ｃ及び２層構造のコネクタ１２０Ａ，１２０Ｂは

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全て、ニッケル、ニッケルメッキされた銅及びその等価物のうち選択された何れか一つであってもよく、ここでその材質を限定するものではない。さらに、このようなコネクタ１２０Ａ，１２０Ｂ，１２０Ｃは、ニッケルと銅からなるクラッド金属であってもよい。さらに、場合によっては、２層構造のコネクタ１２０Ａ，１２０Ｂの第２の連結部材１２２だけがクラッド金属で形成されてもよい。公知のように、このようなクラッド金属は、メッキではない溶接、圧延、鋳造または圧出などの方法で形成され、母材が有しない新しい特性（例えば、半田付けに対する濡れ性（Ｗｅｔｔａｂｉｌｉｔｙ））が向上する。

【００２３】

このようにして、本発明の一実施形態によるバッテリーパック１００のコネクタ１２０Ａ，１２０Ｂ，１２０Ｃ、特にワイヤ１４１Ａ，１４１Ｂが結合、接続、連結または半田付けされるコネクタ１２０Ａ，１２０Ｂは、１層構造ではなく２層構造からなるので、バッテリーセル１１０とコネクタ１２０Ａ，１２０Ｂとの間の結合力が向上するだけでなく、ワイヤ１４１Ａ，１４１Ｂとコネクタ１２０Ａ，１２０Ｂとの間の結合力も向上する。例えば、コネクタ１２０Ａの第１の連結部材１２１がバッテリーセル１１０に先に結合され、次いで第２の連結部材１２２にワイヤ１４１Ａが結合されるからである。言い換えれば、バッテリーセル１１０に第１の連結部材１２１が結合される工程と、第２の連結部材１２２にワイヤ１４１Ａが結合される工程が互いに影響を与えないからである。

【００２４】

一方、ワイヤ１４１Ｂが結合または半田付けされるコネクタ１２０Ｂは、バッテリーセル１１０Ｂ（図２参照）の下面に位置する。すなわち、コネクタ１２０Ｂは、バッテリーセル１１０Ｂの下面の負極に付着される。よって、実質的に図２でコネクタ１２０Ｂは、バッテリーセル１１０Ｂに遮られて外部から見えない。しかし、このようなコネクタ１２０Ｂはコネクタ１２０Ａと同じ構造及び形状を有するので、その図示は省略する。

【００２５】

図３は、本発明の別の実施形態によるバッテリーパックの概略的な構造を示す斜視図である。

図３に示すように、本発明の別の実施形態によるバッテリーパック１０１は、保護回路モジュール１３０にもコネクタ２２０Ａ，２２０Ｂが結合されてもよい。すなわち、コネクタ２２０Ａが保護回路モジュール１３０の正極パッド１３１Ａに接続され、コネクタ２２０Ｂが負極パッド１３１Ｂに接続される。さらに、コネクタ２２０Ａに正極ワイヤ１４１Ａが接続または半田付けされ、コネクタ２２０Ｂに負極ワイヤ１４１Ｂが接続または半田付けされる。ここで、コネクタ２２０Ａ，２２０Ｂは、上述したコネクタ１２０Ａ，１２０Ｂと実質的に同じものであるので、コネクタ２２０Ａ，２２０Ｂについての詳細な説明は省略する。

このようにして、本発明の別の実施形態は、コネクタ２２０Ａ，２２０Ｂがバッテリーセル１１０だけでなく保護回路モジュール１３０にも適用されるので、ワイヤ１４１Ａ，１４１Ｂと保護回路モジュール１３０の間の結合力もさらに向上する。

【００２６】

図４は、本発明の一実施形態によるバッテリーパックのコネクタ及びワイヤの結合構造を示す部分斜視図である。

図４に示すように、本発明の一実施形態によるバッテリーパック１００のコネクタ１２０Ａは、バッテリーセル１１０に溶接される第１の連結部材１２１と、第１の連結部材１２１上に形成された第２の連結部材１２２と、第１の連結部材１２１及び第２の連結部材１２２を連結する折曲可能な連結領域１２３と、第２の連結部材１２２上に形成され、上部に一定長さ突出した一対の結合部材１２４と、第１の連結部材１２１に形成され、第２の連結部材１２２を加圧する加圧部１２５とを含む。ここで、連結領域１２３と加圧部１２５は、互いに反対側に形成されている。また、一対の結合部材１２４は、上方に向かって相互間の間隔が略近くなる形を有する。

さらに、このようなコネクタ１２０Ａは、第１の連結部材１２１がバッテリーセル１１０の正極端子１１１に溶接され、第２の連結部材１２２に具備された一対の結合部材１２

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４に導電性ワイヤ１４１Ａが結合されてもよい。さらに、導電性ワイヤ１４１Ａ及び結合部材１２４に半田付け１５０が形成されてもよい。

【００２７】

図５は、本発明の別の実施形態によるバッテリーパックのコネクタ及びワイヤの結合構造を示す部分斜視図である。

図５に示すように、本発明の別の実施形態によるバッテリーパック１０１のコネクタ２２０Ａは、保護回路モジュール１３０に溶接される第１の連結部材１２１と、第１の連結部材１２１上に形成された第２の連結部材１２２と、第１の連結部材１２１及び第２の連結部材１２２を連結する連結領域１２３と、第２の連結部材１２２上に形成され、上部に一定長さ突出した一対の結合部材１２４と、第１の連結部材１２１に形成され、第２の連結部材１２２を加圧する加圧部１２５とを含む。

【００２８】

さらに、このようなコネクタ２２０Ａは、第１の連結部材１２１が保護回路モジュール１３０の正極パッド１３１Ａに溶接され、第２の連結部材１２２に具備された一対の結合部材１２４に導電性ワイヤ１４１Ａが結合されてもよい。さらに、導電性ワイヤ１４１Ａ及び結合部材１２４に半田付け１５０が形成されてもよい。

実質的に、バッテリーセル１１０に接続されるコネクタ１２０Ａと、保護回路モジュール１３０に接続されるコネクタ２２０Ａとは、互いに同じ構造を有してもよい。よって、以下で説明されるコネクタ１２０Ａ、コネクタ１２０Ａとワイヤ１４１Ａとの連結構造及びコネクタ１２０Ａとワイヤ１４１Ａとの連結方法は、上述した二つの実施形態の両方に適用可能である。

【００２９】

図６ａは、本発明の一実施形態によるコネクタ及びワイヤの結合構造を示す平面図であり、図６ｂは、図６ａの線６ｂ－６ｂに沿った断面図であり、図６ｃは、図６ａの線６ｃ－６ｃに沿った断面図であり、図６ｄは、図６ａの線６ｃ－６ｃに沿った別の断面図である。

図６ａ～図６ｃを参照すると、本発明の一実施形態によるコネクタ１２０Ａは、バッテリーセル（１１０、図４参照）または保護回路モジュール（１３０、図５参照）に接続される第１の連結部材１２１と、第１の連結部材１２１上に形成された第２の連結部材１２２と、第１の連結部材１２１及び第２の連結部材１２２を連結する連結領域１２３と、第２の連結部材１２２上に形成され、上部に一定長さ突出した一対の結合部材１２４と、第１の連結部材１２１に形成され、第２の連結部材１２２を加圧する加圧部１２５とを含む。ここで、第１の連結部材１２１は、下面を第１の面と、上面を第２の面と定義し得る。また、第２の連結部材１２２は、下面を第１の面と、上面を第２の面と定義し得る。このとき、第１の連結部材１２１の上面（第２の面）は第２の連結部材１２２の下面（第１の面）に密着する。

【００３０】

第１の連結部材１２１は、略平らな本体１２１ａと、本体１２１ａから対向する両側に延在された略平らな延長部１２１ｂとを含む。さらに、本体１２１ａ及び延長部１２１ｂには、それぞれ凹溝１２１ｃ，１２１ｄが形成されており、このような凹溝１２１ｃ，１２１ｄには、溶接工程中に溶接工具が位置する。よって、コネクタ１２０Ａは、バッテリーセル（１１０、図４参照）または保護回路モジュール（１３０、図５参照）に容易に溶接される。さらに、本体１２１ａと延長部１２１ｂの間には、切開部１２１ｅが形成されている。よって、溶接工程中に溶接工具による熱が拡散されず凹溝１２１ｃ，１２１ｄに集中され、これにより溶接効率がさらに向上する。このような第１の連結部材１２１は、ニッケル、ニッケルメッキされた銅、ニッケルと銅からなるクラッド金属及びその等価物のうち選択された何れか一つで形成されてもよいが、ここでその材質を限定するものではない。さらに、第１の連結部材１２１は、右側端部を第１の側縁部と、左側端部を第２の側縁部と定義し得る。

【００３１】

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第２の連結部材１２２は、略平らであり、第１の連結部材１２１上に形成されている。このような第２の連結部材１２２は、第１の連結部材１２１の本体１２１ａが有する広さより少し小さく形成されてもよいが、このような広さで第２の連結部材１２２を限定するものではない。また、第２の連結部材１２２の対向する両側に、一定の大きさの穴（ｈｏｌｅ）または開口（ｏｐｅｎｉｎｇ）１２２ａが形成されている。すなわち、第２の連結部材１２２の、ワイヤ１４１Ａを中心に対向する両側に、穴１２２ａが形成されている。このような穴１２２ａを通して、第１の連結部材１２１の表面が上部に露出する。このような穴１２２ａは、半田付け１５０の形成時に過剰に形成された半田付けを収容することで、半田付け１５０がコネクタ１２０Ａの外側に流れ出ることを防止する。このような第２の連結部材１２２は、第１の連結部材１２１と同様に、ニッケル、ニッケルメッキされた銅、ニッケルと銅からなるクラッド金属及びその等価物のうち選択された何れか一つで形成されてもよいが、ここでその材質を限定するものではない。さらに、第２の連結部材１２２は、右側端部を第１の側縁部と、左側端部を第２の側縁部と定義し得る。よって、第１の連結部材と第２の連結部材は、共通の第１の側縁部が互いに連結され、第２の側縁部が互いに隣接する形を有する。

【００３２】

連結領域１２３は、第１の連結部材１２１と第２の連結部材１２２の一側端部を連結する。また、連結領域１２３は実質的に折曲されており、第１の連結部材１２１及び第２の連結部材１２２と同じ材質で形成されてもよい。ここで、連結領域１２３は、第１，第２の連結部材１２１，１２２の第１の側縁部に形成されている。

【００３３】

一対の結合部材１２４は、第２の連結部材１２２から上部に一定長さ突出して形成される。このような一対の結合部材１２４は、第２の連結部材１２２の一部領域が切開されて上部に折曲されることにより形成されたものである。勿論、このような切開によって、第２の連結部材１２２には穴１２２ａが形成される。一対の結合部材１２４は、実質的に第２の連結部材１２２と同じ材質で形成される。また、一対の結合部材１２４は、ワイヤ１４１Ａを中心に対向する両側に形成される。さらに、一対の結合部材１２４は、上方に向かって互いに近くなる。よって、一対の結合部材１２４はワイヤ１４１Ａを略囲む形状を有し、これによりワイヤ１４１Ａはコネクタ１２０Ａに強く結合、連結及び接続される。さらに、一対の結合部材１２４は、別途の工具によりクランプ（ｃｌａｍｐｉｎｇ）されてもよい。すなわち、一対の結合部材１２４の上端がプライヤー（ｐｌｉｅｒ）のような工具により互いに密着されて、クランプされてもよい。これによって、一対の結合部材１２４とワイヤ１４１Ａの間の結合力はさらに向上する。

【００３４】

加圧部１２５は、第１の連結部材１２１から上方に折曲された後、また水平方向に折曲されて、第２の連結部材１２２の端部を加圧する。このような加圧部１２５は、連結領域１２３と対向する反対側に形成される。さらに、加圧部１２５は、ワイヤ１４１Ａの端部と対応する位置に形成される。よって、加圧部１２５によりワイヤ１４１Ａの結合深さが制限される。これにより、コネクタ１２０Ａに対するワイヤ１４１Ａの結合深さが一定となるように制御される。ここで、加圧部１２５は第１及び第２の連結部材１２１，１２２の第２の側縁部に形成されている。

【００３５】

一方、ワイヤ１４１Ａは、一対の結合部材１２４の間に挟まれて結合、接続及び連結される。また、ワイヤ１４１Ａとコネクタ１２０Ａの結合力が増加するように、ワイヤ１４１Ａと一対の結合部材１２４に半田付け１５０がさらに形成されてもよい。さらに、ワイヤ１４１Ａは一対の結合部材１２４の間に挟まれて結合、接続及び連結され、追加的に結合部材１２４がクランプされてもよい。さらに、このようにクランプされた後、ワイヤ１４１Ａと結合部材１２４に半田付け１５０が形成されてもよい。

【００３６】

このような半田付け１５０は、実質的にワイヤ１４１Ａと一対の結合部材１２４だけで

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なく、第１の連結部材１２１及び第２の連結部材１２２の一部領域を覆ってもよい。もちろん、半田付け１５０のうち過剰に使用された一部は、第２の連結部材１２２に形成された穴１２２ａに収容される。実質的に、このために一対の結合部材１２４が有する幅に比べて穴１２２ａの幅が相対的に大きくなるように形成されることで、過剰に使用された半田付け１５０の一部が穴１２２ａに容易に収容されるようになっている。このようにして、ワイヤ１４１Ａはコネクタ１２０Ａに形成された一対の結合部材１２４に結合、接続及び連結されるだけでなく、半田付け１５０で囲まれることで、ワイヤ１４１Ａとコネクタ１２０Ａの間の結合力はさらに向上する。

【００３７】

また、図６ｄに示すように、第２の連結部材１２２には、穴１２２ａの代わりに凹溝１２２ｂが形成されてもよい。このような凹溝１２２ｂにも半田付け１５０のうち過剰に使用された一部が収容されることで、過剰に使用された半田付けがコネクタ１２０Ａの外側に流れ出ることを防止する。

【００３８】

このようにして、本発明の一実施形態では、ワイヤ１４１Ａがコネクタ１２０Ａに具備された一対の結合部材１２４に結合、接続または連結されることができる。また、本発明の別の実施形態では、ワイヤ１４１Ａがコネクタ１２０Ａに具備された一対の結合部材１２４に結合、接続または連結された後、一対の結合部材１２４がクランプされてもよい。また、本発明の別の実施形態では、ワイヤ１４１Ａがコネクタ１２０Ａに具備された一対の結合部材１２４に結合、接続または連結された後、ワイヤ１４１Ａ及び結合部材１２４に半田付け１５０が形成されてもよい。また、本発明の別の実施形態では、ワイヤ１４１Ａがコネクタ１２０Ａに具備された一対の結合部材１２４に結合、接続または連結され、一対の結合部材１２４がクランプされた後、ワイヤ１４１Ａ及び結合部材１２４に半田付け１５０が形成されてもよい。したがって、本発明の実施形態によれば、コネクタ１２０Ａとワイヤ１４１Ａの間の結合力がさらに向上する。

【００３９】

さらに、本発明の一実施形態によると、ワイヤ１４１Ａに大電流が流れて高熱が発生することで、半田付け１５０が溶融される場合にも、一対の結合部材１２４にワイヤ１４１Ａが結合されているため、コネクタ１２０Ａからワイヤ１４１Ａが分離されることが防止される。

【００４０】

図７ａ～図７ｆは、本発明の別の実施形態によるバッテリーパックのコネクタを用いたワイヤの結合方法を順に示す斜視図である。

本発明の別の実施形態によるバッテリーパック１００のコネクタ１２０Ａ及びワイヤ１４１Ａの結合方法は、コネクタ１２０Ａを準備する段階、コネクタ１２０Ａを折曲する段階、コネクタ１２０Ａをバッテリーセル及び／または保護回路基板に電気的に連結する段階及びワイヤ１４１Ａを結合する段階を含む。

本発明の別の実施形態は、コネクタ１２０Ａに具備された一対の結合部材１２４をクランプする段階をさらに含んでもよい。

本発明の別の実施形態は、ワイヤ１４１Ａに半田付け１５０を形成する段階をさらに含んでもよい。ここで、半田付け１５０を形成する段階は、ワイヤ１４１Ａの結合段階の後に行われたり、または結合部材１２４のクランプ段階の後に行われてもよい。これを順次に説明する。

【００４１】

図７ａに示すように、コネクタ１２０Ａを準備する段階では、第１の連結部材１２１、第２の連結部材１２２、連結領域１２３、一対の結合部材１２４及び加圧部１２５を有するコネクタ１２０Ａを準備する。ここで、第１の連結部材１２１及び第２の連結部材１２２は、略平らな形状を有し、連結領域１２３は、容易な折曲のために、第１の連結部材１２１と第２の連結部材１２２の境界線に沿って凹状にラウンド形状を有している。さらに、連結領域１２３がまだ折曲されていないので、一対の結合部材１２４は上方ではなく下

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方に向けて形成されている。さらに、連結領域１２３の反対側に形成された加圧部１２５もまだ上方に折曲された状態ではないので、第１の連結部材１２１と同様に略平らな状態を維持している。

第１の連結部材１２１を構成する本体１２１ａ及び延長部１２１ｂにそれぞれ形成された溶接のための凹溝１２１ｃ，１２１ｄ、溶接時の熱拡散を防止するための切開部１２１ｅ、第２の連結部材１２２に形成された半田付けオーバフロー防止用の穴１２２ａなどについては、既に説明したので、これについての説明は省略する。

【００４２】

図７ｂに示すように、コネクタ１２０Ａを折曲する段階では、第１の連結部材１２１または第２の連結部材１２２を折曲することで、第１の連結部材１２１上に第２の連結部材１２２を位置させる。実質的に、第１の連結部材１２１と第２の連結部材１２２を連結する連結領域１２３を折曲することで、第１の連結部材１２１上に第２の連結部材１２２が位置するようになる。このとき、第１の連結部材１２１から水平方向に突出して形成された加圧部１２５も、上部に折曲される。すなわち、加圧部１２５は略「Ｃ」字形状に折曲される。言い換えれば、加圧部１２５の端部が第２の連結部材１２２の端部を覆うように折曲されることで、第１の連結部材１２１と第２の連結部材１２２の間に隙間が形成されないようにする。上述したように、このような加圧部１２５は第１の連結部材１２１と第２の連結部材１２２を互いに密着させるだけでなく、後述するワイヤ１４１Ａの結合深みを制限する役割も果たす。さらに、このようなコネクタ１２０Ａの折曲段階により、第２の連結部材１２２に形成された穴１２２ａは、第１の連結部材１２１上に位置する。よって、穴１２２ａと対応する第１の連結部材１２１の所定領域が上部に露出する。

【００４３】

図７ｃに示すように、コネクタ１２０Ａをバッテリーセル及び／または保護回路基板に電気的に連結する段階では、コネクタ１２０Ａの第１の連結部材１２１をバッテリーセル１１０及び／または保護回路基板（図示せず）に電気的に連結する。例えば、コネクタ１２０Ａの第１の連結部材１２１をバッテリーセル１１０上に位置させる。より具体的に、第１の連結部材１２１の本体１２１ａと延長部１２１ｂをバッテリーセル１１０上に位置させる。次いで、本体１２１ａ及び延長部１２１ｂにそれぞれ具備された凹溝１２１ｃ，１２１ｄに溶接工具２４０を位置させる。溶接工具２４０からのエネルギーが凹溝１２１ｃ，１２１ｄ及びバッテリーセル１１０に伝達され、これによって凹溝１２１ｃ，１２１ｄを介して第１の連結部材１２１がバッテリーセル１１０に溶接される。ここで、本体１２１ａと延長部１２１ｂの間に形成された切開部１２１ｅは、溶接工程中に溶接工具２４０による熱が拡散せず凹溝１２１ｃ，１２１ｄに集中されるようにし、これによって溶接効率がさらに向上する。

【００４４】

図７ｄに示すように、ワイヤ１４１Ａを結合する段階では、ワイヤ１４１Ａを、第２の連結部材１２２と一対の結合部材１２４が形成する空間に、位置させて結合する。このとき、ワイヤ１４１Ａの結合深みは加圧部１２５により制限されるので、適切な長さのワイヤ１４１Ａが結合部材１２４に結合される。これにより、ワイヤ１４１Ａは、コネクタ１２０Ａに電気的に結合、接続及び連結される。

このようにして、本発明の一実施形態によるコネクタ１２０Ａとワイヤ１４１Ａの結合方法はワイヤ１４１Ａの結合段階で終了されてもよい。

さらに、本発明の別の実施形態によるコネクタ１２０Ａとワイヤ１４１Ａの結合方法は、ワイヤ１４１Ａの結合段階の以後、半田付けを形成する段階がさらに行われた後に終了してもよい。すなわち、半田付けが、ワイヤ１４１Ａ及びワイヤを囲む一対の結合部材１２４に形成されることで、ワイヤ１４１Ａをコネクタ１２０Ａと、より堅固に結合することができる。このとき、半田付けはワイヤ１４１Ａ及び結合部材１２４だけでなく、第１の連結部材１２１及び第２の連結部材１２２の一部領域に形成されてもよい。このとき、過剰に使用された半田付けは第２の連結部材１２２に形成された穴１２２ａの内部に収容されるので、コネクタ１２０Ａの外部に過剰に使用された半田付けが流れ出ることが防止

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させる。

【００４５】

図７ｅに示すように、結合部材１２４をクランプする段階では、ワイヤ１４１Ａの外部に形成された結合部材１２４をクランプする。例えば、プライヤー（ｐｌｉｅｒ）のような工具２３０を用いて一対の結合部材１２４の上端を互いに圧着することで、一対の結合部材１２４の上端がワイヤ１４１Ａに、より近く密着される。

ここで、本発明の別の実施形態によるコネクタ１２０Ａとワイヤ１４１Ａの結合方法は、結合部材１２４のクランプ段階後すぐ終了されてもよい。すなわち、半田付けが形成されなくても、結合部材１２４によりワイヤ１４１Ａをコネクタ１２０Ａに強く結合、接続及び連結することができる。

【００４６】

図７ｆに示すように、ワイヤ１４１Ａに半田付け１５０を形成する段階では、ワイヤ１４１Ａ及び一対の結合部材１２４に半田付け１５０を形成する。このとき、半田付け１５０は、ワイヤ１４１Ａ及び結合部材１２４だけでなく、第１の連結部材１２１及び第２の連結部材１２２の一部領域に形成されてもよい。勿論、このような半田付け１５０の形成時、過剰に使用された半田付けは第２の連結部材１２２に形成された穴１２２ａに収容されるので、過剰に使用された半田付けがコネクタ１２０Ａの外側に流れ出ることが防止される。これにより、ワイヤ１４１Ａは結合部材１２４に結合、接続及び連結されるだけでなく、半田付け１５０がワイヤ１４１Ａを略囲む形状を有するので、ワイヤ１４１Ａとコネクタ１２０Ａの結合強度がさらに向上する。

このようにして、本発明の一実施形態によるバッテリーパック１００のコネクタ１２０Ａとワイヤ１４１Ａの結合方法は、コネクタ１２０Ａに具備された結合部材１２４を利用してワイヤ１４１Ａを１次結合し、次に半田付け１５０でワイヤ１４１Ａを２次結合することで、全体の工程時間が短くなり、また工程全体の間において危険要素がないので、作業安全性も向上する。

【００４７】

以上で説明したものは本発明によるバッテリーパックのコネクタ及びこれの結合方法を実施するための一実施形態に過ぎないものであって、本発明は上記の実施形態に限定されず、以下の特許請求の範囲で請求するように本発明の要旨を逸脱することなく当該発明の属する分野における通常の知識を有する者であれば誰でも様々な変更実施が可能な範囲まで本発明の技術的精神がある。

【符号の説明】

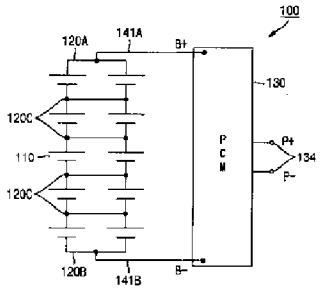
【００４８】

１００　バッテリーパック
１１０　バッテリーセル
１１１　正極端子
１１２　負極端子
１２０Ａ，１２０Ｂ，１２０Ｃ　コネクタ
１２１　第１の連結部材
１２１ａ　本体
１２１ｂ　延長部
１２１ｃ　凹溝
１２２　第２の連結部材
１２２ａ　穴
１２３　連結領域
１２４　結合部材
１２５　加圧部
１３０　保護回路モジュール
１３１Ａ　正極パッド
１３１Ｂ　負極パッド

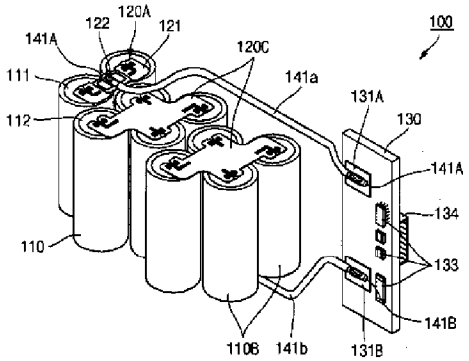
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１３３　　電子素子
１３４　　コネクタ
１４１Ａ，１４１Ｂ　　ワイヤ
１４１ａ，１４１ｂ　　絶縁被覆
１５０　　半田付け

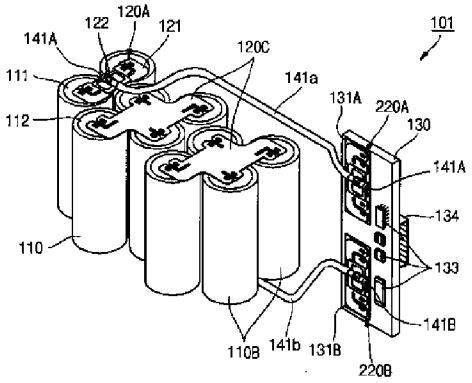
【図１】



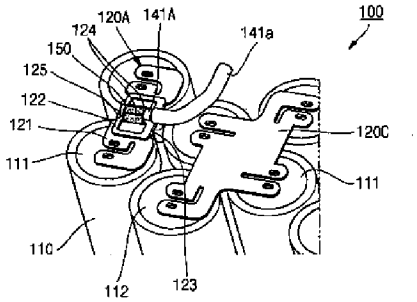
【図２】



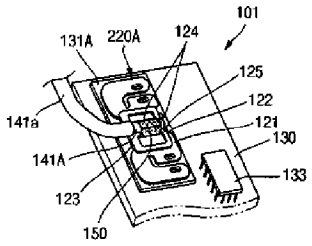
【図３】



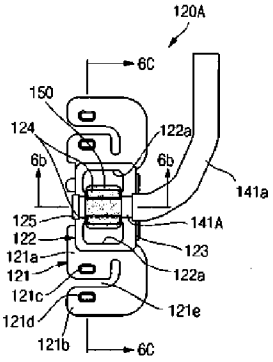
【図４】



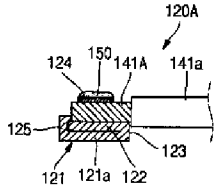
【図５】



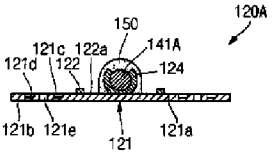
【図６ａ】



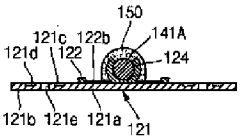
【図６ｂ】



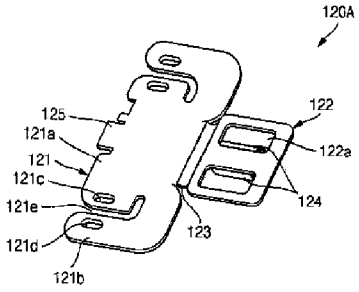
【図６ｃ】



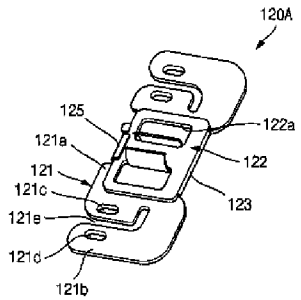
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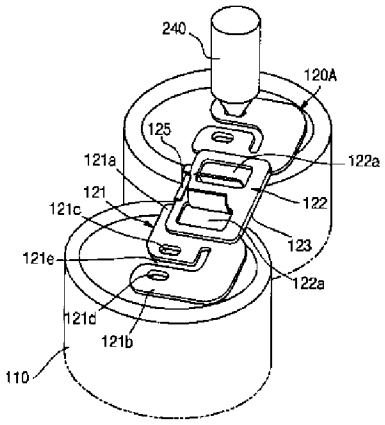
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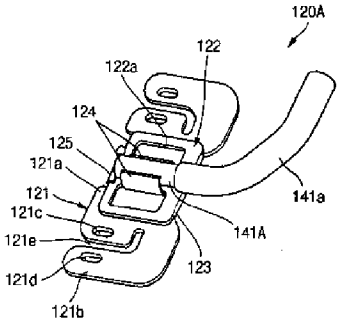
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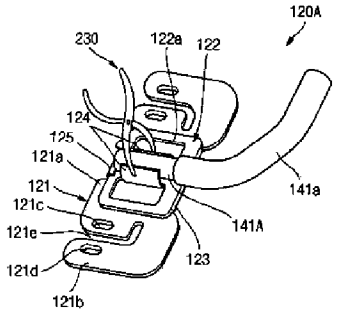
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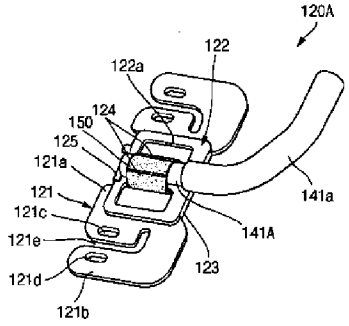
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フロントページの続き

Fターム(参考) 5H040 AA03 AA07 AA22 AS05 AS14 AS19 AT01 AT02 AT04 DD10
JJ02
5H043 AA01 AA03 AA11 AA12 AA19 AA20 BA19 BA20 CA03 CA04
CA08 DA20 FA02 FA22 FA23 FA24 FA40 HA02 HA02D HA02F
HA06 HA06D HA06F HA08D HA08F HA09 HA09D HA09F HA11D HA11F
HA13 HA13D HA13F JA01 JA01D JA01F JA02 JA02D JA02F JA03
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KA07D KA07F KA08D KA08F

ADC EX1002
IPR2025-00885

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 November 2010 (11.11.2010)

PCT

(10) International Publication Number
WO 2010/129723 A2

(51) International Patent Classification:
B60R 16/02 (2006.01) *H02H 7/20* (2006.01)

(21) International Application Number:
PCT/US2010/033799

(22) International Filing Date:
5 May 2010 (05.05.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

61/175,696	5 May 2009 (05.05.2009)	US
12/559,357	14 September 2009 (14.09.2009)	US
12/731,041	24 March 2010 (24.03.2010)	US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

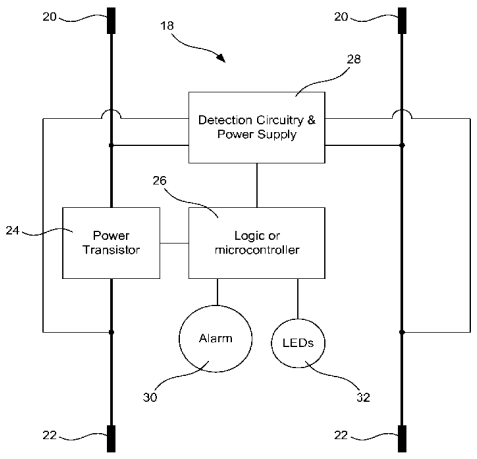
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) **Title**: LOW-VOLTAGE CONNECTION WITH SAFETY CIRCUIT AND METHOD FOR DETERMINING PROPER CONNECTION POLARITY

FIG. 2



(57) **Abstract**: A safety circuit for use in low-voltage systems improves safety of and additional features to low-voltage connections. When incorporated into a battery, the circuit leaves the battery disconnected from the low-voltage system until it determines that it is safe to make a connection. When the safety circuit determines that no unsafe conditions exist and 5 that it is safe to connect the battery or low-voltage systems, the safety circuit may make the connection by way of a soft start that provides a connection over a period of time that reduces or prevents inductive voltage spikes. A method is used for detection of proper polarity of the connections between the battery and the low-voltage system. When incorporated into a jumper cable, the 10 safety circuit provides communication abilities, can provide test abilities, and improves connection safety and functionality, such as allowing transfer of power between low-voltage systems having different voltages.

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ADC EX1002
IPR2025-00885

LOW-VOLTAGE CONNECTION WITH SAFETY CIRCUIT AND METHOD FOR DETERMINING PROPER CONNECTION POLARITY

TECHNICAL FIELD

The present invention relates to batteries and jumper cables and, more particularly, to batteries and jumper cables providing certain safety features.

BACKGROUND ART

Cables such as jumper cables are commonly used to connect two low-voltage (e.g. battery-powered) systems temporarily. However, the use of such cables can result in personal injury and equipment damage. For example, one instance where equipment damage or personal injury occurs is in the case of jump starting a car with a "dead" (i.e. partially- or totally-discharged) battery using a car with a good battery. During connection of jumper cables to jump start the car with the discharged battery, a spark may be created, and if the spark is in the vicinity of hydrogen gas commonly generated by car batteries, the spark can ignite the hydrogen gas to explosive effect. Additionally, as the connection is made between vehicles, inductive voltage spikes may be formed, and the voltage spikes can damage sensitive automotive electronics, including expensive computer-controlled engine control components and the like. Additionally, connecting a jumper cable set backward (i.e. with polarity of one of the battery connections reversed) can also cause injury or damage.

Similar problems can be encountered when replacing a battery in a battery-containing low-voltage system. For example, a battery that is improperly connected (e.g. a battery connected with reverse polarity, a battery connected to a system having an intermittent or long-term short circuit, etc.) can cause equipment damage or injury.

SUMMARY OF THE INVENTION

Implementation of the invention provides a connecting cable between two low-voltage systems (such as batteries) that includes a safety circuit. The safety circuit leaves the two low-voltage systems disconnected until it determines that it is safe to make a connection. If the safety circuit detects an unsafe condition, it responds to the unsafe condition in one or more of several fashions. In some instances, the safety circuit can internally reverse connection polarity to correct for incorrect connections between low-voltage systems of a reversed-polarity type. In some instances, the safety circuit provides an audible and/or visible alarm identifying a potential problem. In some instances, the safety circuit refuses to make a connection between the two low-voltage systems while an unsafe condition exists.

As it may be desirable to connect two low-voltage systems in an instance where one of the low-voltage systems has a completely-discharged battery incorporated into it, implementations of the invention may utilize a method for detection of proper polarity of the connections between the low-voltage systems. This method is particularly useful when a voltage of one of the low-voltage systems is below a reliable detection threshold and relies on nonlinear behavior of any discharged batteries in the low-voltage system. The polarity of the discharged battery (and thus whether the connected cable is connected correctly) is determined by passing a small amount of current through it and determining whether a corresponding voltage rise is observed (indicating a correct polarity connection) or not (indicating an incorrect polarity connection). In some implementations, test currents can be applied in opposite polarities and the resulting measured voltages compared to more reliably detect incorrect polarity connection and additional potential problem causes.

Further implementation of the invention provides a safety circuit for use in low-voltage systems that improves safety of and provides additional features to low-voltage connections. When incorporated into a battery, the circuit leaves the battery disconnected from the low-voltage system until it determines that it is safe to make a connection. When the safety circuit determines that no unsafe conditions exist and that it is safe to connect the battery, the safety circuit may connect the battery by way of a "soft start" that provides a connection over a period of time that reduces or prevents inductive voltage spikes on the low-voltage system. A method is used for detection of proper polarity of the connections between the battery and the low-voltage system. When incorporated into a jumper cable, the safety circuit provides communication abilities, can provide test abilities, and improves connection safety and functionality, such as allowing transfer of power between low-voltage systems having different voltages.

Implementation of the invention provides a battery-integrated connection between a battery and a low-voltage system that includes a safety circuit. The safety circuit leaves the low-voltage system disconnected until it determines that it is safe to make a connection. If the safety circuit detects an unsafe condition, it responds to the unsafe condition in one or more of several fashions. In some instances, the safety circuit can internally reverse connection polarity to correct for incorrect connections to the low-voltage system of a reversed-polarity type. In some instances, the safety circuit provides an audible and/or visible alarm identifying a potential problem. In some instances, the safety circuit refuses to make a connection to the low-voltage system while an unsafe condition exists.

When the safety circuit determines that no unsafe conditions exist and that it is safe to connect or power the low-voltage system, the safety circuit may connect the system by way of a "soft start." The soft start provides a connection between the two systems that is not instantaneous, but is instead provided over a period of time, such as approximately a millisecond to tens of milliseconds, that reduces or prevents inductive voltage spikes on the low-voltage system. The soft start procedure reduces and/or prevents damage to sensitive low-voltage electronics forming a part of the low-voltage system.

Some implementations of the invention utilize one or more high-current transistors as a switch to connect the two low-voltage systems. The one or more transistors are controlled by the safety circuit or control circuit that detects the condition at each end of the connection cable or cables. In other implementations providing automatic correction of attempted reversed-polarity connections, additional components are used to provide additional convenience. While such implementations provide no additional safety benefit over implementations not providing automatic polarity reversal as the connection is not completed when a reversed polarity is detected, the added convenience of not requiring manual polarity correction may justify the added component cost in some instances.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the present invention will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only typical embodiments of the invention and are, therefore, not to be considered limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

Figure 1 shows a perspective view of a jumper cable embodiment;

Figure 2 shows a schematic illustrating concepts in accordance with embodiments of the invention;

Figure 3 shows a perspective view of a representative circuit board in accordance with embodiments of the invention;

Figure 4 shows a generalized circuit schematic representative of a discharged car battery in a car;

Figure 5 shows a representative schematic showing one method for testing a battery for proper polarity;

Figure 6 shows a representative schematic showing another method for testing a battery for proper polarity;

Figure 7 shows a representative circuit diagram for use in embodiments of the invention;

Figures 8-12 show expanded views of portions of the circuit diagram shown in Figure 7;

Figures 9-17 show flow charts illustrating processes that may be implemented in the circuit of Figures 7-12;

Figure 18 shows one example of a battery incorporating protection circuitry;

Figures 19-20 show overview views of a representative circuit diagram for use in embodiments of the invention; and

Figures 21-27 show expanded views of portions of the representative circuit of Figures 19-20 with representative component values added for clarity.

DETAILED DESCRIPTION OF THE INVENTION

A description of embodiments of the present invention will now be given with reference to the Figures. It is expected that the present invention may take many other forms and shapes, hence the following disclosure is intended to be illustrative and not limiting, and the scope of the invention should be determined by reference to the appended claims.

Embodiments of the invention provide a connecting cable or cables (such as jumper cables) between two low-voltage systems (such as batteries, battery-powered systems, or low-voltage systems incorporating one or more batteries) that includes a safety circuit. The safety circuit leaves the two low-voltage systems disconnected until it determines that it is safe to make a connection. If the safety circuit detects an unsafe condition, it responds to the unsafe condition in one or more of several fashions. In some instances, the safety circuit can internally reverse connection polarity to correct for incorrect connections between low-voltage systems of a reversed-polarity type. In some instances, the safety circuit provides an audible and/or visible alarm identifying a potential problem. In some instances, the safety circuit refuses to make a connection between the two low-voltage systems while an unsafe condition exists.

Embodiments of the invention provide a safety circuit for use in low-voltage systems that improves safety of and provides additional features to low-voltage connections. When incorporated into a battery, the circuit leaves the battery disconnected from the low-voltage system until it determines that it is safe to make a connection. When the safety circuit determines that no unsafe conditions exist and that it is safe to connect the battery, the safety circuit may connect the battery by way of a "soft start" that provides a connection over a period

of time that reduces or prevents inductive voltage spikes on the low-voltage system. A method is used for detection of proper polarity of the connections between the battery and the low-voltage system. When incorporated into a jumper cable, the safety circuit provides communication abilities, can provide test abilities, and improves connection safety and functionality, such as allowing transfer of power between low-voltage systems having different voltages.

Further embodiments of the invention provide a battery-integrated connection between a battery and a low-voltage system that includes a safety circuit. The safety circuit leaves the low-voltage system disconnected until it determines that it is safe to make a connection. If the safety circuit detects an unsafe condition, it responds to the unsafe condition in one or more of several fashions. In some instances, the safety circuit can internally reverse connection polarity to correct for incorrect connections to the low-voltage system of a reversed-polarity type. In some instances, the safety circuit provides an audible and/or visible alarm identifying a potential problem. In some instances, the safety circuit refuses to make a connection to the low-voltage system while an unsafe condition exists.

When the safety circuit determines that no unsafe conditions exist and that it is safe to connect or power the low-voltage system, the safety circuit may connect the system by way of a "soft start." The soft start provides a connection between the two systems that is not instantaneous, but is instead provided over a period of time, such as approximately a millisecond to tens of milliseconds, that reduces or prevents inductive voltage spikes on the low-voltage system. The soft start procedure reduces and/or prevents damage to sensitive low-voltage electronics forming a part of the low-voltage system.

Some embodiments of the invention utilize one or more high-current transistors as a switch to connect the two low-voltage systems. The one or more transistors are controlled by the safety circuit or control circuit that detects the condition at each end of the connection cable or cables. In other embodiments providing automatic correction of attempted reversed-polarity connections, additional components are used to provide additional convenience. While such embodiments provide no additional safety benefit over embodiments not providing automatic polarity reversal as the connection is not completed when a reversed polarity is detected, the added convenience of not requiring manual polarity correction may justify the added component cost in some instances.

An embodiment of the invention includes a battery-integrated safety circuit for use in establishing that a low-voltage system is safely and properly connected to a battery. The safety

circuit includes a pair of output terminals, a detection circuit operatively connected to the output terminals and configured to detect whether the output terminals are properly connected to a low-voltage system with a correct polarity, and a power-controlling circuit configured to provide electrical power to the output terminals only when a proper connection of correct polarity has been detected.

In some embodiments, the power-controlling circuit provides electrical power to the output terminals using a soft start procedure that reduces inductive voltage spikes. As one example, the power-controlling circuit may control one or more power transistors that are used to provide electrical power to the output terminals using the soft start procedure. The soft start procedure provides electrical power to the output terminal over a period of approximately a millisecond to tens of milliseconds.

A battery-integrated safety circuit may also include a polarity test circuit configured to supply a test current to the output terminals and measure a resulting voltage to determine a proper polarity of a low-voltage system connected to the output terminals. The polarity test circuit may be configured to supply test currents of different directions and to compare the voltages caused by the test currents.

Another embodiment of the invention provides a battery containing a battery-integrated safety circuit, the battery having a positive terminal, a negative terminal, and a safety circuit operatively connected to the positive terminal and the negative terminal and configured to supply power through the positive and negative terminals only when a connection between the terminals and a low-voltage system has been properly made with a correct polarity. The battery may prevent the supply of power to the positive and negative terminals when a short circuit exists between the positive and negative terminals. The safety circuit may include a polarity test circuit configured to supply a test current to the terminals and measure a resulting voltage to determine a proper polarity of a low-voltage system connected to the battery. The safety circuit may also include a detection circuit operatively connected to the terminals and configured to detect whether the terminals are connected to the low-voltage system with the correct polarity, and a power-controlling circuit configured to provide electrical power to the terminals.

Another embodiment encompasses a battery having an energy storage cell, a pair of output terminals, and a safety circuit electrically connected to the energy storage cell. The safety circuit includes a detection circuit operatively connected to the output terminals for detecting whether the output terminals are properly connected to a low-voltage system with a correct polarity of connection, and a power-controlling circuit configured to supply power from

the energy storage cell to the output terminals only when a proper connection of correct polarity has been detected.

Other embodiments of the invention illustrating features of the battery-incorporated safety circuits provide a connecting cable or cables (such as jumper cables) between two low-voltage systems (such as batteries, battery-powered systems, or low-voltage systems incorporating one or more batteries) that includes a safety circuit. The safety circuit leaves the two low-voltage systems disconnected until it determines that it is safe to make a connection. If the safety circuit detects an unsafe condition, it responds to the unsafe condition in one or more of several fashions. In some instances, the safety circuit can internally reverse connection polarity to correct for incorrect connections between low-voltage systems of a reversed-polarity type. In some instances, the safety circuit provides an audible and/or visible alarm identifying a potential problem. In some instances, the safety circuit refuses to make a connection between the two low-voltage systems while an unsafe condition exists.

When the safety circuit determines that no unsafe conditions exist and that it is safe to connect the two low-voltage systems, the safety circuit may connect the two systems by way of a "soft start." The soft start provides a connection between the two systems that is not instantaneous, but is instead provided over a period of time, such as approximately a millisecond to tens of milliseconds, that reduces or prevents inductive voltage spikes on one or more of the low-voltage systems. The soft start procedure reduces and/or prevents damage to sensitive low-voltage electronics forming a part of one or more of the low-voltage systems.

Some embodiments of the invention utilize two high-current transistors as a switch to connect the two low-voltage systems. The transistors are controlled by the safety circuit or control circuit that detects the condition at each end of the connection cable or cables. In other embodiments providing automatic correction of attempted reversed-polarity connections, additional components are used to provide additional convenience. While such embodiments provide no additional safety benefit over embodiments not providing automatic polarity reversal as the connection is not completed when a reversed polarity is detected, the added convenience of not requiring manual polarity correction may justify the added component cost in some instances.

In some embodiments, inexpensive transistors may be used, and the safety circuit or control circuit incorporates features to protect the transistors from potential damage. For example, the safety or control circuit may maintain a thermal model of the transistors and may turn the transistors off and on to protect the transistors against failure. Additionally, the safety

or control circuit may monitor for over-current conditions that could destroy the transistors in short periods of time, and could turn off the transistors when such conditions are detected. Such types of protection/detection also may serve to protect components of one or more of the connected low-voltage systems, such as by preventing a starter motor from overheating due to excessive cranking. The safety or control circuit may also monitor for under-voltage conditions on the transistor supply side, to prevent the transistors from entering a non-fully-on state that would cause increased heating and damage to the transistors.

As it may be desirable to connect two low-voltage systems in an instance where one of the low-voltage systems has a completely-discharged battery incorporated into it, embodiments of the invention may utilize a method for detection of proper polarity of the connections between the low-voltage systems. Such a method is particularly useful when a voltage of one of the low-voltage systems is below a reliable detection threshold. The method may rely on nonlinear behavior of any discharged batteries in the low-voltage system. The polarity of the discharged battery (and thus whether the connected cable is connected correctly) is determined by passing a small amount of current through it and determining whether a corresponding voltage rise is observed (indicating a correct polarity connection) or not (indicating an incorrect polarity connection). In some embodiments, test currents can be applied in opposite polarities and the resulting measured voltages compared to more reliably detect incorrect polarity connection and additional potential problem causes.

Similar methods may be used to discriminate between a short circuit condition (e.g. clamps touching) and a completely-discharged battery, and at least some embodiments may incorporate such features. Embodiments may also be able to detect whether there are batteries connected to both ends of the circuit by biasing the voltage at each connection to a voltage unlikely to occur in the low-voltage systems, such as 6.5 volts for a typical car battery system. If the voltage then varies from this value by a small amount in either direction, a battery is determined to be connected.

Figure 1 provides a perspective view of a jumper cable set 10 incorporating features in accordance with embodiments of the invention. The jumper cable set 10 includes a first pair of contact clamps 12 and a second pair of contact clamps 14. When two low-voltage systems (e.g. systems commonly including one or more batteries) are to be connected, the first pair of contact clamps 12 and the second pair of contact clamps 14 are used to connect to high and low (e.g. high and ground) terminals of the two low-voltage systems, similar to the manner in which such connections are commonly made with existing jumper cables. In automotive systems and other

vehicles (boats, motorcycles, all-terrain vehicles (ATVs), etc.), the final connection is commonly made to a ground location away from any battery to minimize the risk of any spark igniting hydrogen gas off-gassed by the battery. While this final connection is used or recommended with embodiments of the invention for maximum safety, such sparking is greatly reduced using embodiments of the invention, as no electrical connection is provided between the first pair of contact clamps 12 and the second pair of contact clamps 14 until it has been determined that it is safe to do so.

The jumper cable set 10 includes a control box 16 that provides one or more features including the features of testing the connections and of preventing any electrical connection until it has been determined that it is safe to provide the electrical connection. Although the control box 16 is illustrated as being physically close to the first pair of contact clamps 12 in Figure 1, it should be understood that the control box 16 can be located at any physical position along the jumper cable set 10 where it can control the electrical connection between the two pairs of contact clamps 12, 14. Placing the control box 16 near one of the ends of the jumper cable set 10 may provide some benefits to a user of the jumper cable set 10, such as making it more intuitive to know which end of the jumper cable set 10 has a problem by lighting an indicator on one side of the control box 16. It may also make it easier to see when the unit is powered (such as by a power-on LED). It also keeps the control box 16 in a location less likely to be stepped on, tripped over, etc. Such a location makes it less likely for one of the two pairs of contact clamps 12, 14 to be disturbed from their attachments to the battery by a user seeking to view the control box 16, and may assist in keeping the control box 16 out of water that may be on an underlying surface.

The control box 16 includes a safety circuit that leaves the two low-voltage systems disconnected until the safety circuit determines that it is safe to make the connection. If the safety circuit determines that it is unsafe to proceed, it may sound an audible alarm or illuminate one or more warning lights on the control box 16 to identify any detected potential problem before the problem can cause damage or injury. In some embodiments, the selection of lights illuminated or a physical and/or timed pattern of lights illuminated may indicate the type of problem detected. In other embodiments, no alarm (visual or auditory) is provided; instead, the connection is simply not made.

When the safety circuit determines that it is safe to proceed, the safety circuit completes the connection between the two low-voltage systems smoothly in a soft start. The soft start prevents or minimizes inductive voltage spikes that could damage sensitive electronics of the

low-voltage systems (such as an automobile computer component). In some embodiments, as a connection is made, and audible and/or visual notification may be provided so the user becomes aware that the connection has been made. In the case of a vehicle having a discharged battery, the user can thus be notified that the vehicle can then be started.

Figure 2 provides a diagram illustrating the concepts incorporated into one embodiment of a safety circuit 18 such as housed within the control box 16. The safety circuit 18 includes input terminals 20 and output terminals 22 that are electrically connected to the first and second pairs of contact clamps 12, 14. The input terminals 20 and the output terminals 22 are connected in this embodiment by way of one or more power transistors 24. The power transistor 24 (or transistors) are controlled by a logic circuit or microcontroller 26 that is operatively connected to a detection circuit and power supply 28. The detection circuit and power supply 28 and the logic circuit or microcontroller 26 may be powered by power received from the input terminals 20 (or alternatively the output terminals 22, depending on how the jumper cables are connected to active/inactive low-voltage systems), and therefore, no internal battery/power supply need be provided in at least some embodiments. The detection circuitry detects connection conditions on the input terminals 20 and the output terminals 22. The detection circuitry determines whether it is safe to connect the input terminals 20 and the output terminals 22. In embodiments where the safety circuit 18 is configured to correct for incorrect connection conditions (not shown in Figure 2) such as a reversed-polarity connection, the detection circuitry also detects such conditions and signals that a correction is necessary.

Control or detection information is passed from the detection circuitry to the logic circuit or microcontroller 26. The logic circuit or microcontroller 26 uses this information to activate a connected alarm 30 and one or more optical signals 32 based on the conditions detected by the detection circuitry. For example, if proper connection conditions are detected and it is determined that it is safe to make a connection, the logic circuit or microcontroller 26 can activate a green LED as a signal of proper connection prior to or concurrent with making an electrical connection between the two low-voltage circuits connected to the input terminals 20 and the output terminals 22. Alternatively, a red LED might be activated if an improper connection is detected, along with activation of the alarm 30. Different signals (via the alarm 30 and/or the optical signal 32 or optical signals 32) may be used to indicate different detected conditions (e.g. reversed polarity, no connection, short circuit, etc.).

When the safety circuit 18 determines that it is safe to proceed, the one or more power transistors 24 is used to make the electrical connection between the input terminals 20 and the

output terminals 22, thereby connecting the two low-voltage systems. The one or more power transistors 24 may be controlled so as to make the electrical connection in a "soft start" to eliminate inductive voltage spikes that could cause damage to sensitive electronic components that are part of one or both low-voltage systems. The soft start is implemented in the illustrated embodiment by way of the one or more power transistors 24, which allow the electrical connection (e.g. the flow of electrical current between the input terminals 20 and the output terminals 22) to be made slowly, such as over a period of approximately one or a few milliseconds to tens of milliseconds. The one or more power transistors 24 are controlled by small voltages provided by the logic or microcontroller 26.

Although the soft start procedure has been illustrated in Figure 2 using one or more power transistors 24 (which may include one or more power transistor 24 on each of the positive and negative cables, if desired), other embodiments are envisioned, including mechanical embodiments. For example, the soft start concept can be approximated using mechanical relays fitted with suitable filtering components such as inductors and diodes and other spark-suppression components or devices. For example, one system using relays to provide a soft start approximation utilizes a pair of inductors, one on each side of the relay, with back-to-back zener diode pairs between the inductor and the relay and the other line on each side of the relay.

It is anticipated that such an embodiment might be larger and bulkier than an embodiment using semiconductor-based switches. Those of skill in the art will appreciate configurations of such devices that can be used in such embodiments. Similarly, although the embodiment of Figure 2 provides one or more power transistors 24 acting as switches to connect the two low-voltage systems, other more-complicated configurations can be provided that provide for additional features, such as automatic polarity reversal. In such an embodiment, if the polarity of the connected input terminals 20 or output terminals 22 has been reversed, the safety circuit 18 uses the extra components to correct the polarity as the input terminals 20 are electrically connected to the output terminals 22. Thus, in such an embodiment, the safety circuit 18 includes components for selectively connecting either of the input terminals 20 to either of the output terminals 22. Although such an embodiment does not improve safety over the embodiment of Figure 2, it does increase convenience, as a user need not remove and re-connect the previously-made connections between low-voltage systems.

Embodiments of the invention can be used in a wide variety of systems for connecting to low-voltage systems and/or for connecting between low-voltage systems. Non-limiting examples include jumper cable sets, retrofit modules for installation on existing jumper cable

sets, booster boxes, battery chargers, ground power units for aircraft, temporary power units for recreational vehicles, trailers, boats, and the like, battery-powered equipment charging cords (fork lifts, floor scrubbers, tugs, etc.), DC power connections for solar cells, fuel cells, and other DC-generating equipment, and DC power connections for electronics. It will be understood that embodiments may be used in a variety of situations.

Embodiments of the invention provide a wide variety of benefits. Such benefits include the soft start procedure that eliminates inductive voltage spikes. Another benefit is the small size of the safety circuit 18, such that the safety circuit 18 can often be provided in-line with the connecting cable, such as illustrated in the jumper cable set 10 shown in Figure 1. Figure 3 also illustrates this benefit, showing a perspective view of a representative circuit board that may be used to implement embodiments of the invention. Another benefit is that embodiments keep the power between various terminals off when there are problems that could cause damage or injury, such as reversed cable connections, arcing from short circuits if cable clamps are touching, and prevention of connection to a failed battery incorporated in a low-voltage system. Still other benefits include providing audible and/or visual warnings of unsafe conditions and/or safe connections.

For example, the following is provided by way of sample actions that can be taken using a jumper cable embodiment. If the cables are connected properly, a steady green LED lamp may be lit to indicate that the connection is safe and ready. The power is applied by a soft start as described above, and the user is able to start the car being jumped. However if the cables are connected backward (and the system does not provide the ability to correct reversed connections), a red LED lamp might flash and the power remains off. The user could then reconnect the cables correctly and try again. Similarly, if the cable clamps accidentally are touching or if the positive clamp is also touching a ground source, the red LED could flash (possibly in a different timing pattern or a different LED), the connection would not be completed, and the user could adjust or reconnect the cables correctly and try again. If a connection is attempted to a low-voltage system having a discharged battery with an internal short circuit, the red LED could flash, the power stays off, and the car could not be jump started, even after attempted repositioning of the cables.

Other conditions may result in disconnection of the power between the cable clamps in at least some embodiments. For example, the safety circuit 18 may be programmed to detect a successful starting of a car with a low/dead battery. Upon detection of a successful start, the connection between low-voltage systems is no longer necessary, so the safety circuit 18 may be

programmed to automatically electrically disconnect the two systems for safe removal of the jumper cables. Similarly, if the safety circuit 18 determines that a previously-good connection fails (such as one of the cable clamps falls off), it may automatically and rapidly interrupt the connection, thereby preventing potential damage or injury. As yet another example, if a user attempts to crank the engine on the discharged car for longer than a selected period of time (such as thirty seconds), the safety circuit 18 may automatically shut off the connection between systems for a predetermined time (such as one minute) to allow the starter and the jumper cables (e.g. the controller itself) to cool. If the power is interrupted in this fashion, a red LED might be lit (again, a different pattern or different light might be used) while the connection is interrupted, and a green LED re-lit when the user is permitted to re-try engine starting.

As discussed above, when jumper cables are connected to a car having a discharged battery, the polarity of the connection must be correct to avoid damage to the cars. In many instances, a discharged battery still has a significant residual voltage, but lacks sufficient starting power to start the car. In such instances, upon connection of jumper cables in accordance with embodiments of the invention, the polarity of the made connection may be determined by way of measuring the voltage at the connection. However, in some instances, the discharged battery is completely discharged, such as when the headlights have been left on for an extended period. In other instances, a battery may not be completely dead, but a sufficient electrical load is attached to the battery such that the voltage is too low to allow reliable polarity detection. For example, if a polarity determination is attempted with a low battery when the vehicle's headlights are on, the brake pedal is depressed, or the heater is on, etc., the detected voltage may be close to zero, even if the polarity would be detectable if the load were removed. In such instances, the discharged battery provides insufficient voltage to reliably determine correctness of the polarity of the attempted connection by way of measuring the voltage of the discharged battery alone. Instead, a different method is used to determine whether the connection has been made using proper polarity. This allows an automatic jumper cable controller using this method to prevent damage if the cables are accidentally connected backward while still allowing the car with the discharged battery to be started safely.

To understand the method, Figure 4 provides an electrical circuit diagram that models the car with the discharged battery. The polarity of the discharged battery can be determined by passing a small amount of current through it (and potentially simultaneously through any connected electrical components). The polarity is determined by observing the resulting voltage created in the battery-car system. When a proper-polarity connection is made, the discharged

battery's voltage will rise in a normal fashion; however, when the cables are connected backward, the voltage is limited by the nonlinear behavior of the discharged battery and the automotive equipment attached to it. This allows the control circuitry to identify an incorrectly-connected charging system before it can cause a problem.

In Figure 4, a resistance 36 and a capacitance 38 model headlights, interior lights, and other electrical loads of the automotive equipment that may be present. Meanwhile, a diode 40 represents/models the non-linear behavior of the discharged battery and the diodes in the car's alternator. When the jumper cables are connected correctly, the diode 40 conducts only a negligible amount of current, allowing the voltage to rise in response to the test current. In contrast, when the jumper cables are connected backwards, the diode conducts most of the test current, thus limiting the resulting voltage to a small value. When a reversed connection is detected, the controller can respond in any fashion discussed above (e.g. prevent completing the connection, sound an alarm or illuminate a warning light, automatically reverse the connection, etc.).

Figures 5 and 6 illustrate two embodiments for detecting correct polarity of a discharged battery. In Figure 5, a test current source 42 is electrically connected to a system containing a discharged battery 44 and other electrical loads 46. In this embodiment, a single test current is passed through the discharged battery 44. If the voltage rises above a voltage threshold (say approximately two volts for a twelve-volt battery), the associated charging equipment or other controller determines that the polarity correction is correct, and proceeds to complete the connection to the low-voltage system so the battery can be charged. If the voltage does not rise above the threshold, the connection is not completed. This embodiment has an advantage of simplicity when compared with the embodiment of Figure 6.

In the embodiment of Figure 6, a bidirectional current source 48 is used in place of the test current source 42. Thus, in this embodiment, two test currents are used in succession, one in each direction. The two induced voltages are compared with the voltage threshold, where one will commonly be found to be above the threshold while the other voltage is below the threshold. This embodiment, while more complicated than the embodiment of Figure 6, can identify other problem cases, which may be less likely. For example, if both voltages are below the threshold, this condition may be indicative of a battery having an internal short circuit. As another example, if both voltages are above the threshold, it may be indicative of a broken battery cable on the car having the discharged battery. As may be appreciated, these methods of detecting proper polarity of connection to a discharged battery as well as other battery

conditions may be implemented into a wide variety of applications, including battery charging systems, battery boosting systems, jumper cable systems, and the like.

Figure 7 provides a circuit diagram of one embodiment of the safety circuit 18. The view of Figure 7 has been expanded to show illustrative components and component values in Figures 8-12, according to the areas marked in Figure 7: area 50 is shown in more detail in Figure 8, area 52 is shown in more detail in Figure 9, area 54 is shown in more detail in Figure 10, area 56 is shown in more detail in Figure 11, and area 58 is shown in more detail in Figure 12. While an illustrative circuit has been shown and illustrative component values have also been shown, it is anticipated that many different circuit components, values, and variations could alternatively be used. Therefore, the illustrated circuit and component values are provided by way of description of one circuit for implementing an embodiment of the invention, and not by way of limitation.

Figures 13-17 illustrate flow charts describing one set of processes that may be implemented using the circuitry illustrated in Figures 7-12, and are illustrative of features of some embodiments of the invention. In the description that follows, references to pin numbers are in reference to pins of a microcontroller 60 contained in the illustrated circuitry, and the pin numbers so referenced are shown in more detail in Figure 9. The pin number references should be understood to be illustrative, and it is anticipated that microcontrollers similar to microcontroller 60 can be programmed to respond to a wide variety of circumstances on varying pins and to provide responses to a wide variety of pins. It is anticipated that one or more of the circuit components (including any microcontrollers similar to microcontroller 60) may include programmed or programmable components incorporating logic and/or software configured to effect processes similar to those discussed with respect to Figures 13-17, and embodiments of the invention embrace and incorporate such logic and/or software.

Figure 13 provides a flow chart for a main process of the circuitry of Figures 7-12. Execution begins at step 62, where at least one pair of contact claims (e.g. the first pair of contact clamps 12 and/or the second pair of contact clamps 14) is connected to a voltage source of at least a minimum voltage (here six volts). Connection of one or more of the contact clamps to a voltage supply serves to provide power to the circuit and any components thereof that require such supply to begin working, such as the microcontroller 60. Once at least one of the pairs of contact clamps is connected, any ports needing initialization are initialized.

Execution then proceeds to decision block 64, where a determination is made as to whether to calibrate the system. Whether to calibrate may be determined by an external input

that drives one of the pins of the microcontroller to low (or to high), such as by a jumper or other device. If calibration is to occur, execution proceeds to the calibration processes illustrated in Figure 16, otherwise, execution proceeds to decision block 66. At decision block 66, it is determined whether the user is done connecting cables. This may be determined by way of determining whether voltages measured at the cable clamps are within a few counts of the last several measurements. The measured voltages remain fairly stable once a particular connection has been made. If the user is still connecting the cables, execution loops back for further evaluation of whether the user has completed connecting the cables.

Otherwise, execution proceeds to decision block 68, where a determination is made as to whether both pairs of clamps are above a minimum reference voltage. In the illustrated flow chart, the minimum reference voltage is 2.5 volts, but other reference voltages may be used. If both pairs of clamps are not above the minimum reference voltage, execution proceeds to reverse polarity detection processes illustrated in Figure 14. If, however, both pairs of clamps are above the minimum reference voltage, execution proceeds to decision block 70, where a determination is made as to whether batteries are connected to both ends of the jumper cables, such as by determining whether the low voltage cable is not at the open circuit voltage. If it is determined that batteries are not connected to both ends, execution loops back to decision block 66. If, however, batteries are connected at both ends, execution proceeds to step 72, where the two low-voltage power systems are electrically connected (such as by making pin 10 of the microcontroller high to control high-current transistors). As discussed above, the electrical connection of the two low-voltage systems can be made by way of a soft start.

Execution then proceeds to decision block 74, where a determination is made as to whether too much current is flowing. This determination is made by determining whether the absolute value of the difference in currents in the two cables (positive and negative) is greater than a selected reference current. If too much current is flowing, execution proceeds to cool down procedures illustrated in Figure 15. If the reference current is not exceeded, execution proceeds to decision block 76, where a determination is made as to whether a brown-out condition (a condition where there is an under-voltage on the supply side that may cause the power transistors to fail to turn on completely) is detected. If such a condition is detected, execution proceeds to the cool-down procedures of Figure 15. If not, execution proceeds to decision block 78, where a determination is made as to whether at least a minimum amount of current (illustrated as ten amps) is flowing through the cables. If the minimum current is flowing, then the cables are still needed, and execution loops back to step 72. If, however, the

current flow has dropped below the minimum current (e.g. the car with the discharged battery has been started, etc.), execution proceeds to step 80, where the microcontroller 60 electrically disconnects the two low-voltage systems (e.g. by making pin 10 low). Thereafter, execution either terminates (not shown) or loops back to decision block 66 for detection of a need to electrically re-connect the cable ends.

Figure 14 shows an illustrative polarity detection procedure that may be used when both pairs of cable clamps are not determined to be above a minimum reference voltage, as determined at decision block 68 of Figure 13. Execution proceeds to decision block 82, where a determination is made as to which cable is low voltage. If Cable A (corresponding, for example, to the first pair of contact clamps 12) is low voltage, execution proceeds to step 84, where one or more red LEDs (or some other signal) corresponding to Cable A are turned on to provide a signal to the user of the cables (e.g. pin 7 is made high). Alternatively, if Cable B is low voltage, execution proceeds to step 86, where one or more red LEDs (or some other signal) corresponding to Cable B are turned on to provide a signal to the user of the cables (e.g. pin 8 is made high).

In either instance, execution then proceeds to decision block 88, where a determination is made as to whether the cable having the lower voltage is at a voltage below a negative reference voltage (illustrated as negative 2.5 volts). If the voltage of the cable having the lower voltage is determined to have such a voltage, that cable is connected in reverse polarity, and execution returns to Figure 13, Location 13A, immediately prior to decision block 66. Thus, whichever red LEDs (or other signal) were turned on will remain on until the cable connected in reverse polarity is removed and reconnected with proper polarity.

If, the lower voltage clamp is not more negative than the negative reference voltage, one of two circumstances may be present. First, the polarity may be correct, but the lower-voltage cable (e.g. the portion of the control circuit connected to the lower-voltage system) may be connected to a battery so discharged as to prevent reliable detection of the polarity based on voltage measurements alone. Second, the polarity may be incorrect, but the lower-voltage cable (e.g. portion of the control circuit) may be connected to a battery so discharged as to prevent reliable detection of the polarity based on voltage measurements alone. In either case, the control circuit may apply a small current to the system to determine which circumstance is occurring, so execution proceeds to step 90, where a small current is permitted to flow from the high-voltage cable to the low-voltage cable (e.g. pin 5 is made high). In the illustrated case, the current is shown as being five amps.

Execution then proceeds to decision block 92, where a determination is made as to whether any noise associated with opening a short on the cable has been detected. If so, execution proceeds to step 94 where the current is turned off (e.g. pin 5 made low). Execution then proceeds to step 96, where the red LEDs are turned off (pins 7 and/or 8 made low), and then proceeds to Figure 13, Location 13A, immediately prior to decision block 66. As long as the short circuit condition exists, execution will then return to the processes of Figure 14 and loop back to Location 13A of Figure 13, causing the process to repeatedly pass through one of steps 84 and 86, followed by step 96, causing one set of LEDs (or other signal) to flash, thereby indicating to the user the presence of a short circuit.

As discussed above, a reversed connection, such as to a system having a very discharged battery, may conduct current similarly to a short circuit, which may therefore also signal a reversed connection. Therefore, a user seeing a flashing red LED may be instructed (or know from instructions for the cables) to attempt to reverse the connection. Then, if the flashing red LED continues, the user may be instructed to make no further attempts to connect the two low voltage systems or to jump start the discharged vehicle because a short circuit appears to exist.

If no short circuit is detected at decision block 92, execution proceeds to decision block 98, where a determination is made whether both pairs of clamps are above a reference voltage (here illustrated as 2.5 volts). If the polarity of the low voltage cable connection is correct, the small current will eventually raise the voltage of the discharged system above this reference voltage. Therefore, until both pairs of clamps are above 2.5 volts, execution loops back to decision block 92 as shown. Once both pairs of clamps are above 2.5 volts, execution proceeds to step 100, where the small current is turned off (e.g. pin 5 made low), and then execution proceeds to step 102, where all red LEDs are turned off (e.g. pins 7 and/or 8 made low). Execution then returns to Figure 13 at Location 13B, just prior to step 72, where the low-voltage systems are electrically connected. Thus, the low-voltage systems are electrically connected at step 72 after the process of Figure 14 determines that the connections have been made with proper polarity.

Figure 15 illustrates a representative cool-down procedure that may be used in situations where either an over-current condition (e.g. decision block 74) or a brown-out condition (e.g. decision block 76) is detected. If either condition lasts for too long, the condition can lead to failure of the power transistors, especially when less-expensive power transistors are used. In the case of a brown-out, the lower voltage prevents the power transistors from turning on (or staying on) completely, which may increase the heat losses experienced by the transistors,

leading to failure. Over-current conditions can also destroy the transistors. To allow for the use of less-expensive power transistors, the process illustrated in Figure 15 permits shutoff of the transistors before failure occurs and gives the transistors time to cool off before use of the transistors resumes. Although the description of Figure 15 is directed to the primary power transistors, it should be understood that similar processes may be used for the transistors providing the low-current current discussed with respect to Figure 14.

In Figure 15, execution begins at step 104, where a logo LED (which, when on, may be indicative that the cables are powered and ready for normal use) is turned off (e.g. pin 6 made low). Execution then proceeds to step 106, where all the red LEDs (or other indicators) are turned on (e.g. pins 7 and 8 made high), indicative of the overheat fault condition. At step 108, the low-voltage systems are electrically disconnected (e.g. pin 10 made low and pin 9 made high). At step 110, the power connect system is reset (e.g. pin 9 made low), while at step 112, the system waits for a period of time to allow the transistors to cool. The microcontroller 60 may be programmed with a model (such as linear over time) approximating heat losses of the transistors over time to ensure that the period of time where the transistors are turned off is adequate to permit sufficient cooling of the transistors before a restart is attempted. Similarly, a thermal model (such as a time integration of current squared times resistance losses) may be used by the microcontroller to approximate heating of the transistors in normal use for protective shut-off and restart procedures as outlined in somewhat more detail in Figure 17.

Once sufficient time has passed to allow the transistors to be safely turned on again, execution proceeds to step 114, where the logo LED is turned on (e.g. pin 6 made high), and to step 116, where the red LEDs (or other signals) are turned back off (e.g. pins 7 and 8 made low). Thereafter, execution returns to Location 13A of Figure 13, just prior to decision block 66, where safety checks are re-executed before the low-voltage systems are re-connected at step 72. Thus, if one or more of the connections to one of the low-voltage systems has changed or if any other circumstance has changed during the cool-down procedure of Figure 15, power may not be reconnected immediately or at all.

Figure 16 shows an example calibration process that may be used when calibration is desired (such as after decision block 64 in Figure 13. Execution begins at step 118, where a wait period passes to allow equilibrium has been reached in the system. Execution then proceeds to decision block 120, where a determination is made as to whether both cables are close to a predetermined calibration reference voltage, illustrated in this case as thirteen volts. If not, execution loops at this point (or back to before the wait period of step 118) until this

condition is met. It is assumed at this point that both cables are connected to the same voltage source, and at step 122 the difference is stored as a difference offset between the cables. Once calibration is complete, the logo LED is turned on (e.g. pin 6 made high) at step 124, and all red LEDs are turned on (e.g. pins 7 and 8 made high) at step 126, signaling the completion of the calibration to the user. Execution may then end, or may return to Location 13A of Figure 13 for regular use of the cables.

Figure 17 shows an example interrupt process that may occur at any time during any of the other processes discussed above. For example, the microcontroller 60 may be programmed to run the interrupt process at fixed intervals to monitor conditions of the cables and circuitry. Execution begins with decision block 128, where it is determined whether there is demand for the LED lights (or other signals). If so, execution proceeds to decision block 130, where the microcontroller 60 determines whether the B light (corresponding to one of the cables) is on. If yes, it is turned off at step 130, and if no, it is turned on at step 134. Similarly, at decision block 136, the microcontroller 60 determines whether the A light (corresponding to the other cable) is on. If yes, it is turned off at step 138, and if no, it is turned on at step 140. Execution then proceeds to decision block 142 (where execution also proceeds if there is no demand for the LED lights.

At decision block 142, a determination is made as to whether there is demand for the low-current supply (in this case illustrated as five amps). If yes, execution proceeds to a determination of whether the low-current transistor is over its power dissipation limit (e.g. is in danger of overheating or failing due to heat) at decision block 144. If yes, the low-current transistor is turned off at step 146. If not, the low-current transistor is left on. After the low-current supply check (and change, if any), execution proceeds to decision block 150, where a determination is made as to whether there is demand for the main power transistors. If yes, execution proceeds to a determination of whether the main power transistors are over their power dissipation limits (e.g. in danger of overheating or failing due to heat) at decision block 152. If yes, the main power transistors are turned off at step 154. If not, the main power transistors are left on at step 156. After the main power transistors check, execution returns to whatever point in the process where the interrupt procedure was begun.

Although the processes illustrated in Figures 13-17 have been illustrated in particular orders, it should be understood that the order of specific steps and decisions is not always critical. For example, many of the steps and decisions may be taken essentially simultaneously or simultaneously. In addition, in any situation where it is possible to vary the order of steps to

an order other than the specifically-illustrated order, it should be understood that such orders are embraced by the embodiments of the invention. Thus the particular ordering of steps illustrated is provided by way of instruction and illustration only, and not by way of limitation.

Embodiments of the invention have been described above with respect to connecting two low-voltage systems together, such as with jumper cables. In addition, it has been indicated that embodiments of the invention can be incorporated into other devices, such as booster boxes, battery chargers, ground power units for aircraft, temporary power units, battery-powered equipment charging cords, etc. In some instances, embodiments of the invention may be incorporated into batteries and battery packs. In such embodiments, internal elements of the battery or battery pack, or the battery or battery pack itself may be viewed as or considered a first low-voltage system, and the item to be powered by the battery or battery pack may be viewed as or considered a second low-voltage system. Such embodiments of the invention may be used to prevent injury and damage that may be caused by connecting or attempting to connect the battery or battery pack to the item incorrectly or when a dangerous condition such as a short circuit exists in the item.

For example, Figure 18 shows a battery 160 of a type illustrating certain battery-incorporated embodiments. The battery 160 includes a positive terminal 162 and a negative terminal 164. The positive terminal 162 and the negative terminal 164 serve to provide connections for electrically connecting the battery 160 to a low-voltage system. For example, many vehicles utilize batteries of a type similar to the battery 160, and the battery 160 may be used to replace a standard battery for a vehicle. Batteries or battery packs similar to or incorporating features of the battery 160 (as discussed below and herein) may be used for any of a variety of low-voltage systems utilizing one or more batteries or battery packs.

The battery 160 of Figure 18 incorporates the safety features discussed herein. To do this, circuitry similar to that discussed herein is incorporated into the battery 160. Such circuitry may include a detection circuit and a power-controlling circuit. Thus, with reference to Figure 2, the input terminals 20 of the circuit depicted in Figure 2 may be connected internally to portions of the battery 160 so as to be provided with or receive the energy supplied by one or more cells of the battery 160. The output terminals 22 are electrically connected to the positive terminal 162 and the negative terminal 164 of the battery, thereby providing power to the positive terminal 162 and the negative terminal 164, and to any low-voltage system connected thereto, as long as the safety circuit 18 determines that it is safe to provide power to the positive terminal 162 and the negative terminal 164.

The battery 160 of Figure 18 may include any of a variety of features designed to communicate with a user of the battery 160. For example, the battery 160 may include an indicator 166. The indicator 166 may include one or more indicator lights or LEDs and/or one or more audible alarms to communicate a status of the battery 160 and/or a connection thereto. In some embodiments, the battery 160 may include a display 168. The display 168 may be a static display (such as instructions explaining how to interpret signals communicated by the indicator 166), or it may be a variable display, such as a LCD or other variable display capable of displaying information to a user in a more complex manner (such as by way of changing text or icons displayed on the variable display). The illustrated indicator 166 and display 168 are provided by way of example only, and it should be understood that any of a variety of mechanisms may be used to provide information to a user of the battery 160.

Various embodiments of the battery 160 provide any or all of the functions discussed herein with respect to the various embodiments of jumper cables. For example, if circuitry incorporated into the battery 160 detects a short circuit between the positive terminal 162 and the negative terminal 164 (such as might be caused by a metal tool inadvertently laid across the positive terminal 162 and the negative terminal 164 of the battery 160), the circuitry determines either not to supply power to the positive terminal 162 and the negative terminal 164 or, if power was previously being supplied, determines to interrupt power to the positive terminal 162 and the negative terminal 164. This prevents/reduces the chances of sparks, electrical shocks, arcs, inadvertent draining of the energy stored in the battery 160, and other problems. When a short circuit is detected, one or more of the indicator 166 and the display 168 may provide a visible or audible indication that a short circuit condition exists.

Similarly, the circuitry in the battery (or other device) may respond to any of a variety of events while power is being supplied. There are several non-limiting examples of situations where the circuitry may determine to interrupt power. In one example, an over-current condition is detected. In another example, an undesirable temperature is detected, such as at a cell of the battery 160, at a terminal of the battery 160, at some point of the circuitry, or at some other point of the low-voltage system to which the battery 160 is connected. Thus, certain embodiments embrace the use of thermal detectors in communication with the circuitry of the battery 160 (or other device in which the circuitry is incorporated (e.g. jumper cables) by any method of communication discussed herein or later invented. In another example, the circuitry may detect a voltage/current waveform associated with a fault such as a ground fault or an arc

fault, or any other fault, and may determine to interrupt power accordingly. Any other fault criteria may be used to make a determination to interrupt power.

The battery 160 may also incorporate off-until-needed features similar to those incorporated into the jumper cables. Thus, when the battery 160 is disconnected (physically and/or electrically) from any normal load, no voltage difference may be provided between the positive terminal 162 and the negative terminal 164, or only a minimal (e.g. test) voltage difference may be detected between the positive terminal 162 and the negative terminal 164. This further improves safety of the battery 160. The battery 160 may be programmed with a variety of behaviors for a variety of desired functionalities. For example, while the flow chart of Figure 13 illustrates disconnecting power systems when less than ten amps is flowing between low voltage systems (analogous here to less than ten amps flowing to/from the battery from/to the connected system, e.g. car), it should be understood that it may be desirable to maintain power supplied by the battery 160 at much lower current flows. For example, in a battery connected to a vehicle, it may be desirable to run one or more accessories of the vehicle that may use significantly less than ten amps.

Thus, with respect to implementing the flow charts depicted in Figures 13-17 in a battery-integrated system, it should be understood that some aspects of the flow charts may be modified as desired to achieve the desired functionality for a given situation. For example, because the system is integrated into the battery 160 itself, the system may be programmed and the flow charts simplified according to known information. In such a system, the safety circuitry is presumably correctly connected to the internal cell or cells of the battery, so any steps directed to ensuring that the first connection is correctly made may be omitted or modified appropriately.

Embodiments of the battery 160 incorporate the reverse-polarity detection features discussed herein. Thus, the battery 160 is able to detect not only short circuit conditions, but will also detect when it has been improperly installed into a low-voltage system, such as a vehicle. These features are most advantageous in batteries designed for low voltage systems such as vehicles where the polarity of the low-voltage system is detectable using the test functionalities discussed herein with respect to Figures 4-6. It will be understood that in a vehicle or other low-voltage system designed for a single battery, the only voltage source is the battery 160 itself, so the response of the vehicle or other low-voltage system to test currents/voltages supplied by the battery 160 are used to determine whether a proper-polarity connection has been made. Thus, the battery 160 may include a polarity test circuit configured

to supply a test current to the connected low-voltage system and measure a resulting voltage to determine a proper polarity of a low-voltage system connected to the battery 160. When an improper-polarity connection is made/attempted, the battery 160 uses one or both of the indicator 166 and the display 168 to communicate to the user that the polarity has been reversed and that remedial action should be taken.

Figures 19 and 20 depict a circuit diagram for an alternative exemplary circuit that may be used with certain embodiments of the invention. Because of the size of the circuit diagram depicted in Figures 19 and 20, expanded views of the circuit are depicted in Figures 21-27. Specifically, areas of Figures 19 and 20 defined by the dashed lines are depicted in Figures 21-27 as follows: area 170 of Figure 19 is depicted in more detail in Figure 21, area 172 of Figure 19 is depicted in more detail in Figure 22, area 174 of Figure 19 is depicted in more detail in Figure 23, area 176 of Figure 19 is depicted in more detail in Figure 24, area 178 of Figure 19 is depicted in more detail in Figure 25, area 180 of Figure 19 is depicted in more detail in Figure 26, and area 182 of Figure 19 is depicted in more detail in Figure 27. In the expanded views of Figures 21-27, representative components and component values have been illustrated by way of example only. It will be understood that other circuits, components, and component values may be used to create circuits of varying degrees of similarity to the illustrated circuit having functionality similar to that discussed herein. Such embodiments are embraced within the scope of the present invention.

In the control circuit embodiment shown in Figures 19-27 two pairs of field-effect transistors (FETs) are used in a back-to-back configuration. One transistor of each pair controls the current flow in one direction. In the illustrated embodiment of Figures 19, the first pair of transistors are labeled Q2 and Q3 in Figures 21-22, and the second pair of transistors is labeled Q1 and Q4. Two pairs of FETs are used in the current example to provide a desired amount of maximum current flow. Therefore, certain embodiments embrace the use of a single pair of transistors, as well as the use of three, four, five, or more pairs of transistors, as desired to achieve particular performance characteristics. Benefits are achieved through the independent control of these two pairs (or other amounts of pairs) of transistors. One of the pair of transistors is used to provide feedback to precisely control the current through the other of the pair of transistors, thereby controlling the total current flow through the jumper cable controller. In situations where the direction of current flow is known, such as where the controller is incorporated into a battery or battery pack, one transistor from each pair may be replaced by a static resistor as a current feedback device (current shunt resistor), as will be discussed below.

In the illustrated embodiment, the controller first determines a direction of current flow through the circuit to choose which transistor of the pair of transistors is to function as a current shunt resistor. After identifying the transistor(s) to serve as a current shunt resistor, those transistors are turned fully on, establishing a known resistance through the transistors acting as the current shunt. An amplifier circuit permits the voltage drop to be measured by a micro-controller. The micro-controller uses the measured voltage drop to determine the gate voltage for the controlling set of transistors and thereby the current through the entire circuit. The direction of flow of current through the jumper cables does not affect function of the circuit. Cost of the circuit components is relatively low.

Thus, if current is to flow from left to right in Figure 19, one or both of transistors Q3 and Q4 are turned fully on to serve as the current shunt resistor. Then, the controller measures the voltage drop across the transistors Q3 and Q4 as one or both of transistors Q1 and Q2 is slowly turned on, and sets the gate voltage for the transistor(s) Q1 and Q2 accordingly to achieve the desired current flow through the transistor(s) Q1 and Q2 and thus through the entire circuit. When current is to flow from right to left in Figure 19, one or both of transistors Q1 and Q2 are turned fully on to serve as the current shunt resistors, and the controller measures the voltage drop across those transistors as one or both of transistors Q3 and Q4 are turned on to the desired level.

In an embodiment where less current is needed, one of the pairs of transistors may be omitted from the circuit shown in Figure 19. Thus, either the pair of transistors Q2, Q3 may be omitted, or the pair of transistors Q1, Q4 may be omitted. Conversely, if greater current flow is needed, additional pairs of transistors may be provided until the desired current capacity is met, with each pair of transistors connected to all other pairs through extension of the cross configuration shown connecting the transistors Q1, Q2, Q3, and Q4 in Figures 19, 21, and 22.

As mentioned above, in certain embodiments, it may be known that the current will only flow in a certain direction. For example, the controller may be incorporated into a battery to provide safety features as discussed herein. In this instance, it may not be necessary to utilize one or more transistors as a current shunt resistor: instead one or more static resistors may be used to reduce costs. While multiple static resistors may be used for multiple transistors, it will be appreciated from the parallel configuration of the circuit of Figure 19 that a single static resistor may be used for multiple transistors. In such embodiments, the voltage drop may be measured across the static resistor(s) and this may be used to control the gate voltage at the transistor(s) in a fashion similar to that described above.

There are significant benefits of circuits such as the embodiment of Figures 19-27. As one example, a jumper cable or other connection system incorporating the embodiment of Figures 19-27 can be used to control current for jump starting vehicles having low-voltage systems of dissimilar voltages. Thus, a person could jump start a vehicle having a six-volt electrical system using a vehicle having a twelve-volt electrical system or a twenty-four-volt electrical system. The controller recognizes the lower-voltage system and then uses the two-transistor pair to supply sufficient current while preventing the voltage from rising higher than is safe or desirable for the six-volt system. The same could be true for jump starting between an overland truck having a twenty-four-volt system and a light car or truck having a twelve-volt electrical system.

As another example of benefits provided by such embodiments, jumper cables incorporating such embodiments may be used to test the viability of a battery in a vehicle. To perform the test, one end of the jumper cables (e.g. one set of either the first pair of contact clamps 12 or the second pair of contact clamps 14) is connected together to form a short circuit between the positive and negative leads. The other end of the jumper cables is connected to the battery to be tested. The controller initiates a battery test and uses the control circuitry to flow a known significant amount of current through the battery while monitoring the voltage drop of the battery. For example, if the controller allows three hundred amps to flow through the module for a few seconds, the battery is presumably good if it is able to maintain proper voltage during the test.

Another example of benefits provided by embodiments such as illustrated in Figures 19-27 is permitting the jumper cable to be used to test the viability of a vehicle's alternator. One end of the jumper cables is shorted as with the battery test, and various current load profiles can be imposed on the alternator up to and beyond the charging limit of the vehicle's alternator. The controller monitors the voltage of the alternator while the test is being performed. The voltage behavior of the alternator under these electric loads allows the controller to determine if the alternator is functioning properly or not.

Jumper cables incorporating the circuit embodiment of Figures 19-27 and similar circuits may be used to provide trickle charging to a battery. For example, in some instances it may be desirable to keep a battery charged, but do no more than that. Using jumper cables incorporating embodiments of the invention, the controller permits a precise trickle charge rate to be supplied to keep a battery charged.

Additionally, such embodiments of the jumper cables/jumper cable control circuitry permit the setting of an over-current threshold. This permits certain measures of protection, such as while the jumper cables are connected to a vehicle being simultaneously worked on. For example, if an individual is planning on working on a vehicle while jumper cables are connected to the vehicle's electric system, an over-current threshold may be set, such as to twenty amps, to provide a certain amount of power to the vehicle without supplying so much as to be potentially dangerous for either the person or the vehicle's components. Thus, embodiments of the invention provide further safety improvements over existing systems for connecting low-voltage systems such as vehicles.

Certain controller/circuit embodiments, such as that illustrated in Figures 19-27, incorporate the ability to communicate status, performance levels, and any parameter the controller measures. Communication directed to the controller/controller circuit is provided by way of imposing a communication signal onto the jumper cable wires. The micro-controller can detect this signal using the same detection circuit that is used to measure the cable voltage. For example, this could include a five volt peak-to-peak signal imposed on the cable voltage. The micro-controller could filter or otherwise segregate the AC and DC components of the cable voltage, allowing input communication simultaneous with jumper cable use.

Communication out from the device can be accomplished in several ways. One way to communicate out from the controller is using the jumper cable wires in the same fashion as just described for communications to the controller. Thus, the control module imposes the communication signal on the jumper cable lines. A second communications technique out from the device may be accomplished using one or more user-feedback LEDs as optical transmitter. In this instance, the micro-controller implements an optical communication protocol that is clocked out through the LED or LEDs. An optical receiver decodes the information passed out through the LED or LEDs as encoded by the jumper cable control unit.

Communication ability such as provided in the described embodiments provides several benefits to jumper cables incorporating this ability. As one example, an external tool can provide an enhanced user interface with the jumper cable control module. For example, an external device could slide over the jumper cable up to the control module, or could be otherwise placed over the control module so as to sense one or more LED lights of the control module. A user might then be able to see a display of the amount of current flowing during a jump start, could view relevant performance criteria detected by a battery test as described

above, or could view relevant performance criteria detected by an alternator test as described above.

Furthermore, integration with other tools may be achieved. For example, a vehicle analyzer, engine diagnostic tool, or other test system could obtain real-time information about the electrical system performance. Additionally, the test systems could command the jumper cable control module to apply variable or large electrical loads as part of a testing protocol. This may enhance the test systems' diagnostic capabilities.

In at least some embodiments, the communication capability of the jumper cable controller may be used for reprogramming of the controller. For example, updated firmware may be programmed after manufacture is complete, or even after a customer has taken possession of the product. In addition, the communication capability permits interactive testing of the jumper cable set after manufacture and before it leaves the production facility.

The battery-integrated low-voltage safety features discussed herein may be used in a wide variety of circumstances and systems, including as batteries and battery packs of vehicles such as standard gas- or diesel-powered vehicles, hybrid vehicles, plug-in hybrid vehicles, marine vehicles, and the like, or in any system using one or more batteries and/or battery packs.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims, rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

CLAIMS

What is claimed and desired to be secured by Letters Patent is:

1. A safety circuit for use in establishing connections between low-voltage systems to transfer energy from a first low-voltage system to a second low-voltage system, comprising:

a pair of input terminals;

a pair of output terminals;

a detection circuit operatively connected to the input terminals and the output terminals for detecting whether the input terminals and the output terminals are properly connected to first and second low-voltage systems, respectively; and

a connection-controlling circuit configured to electrically connect the input terminals to the output terminals only when a proper connection has been detected and using a soft start procedure that reduces inductive voltage spikes.

2. A safety circuit as recited in claim 1, wherein the connection-controlling circuit controls one or more power transistors that are used to electrically connect the input terminals to the output terminals using the soft start procedure.

3. A safety circuit as recited in claim 2, wherein the soft start procedure connects the first low-voltage system to the second low-voltage system over a period of tens of milliseconds.

4. A safety circuit as recited in claim 1, wherein the safety circuit is incorporated into a jumper cable.

5. A safety circuit as recited in claim 1, wherein the safety circuit is incorporated into a battery charger.

6. A safety circuit as recited in claim 1, wherein the safety circuit is incorporated into a battery boost.

7. A safety circuit as recited in claim 1, further comprising a discharged battery test circuit configured to supply a test current to the output terminals and measure a resulting voltage to determine a proper polarity of a discharged battery connected to the output terminals.

8. A safety circuit as recited in claim 7, wherein the discharged battery test circuit is configured to supply test currents of different directions and to compare the voltages caused by the test currents.

9. A safety circuit as recited in claim 1, wherein the safety circuit is configured to detect whether a battery is connected to one of the pair of input terminals and the pair of output terminals by biasing the desired terminals to a voltage unlikely to occur naturally in one of the low-voltage systems and determining whether the voltage aberrates from the biased voltage by a given amount.

10. A safety circuit as recited in claim 1, wherein the safety circuit is configured to discriminate between a short circuit and a discharged battery by measuring the rise and fall time of a voltage measured across one of the pair of input terminals and the pair of output terminals as a limited current is allowed to flow.

11. A method of testing a polarity of a discharged battery connected to a first low-voltage system comprising:

connecting a test current source to a first low-voltage system containing a discharged battery;

supplying a first test current to the first low-voltage system; and

measuring a first resulting voltage of the first low-voltage system.

12. A method as recited in claim 11, further comprising making an electrical connection between the first low-voltage system and a second low-voltage system only if the first resulting voltage exceeds a predetermined threshold voltage.

13. A method as recited in claim 11, further comprising:

supplying a second test current to the first low-voltage system, wherein the second test current is in an opposite direction to the first low-voltage system; and

measuring a second resulting voltage of the first low-voltage system.

14. A method as recited in claim 13, further comprising making an electrical connection between the first low-voltage system and a second low-voltage system only if only one of the first resulting voltage and the second resulting voltage exceeds a predetermined threshold

voltage and if the electrical connection will be of a proper polarity indicated by the measured first and second resulting voltages.

15. A method as recited in claim 11, wherein the method is incorporated as a test method upon connection of a battery charger to a system having a discharged battery.

16. A method as recited in claim 15, wherein the system having a discharged battery is a vehicle.

17. A method as recited in claim 11, wherein the method is incorporated as a test method upon connection of a battery boost to a system having a discharged battery.

18. A method as recited in claim 11, wherein the method is incorporated as a test method upon connection of a jumper cable to a vehicle having a discharged battery.

19. A jumper cable for use in establishing connections between low-voltage systems to transfer energy from a first low-voltage system to a second low-voltage system, comprising:

a safety circuit comprising:

a pair of input terminals;

a pair of output terminals;

a detection circuit operatively connected to the input terminals and the output terminals for detecting whether the input terminals and the output terminals are properly connected to first and second low-voltage systems, respectively; and

a connection-controlling circuit configured to electrically connect the input terminals to the output terminals only when a proper connection has been detected and using a soft start procedure that reduces inductive voltage spikes;

a first cable connected to the input terminals and comprising first contact clamps for connecting to the first low-voltage system; and

a second cable connected to the output terminals and comprising second contact clamps for connecting to the second low-voltage system.

20. A jumper cable as recited in claim 19, wherein the safety circuit comprises a transistor protection system for protecting transistors used to electrically connect the input terminals to the output terminals, the transistor protection system comprising:

a microcontroller that maintains a thermal model of heating of the transistors when power is flowing and a thermal model of cooling of the transistors when power is not flowing, that monitors for over-current conditions that could destroy the transistors, and that monitors for under-voltage conditions on the supply side.

21. A jumper cable as recited in claim 19, wherein the safety circuit is contained in a control box proximate one of the first contact clamps and the second contact clamps.

22. A jumper cable as recited in claim 21, wherein the control box comprises a plurality of light emitting diodes for signaling conditions detected by the safety circuit to a user of the jumper cable.

23. A battery-integrated safety circuit for use in establishing that a low-voltage system is safely and properly connected to a battery, comprising:

a pair of output terminals;

a detection circuit operatively connected to the output terminals and configured to detect whether the output terminals are properly connected to a low-voltage system with a correct polarity; and

a power-controlling circuit configured to provide electrical power to the output terminals only when a proper connection of correct polarity has been detected.

24. A battery-integrated safety circuit as recited in claim 23, wherein the power-controlling circuit provides electrical power to the output terminals using a soft start procedure that reduces inductive voltage spikes.

25. A battery-integrated safety circuit as recited in claim 24, wherein the power-controlling circuit controls one or more power transistors that are used to provide electrical power to the output terminals using the soft start procedure.

26. A battery-integrated safety circuit as recited in claim 24, wherein the soft start procedure provides electrical power to the output terminal over a period of approximately a millisecond to tens of milliseconds.

27. A battery-integrated safety circuit as recited in claim 23, further comprising a polarity test circuit configured to supply a test current to the output terminals and measure a resulting voltage to determine a proper polarity of a low-voltage system connected to the output terminals.

28. A battery-integrated safety circuit as recited in claim 27, wherein the polarity test circuit is configured to supply test currents of different directions and to compare the voltages caused by the test currents.

29. A battery containing a battery-integrated safety circuit comprising:

a positive terminal;

a negative terminal; and

a safety circuit operatively connected to the positive terminal and the negative terminal and configured to supply power through the positive and negative terminals only when a connection between the terminals and a low-voltage system has been properly made with a correct polarity.

30. A battery as recited in claim 29, wherein the battery prevents the supply of power to the positive and negative terminals when a short circuit exists between the positive and negative terminals.

31. A battery as recited in claim 29, wherein the safety circuit comprises a polarity test circuit configured to supply a test current to the terminals and measure a resulting voltage to determine a proper polarity of a low-voltage system connected to the battery.

32. A battery as recited in claim 29, wherein the safety circuit comprises:

a detection circuit operatively connected to the terminals and configured to detect whether the terminals are connected to the low-voltage system with the correct polarity; and

a power-controlling circuit configured to provide electrical power to the terminals.

33. A battery as recited in claim 32, wherein the power-controlling circuit is configured to interrupt power to the positive and negative terminals after it has been supplied when an improper condition is detected.

34. A battery as recited in claim 33, wherein the improper condition comprises a condition selected from the group of:

an overcurrent;

a temperature that is higher than desired;

a ground fault;

an arc fault; and

a short circuit.

35. A battery as recited in claim 29, wherein the safety circuit comprises one or more field-effect transistors configured to permit precise control of the flow of current from the battery.

36. A safety circuit for use in connecting two low-voltage systems comprising:

a first pair of terminals for connecting the safety circuit to a first low-voltage system;

a second pair of terminals for connecting the safety circuit to a second low-voltage system;

at least one pair of transistors in a back-to-back configuration, whereby one transistor of each pair of transistors controls a flow of current between the first and second pairs of terminals in one direction so that the safety circuit can control the flow of current between the first and second pairs of terminals in either direction;

an amplifier circuit configured to measure a voltage drop of a selected transistor of each pair of transistors when the selected transistor is switched fully on as a current shunt; and

a micro-controller operatively connected to the amplifier circuit and to each pair of transistors and configured to use the measured voltage drop to determine a gate voltage for the other of each pair of transistors to control the current between the first and second pairs of terminals.

37. A safety circuit as recited in claim 36 incorporated into a jumper cable.

38. A safety circuit as recited in claim 36 adapted to connect and transfer power between two low-voltage systems of dissimilar operating voltages.

39. A safety circuit as recited in claim 36, wherein the safety circuit is capable of being configured to limit current flow between the first and second pairs of terminals to a maximum current.

40. A safety circuit as recited in claim 36 wherein the micro-controller is adapted to perform a low-voltage system test of one of:

a battery, by allowing a certain known amount of current to flow through the battery for a short time when the first pair of terminals is electrically connected to the battery and when the second pair of terminals is short-circuited; and

an alternator, by imposing various current load profiles on the alternator when the first pair of terminals is electrically connected to the alternator and when the second pair of terminals is short-circuited.

41. A safety circuit as recited in claim 36, further comprising a communication system permitting communication with devices external to a device incorporating the safety circuit.

42. A safety circuit as recited in claim 41, wherein the communication system is configured with external devices using one of:

an AC signal imposed on a DC voltage at one of the first and second pairs of terminals; and

an optical transmission and receiving system between the safety circuit and the external devices.

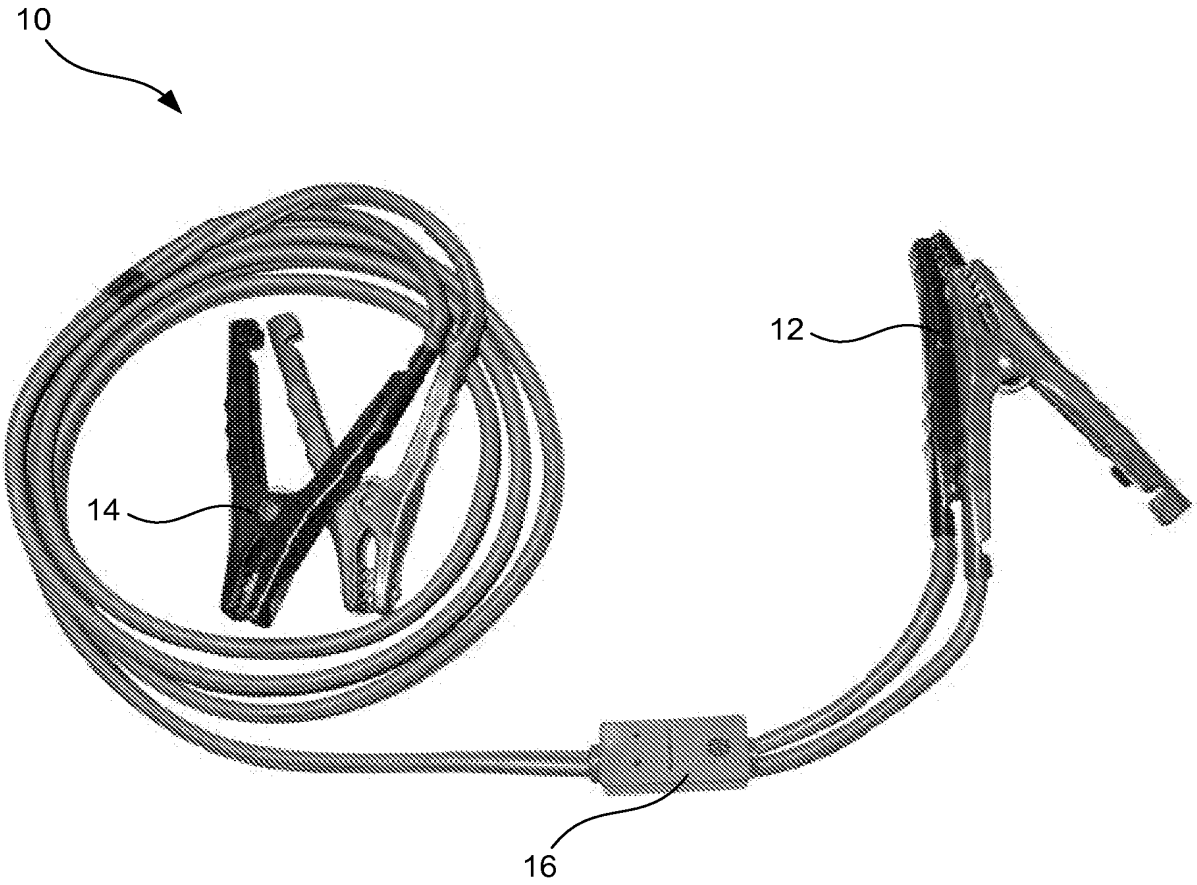


FIG. 1

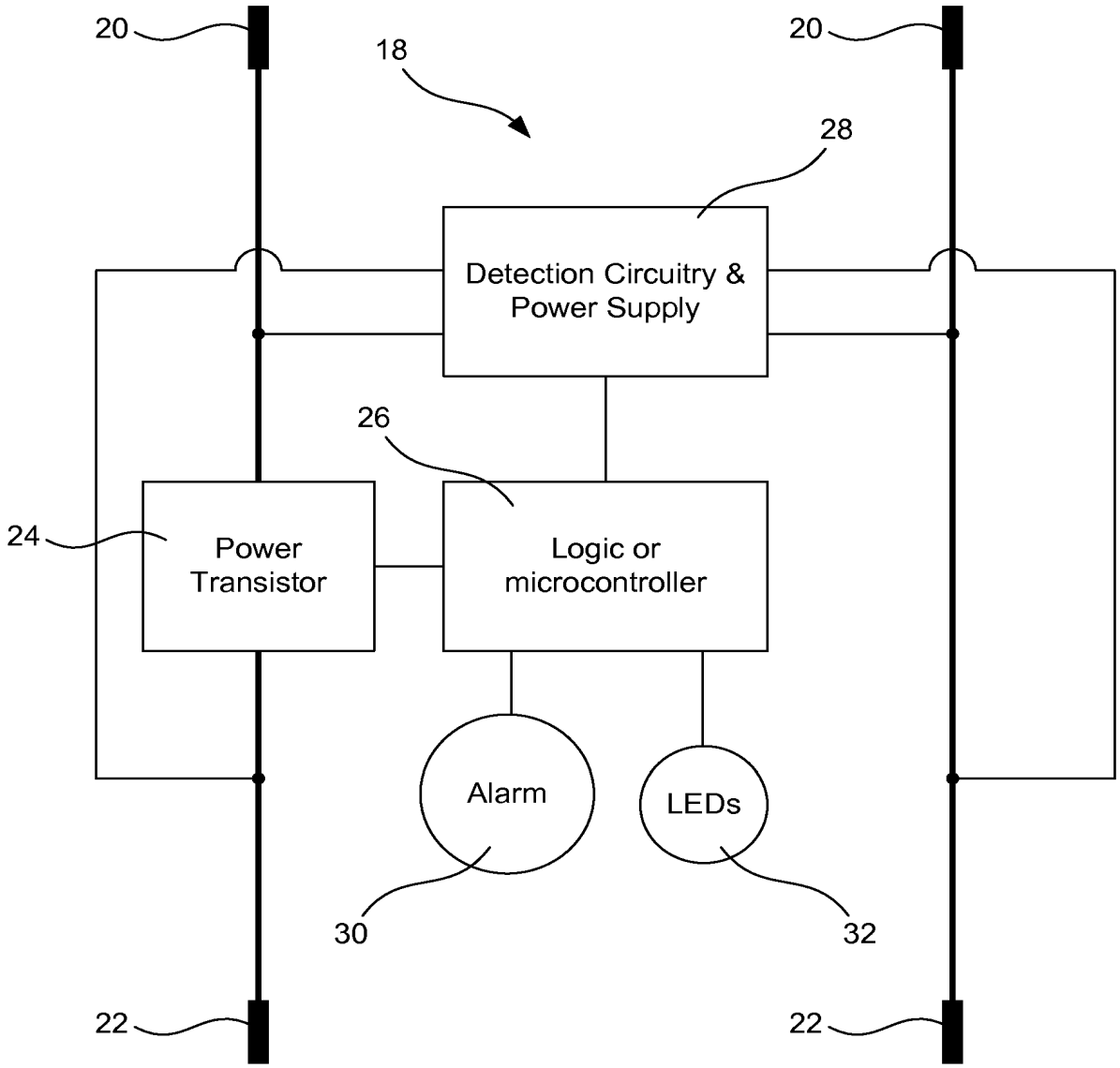

20
18
20
28
Detection Circuitry & Power Supply
26
24
Power Transistor
Logic or microcontroller
Alarm
LEDs
30
32
22
22

FIG. 2

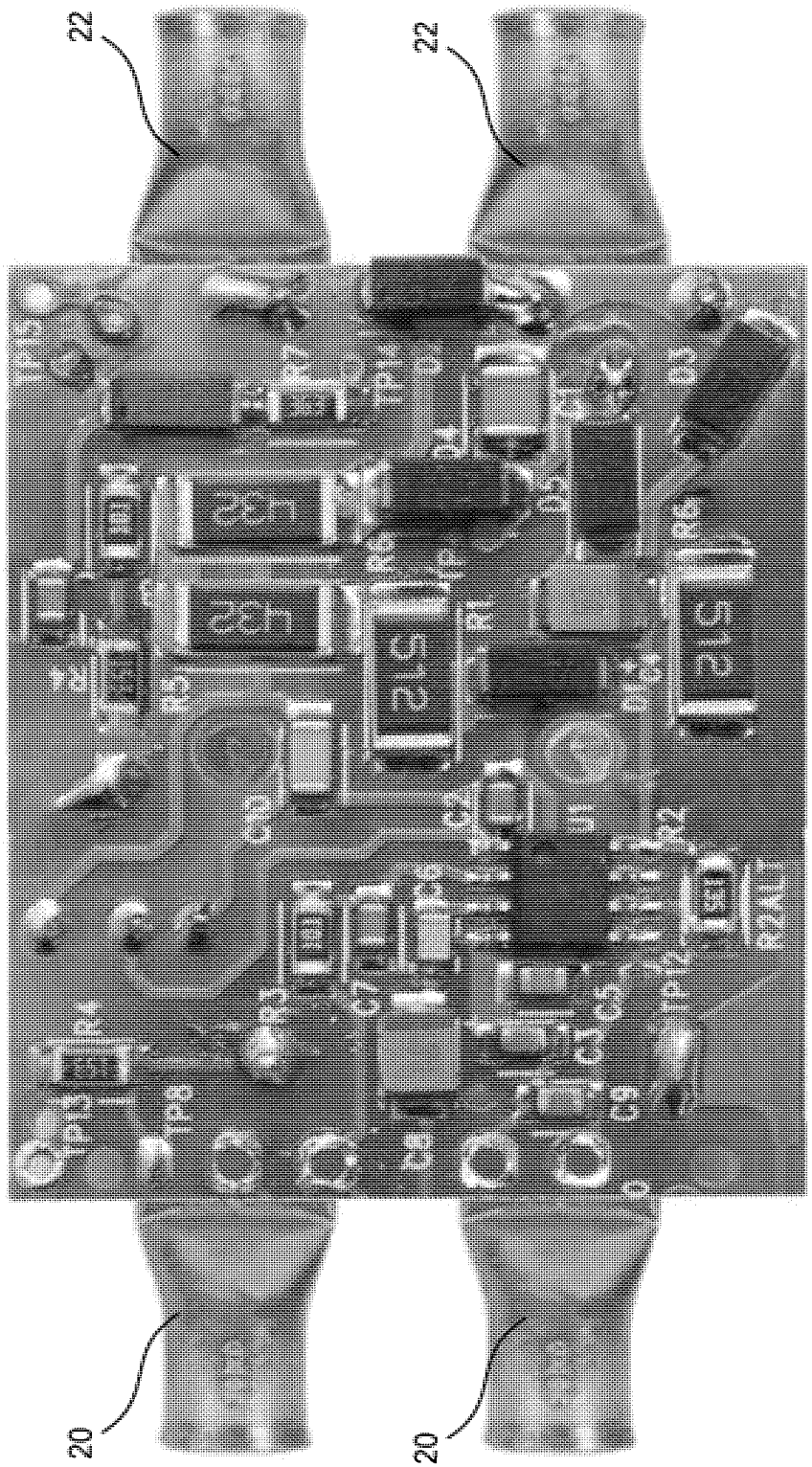


FIG. 3

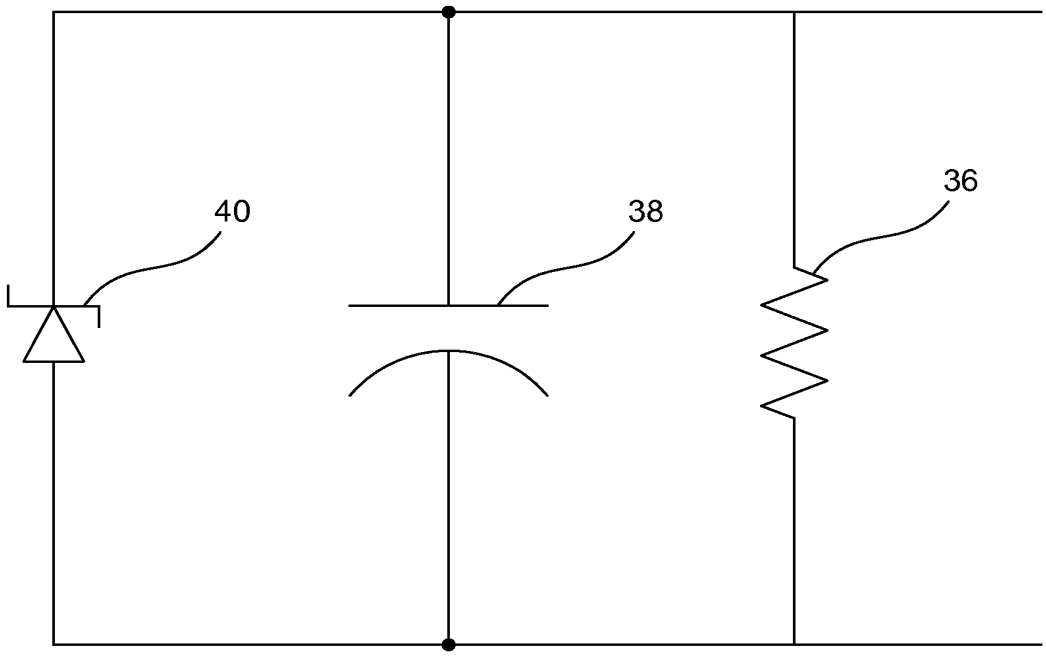


FIG. 4

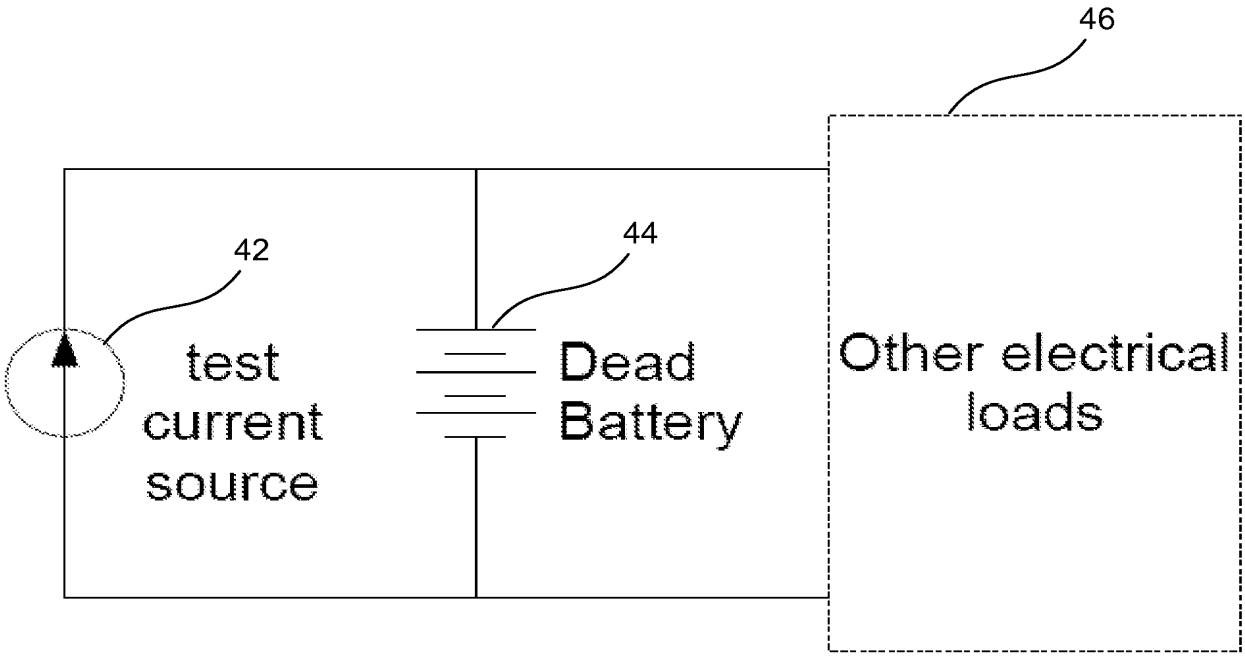

46
42
44
test
current
source
Dead
Battery
Other electrical
loads
Single test current direction

FIG. 5

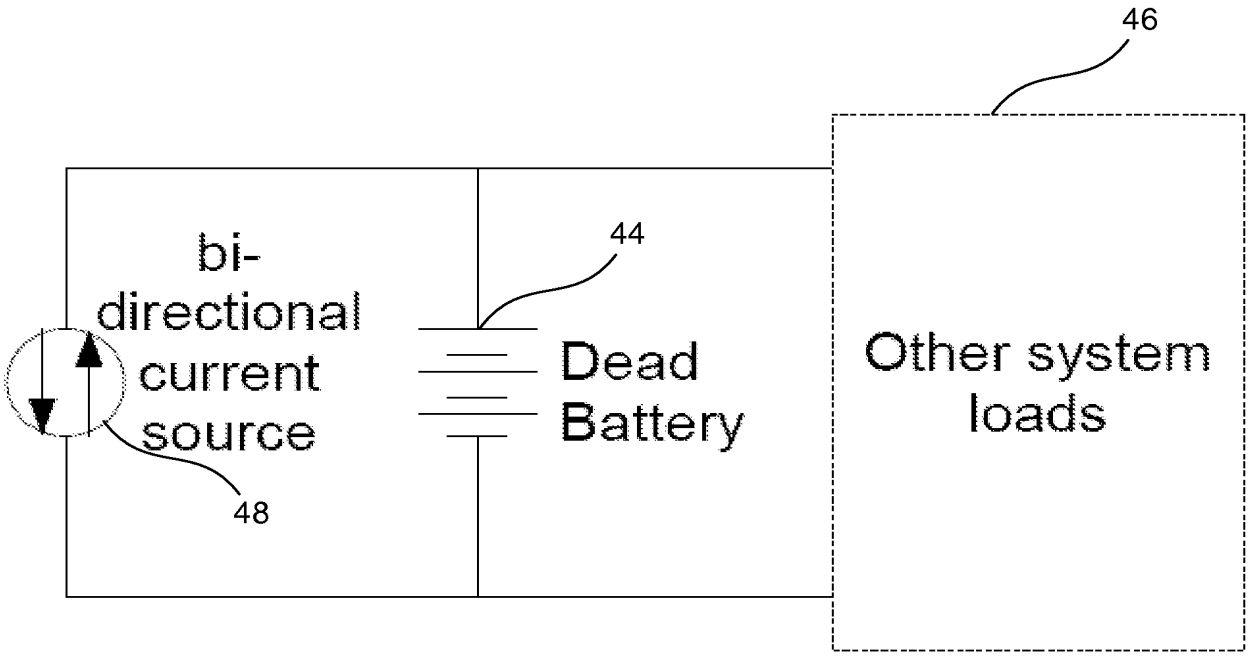

46
bi-
directional
current
source
48
44
Dead
Battery
Other system
loads
Bi-directional test current direction

FIG. 6

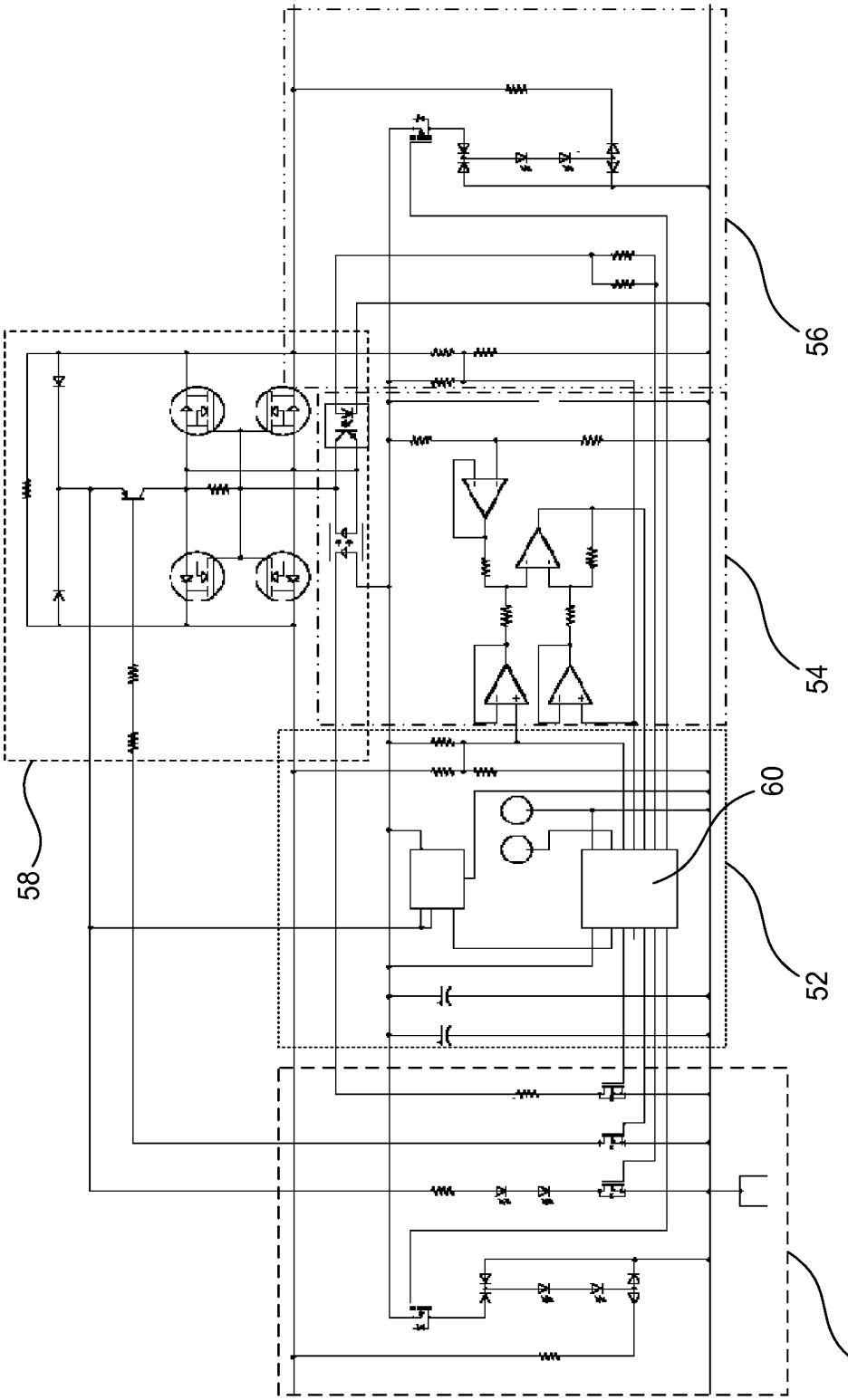


FIG. 7

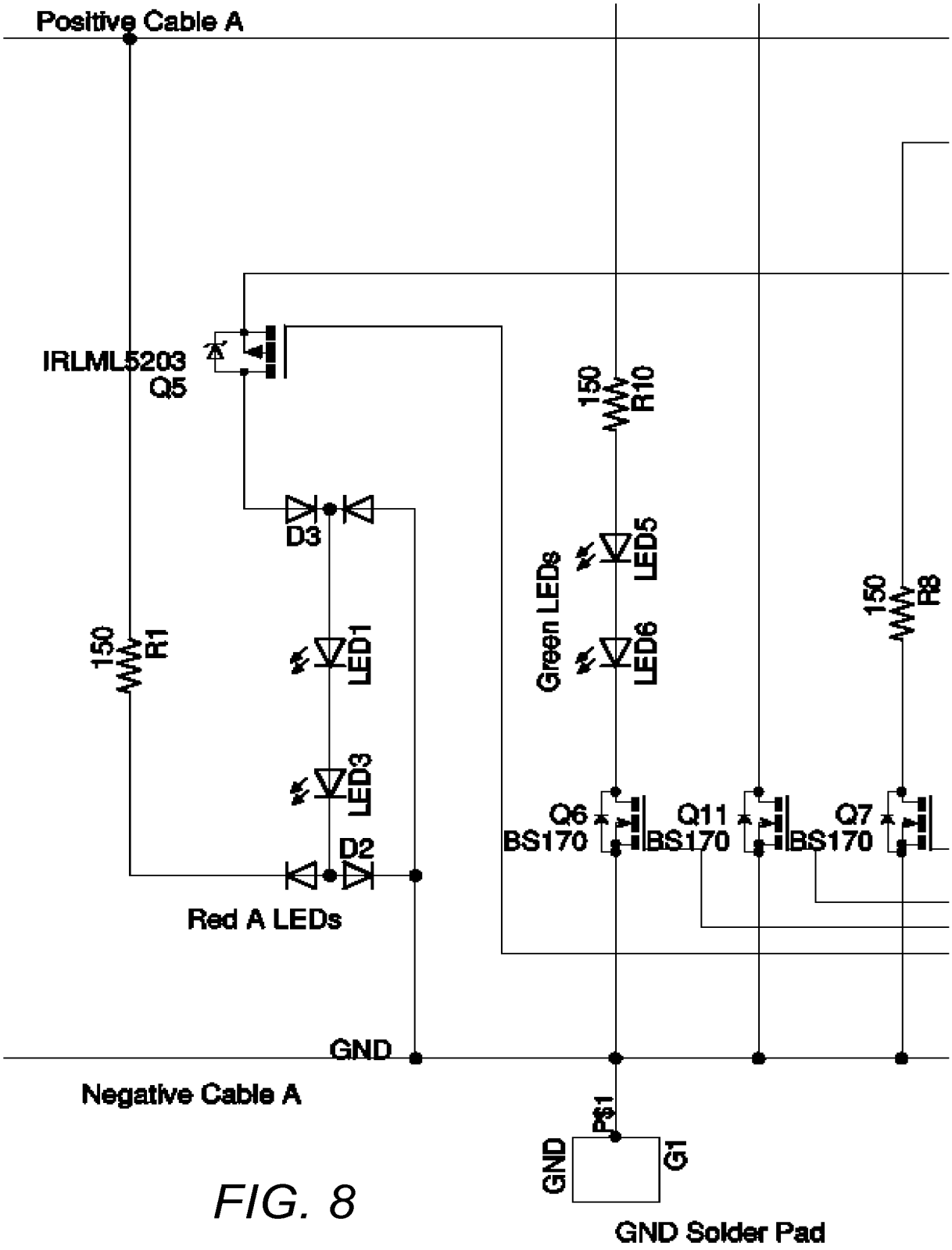

Positive Cable A
IRLML5203
Q5
150
R10
D3
LED5
Green LEDs
LED6
150
R8
150
R1
LED1
LED3
D2
Q6
BS170
Q11
BS170
Q7
BS170
Red A LEDs
GND
Negative Cable A
P$1
GND
G1
GND Solder Pad

FIG. 8

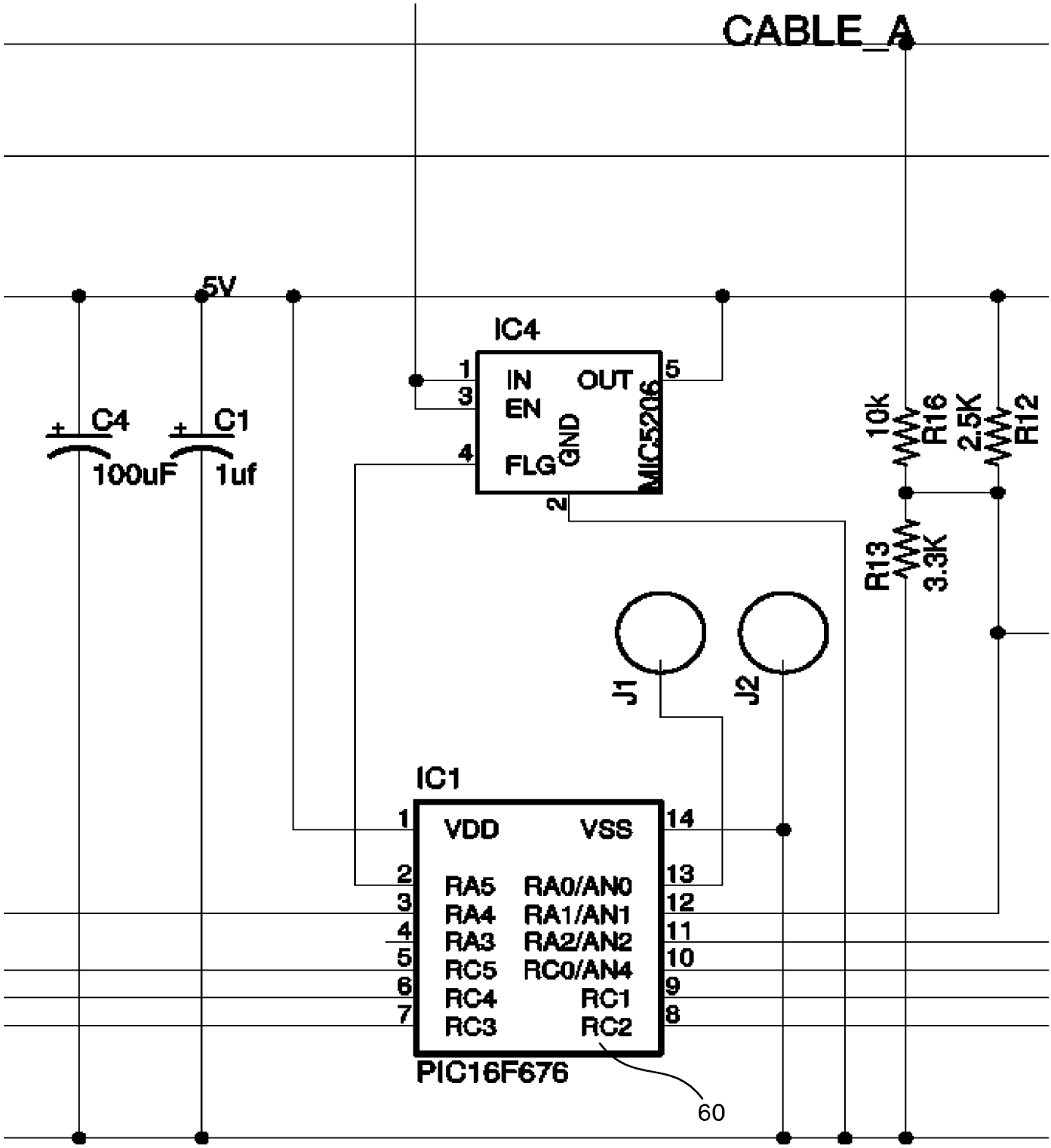

CABLE_A
5V
IC4
1
3
4
2
5
IN
EN
FLG
GND
OUT
MIC5206
C4
100uF
C1
1uf
10k
R16
2.5K
R12
R13
3.3K
J1
J2
IC1
1
2
3
4
5
6
7
14
13
12
11
10
9
8
VDD
VSS
RA5
RA4
RA3
RC5
RC4
RC3
RA0/AN0
RA1/AN1
RA2/AN2
RC0/AN4
RC1
RC2
PIC16F676
60

FIG. 9

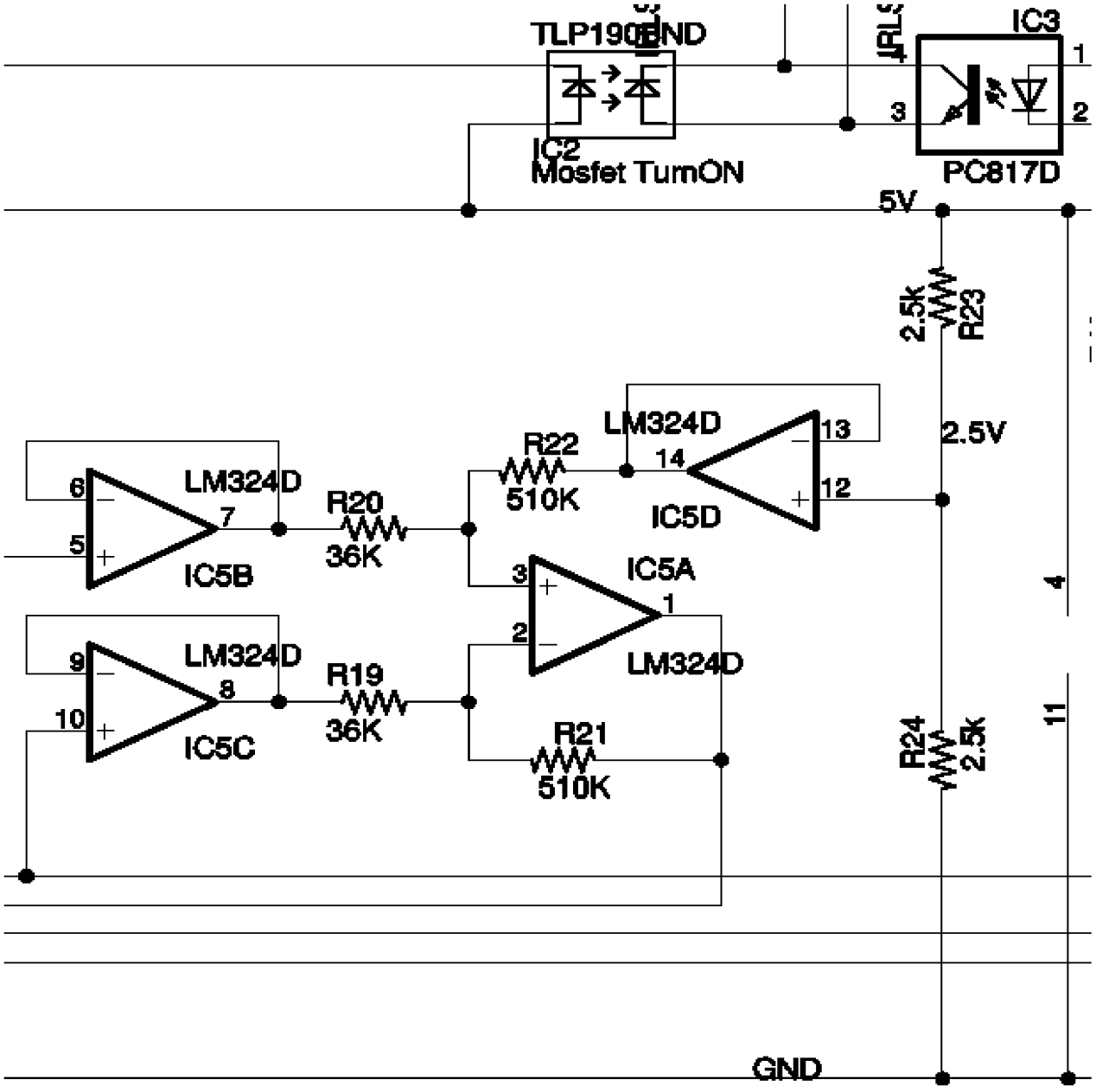

TLP190B
GND
IC3
1
2
3
PC817D
IC2
Mosfet TurnON
5V
2.5k
R23
2.5V
LM324D
R22
510K
14
13
12
IC5D
6
5
7
LM324D
R20
36K
IC5B
3
IC5A
1
2
LM324D
9
10
8
LM324D
R19
36K
IC5C
R21
510K
R24
2.5k
4
11
GND

FIG. 10

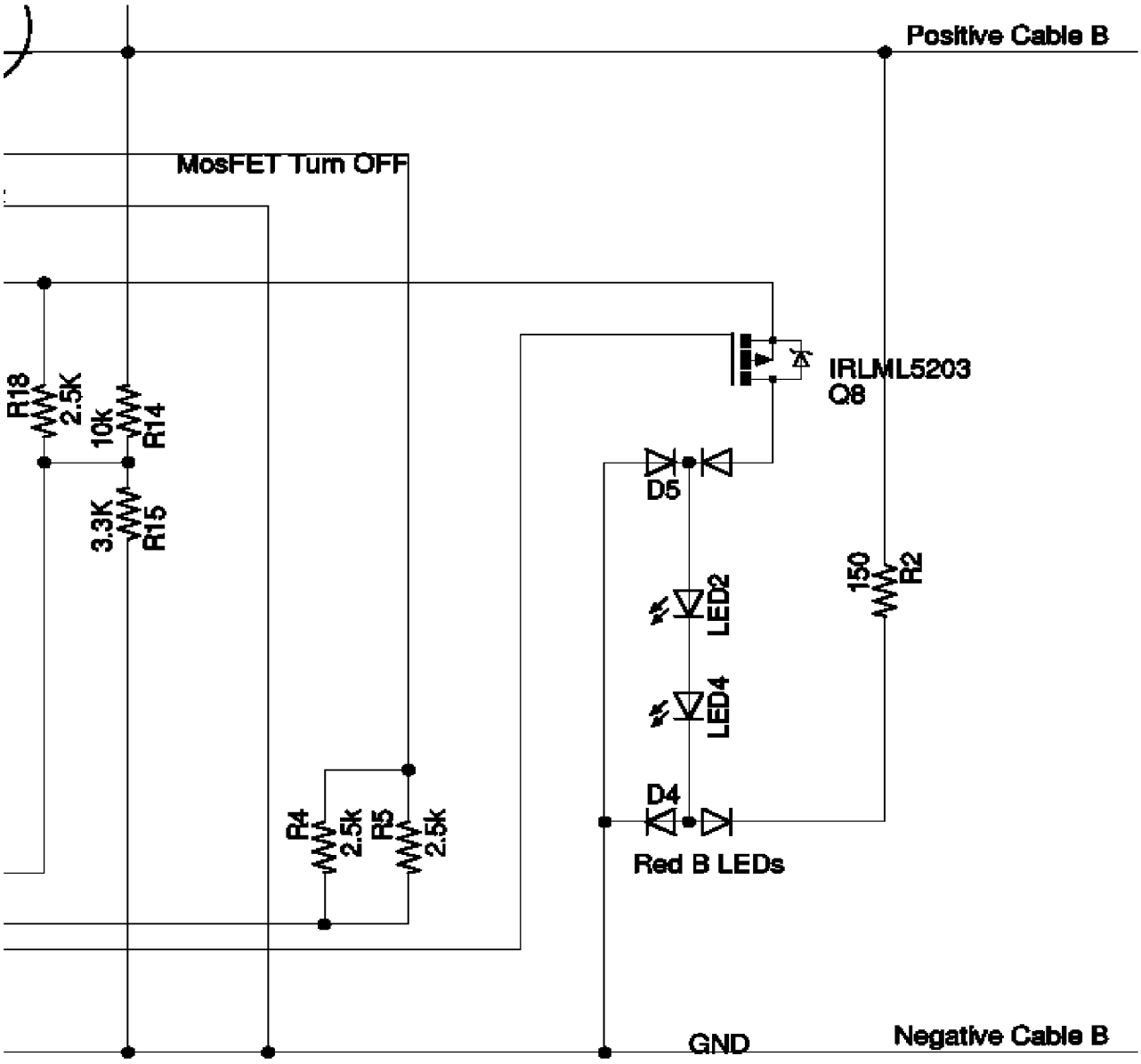

Positive Cable B
MosFET Turn OFF
IRLML5203
Q8
R18
2.5K
10k
R14
3.3K
R15
D5
LED2
LED4
150
R2
D4
R4
2.5k
R5
2.5k
Red B LEDs
GND
Negative Cable B

FIG. 11

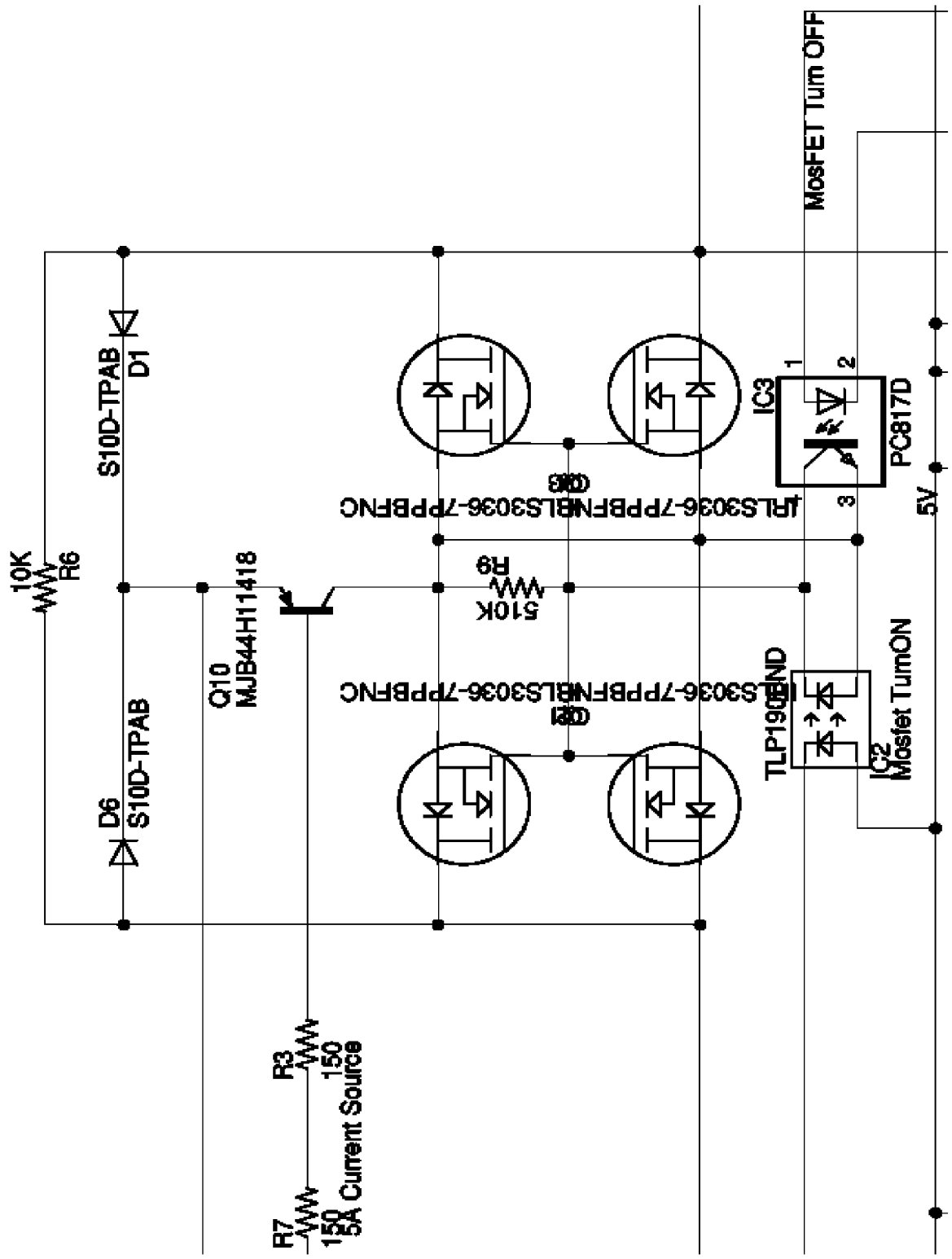

MosFET Turn OFF
S10D-TPAB
D1
IC3
PC817D
5V
10K
R6
R9
510K
Q10
MJB44H11418
D6
S10D-TPAB
TLP190B
IC2
Mosfet TurnON
R3
150
5A Current Source
R7
150

FIG. 12

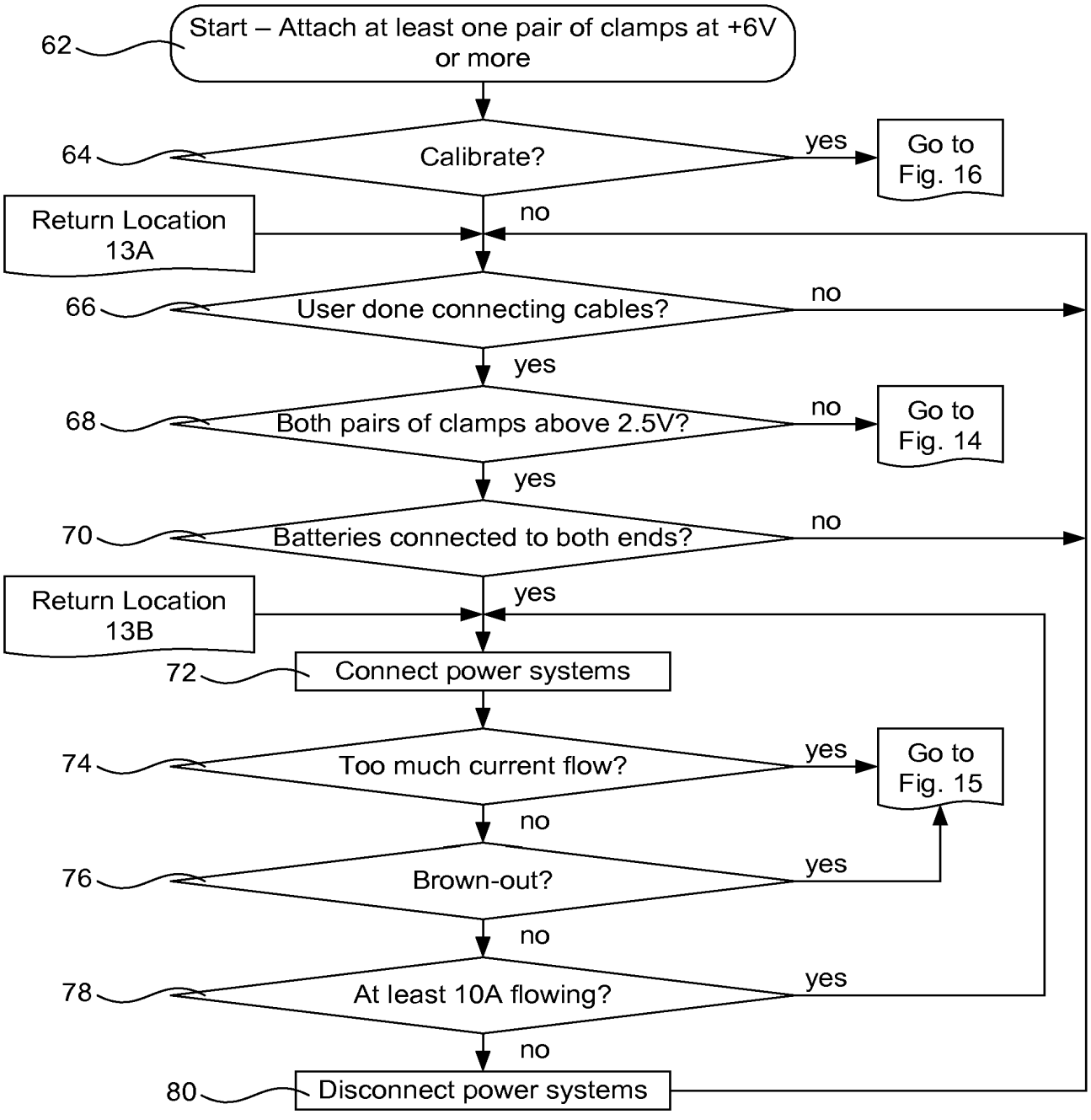

62
Start – Attach at least one pair of clamps at +6V or more
64
Calibrate?
yes
Go to Fig. 16
Return Location 13A
no
66
User done connecting cables?
no
yes
68
Both pairs of clamps above 2.5V?
no
Go to Fig. 14
yes
70
Batteries connected to both ends?
no
Return Location 13B
yes
72
Connect power systems
74
Too much current flow?
yes
Go to Fig. 15
no
76
Brown-out?
yes
no
78
At least 10A flowing?
yes
no
80
Disconnect power systems

FIG. 13

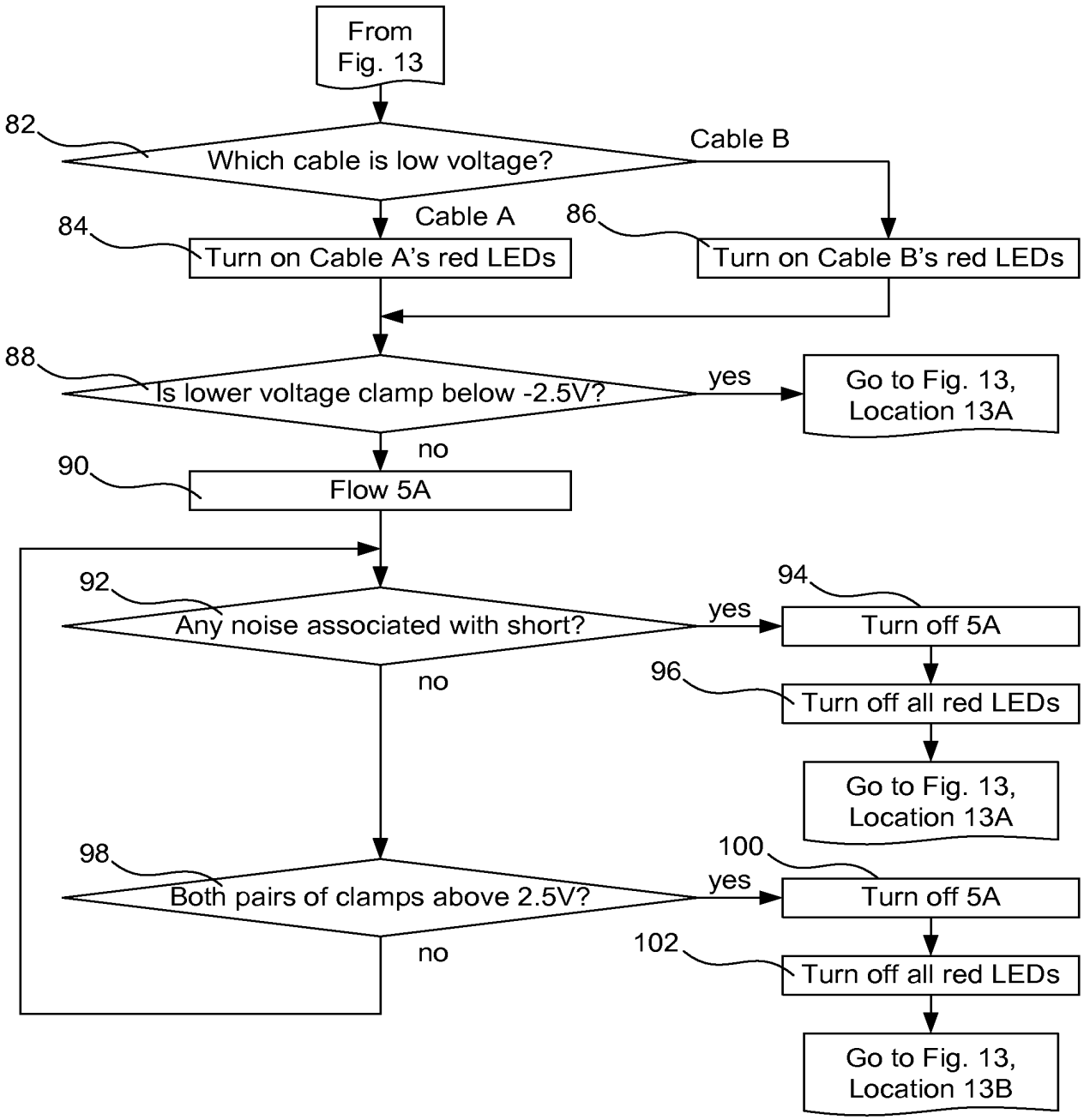

From Fig. 13
82
Which cable is low voltage?
Cable B
Cable A
84
Turn on Cable A's red LEDs
86
Turn on Cable B's red LEDs
88
Is lower voltage clamp below -2.5V?
yes
Go to Fig. 13, Location 13A
no
90
Flow 5A
92
Any noise associated with short?
yes
94
Turn off 5A
no
96
Turn off all red LEDs
Go to Fig. 13, Location 13A
98
Both pairs of clamps above 2.5V?
yes
100
Turn off 5A
no
102
Turn off all red LEDs
Go to Fig. 13, Location 13B

FIG. 14

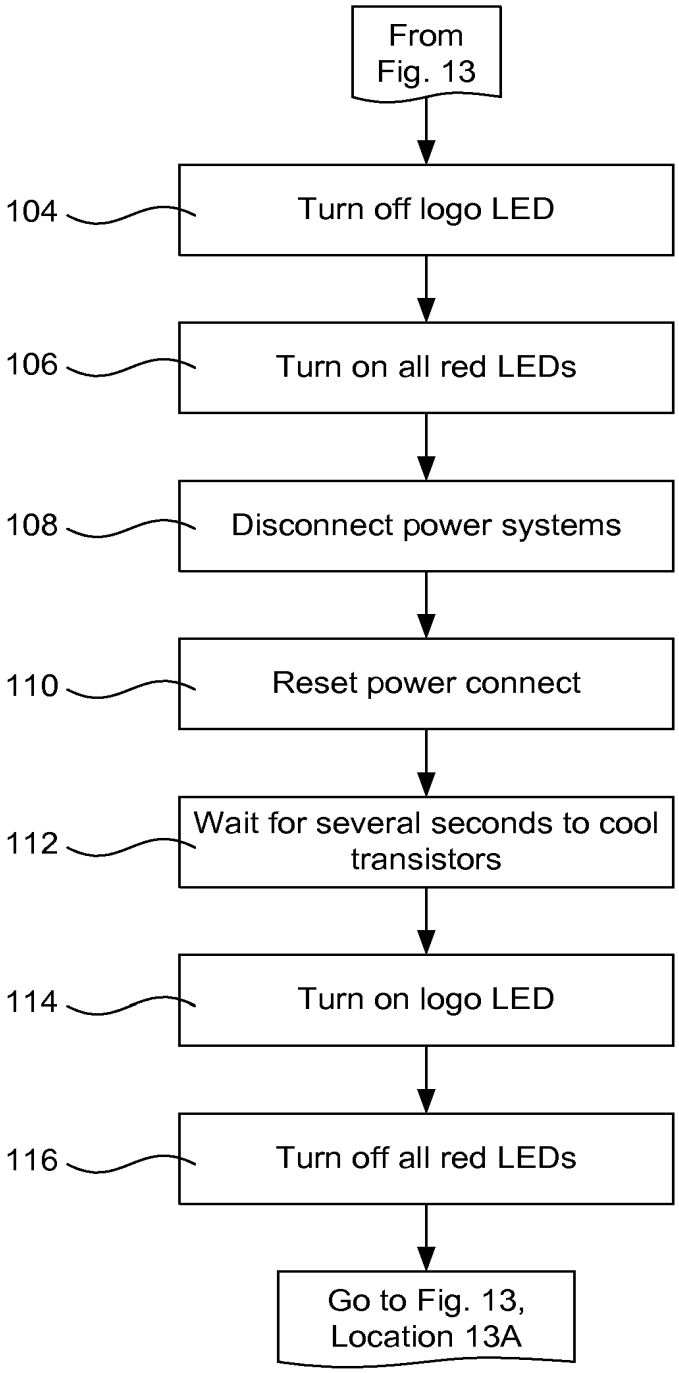

From Fig. 13
104
Turn off logo LED
106
Turn on all red LEDs
108
Disconnect power systems
110
Reset power connect
112
Wait for several seconds to cool transistors
114
Turn on logo LED
116
Turn off all red LEDs
Go to Fig. 13, Location 13A

FIG. 15

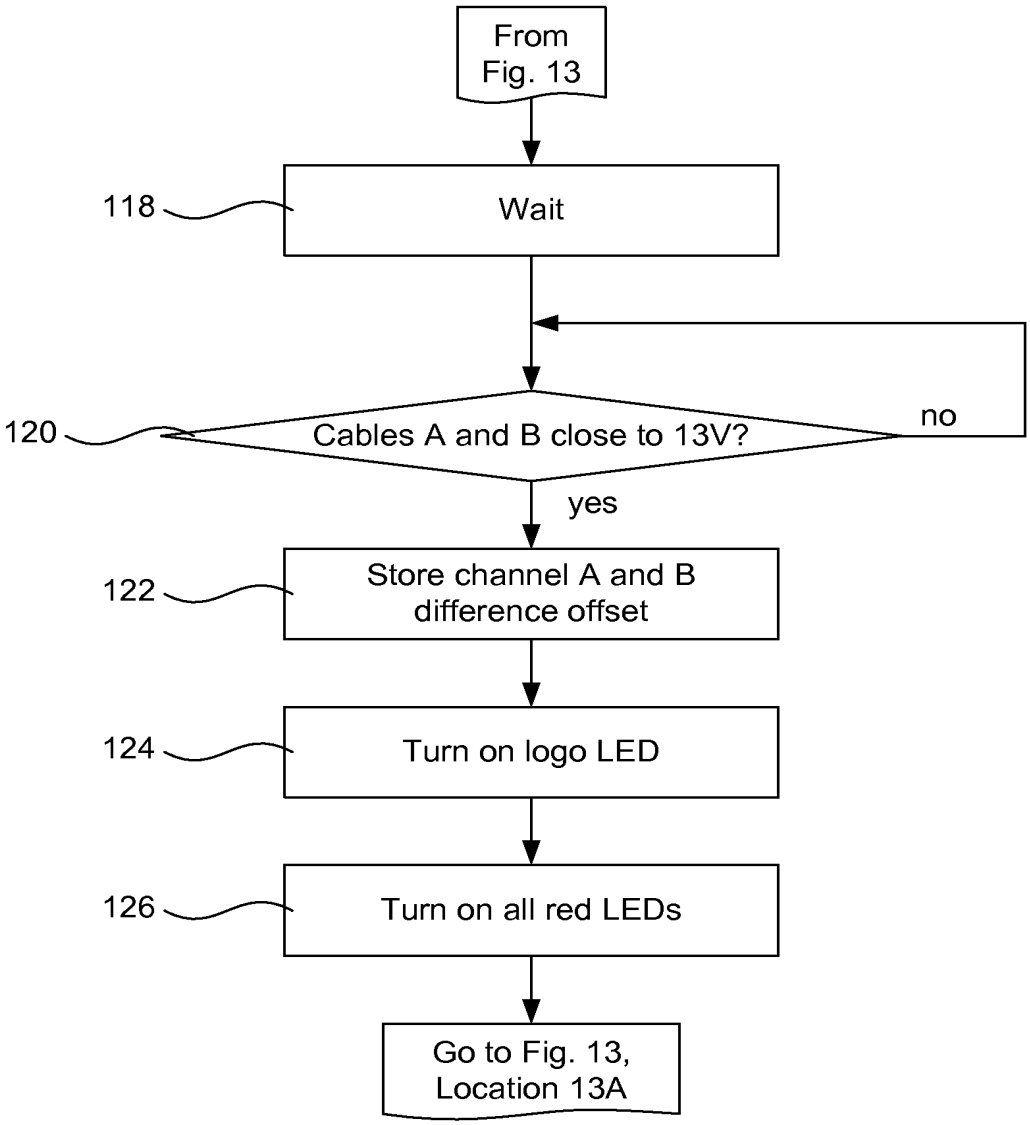

From Fig. 13
118
Wait
120
Cables A and B close to 13V?
no
yes
122
Store channel A and B difference offset
124
Turn on logo LED
126
Turn on all red LEDs
Go to Fig. 13, Location 13A

FIG. 16

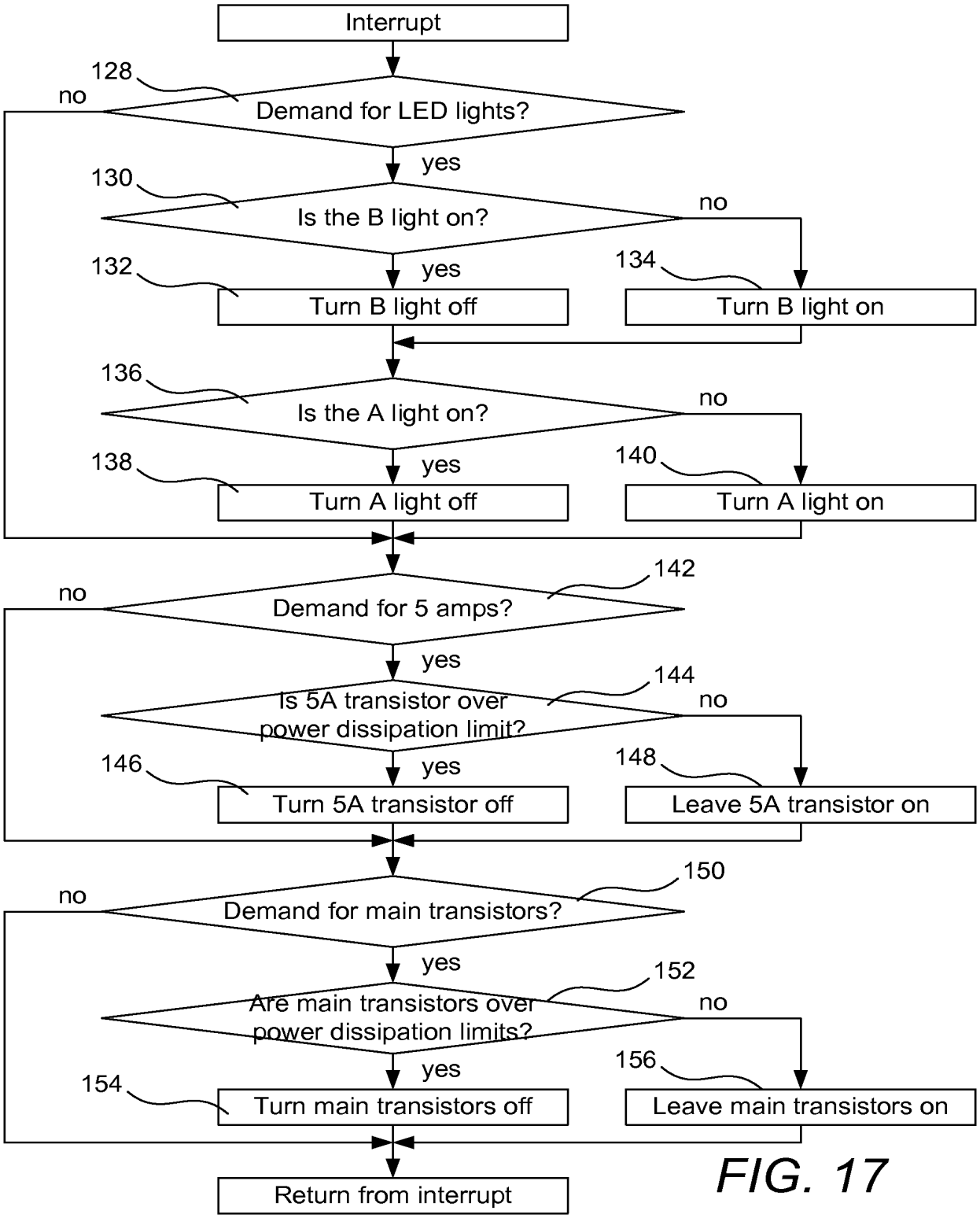

Interrupt
128
Demand for LED lights?
no
yes
130
Is the B light on?
no
yes
132
Turn B light off
134
Turn B light on
136
Is the A light on?
no
yes
138
Turn A light off
140
Turn A light on
142
Demand for 5 amps?
no
yes
144
Is 5A transistor over power dissipation limit?
no
yes
146
Turn 5A transistor off
148
Leave 5A transistor on
150
Demand for main transistors?
no
yes
152
Are main transistors over power dissipation limits?
no
yes
154
Turn main transistors off
156
Leave main transistors on
Return from interrupt

FIG. 17

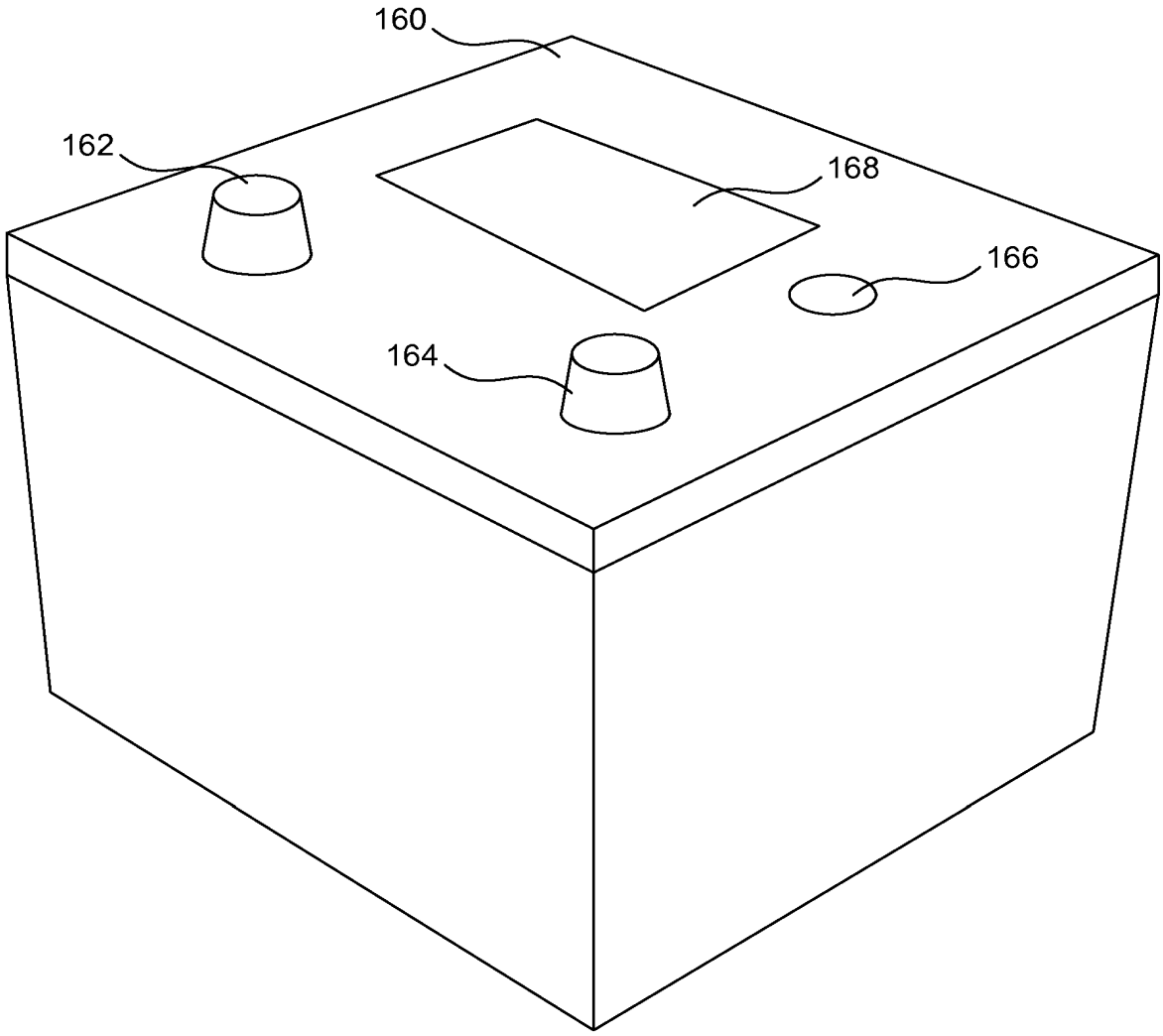


FIG. 18

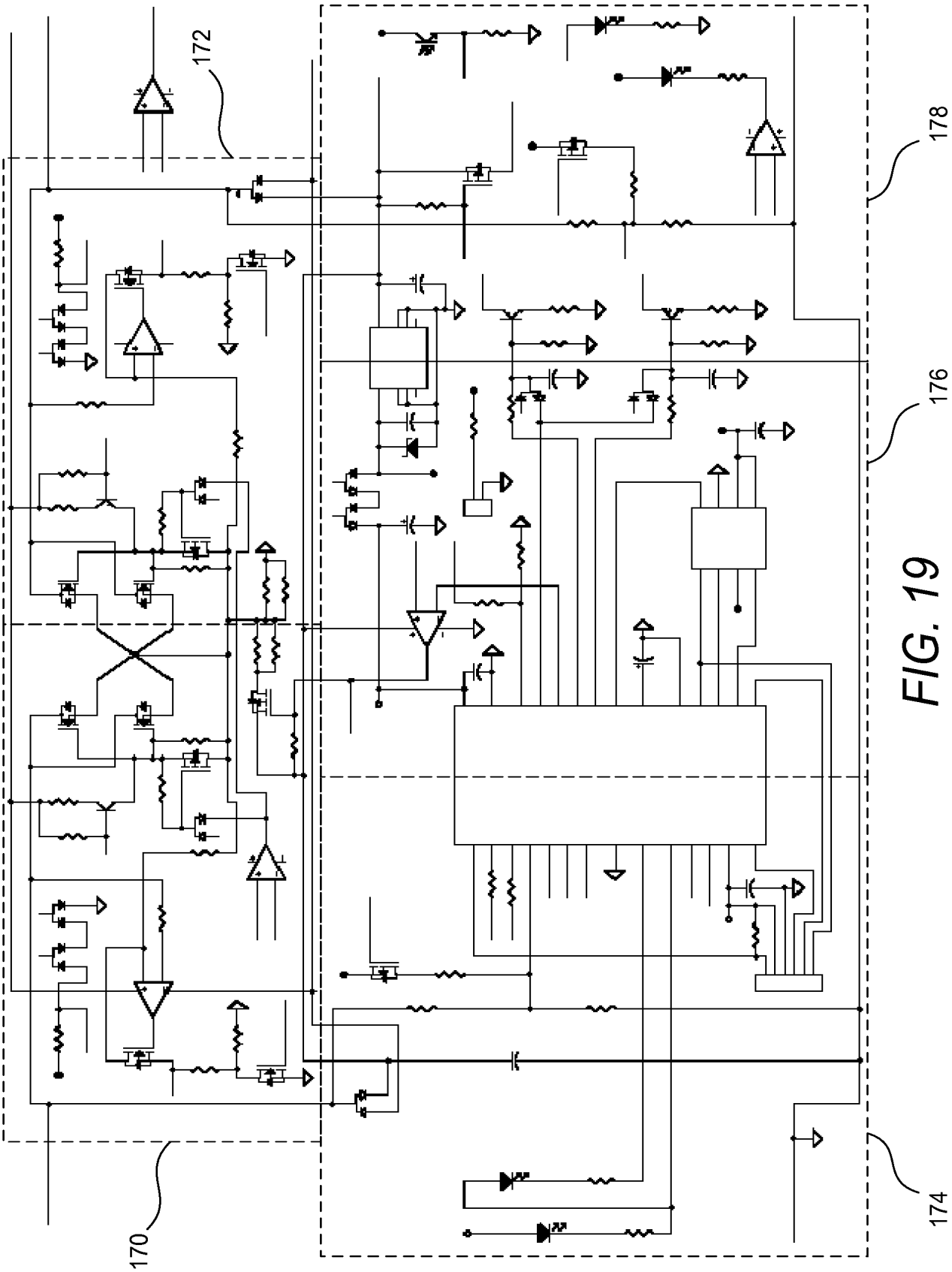


FIG. 19

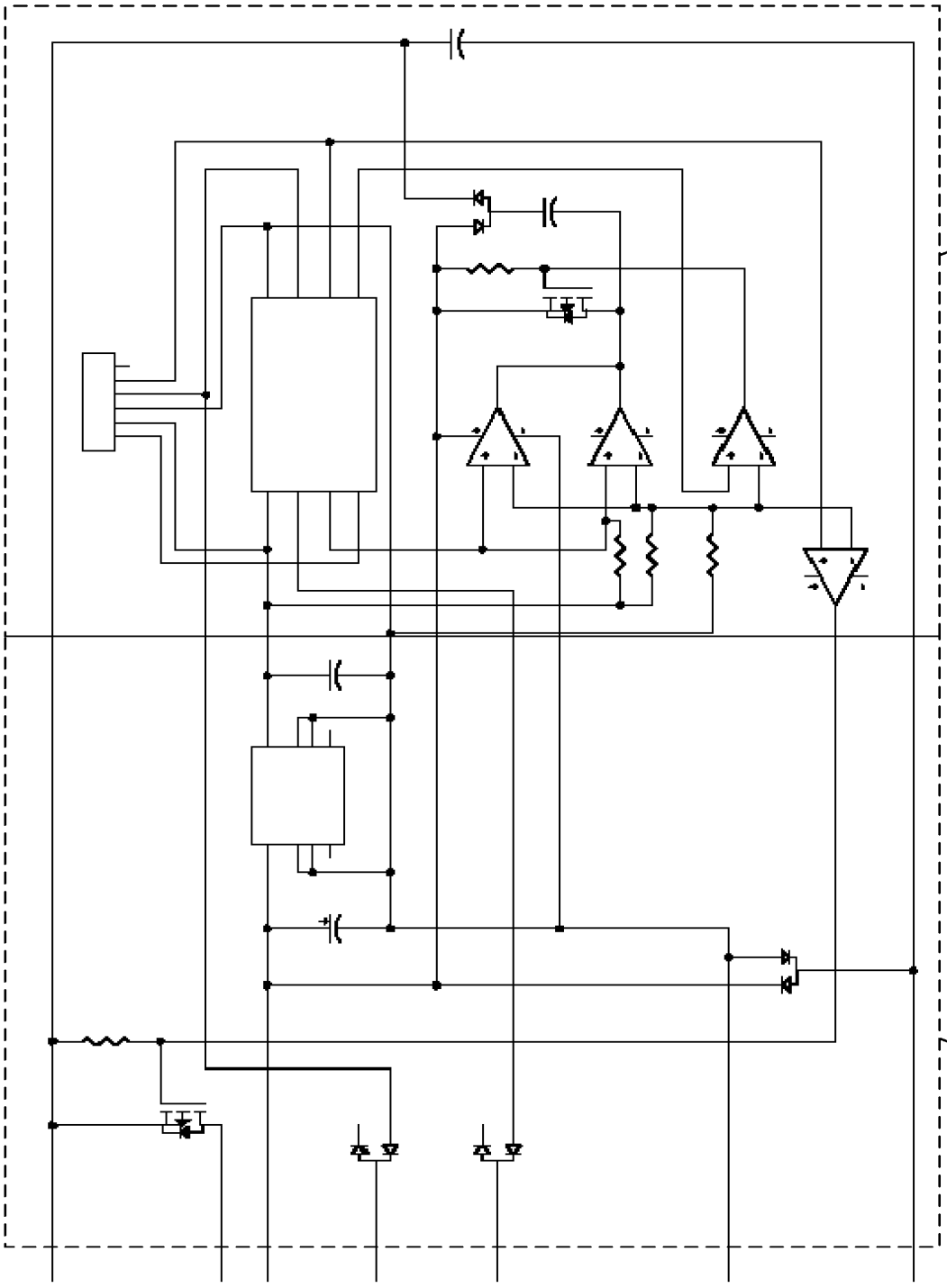


FIG. 20

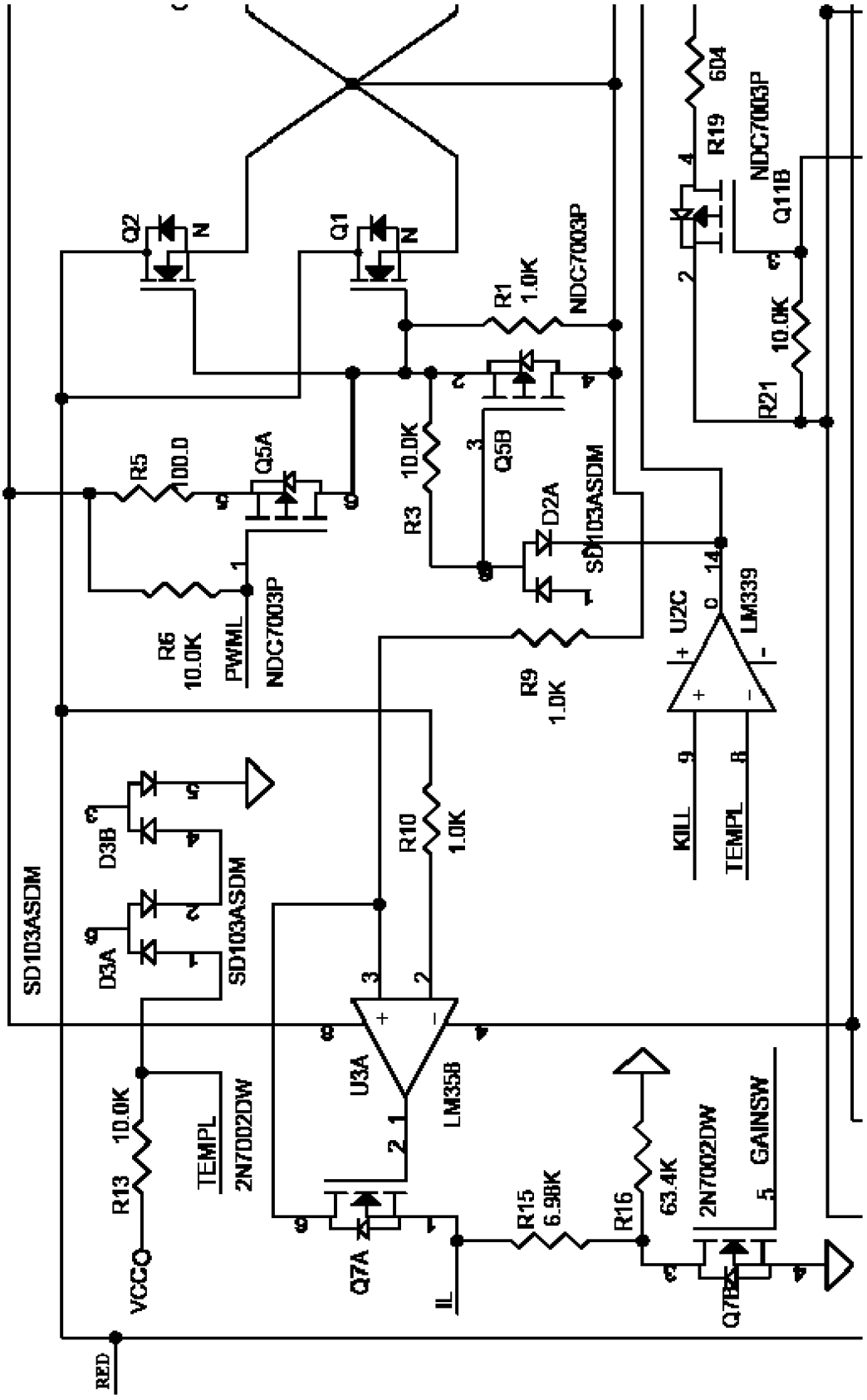

Q2
Q1
R1
1.0K
NDC7003P
R19
604
Q11B
R21
10.0K
R5
100.0
Q5A
R3
10.0K
Q5B
D2A
SD103ASDM
R6
10.0K
PWML
R9
1.0K
U2C
LM339
KILL
TEMPL
D3B
D3A
R10
1.0K
U3A
LM358
R13
10.0K
VCCO
2N7002DW
Q7A
R15
6.98K
R16
63.4K
GAINSW
Q7B
IL
RED

FIG. 21

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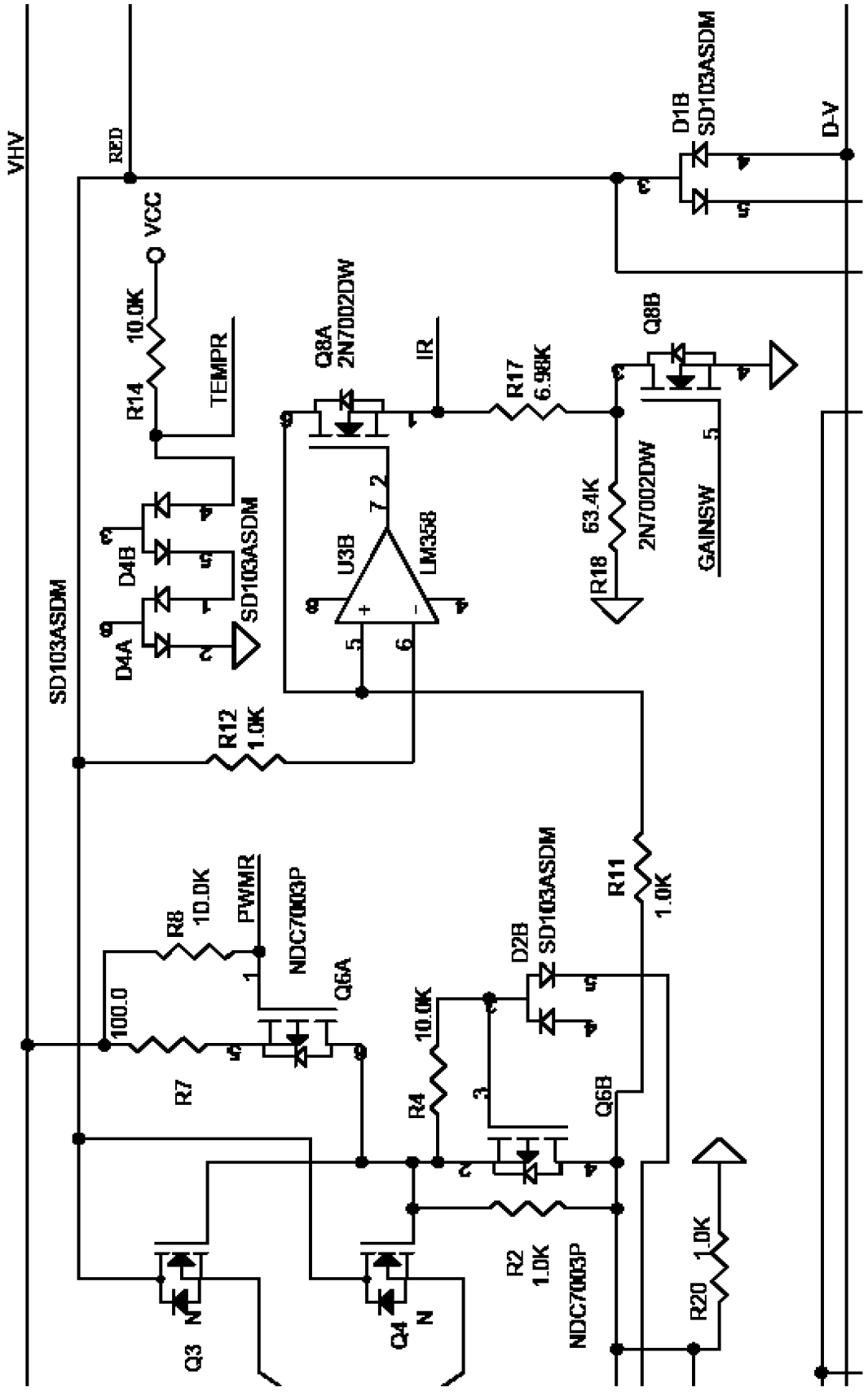

VHV
RED
VCC
10.0K
R14
TEMPR
Q8A
2N7002DW
IR
R17
6.98K
Q8B
D1B
SD103ASDM
D-V
SD103ASDM
D4B
D4A
SD103ASDM
U3B
LM358
R18
63.4K
2N7002DW
GAINSW
R12
1.0K
R8
10.0K
PWMR
NDC7003P
Q6A
100.0
R7
D2B
SD103ASDM
R11
1.0K
R4
10.0K
Q6B
R2
1.0K
NDC7003P
R20
1.0K
Q3
N
Q4
N

FIG. 22

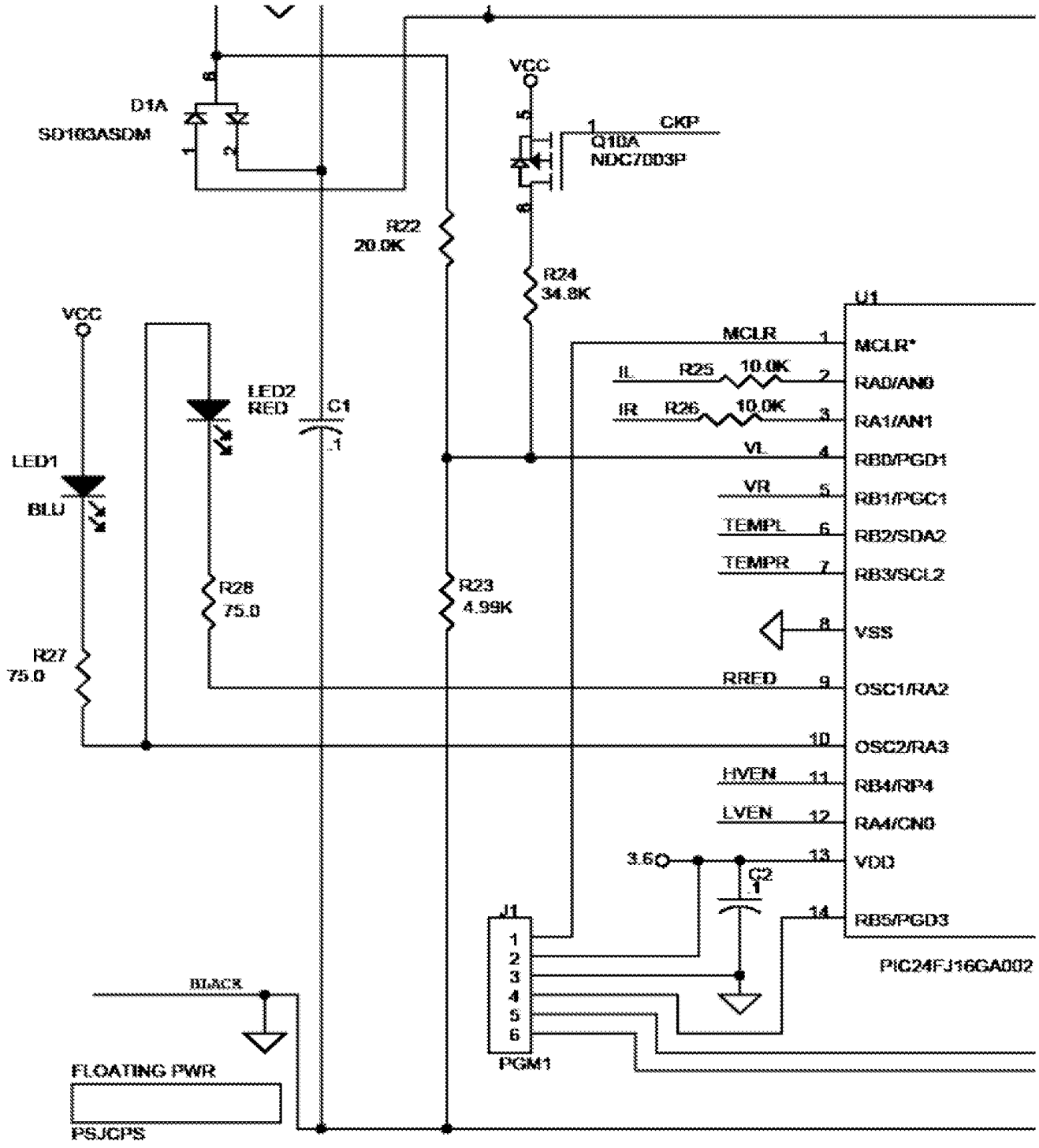

D1A
SD103ASDM
VCC
Q1DA
NDC7003P
CKP
R22
20.0K
R24
34.8K
U1
MCLR
MCLR*
IL
R25
10.0K
RA0/AN0
IR
R26
10.0K
RA1/AN1
VI
RB0/PGD1
VR
RB1/PGC1
TEMPL
RB2/SDA2
TEMPR
RB3/SCL2
VSS
RRED
OSC1/RA2
OSC2/RA3
HVEN
RB4/RP4
LVEN
RA4/CN0
3.6
C2
VDD
RB5/PGD3
PIC24FJ16GA002
J1
PGM1
LED2
RED
C1
.1
LED1
BLU
R28
75.0
R23
4.99K
R27
75.0
BLACK
FLOATING PWR
PSJCPS

FIG. 23

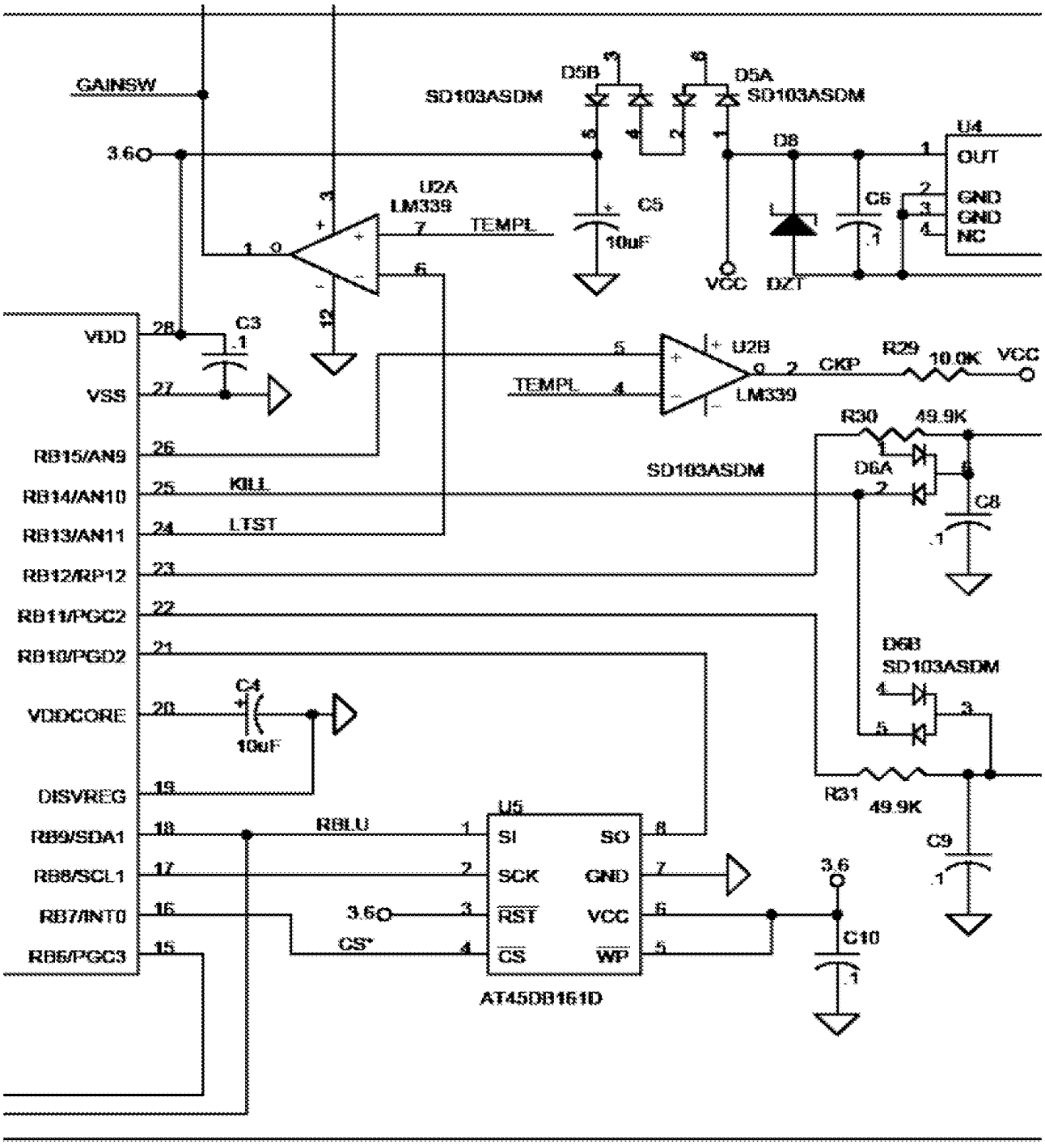

GAINSW
3.6
D5B
SD103ASDM
D5A
SD103ASDM
U4
OUT
GND
GND
NC
D8
C6
U2A
LM339
TEMPL
C5
10uF
VCC
DZT
VDD
VSS
C3
.1
U2B
LM339
CKP
R29
10.0K
VCC
R30
49.9K
D6A
SD103ASDM
C8
.1
RB15/AN9
RB14/AN10
KILL
RB13/AN11
LTST
RB12/RP12
RB11/PGC2
RB10/PGD2
D6B
SD103ASDM
VDDCORE
C4
10uF
DISVREG
R31
49.9K
C9
.1
RB9/SDA1
RB8/SCL1
RB7/INT0
RB6/PGC3
RBLU
U5
SI
SCK
RST
CS
SO
GND
VCC
WP
AT45DB161D
3.6
CS*
C10
.1

FIG. 24

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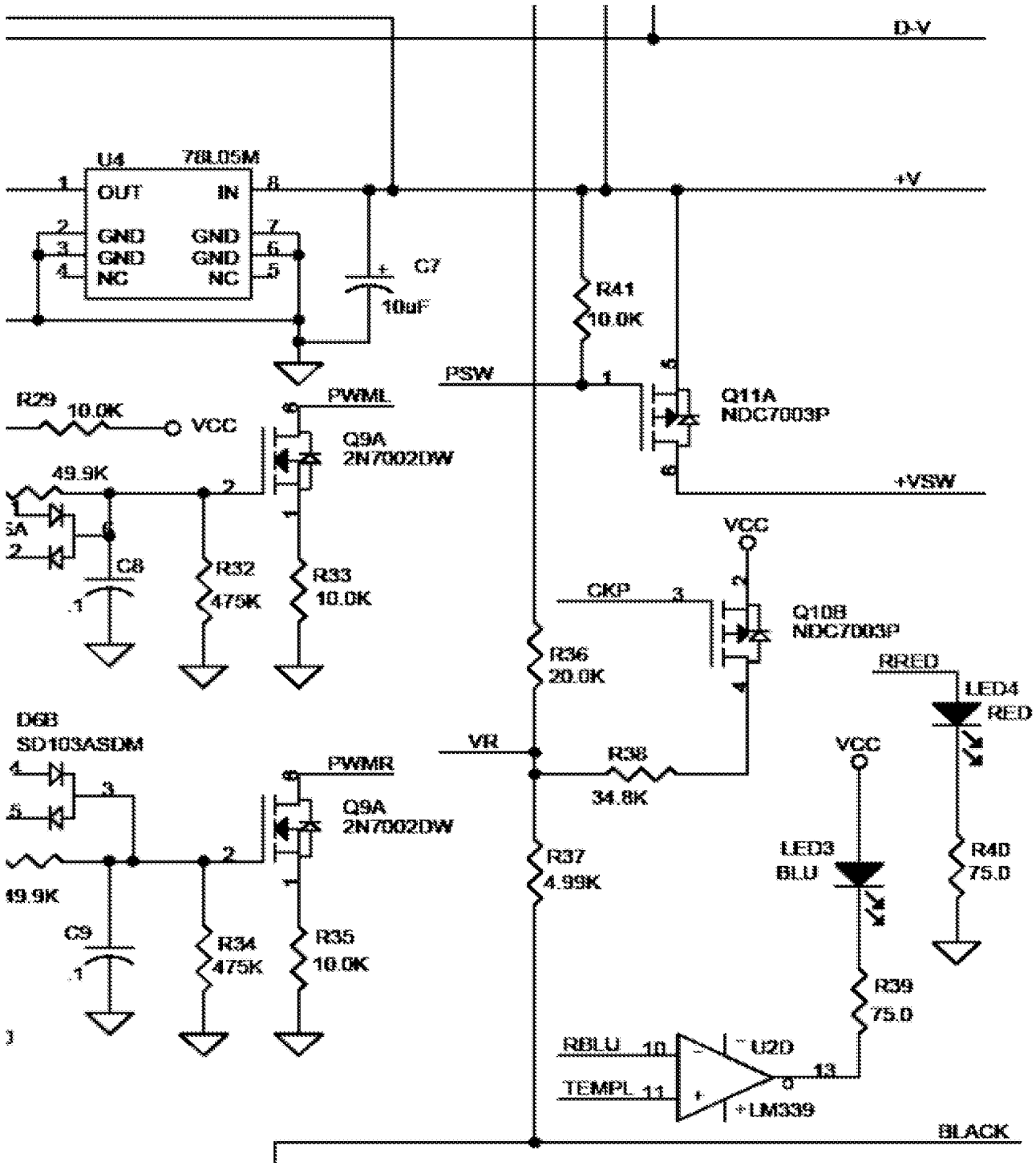

D-V
+V
U4
78L05M
OUT
IN
GND
GND
NC
C7
10uF
R41
10.0K
PSW
Q11A
NDC7003P
+VSW
R29
10.0K
VCC
PWML
Q9A
2N7002DW
49.9K
C8
.1
R32
475K
R33
10.0K
CKP
Q10B
NDC7003P
R36
20.0K
RRED
LED4
RED
D6B
SD103ASDM
VR
R38
34.8K
PWMR
Q9A
2N7002DW
R37
4.99K
LED3
BLU
R40
75.0
C9
R34
475K
R35
10.0K
R39
75.0
RBLU
TEMPL
U2D
LM339
BLACK

FIG. 25

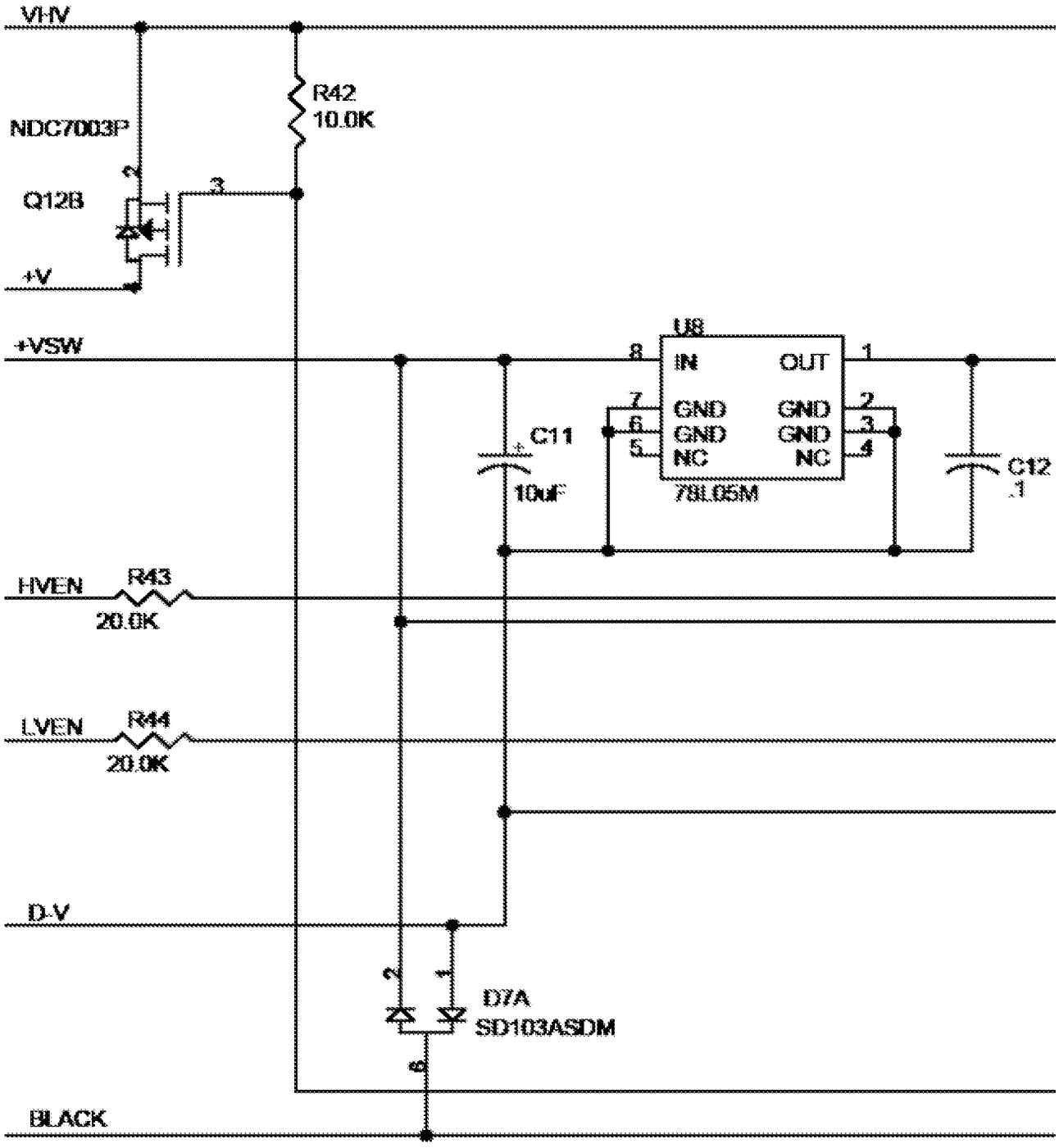

VHV
R42
10.0K
NDC7003P
Q12B
+V
+VSW
U8
IN
OUT
GND
GND
GND
GND
NC
NC
78L05M
C11
10uF
C12
.1
HVEN
R43
20.0K
LVEN
R44
20.0K
D-V
D7A
SD103ASDM
BLACK

FIG. 26

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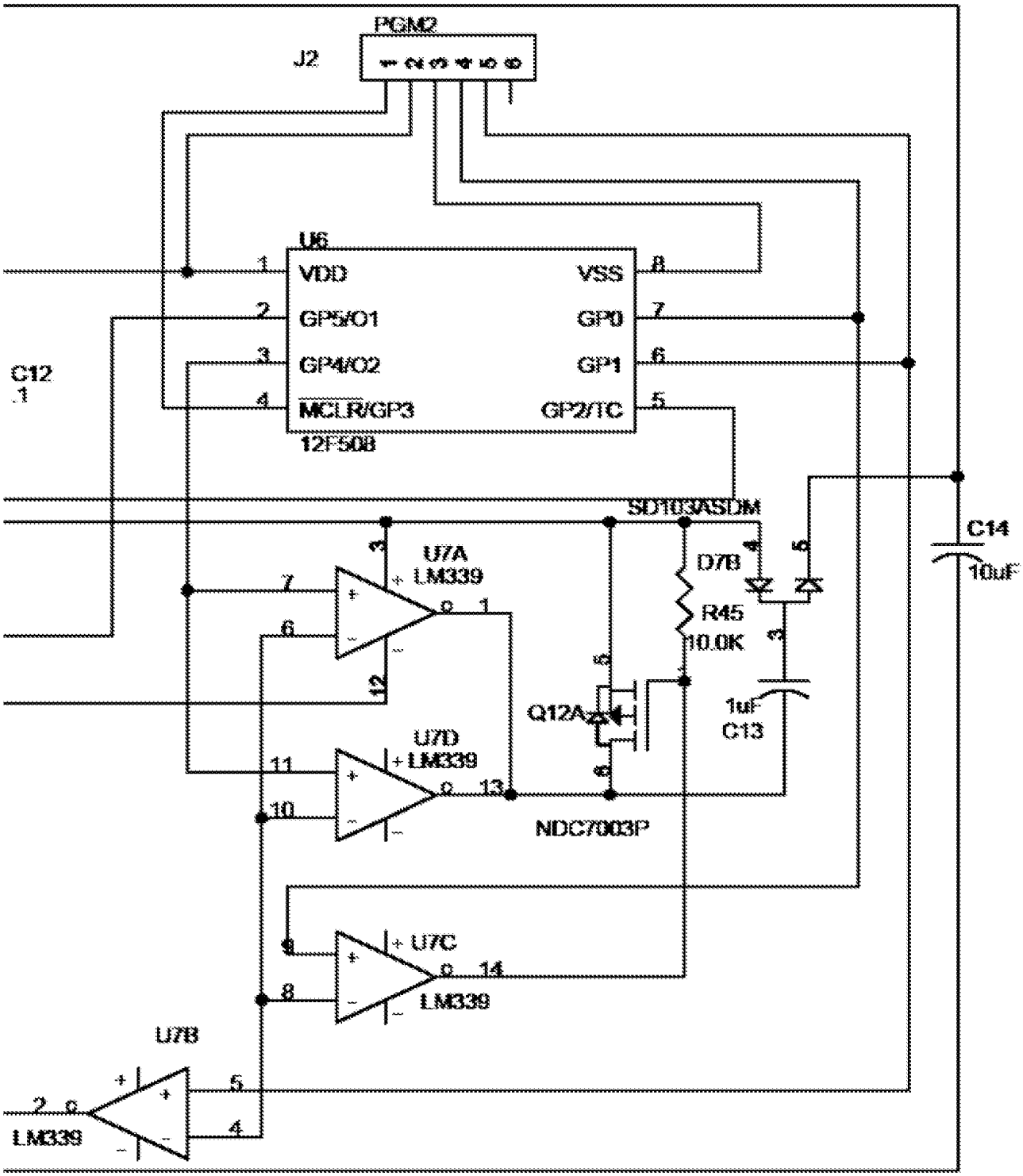

PGM2
J2
U6
VDD
VSS
GP5/IO1
GP0
GP4/IO2
GP1
MCLR/GP3
GP2/TC
12F508
C12
.1
SD103ASDM
C14
10uF
U7A
LM339
D7B
R45
10.0K
1uF
C13
Q12A
U7D
LM339
NDC7003P
U7C
LM339
U7B
LM339

FIG. 27

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
18 February 2016 (18.02.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/025869 A1

(51) International Patent Classification:
H02M 3/18 (2006.01) *H02J 7/02* (2016.01)

(21) International Application Number:
PCT/US2015/045335

(22) International Filing Date:
14 August 2015 (14.08.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/037,379 14 August 2014 (14.08.2014) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: COMPACT MULTIFUNCTIONAL BATTERY BOOSTER

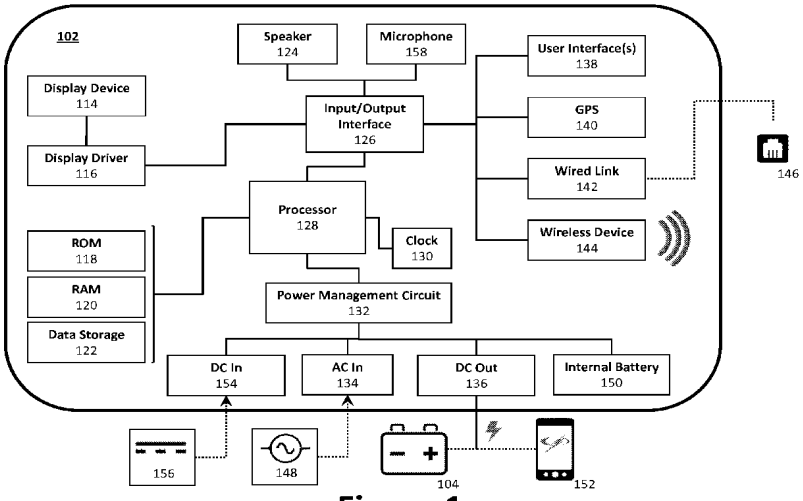


Figure 1

(57) **Abstract**: A compact battery charger for charging a battery comprising: a microprocessor; a set of terminals operatively coupled to said microprocessor and configured to electrically couple with an automotive battery; and an internal lithium ion battery, wherein the internal lithium ion battery is a lithium ion battery, wherein a single-ended primary-inductor converter may be configured to receive an input voltage of 5VDC to 20VDC and output a predetermined DC charge voltage to said internal lithium ion battery.

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COMPACT MULTIFUNCTIONAL BATTERY BOOSTER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 62/037,379 by Brian F. Butler et al., filed on August 14, 2014 and entitled "Compact Multifunctional Battery Booster." U.S. Provisional Patent Application No. 62/037,379 is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to a portable battery booster system and apparatus. More specifically, the present invention relates to systems, methods, and apparatuses for providing a compact multifunctional battery booster and charger.

BACKGROUND

[0003] It is well known that motorists from time to time find themselves with a battery of insufficient charge to start their vehicle. This is generally an occasion of extreme inconvenience and distress, particularly where one finds himself in this situation in an area where there are other vehicles and drivers, but no means for connecting the battery of the disabled vehicle to the battery of one of the other available vehicles. To remedy this, battery boosters were developed to jump start stranded cars. For example, U.S. Patent No. 4,079,304 discloses a battery booster system for jump starting an engine of a vehicle with a defective (or depleted) battery and interconnecting the same with a vehicle having a charged battery. Similarly, U.S. Patent Publication No. 2014/0159509 discloses a portable battery boost and jump starter apparatus for charging a vehicle battery. Typically, such battery booster systems rely on an internal lead acid battery, which is typically large, heavy, and cumbersome. Despite the advancements thus far, a need exists for an improved compact multifunctional battery booster, and, more particularly, to an improved lithium ion battery booster.

SUMMARY OF THE INVENTION

[0004] The present disclosure is directed to an improved compact multifunctional battery booster and charger, and, more particularly, to an improved lithium ion battery booster and charger.

[0005] According to a first aspect of the present invention, a compact battery booster comprises: a processor; a display device operatively coupled to the processor, wherein the display device displays a status of the compact battery booster; a storage capacitor and an internal lithium ion

battery, each of said storage capacitor and said internal lithium ion battery configured to provide a boosting energy to a vehicle coupled to an external battery; a direct current (DC) output terminal configured to electrically couple with the external battery; a single-ended primary-inductor converter configured to receive a variable input voltage between 5 volts DC and 20 volts DC and to output a predetermined output voltage to said storage capacitor and said internal lithium ion battery; and a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said storage capacitor or said internal lithium ion battery, thereby providing the boosting energy from said storage capacitor or said internal lithium ion battery to said vehicle.

[0006] According to a second aspect of the present invention, a compact battery charger comprises: a processor; a display device operatively coupled to the processor, wherein the display device displays a status of the compact battery charger; an internal lithium ion battery, said internal lithium ion battery configured to provide a predetermined output energy; a direct current (DC) output terminal, wherein the DC output terminal is configured to couple with an external battery; a single-ended primary-inductor converter configured to receive an input voltage within predetermined input voltage range and to output a predetermined charge voltage to said internal lithium ion battery; and a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said internal lithium ion battery, thereby providing the predetermined output energy from said internal lithium ion battery to said external battery.

[0007] According to a third aspect of the present invention, a compact battery charger comprises: an internal lithium ion battery, said internal lithium ion battery configured to provide a predetermined output energy; a direct current (DC) output terminal, wherein the DC output terminal is configured to couple with an external battery; an internal induction coil, wherein the internal induction coil receives energy from an electromagnetic field created by an external induction coil and converts the electromagnetic field to produce an input voltage; a DC to DC converter that receives the input voltage and outputs a predetermined output voltage to said internal lithium ion battery; and a power management circuit operatively coupled to the processor, the power management circuit configured to electrically couple the DC output terminal with said internal lithium ion battery, thereby providing the predetermined output energy from said internal lithium ion battery to said external battery.

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[0008] In certain aspects, the storage capacitor is a supercapacitor.

[0009] In certain aspects, the storage capacitor draws a charging current from the external battery.

[0010] In certain aspects, the device further comprises a supercapacitor, wherein the single-ended primary-inductor converter charges the supercapacitor.

[0011] In certain aspects, the device further comprises a supercapacitor, wherein the supercapacitor draws current from the external battery to charge the supercapacitor.

[0012] In certain aspects, the predetermined input voltage range is 5 volts to 20 volts.

[0013] In certain aspects, the predetermined charge voltage is greater than the input voltage.

[0014] In certain aspects, the predetermined output energy is a boosting energy for starting an engine coupled to the external battery.

[0015] In certain aspects, the predetermined output energy is a charging energy for charging the external battery.

[0016] In certain aspects, the device further comprises (1) a reverse polarity sensor configured to detect a polarity of the external battery; (2) a temperature sensor configured to detect a temperature of said internal lithium ion battery and to provide a temperature signal to said processor; and (3) a voltage sensor configured to detect a voltage of said internal lithium ion battery.

[0017] In certain aspects, the device further comprises a removable internal data storage device.

[0018] In certain aspects, the device further comprises an internal induction coil, wherein the internal induction coil receives energy from an electromagnetic field created by an external induction coil and converts the electromagnetic field to produce the input voltage.

[0019] In certain aspects, the device further comprises a second DC output terminal, wherein the DC output terminal provides a boosting energy for starting an engine coupled to the external battery, and wherein the second DC output terminal provides a charging energy to a portable electronic device.

[0020] In certain aspects, the second DC output terminal is a Universal Serial Bus (USB) port.

[0021] In certain aspects, the display device enters into a sleep mode after a predetermined time period of inactivity.

[0022] In certain aspects, the DC output terminal runs a predetermined current through the external battery to preheat the external battery.

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[0023] In certain aspects, the device further comprises a DC to alternating current (AC) converter coupled between the internal lithium ion battery and an AC output terminal.

[0024] In certain aspects, the device further comprises an internal data storage device, wherein the internal data storage device backs up digital content stored to a portable electronic device via a USB port.

DESCRIPTION OF THE DRAWINGS

[0025] These and other advantages of the present invention will be readily understood with reference to the following specifications and attached drawings wherein:

[0026] Figure 1 illustrates an exemplary compact battery charger block diagram configured for use with a battery charging system.

[0027] Figure 2 illustrates a flow diagram of an example method for providing the jump start function using a compact battery charger.

[0028] Figure 3 illustrates an example schematic diagram of a charger having a single-ended primary-inductor converter circuit and a supercapacitor.

DETAILED DESCRIPTION

[0029] Preferred embodiments of the present invention will be described hereinbelow with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail because they may obscure the invention in unnecessary detail. The present invention relates to a compact battery charger system, method, and apparatus. For this disclosure, the following terms and definitions shall apply:

[0030] As used herein, the word "exemplary" means "serving as an example, instance, or illustration." The embodiments described herein are not limiting, but rather are exemplary only. It should be understood that the described embodiments are not necessarily to be construed as preferred or advantageous over other embodiments. Moreover, the terms "embodiments of the invention," "embodiments," or "invention" do not require that all embodiments of the invention include the discussed feature, advantage, or mode of operation.

[0031] The terms "communicate" and "communicating" as used herein, include both conveying data from a source to a destination and delivering data to a communications medium, system, channel, network, device, wire, cable, fiber, circuit, and/or link to be conveyed to a destination. The term "communication" as used herein means data so conveyed or delivered. The

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term "communications" as used herein includes one or more of a communications medium, system, channel, network, device, wire, cable, fiber, circuit, and/or link.

[0032] The terms "coupled," "coupled to," and "coupled with" as used herein, each mean a relationship between or among two or more devices, apparatuses, files, circuits, elements, functions, operations, processes, programs, media, components, networks, systems, subsystems, and/or means, constituting any one or more of: (i) a connection, whether direct or through one or more other devices, apparatuses, files, circuits, elements, functions, operations, processes, programs, media, components, networks, systems, subsystems, or means; (ii) a communications relationship, whether direct or through one or more other devices, apparatuses, files, circuits, elements, functions, operations, processes, programs, media, components, networks, systems, subsystems, or means; and/or (iii) a functional relationship in which the operation of any one or more devices, apparatuses, files, circuits, elements, functions, operations, processes, programs, media, components, networks, systems, subsystems, or means depends, in whole or in part, on the operation of any one or more others thereof.

[0033] The term "data" as used herein means any indicia, signals, marks, symbols, domains, symbol sets, representations, and any other physical form or forms representing information, whether permanent or temporary, whether visible, audible, acoustic, electric, magnetic, electromagnetic, or otherwise manifested. The term "data" is used to represent predetermined information in one physical form, encompassing any and all representations of corresponding information in a different physical form or forms.

[0034] The term "database" as used herein means an organized body of related data, regardless of the manner in which the data or the organized body thereof is represented. For example, the organized body of related data may be in the form of one or more of a table, map, grid, packet, datagram, frame, file, email, message, document, report, list, or any other form.

[0035] The term "network" as used herein includes both networks and inter-networks of all kinds, including the Internet, and is not limited to any particular network or inter-network.

[0036] The term "processor" as used herein means processing devices, apparatuses, programs, circuits, components, systems, and subsystems, whether implemented in hardware, tangibly embodied software, or both, and whether or not it is programmable. The term "processor" as used herein includes, but is not limited to, one or more computing devices, hardwired circuits, signal-modifying devices and systems, devices and machines for controlling systems, central processing units,

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programmable devices and systems, field-programmable gate arrays, application-specific integrated circuits, systems on a chip, systems comprising discrete elements and/or circuits, state machines, virtual machines, data processors, processing facilities, and combinations of any of the foregoing.

[0037] A compact battery charger 102, as disclosed herein, may be used to start (a/k/a "boost", "jump", or "jump start") an engine coupled to an external battery 104 (*e.g.*, a 6V/12V nominal voltage vehicular battery, which may be fully or partially depleted). In certain aspects, the compact battery charger 102 may be further configured to charge the external battery 104, and/or other electronic devices operatively coupled with the compact battery charger 102. Example vehicular batteries include, without limitation, lead-acid batteries (*e.g.*, wet/flooded batteries, calcium-calcium batteries, Valve-Regulated, Lead Acid (VRLA) batteries, gel cell, and Absorbed Glass Mat (AGM)) and other rechargeable batteries (*e.g.*, lithium ion, lithium ion polymer, Nickel-Metal Hydride (NiMH), Nickel Cadmium (NiCd)). Other electronic devices that may be operatively coupled with the compact battery charger 102 include, for example, portable electronic devices 152 (*e.g.*, phones, tablet computers, portable computers, etc.), toys, etc.

[0038] Figure 1 illustrates a block diagram of an example compact battery charger 102. Specifically, Figure 1 illustrates a compact battery charger 102 having a processor 128 (*e.g.*, a central processing unit (CPU)) that is operatively coupled to a Read-Only Memory (ROM) 118 for receiving one or more instruction sets, to a Random Access Memory (RAM) 120 having a plurality of buffers for temporarily storing and retrieving information, and to an internal data storage device 122 (*e.g.*, a hard drive, such a solid state drive, or other non-volatile data storage device, such as flash memory). A clock 130 is also coupled to the processor 128 for providing clock or timing signals or pulses thereto. Those skilled in the art will understand that the compact battery charger 102 includes one or more bus structures for interconnecting its various components. Further, to increase ease of use in mobile applications, the various components of a compact battery charger 102 may be housed in a single housing. In certain aspects, multiple processors 128 may be provided to facilitate operation of the compact battery charger 102, whether or not embodied within the compact battery charger 102 itself. Accordingly, serial communication may be employed to communicate information and data between multiple processors that may be used.

[0039] The internal battery 150 may be a rechargeable lithium ion battery for outputting a direct current (DC) voltage, such as lithium iron phosphate and lithium ion polymer batteries. The internal battery 150 should be sufficiently rated to boost (jump start) a vehicle coupled to an external

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IPR2025-00885