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UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/989,273	08/09/2016	9412994	4984	4437

68151 7590 07/20/2016
RALPH H. DOUGHERTY
4219 KRONOS PLACE
CHARLOTTE, NC 28210

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 598 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Martin Koebler, Davidson, NC;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PART B - FEE(S) TRANSMITTAL

RECEIVED
CENTRAL FAX CENTER

Complete and send this form, together with applicable fee(s), to: **Mail** Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or **Fax** (571)-273-2885

JUN 30 2016

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

68151 7590 06/27/2016
RALPH H. DOUGHERTY
4219 KRONOS PLACE
CHARLOTTE, NC 28210

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

RALPH H. DOUGHERTY (Depositor's name)
Ralph H. Dougherty (Signature)
6-30-2016 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/989,273	05/23/2013	Martin Koebler	4984	4437

TITLE OF INVENTION: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	09/27/2016

EXAMINER	ART. UNIT	CLASS-SUBCLASS
PELTON, NATHANIEL R	2859	320.135000

07/01/2016 JVONG2 00000001 13989273

01 FC:2501

488.00 DP

02 FC:8001

30.00 DP

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47, Rev. 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

RALPH H. DOUGHERTY

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☒ Advance Order - # of Copies 10

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
- ☒ Payment by credit card. Form PTO-2038 is attached.
- ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature

Ralph H. Dougherty

Date

6-30-2016

Typed or printed name

RALPH H. DOUGHERTY

Registration No.

25,851

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JUN 30 2016

FAX COVER SHEET

TO	
COMPANY	
FAXNUMBER	15712738300
FROM	Ralph H Dougherty PA
DATE	2016-07-01 00:03:27 GMT
RE	Dkt 4984 - Issue Fee

COVER MESSAGE

FAX TO: US Patent and Trademark Office

FAX NO: 1-571-273-8300

FROM: Ralph H. Dougherty

No. of Pages: 4 (counting cover sheet)

Art Unit: 2859 (Examiner: Nathaniel PELTON)

Applicant: MARTIN KOEBLER

Serial No: 13/989,273

Filed: May 23, 2013

Title: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

Our File: Docket 4984

=====

PLEASE CONFIRM RECEIPT OF THIS TRANSMISSION

Dear Sirs:

WWW.MYFAX.COM

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JUN 30 2016

Please forward the attached document to Mail Stop ISSUEFEE.

Thank you for your prompt attention to this matter.

Very truly yours,

Ralph H. Dougherty
Ralph H. Dougherty

Reg. No. 25,851
Ralph H. Dougherty, P.A.
Patent, Trademark, Copyright Law
4219 Kronos Place
Charlotte, NC 28210 USA
Phone: 704-940-3988
Fax: 704-631-4996
E-Mail: <mailto:ralph@ralphdougherty.com> ralph@ralphdougherty.com

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JUN 30 2016

PTO/SB/97 (07-09)

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

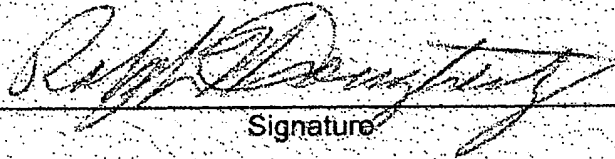
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Certificate of Transmission under 37 CFR 1.8

I hereby certify that this correspondence is being facsimile transmitted to the United States Patent and Trademark Office

on June 30, 2016

Date



Signature

RALPH H. DOUGHERTY

Typed or printed name of person signing Certificate

25,851

704-940-3988

Registration Number, if applicable

Telephone Number

Note: Each paper must have its own certificate of transmission, or this certificate must identify each submitted paper.

This collection of information is required by 37 CFR 1.8. 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 1.8 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.



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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

68151 7590 06/27/2016
RALPH H. DOUGHERTY
4219 KRONOS PLACE
CHARLOTTE, NC 28210

EXAMINER

PELTON, NATHANIEL R

ART UNIT

PAPER NUMBER

2859

DATE MAILED: 06/27/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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13/989,273

05/23/2013

Martin Koebler

4984

4437

TITLE OF INVENTION: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	09/27/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax **(571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

68151 7590 06/27/2016
RALPH H. DOUGHERTY
4219 KRONOS PLACE
CHARLOTTE, NC 28210

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/989,273	05/23/2013	Martin Koebler	4984	4437

TITLE OF INVENTION: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	09/27/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
PELTON, NATHANIEL R	2859	320-135000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363). ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached. ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.	2. For printing on the patent front page, list (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____ (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____ 3 _____
---	---

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
☐ Applicant asserting small entity status. See 37 CFR 1.27
☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____
Typed or printed name _____ Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/989,273	05/23/2013	Martin Koebler	4984	4437

68151 7590 06/27/2016
RALPH H. DOUGHERTY
4219 KRONOS PLACE
CHARLOTTE, NC 28210

EXAMINER

PELTON, NATHANIEL R

ART UNIT	PAPER NUMBER
----------	--------------

2859

DATE MAILED: 06/27/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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.
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 Cooperation Treaty.
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.

Notice of Allowability	Application No. 13/989,273	Applicant(s) KOEBLER, MARTIN	
	Examiner NATHANIEL PELTON	Art Unit 2859	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to amdt on 04/06/2016.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ 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.
3. ☒ The allowed claim(s) is/are 10-16 and 21-36. As a result of the allowed claim(s), 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.
4. ☐ 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)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|--|
| 1. ☐ Notice of References Cited (PTO-892) | 5. ☒ Examiner's Amendment/Comment |
| 2. ☐ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date _____ | 6. ☒ Examiner's Statement of Reasons for Allowance |
| 3. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 7. ☒ Other <u>see detailed action</u> . |
| 4. ☐ Interview Summary (PTO-413),
Paper No./Mail Date _____. | |

/NATHANIEL PELTON/
Examiner, Art Unit 2859

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Response to Amendment

Acknowledgement is made of the amendments/arguments filed 04/06/2016 in which claims 1-7 and 10-16 were amended claims 8, 9, 17-20 canceled, and claims 21-36 added. Claims 1-7, 10-16, and 21-36 are pending for examination below.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Ralph Dougherty on 06/22/2016.

The claim set filed on 04/06/2016 has been amended as follows:

In the claims:

Claim 1 (Canceled).

Claim 2 (Canceled).

Claim 3 (Canceled).

Claim 4 (Canceled).

Claim 5 (Canceled).

Claim 6 (Canceled).

Claim 7 (Canceled).

Allowable Subject Matter

Claims 10-16 and 21-36 are allowed.

The following is an examiner's statement of reasons for allowance:

With respect to claims 12 and 27, the prior art of record does not suggest or disclose the claimed combination of elements or steps as recited, most particularly the claimed, "at least one lithium-based rechargeable cell within said housing, said cell having a positive pole and a negative pole, a circuit board within said housing having a cutoff function incorporated therein, said circuit board including a plurality of pairs of solid state switches with each pair of solid state switches connected in a parallel configuration to another pair of solid state switches, each switch having a source and a drain, the switches of a pair of solid state switches being configured such that either the drains of the switches are connected or the sources of the switches are connected; and said parallel configuration of the plurality of solid state switches being connected in series with said one or more cells between said positive and negative terminals of the battery pack."

Claims 10, 11, 13-16, 21-26, and 28-36 depend from claims 12 and 27 and are allowed for the same reasons.

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."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to NATHANIEL PELTON whose telephone number is (571)270-1761. The examiner can normally be reached on M-F 9:00-5:00 and by e-mail at nathaniel.pelton@uspto.gov (please include authorization to communicate via e-mail).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard Isla-Rodas can be reached on 571-272-5056. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2859

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 <http://pair-direct.uspto.gov>. 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.

/NATHANIEL PELTON/
Examiner, Art Unit 2859

Search Notes 	Application/Control No. 13989273	Applicant(s)/Patent Under Reexamination KOEBLER, MARTIN
	Examiner NATHANIEL PELTON	Art Unit 2859

CPC- SEARCHED		
Symbol	Date	Examiner
H02J 7/00	12-28-15	nrp
H02H 3/26, 7/18	12-28-15	nrp
H02J 7/00	6-23-16	nrp
H02H 3/26, 7/18	6-23-16	nrp
H01M 10/052, 10/4207, 10/425, 2010/4271, 2220/20, 2/34	6-23-16	nrp

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
320	135	12-28-15	nrp
320	135	6-23-16	nrp
361	087	6-23-16	nrp
429	150, 99, 007, 096	6-23-16	nrp

SEARCH NOTES		
Search Notes	Date	Examiner
requested PLUS search on spec and claims	12-28-15	nrp
performed inventor search	12-28-15	nrp
text searched for key concepts	12-28-15	nrp
updated East search (see attached)	6-23-16	nrp

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
H02J	7/00	6-23-16	nrp

/NATHANIEL PELTON/ Examiner.Art Unit 2859	
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INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
H02H	3/26, 7/18	6-23-16	nrp
H01M	10/052, 10/4207, 10/425, 2010/4271, 2220/20, 2/34	6-23-16	nrp
320	135	6-23-16	nrp
361	087	6-23-16	nrp
429	150, 99, 007, 096	6-23-16	nrp

/NATHANIEL PELTON/
Examiner.Art Unit 2859

Issue Classification 	Application/Control No. 13989273	Applicant(s)/Patent Under Reexamination KOEBLER, MARTIN	
	Examiner NATHANIEL PELTON	Art Unit 2859	

CPC						
Symbol					Type	Version
H01M		2		34	F	2013-01-01
H01M		10		4207	I	2013-01-01
H01M		10		425	I	2013-01-01
H02H		3		26	I	2013-01-01
H02J		7		00	I	2013-01-01
H01M		10		052	A	2013-01-01
H01M		2010		4271	A	2013-01-01
H01M		2220		20	A	2013-01-01
H02H		7		18	I	2013-01-01

CPC Combination Sets				
Symbol	Type	Set	Ranking	Version

/NATHANIEL PELTON/ Examiner.Art Unit 2859 (Assistant Examiner)	6-23-16 (Date)	Total Claims Allowed: 23	
/NATHANIEL PELTON/ Examiner.Art Unit 2859 (Primary Examiner)	06/23/2016 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 16

Issue Classification 	Application/Control No. 13989273	Applicant(s)/Patent Under Reexamination KOEBLER, MARTIN
	Examiner NATHANIEL PELTON	Art Unit 2859

☐ Claims renumbered in the same order as presented by applicant															
☐ CPA															
☐ T.D.															
☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
-	1	-	17	20	33										
-	2	-	18	21	34										
-	3	-	19	22	35										
-	4	-	20	23	36										
-	5	8	21												
-	6	9	22												
-	7	10	23												
-	8	11	24												
-	9	12	25												
2	10	13	26												
3	11	14	27												
1	12	15	28												
4	13	16	29												
5	14	17	30												
6	15	18	31												
7	16	19	32												

/NATHANIEL PELTON/ Examiner.Art Unit 2859	6-23-16	Total Claims Allowed:	
(Assistant Examiner)	(Date)	23	
/NATHANIEL PELTON/ Examiner.Art Unit 2859	06/23/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S21	1	"20130241498".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/20 14:16
S22	7635	h02j7/00.cpc. or h02h3/26.cpc. or h02h7/18.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/20 14:16
S23	2261	S22 and @ad< "20101129"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/20 14:17
S24	103	S23 and (parallel\$2 near5 switch\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/20 14:19
S25	21091	h01m10/052.cpc. or h01m10/4207.cpc. or h01m10/425.cpc. or h01m2010/4271.cpc. or h01m2220/20.cpc. or h01m2/34.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/20 14:33
S26	89091	h01m10/052.cpc. or h01m10/4207.cpc. or h01m10/425.cpc. or h01m2010/4271.cpc. or h01m2220/20.cpc. or h01m2/34.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/20 14:34
S27	46880	S26 and @ad< "20101129"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/20 14:34
S28	405	S27 and (parallel\$2 near5 switch\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/20 14:35
S29	89114	h01m10/052.cpc. or h01m10/4207.cpc. or h01m10/425.cpc. or h01m2010/4271.cpc. or h01m2220/20.cpc. or h01m2/34.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/21 12:39

S30	46881	S29 and @ad< "20101129"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/21 12:39
S31	1078	S30 and ((source or drain) near5 connect\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/21 12:39
S32	633	S31 and parallel\$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/21 12:44
S33	1645	320/135 or 361/087	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 13:09
S34	1235	S33 and @ad< "20101129"	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/23 13:09
S35	151	S34 and (parallel\$2 near5 switch\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 13:09
S36	3405	429/150 or 429/99 or 429/007 or 429/096	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 13:46
S37	2594	S36 and @ad< "20101129"	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/23 13:46
S38	64	S37 and (parallel\$2 near5 switch\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 13:46
S39	696	(S34 or S37) and ((source or drain) near5 connect\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 14:10
S40	3406	(h01m10/052.cpc. or h01m10/4207.cpc. or h01m10/425.cpc. or h01m2010/4271.cpc. or h01m2220/20.cpc. or h01m2/34.cpc.) and (balanc\$3 or equiliz\$5) and (lithium)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 16:22
S41	1388	S40 and @ad< "20101129"	US-PGPUB;	OR	ON	2016/06/23

			USPAT; USOCR			16:23
S42	1504	S40 and @ad< "20101129"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 16:23
S43	67	S42 and (parallel\$2 near5 switch\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 16:23
S44	157	S42 and ((source or drain) near5 connect\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 16:23
S45	209	S43 or S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/23 16:24
S46	75	((Martin) near2 (Koebler)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/23 17:01

EAST Search History (I nterference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S47	9	((batter\$3 or cell or accumulat\$3 or storage) (volt or voltage or potential)(lithium or lithium\$1based)(positive)(negative)(switch\$3) (parallel) (seri\$4) (drain)(source)).clm.	US-PGPUB; USPAT	AND	ON	2016/06/23 17:06
S48	11	((batter\$3 or cell or accumulat\$3 or storage) (volt or voltage or potential)(lithium or lithium\$1based)(positive)(negative)(switch\$3) (parallel) (drain)(source)).clm.	US-PGPUB; USPAT	AND	ON	2016/06/23 17:06
S49	45	((batter\$3 or cell or accumulat\$3 or storage) (volt or voltage or potential)(lithium or lithium\$1based)(positive)(negative)(switch\$3) (parallel) (drain or source)).clm.	US-PGPUB; USPAT	AND	ON	2016/06/23 17:06
S50	219	((batter\$3 or cell or accumulat\$3 or storage) (volt or voltage or potential)(lithium or lithium\$1based)(switch\$3)(parallel)(drain or source)).clm.	US-PGPUB; USPAT	AND	ON	2016/06/23 17:06
S51	2	320/108 and S50	US-PGPUB; USPAT	AND	ON	2016/06/23 17:07
S52	5	S50 and (h02j7/00.cpc. or h02h3/26.cpc. or h02h7/18.cpc.)	US-PGPUB; USPAT	AND	ON	2016/06/23 17:07
S53	38	S50 and (h01m10/052.cpc. or	US-	AND	ON	2016/06/23

		h01m10/4207.cpc. or h01m10/425.cpc. or h01m2010/4271.cpc. or h01m2220/20.cpc. or h01m2/34.cpc.)	PGPUB; USPAT			17:07
S54	3	S50 and (429/150 or 429/99 or 429/007 or 429/096)	US- PGPUB; USPAT	AND	ON	2016/06/23 17:08
S55	0	S50 and 361/087	US- PGPUB; USPAT	AND	ON	2016/06/23 17:08

6/ 23/ 2016 5:23:00 PM
C:\ Users\ npelton\ Documents\ EAST\ Workspaces\ 13989273.wsp

<i>Index of Claims</i> 	Application/Control No. 13989273	Applicant(s)/Patent Under Reexamination KOEBLER, MARTIN
	Examiner NATHANIEL PELTON	Art Unit 2859

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant				☐ CPA				☐ T.D.				☐ R.1.47			
CLAIM		DATE													
Final	Original	12/28/2015	06/23/2016												
	1	✓	-												
	2	✓	-												
	3	✓	-												
	4	✓	-												
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	3		=												
	35		=												

<i>Index of Claims</i> 	Application/Control No. 13989273	Applicant(s)/Patent Under Reexamination KOEBLER, MARTIN
	Examiner NATHANIEL PELTON	Art Unit 2859

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant				☐ CPA		☐ T.D.		☐ R.1.47	
CLAIM		DATE							
Final	Original	12/28/2015	06/23/2016						
	36		=						

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT EXAMINING OPERATIONS

Art Unit: 2859 (Examiner: Nathaniel R. PELTON)

Applicant: MARTIN KOEBLER

Serial No: 13/989,273

Confirmation No.: 4437

Filed: May 23, 2013

Title: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

Charlotte, North Carolina
April 26, 2016

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

INTERVIEW SUMMARY

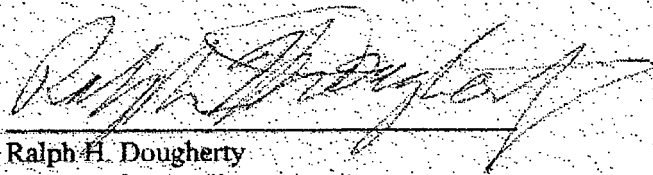
Dear Sir:

This Interview Summary memorializes an interview conducted on April 13, 2016, between Examiner Pelton, the inventor Martin Koebler and Guy Gosnell (Reg. No. 34,610).

Consistent with the Applicant-Initiated Interview Summary provided by the Examiner, the amendments (filed on April 6, 2013) to the independent claims focusing primarily upon independent Claims 1 and 12 were summarized and the distinctions between the amended independent claims

and the cited references, particularly Miyashita et al. (US Published Application No. 2006/0087280) and Smith (US Patent 5,635,821), were discussed. The Examiner indicated that the amendments likely overcame the prior grounds of rejection, but further searching of the amended claims was required.

Respectfully submitted,



Ralph H. Dougherty
Attorney for Applicant
Registration No. 25,851
RALPH H. DOUGHERTY, P.A.
4219 Kronos Place
Charlotte, North Carolina 28210
Telephone: (704) 940-3988
Facsimile: (704) 631-4996

Attorney's
Docket 4984

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APR 26 2016

FAX COVER SHEET

TO	
COMPANY	
FAXNUMBER	15712738300
FROM	Ralph H Dougherty PA
DATE	2016-04-26 16:28:13 GMT
RE:	Dkt 4984 - Examiner Nathaniel R. PELTON, Art Unit 2859

COVER MESSAGE

FAX TO: US Patent and Trademark Office

FAX NO: 1-571-273-8300

FROM: Ralph H. Dougherty

No. of Pages: 3 (counting cover sheet)

Art Unit: 2859 (Examiner: Nathaniel PELTON)

Applicant: MARTIN KOEBLER

Serial No: 13/989,273

Filed: May 23, 2013

Title: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH
THEREFOR

Our File: Docket 4984

=====

PLEASE CONFIRM RECEIPT OF THIS TRANSMISSION

Dear Sirs:

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APR 26 2016

Please forward the attached document to Examiner Nathaniel R. PELTON, Art Unit 2859.

Thank you for your prompt attention to this matter.

Very truly yours,

Ralph H. Dougherty
Ralph H. Dougherty

Reg. No. 25,851
Ralph H. Dougherty, P.A.
Patent, Trademark, Copyright Law
4219 Kronos Place
Charlotte, NC 28210 USA
Phone: 704-940-3988
Fax: 704-631-4996
E-Mail: <mailto:ralph@ralphdougherty.com> ralph@ralphdougherty.com

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/989,273	05/23/2013	Martin Koebler	4984	4437

68151 7590 04/19/2016
RALPH H. DOUGHERTY
4219 KRONOS PLACE
CHARLOTTE, NC 28210

EXAMINER

PELTON, NATHANIEL R

ART UNIT	PAPER NUMBER
----------	--------------

2859

MAIL DATE	DELIVERY MODE
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04/19/2016

PAPER

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.

<i>Applicant-Initiated Interview Summary</i>	Application No. 13/989,273	Applicant(s) KOEBLER, MARTIN	
	Examiner NATHANIEL PELTON	Art Unit 2859	

All participants (applicant, applicant's representative, PTO personnel):

- (1) NATHANIEL PELTON. (3) GUY GOSNELL (34,610).
 (2) MARTIN KOEBLER (INVENTOR). (4) ____.

Date of Interview: 13 April 2016.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
 If Yes, brief description: ____.

Issues Discussed ☐101 ☐112 ☐102 ☒103 ☒Others
 (For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1 and 12.

Identification of prior art discussed: Miyashita US2006/0087280 and Smith US5,635,821.

Substance of Interview

(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Applicant described the invention in detail and presented further amendments to distinguish from the prior art.
Examiner stated an updated search would need to be performed since the amendments were extensive and changed the scope of the claims. No agreements were made.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☒ Attachment

/NATHANIEL PELTON/
 Examiner, Art Unit 2859

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews

Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

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

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/989,273	Filing Date 05/23/2013	☐ To be Mailed
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ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO**APPLICATION AS FILED – PART I**

(Column 1)

(Column 2)

FOR	NUMBER FILED	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 \$ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =	
☐ 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	04/06/2016	CLAIMS REMAINING AFTER AMENDMENT	Minus	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	* 30	Minus	** 20	= 10	x \$40 =	400
	Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	x \$210 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	400

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	Minus	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X \$ =
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X \$ =
	☐ 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.

** 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 number found in the appropriate box in column 1.

LIE
/VIKKI GRAY/

This collection of information is required by 37 CFR 1.16. 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 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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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT EXAMINING OPERATIONS

Art Unit: 2859 (Examiner: Nathaniel R. PELTON)
Applicant: MARTIN KOEBLER
Serial No: 13/989,273
Filed: May 23, 2013
Title: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

Charlotte, North Carolina
April 6, 2016

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

Dear Sir:

AMENDMENT

Responsive to the Official Action dated January 6, 2016, kindly amend the above-identified application as follows:

Amendments to the Claims begin on page 2.

Remarks begin on page 9 of this paper.

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

In the claims:

Please amend the claims to read as follows:

1. (Currently Amended) A battery pack for driving an electrical device in a 12 volt to 120 volt operating system, said battery pack having a positive terminal and a negative terminal, comprising:
a battery pack housing having at least a first portion and a mating second portion; and
at least one lithium-based rechargeable cell within said housing, said at least one cell having
a positive pole connected to said positive terminal and a negative pole connected to said negative terminal; and
a circuit board within said housing configured to balance each individual cell within said housing,
wherein a total discharging amount of each lithium-based cell in the battery pack is from three
3 Ah to 5000 Ah, and charging voltage per one cell is 3.0 to 4.2 V.
2. (Currently Amended) The A battery pack according to claim 1 wherein the lithium-based cell is a lithium iron phosphate cell.
3. (Currently Amended) The A battery pack according to claim 2, wherein the lithium iron phosphate cell is selected from the group consisting of LiFePO_4 , LiFePO_3 , LiFeMgPO_4 , and LiFeYPO_4 cells.
4. (Currently Amended) The A battery pack according to claim 1 wherein the lithium-based cell is selected from the group consisting of LiCoO_2 , LiMn_2O_3 , LiNiCoAlO_2 , LiNiMnCoO_2 , and $\text{Li}_4\text{Ti}_5\text{O}_{12}$ cells.

Serial Number 13/989.273
Attorney's Docket 4984
Art Unit 2859

5. (Currently Amended) ~~The A~~ battery pack according to claim 1, wherein said battery pack comprises four lithium-based rechargeable cells in series in said housing.

6. (Currently Amended) ~~The A~~ battery pack according to claim 1, wherein said battery pack comprises an even number of lithium-based rechargeable cells in said housing.

7. (Currently Amended) ~~The A~~ battery pack according to claim 1 wherein said electrical device is an internal combustion engine starting device connected to ~~an~~ a large internal combustion engine having 1, 2, 3, 4, 5, 6, 8, or 12 cylinders.

8. (Cancelled) ~~A battery pack according to claim 1, further comprising a protection circuit board within said housing.~~

9. (Cancelled) ~~A battery pack according to claim 8, wherein said protection circuit board is a cut-off board.~~

10. (Currently Amended) ~~The A~~ battery pack according to claim ~~9~~ 12, wherein said protection circuit board ~~is a cut-off board comprising a~~ has an associated controller within said housing, said controller having associated means for periodically measuring a load to detect a change in load impedance, ~~further comprising~~ and a switch within said housing between said battery pack and said electrical device, and means for turning on said switch to provide power to the electrical device to restart the device.

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

11. (Currently amended) ~~The A~~ battery pack according to claim ~~9~~ 12, wherein said protection circuit board ~~is a cut-off board comprising a~~ has an associated controller within said housing, 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. (Currently amended) ~~Solid state switching apparatus for one or more cells in a~~ A battery pack for driving an electrical device in a 12 volt to 120 volt operating system, said battery pack having a positive terminal and a negative terminal, comprising:

a battery pack housing having at least a first portion and a mating second portion;
~~encased in a battery pack housing, said battery pack having a positive terminal and a negative terminal;~~
~~each of said cells having a positive pole and a negative pole, said apparatus battery pack housing comprising:~~

~~at least a pair of solid state switches within said battery pack housing, 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;~~

~~at least one lithium-based rechargeable cell within said housing, each such cell having a positive pole and a negative pole;~~

a circuit board within said housing configured to balance each individual cell within said housing, and having a cutoff function incorporated therein, said circuit board including a plurality of pairs of solid state switches with each pair of solid state switches connected in a parallel configuration to another pair of solid state switches, each switch having a source and a drain, the switches of a pair of solid state switches being configured such that either the drains of the switches are connected or the sources of the switches are connected; and

Serial Number 13/989,273
Attorney's Docker 4984
Art Unit 2859

said parallel configuration of the plurality of solid state switches being connected in series with said one or more cells between said positive and negative terminals of the battery pack.

13. (Currently Amended) The battery pack Apparatus according to claim 12, wherein the said solid state switches are MOSFETs or IGBTs.

14. (Currently Amended) The battery pack Apparatus according to claim 12, wherein the said solid state switches are transistors, FET, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET.

15. (Currently Amended) The battery pack Apparatus according to claim 12, wherein the said solid state switches are either n-type or p-type.

16. (Currently Amended) The battery pack Apparatus according to claim 12, wherein said one or more cells are selected from the group consisting of LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , LiFeYPO_4 , LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , $\text{Li}_4\text{Ti}_5\text{O}_{12}$, lead-acid, NiCd, and nickel metal hydride (NiMH) batteries.

17. (Cancelled) 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. (Cancelled) Solid state switching apparatus for one or more cells in a battery pack encased in a battery pack housing, said 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 within said battery pack housing, each switch having a

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

~~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. (Cancelled) 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. (Cancelled) Apparatus according to claim 18, wherein said one or more cells are selected from the group consisting of LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , LiFeYPO_4 , LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , $\text{Li}_4\text{Ti}_3\text{O}_{12}$, lead acid, NiCd, and nickel metal hydride (NiMH) batteries.

Add the following new claims:

21. (Newly presented) The battery pack according to claim 12 wherein the lithium-based cell is a lithium iron phosphate cell.

22. (Newly presented) The battery pack according to claim 12, wherein the lithium iron phosphate cell is selected from the group consisting of LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , and LiFeYPO_4 cells.

23. (Newly presented) The battery pack according to claim 12 wherein the lithium-based cell is selected from the group consisting of LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , and $\text{Li}_4\text{Ti}_3\text{O}_{12}$ cells.

24. (Newly presented) The battery pack according to claim 12, wherein said battery pack comprises four lithium-based rechargeable cells in series in said housing.

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

25. (Newly presented) The battery pack according to claim 12, wherein said battery pack comprises an even number of lithium-based rechargeable cells in said housing.

26. (Newly presented) The battery pack according to claim 12, wherein said circuit board has an associated controller, said controller being adapted to control one of each pair of said solid state switches in parallel separately and independently, whereby said controller has independent control of charging and discharging.

27. (Newly presented) A battery pack for driving an electrical device in a 12 volt to 120 volt operating system, said battery pack comprising:

- a battery pack housing having at least first and second mating portions, said housing having a positive terminal and a negative terminal;

- at least one lithium-based rechargeable cell within said housing, said cell having a positive pole and a negative pole;

- a circuit board within said housing having a cutoff function incorporated therein, said circuit board including a plurality of pairs of solid state switches with each pair of solid state switches connected in a parallel configuration to another pair of solid state switches, each switch having a source and a drain, the switches of a pair of solid state switchers being configured such that either the drains of the switches are connected or the sources of the switches are connected; and

- said parallel configuration of the plurality of solid state switches being connected in series with said one or more cells between said positive and negative terminals of the battery pack.

28. (Newly presented) The battery pack according to claim 27 wherein the lithium-based cell is a lithium iron phosphate cell.

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

29. (Newly presented) The battery pack according to claim 27, wherein the lithium iron phosphate cell is selected from the group consisting of LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , and LiFeYPO_4 cells.

30. (Newly presented) The battery pack according to claim 27, wherein the lithium-based cell is selected from the group consisting of LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , and $\text{Li}_4\text{Ti}_5\text{O}_{12}$ cells.

31. (Newly presented) The battery pack according to claim 27, wherein said battery pack comprises four lithium-based rechargeable cells in series in said housing.

32. (Newly presented) The battery pack according to claim 27, wherein said battery pack comprises an even number of lithium-based rechargeable cells in said housing.

33. (Newly presented) The apparatus according to claim 27, wherein said solid state switches are MOSFETs or IGBTs.

34. (Newly presented) The apparatus according to claim 27, wherein said solid state switches are transistors, FET, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET.

35. (Newly presented) The apparatus according to claim 27, wherein said solid state switches are either n-type or p-type.

36. (Newly presented) The apparatus according to claim 27, wherein said one or more cells are selected from the group consisting of LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , LiFeYPO_4 , LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , $\text{Li}_4\text{Ti}_5\text{O}_{12}$, lead-acid, NiCd, and nickel metal hydride (NiMH) batteries.

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APR 06 2016

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

REMARKS

In the Office Action Summary, the Examiner has checked the statement "The Specification is objected to by the Examiner." However, there is no such objection set forth in the Detailed Action. Thus, it is respectfully submitted that this objection to the Specification be withdrawn.

Claims 12-20 are objected to for not beginning with an article. The claims have been appropriately amended in this regard.

Claims 1-20 currently stand rejected in this case. In response to, and in accordance with the Examiner's indications, Applicant has addressed the rejections by amending the claims and adding new claims. By the present response, Applicant has amended Claims 1, and 12 to overcome the rejections under 35 U.S.C. §103. Claims 8, 9, and 17 through 20 have been cancelled. Applicant has also amended Claims 2 through 7, and 10 through 16 to provide proper antecedent basis and clarity. Applicant has also added claims 21 through 36, in accordance with the teachings of the Specification.

In compliance with MPEP § 2163.III.A, the statements of support for amendments to the claims are set forth below:

Claims 1 and 12 have been amended to provide clarity and to overcome rejections under 35 U.S.C. § 103. Support for these claim amendments can be found at paragraphs [0007], [0009], [0078], [00032], [0068], [0075], [0079], [0021], [0092], and [0082], and in Figures 1-3, 7, 13, and 15-16 of the originally filed specification.

Claim 7 has been amended to provide clarity and to overcome claim objections. Support for amendment of this claim can be found at paragraph [0080] of the originally filed specification.

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

Claims 2, 3, 4, 5, 6, 7, 10, 11, 13, 14, 15 and 16 have been amended to provide proper antecedent basis.

Claims 10 and 11 more properly should depend from Claim 12 than Claim 1, and thus they have been amended to depend from Claim 12, as well as to provide clarity and better readability.

No new matter is added by the amendments to the claims as presented herein.

For ease of understanding the invention as presently claimed, there are three variations of the invented concept which are covered by the claims, as follows:

Claims 1 - 7, as presently presented, are drawn to a battery pack within a housing, and having a cell-balancing circuit board within the housing, and a positive and negative terminal thereon.

Claims 12 - 16, 10 - 11, and 21 - 26 are drawn to a battery pack within a housing, with a cell balancing circuit board within the housing, the circuit board having a cutoff function incorporated therein, the circuit board including a plurality of pairs of solid state switches connected in parallel, each switch having a source and a drain, with either the drains or the sources of each switch of a pair of solid state switches being connected.

Claims 27 - 36 are drawn to a battery pack within a housing, a circuit board within the housing having a cutoff function incorporated therein, the circuit board including a plurality of pairs of solid state switches connected in parallel, each switch having a source and a drain, with either the drains or the sources of each switch of a pair of solid state switches being connected.

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

Claims 1 and 6-9 are rejected under 35 U.S.C. 103 as being unpatentable over Miyashita et al. (US 2006/0087280) in view of Castillo et al. (US2010/0320961). Claims 8 and 9 are cancelled.

Regarding Claim 1, the Examiner indicated that Miyashita teaches a battery pack for driving an electrical device in a 12 volt to 120 volt operating system; said battery pack comprising: a battery pack housing [16 Figs 1-3; par. 0068-0069]; and at least one lithium-based rechargeable cell within said housing. The Examiner admits that Miyashita fails to explicitly disclose wherein a total discharging amount of each lithium based cell in the battery pack is from three (3) Ah to 5000 Ah. The Examiner indicates that Castillo teaches wherein a total discharging amount of each lithium-based cell in a battery pack is from three (3) Ah to 5000 Ah [par. 0063]. Since the total discharging amounts appear not to be a meaningful limitation, Applicant has amended claim 1 to clarify the housing, that the rechargeable cell is within the housing, and that a cell-balancing circuit board is present within the housing. Reconsideration of this rejection is respectfully requested for the following reasons. The present application relates to an 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.

Claim 1 now recites that the battery pack has a housing with a positive terminal and a negative terminal thereon, that one or more rechargeable lithium-based cell(s) are within the housing, and that a circuit board is provided within the housing which balances the cells. These features are specifically depicted in Figures 1, 2, 3, 7, and 13 of the application, as filed. This is not shown in Miyashita or in Castillo.

Reconsideration of this rejection is respectfully requested for the following reasons. The present application relates to an 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.

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

The invention of claim 1 includes a battery pack housing with at least one lithium-based rechargeable cell within the housing, and a circuit board within the housing configured to balance or equalize the voltages of each cell. Miyashita teaches a battery pack for driving a compact electric motor of a compact engine starting device, and a protection circuit includes an over discharge inhibit circuit interposed in the electric motor driving circuit for automatically stopping the driving operation of the electric motor after the time required for starting the engine has elapsed. There is no cell-balancing circuit board, nor any suggestion of this feature.

Castillo is cited as teaching a transport and/or storage container with integrated charging function for rechargeable wireless earphones. The Castillo invention comprising a container housing, at least one receiving unit for at least partially receiving a rechargeable wireless earphone and an electrical container charging contact for connecting the transport and/or storage container to an electrical energy source, wherein the receiving unit has an electrical coupling contact cooperating with an electrical earphone charging contact of a rechargeable wireless earphone when it is placed in the receiving unit for recharging and wherein the electrical container charging contact and the electrical coupling contact are in the form of mutually complementary electrical contacts. Clearly, Castillo is non-analogous art to that of starting large engines, and thus should receive no consideration. Note, however that Castillo ALSO does not include Applicant's cell-balancing circuit board.

Miyashita teaches a single "packed" battery including a lithium-based secondary battery having two cells and various electronic circuits. The electronic circuits include a later-described battery protection circuit, a battery charging circuit and various circuits for driving an engine. In this embodiment, the total discharge capacity is set to 1000 mAh, and the driving current of the starting electric motor 131 is set to 26A. In the present invention, the total discharging amount of each lithium based cell in the battery pack is from one (1) Ah to 5000 Ah. In Miyashita the total discharging amount

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

of the lithium-based secondary battery in the battery pack is only 500 to 2000 mAh and charging voltage per one cell is 3.0 to 4.2V. Miyashita starts only very small engines with very small battery packs and only provides a normal protection circuit such as a self-discharge preventing circuit and an over current preventing circuit. In the present application, a cell-balancing circuit board is placed within the casing of the battery housing for safety protection. The cell-balancing circuit board is configured to balance out individual cells. This circuit forces all of the cells to have identical voltages. Separately, or in combination, the cited references fail to illustrate the structural arrangement and functional aspects of Applicant's invention as defined in amended claim 1. Thus claim 1 is clearly unobvious from the references within the meaning of 35 USC 103.

Regarding Claim 6, the Examiner states that Miyashita discloses wherein said battery pack comprises an even number of lithium-based rechargeable cells in said housing. In actuality, Miyashita discloses a battery pack for driving a compact electric motor of a compact engine starting device mounted on a working machine, comprising lithium-based secondary battery comprising just two cells. In contrast, the applicant's invention includes four cells connected in series having a nominal voltage of 13.2V. For each 12 volt increment, four LiFePO_4 cells are required in series. The current application is expandable to any even number of cells within the battery pack. For at least this reason, Claim 6 is believed to be allowable. In addition, claim 6 depends from claim 1 and is thus equally allowable with claim 1 for the reasons set forth above.

Regarding Claim 7, the Examiner indicates that the Abstract of Miyashita discloses wherein said electrical device is an internal combustion engine starting device connected to an internal combustion engine. Miyashita actually teaches a compact battery having large output which drives an ultra-compact electric motor for starting a compact engine mounted in various working machines such as a carrying harvester, a chain saw, a lawnmower, a piggyback type harvester, a power spraying machine, an engine

Serial Number 13/989,273
 Attorney's Docket 4984
 Art Unit 2859

blower, a duster and a hedge trimmer, an engine starting device driven by a battery pack, and a manual working machine having the engine starting device. All of these are small engines. In contrast, the applicant's invention is useful with motor cycle engines and much larger engines. Miyashita only starts very small engines with very small battery packs. The present invention start large internal combustion engines, as reflected in amended Claim 7. For these reasons, Claim 7 is believed to be allowable, as well as the reason that it depends from an allowable claim, Claim 1.

Claims 8 and 9 have been cancelled.

Claims 2-4 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Miyashita et al. (US 2006/0087280) and Castillo et al. (US2010/0320961) as applied above and further in view of Chiang et al. (US2009/0123813). Regarding Claims 2-4, the Examiner admits that Miyashita fails to disclose Applicant's types of lithium cells. The Examiner indicates that Chiang discloses wherein the lithium-based cell is a lithium iron phosphate cell, wherein the lithium iron phosphate cell is selected from the group consisting of LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , and LiFeYPO_4 cells [par.0066-0069], and wherein the lithium-based cell is selected from the group consisting of LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , and $\text{Li}_4\text{Ti}_3\text{O}_{12}$ cells. Chiang discloses electro active compositions for use in lithium ion battery electrodes. The compositions, such as multi-functional mixed metal olivines, provide an electrochemical cell having a plurality of open circuit voltages at different states of charge. The compositions afford improved state-of-charge monitoring, overcharge protection and/or over discharge protection for lithium ion batteries. Chiang selected lithium iron phosphate cells from $\text{Li}(\text{Mn},\text{Fe})\text{PO}_4$, LiFePO_4 and LiMnPO_4 . Chiang selected lithium-based cells from $\text{Li}(\text{Ni}, \text{Co})\text{O}_2$ and $\text{Li}(\text{Co},\text{Al})\text{O}_2$. In contrast, in the applicant's invention LiFePO_4 , LiFePO_4 , LiFeMgPO_4 and LiFeYPO_4 are used as lithium iron phosphate cells(0017), three of which differ from the compositions taught by Chiang, and LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , and $\text{Li}_4\text{Ti}_3\text{O}_{12}$ (0061) are used as lithium based cells, all of which

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

differ from those taught by Chiang. For at least this reason, Claims 2 through 4 are believed to be allowable.

Claim 5 is rejected under pre-AIA 35 U.S.C. 103(a) as unpatentable over Miyashita et al. (US 2006/0087280) and Castillo et al. (US 2010/0320961) as applied above and further in view of Takano et al. (US 2012/0139456). Regarding Claim 5, the Examiner admits that Miyashita fails to disclose wherein said battery pack comprises four lithium-based rechargeable cells in series in said housing. The Examiner further indicates that Takano teaches a battery pack comprises four lithium-based rechargeable cells in series in said housing. Takano teaches an electric operating machine such as an electric lawn mower that can control or change the rotation speed of the motor regardless of the output of the battery mounted and allow for mounting/dismounting of batteries of different outputs, and Takano provides an electric operating machine that is lightweight and well-balanced and therefore excellent in operability. Takano's teachings are from a non-analogous art, and are not teachings to which a person of ordinary skill in the art would seek out to learn how to drive an electrical device in a 12 volt to 120 volt operating system, particularly for starting an internal combustion engine. In contrast to Takano's eight lithium ion battery cells comprising, four battery cells connected in series while connected in parallel with another four serially-connected battery cells. Applicant's battery pack comprises four lithium based rechargeable cells in series within the battery pack housing, and a cell balancing circuit board which is configured to balance out each individual cell. Both Miyashita and Takano fail to explain cell balancing for each individual cell and the structural arrangement of the cells in Applicant's case and in Miyashita and Takano are different. Further claim 5 depends from claim 1, and is thus equally allowable with claim 1 for the reasons set forth above.

Claim 10 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. (US 2006/0087280) and Castillo et al. (US 2010/0320961) as applied above and further in view of

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

Wu (US 2007/0080662). The Examiner admits that Miyashita fails to disclose a protection circuit board as described in claim 10, but alleges that Wu teaches [114 Fig. 4; par. 0070-0076] a protection circuit board being a cut-off board comprising a controller with associated means for periodically measuring a load to detect a change in load impedance, and a switch between the battery pack and the electrical device, and means for turning on the switch to provide power to the electrical device to restart the engine. Wu is not referring to measuring the load impedance when the battery is disconnected from the load. When Wu speaks of monitoring "the battery pack charge/discharge current and high voltage bus di-electric impedance level (Ohm)...", Wu is referring to measuring those parameters when the battery is connected to the load. Furthermore, Wu makes no mention of measuring the load impedance when the battery is disconnected and such measurement being used to determine when to reconnect the battery to the load. It should be noted that Wu's system comprises a complex number of circuit boards on a CAN (controller area network) bus located externally to the battery pack. Each circuit board is in communication with a complex communication network that is powered by a separate source. Wu does not introduce cut-off protection by solid state switches such as MOSFETs inside a battery housing. Clearly, therefore, Claim 10 is patentable over the cited references.

Claim 11 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. (US 2006/0087280) and Castillo et al. (US 2010/0320961) as applied above and further in view of Smith (US Patent 5,635,821). The Examiner admits that Miyashita fails to teach any specifics of claim 11, but states that Smith teaches a protection circuit board that is a cutoff board having an associated 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 [col 3, lines 9-40; col 7, lines 39-42]. In actuality, Smith has nothing to do with an excessive discharge current or a short circuit condition, nor to disconnecting the battery from the load under these conditions. Rather, Smith provides means for disconnecting the

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

battery from a charger under the following conditions: 1) the cell is overcharged; 2) the cell is over-discharged; or 3) the charging current is too great. That does NOT describe a short circuit protection circuit. Finally, Smith, in Col. 7 lines 39-42, has nothing to do with excessive discharge current or a short circuit condition of the load, but rather describes a circuit that provides protection in the event of a short-circuited battery cell during charging.

Claims 12-15, 18, and 19 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. (US 2006/0087280) in view of Smith (US Patent 5,635,821). Claim 18 and 19 have been cancelled. Claim 12 has been amended to recite: "a circuit board within said housing configured to balance each individual cell within said housing, and having a cutoff function incorporated therein, said circuit board including a plurality of pairs of solid state switches with each pair of solid state switches connected in a parallel configuration to another pair of solid state switches, each switch having a source and a drain, the switches of a pair of solid state switches being configured such that either the drains of the switches are connected or the sources of the switches are connected, and said parallel configuration of the plurality of solid state switches being connected in series with said one or more cells between said positive and negative terminals of the battery pack."

Regarding Claim 12, the Examiner has indicated that Miyashita teaches a switching apparatus for one or more cells in a battery pack encased in a battery pack housing, said 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 switches within said battery pack housing. The Examiner admits that Miyashita fails to disclose the switches are solid state switches, each switch having a source and a drain with drains connected, said solid state switches being connected to the positive/negative pole of said one or more cells in series and to said positive/negative terminal, the negative/positive pole of said one or more cells being connected to said negative/positive terminal. The Examiner states that

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

Smith teaches a switching apparatus for a battery pack wherein the switches are solid state switches, each switch having a source and a drain with drains/sources 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. In actuality, Smith teaches a circuit for charging a deeply discharged battery cell, not for starting an internal combustion engine. Smith includes two power FETs connected back-to-back in series at a common source node and a common gate node, a resistor connected between the common source node and the common gate node and plus and minus battery pack terminals for connection to a charger. In the Applicant's invention, multiple (at least two) pairs of solid state switches (e.g., MOSFETs) are connected in parallel. The invention of claim 12 differs from Smith and Miyashita by having a balancing function provided by the circuit boards that have a plurality of pairs of solid state switches arranged in a parallel configuration and connected as now set forth in the amended independent claim. Each solid state switch has a source and a drain with either the drains or the sources connected and the parallel configuration of the plurality of solid state switches is connected in series with the one or more cells between the positive and negative terminals of the battery pack. As the solid state switches are connected in parallel, the present invention as defined in Claim 12 can increase the current capabilities. Note that in Smith the gates are connected together, so Smith's switch isn't directional. It is either open, thereby preventing current flow in either direction, or it is closed, thereby allowing current flow in either direction. The present invention allows control of the gates separately and independently, thereby giving independent control of charging and discharging. To reiterate, the present invention differs from the teachings of Smith by having a balancing circuit on the cut-off boards and having multiple pairs of switches in parallel in a source-to-source or drain-to-drain configuration. Thus, it is submitted that Claims 12-15 are allowable over the references within the meaning of 35 USC 103.

Serial Number 13/989,273
 Attorney's Docket 4984
 Art Unit 2859

Regarding Claims 13 -15, and cancelled Claim 19, the Examiner admits that Miyashita fails to disclose the type of solid state switch of Applicant. The Examiner avers that Smith discloses wherein the solid state switches are MOSFETs or IGBTs, wherein the solid state switches are transistors, FET, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET, wherein the solid state switches are either n-type or p-type [col. 4 lines 1-5], further comprising a housing for said one or more cells, batteries, wherein said solid state switches are within said housing [col. 9, line 56 to col. 10, line 7; see also Fig. 6]. Miyashita teaches two electronic switches, an engine starting switch and an engine stop switch. But Miyashita fails to disclose the type of solid state switch. In Smith, the solid state switches used are transistors, FET, BJT and CMOS. In the applicant's invention, the solid state switches used are transistors, FET, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS and HEXFET. The solid state switches like JFET, VMOS, TMOS, Vertical DMOS, HEXFET and IGBT are not mentioned in Miyashita nor in Smith. In Smith, the power switch includes two power N-channel MOSFETs which are connected back-to-back in series and connected at a common source node and the gates of two MOSFETs, connected at a common gate node, but in the Applicant's invention, the pairs of p-type or n-type solid state switches are connected in parallel within the battery housing. By connecting pairs of solid state switches in parallel, the present invention can increase the current capabilities. Clearly, Claims 13 -15 are also allowable.

Claims 16 and 20 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. (US 2006/0087280) and Smith (US Patent 5,635,821) as applied above, and further in view of Chiang et al. (US 2009/01238-13). Claim 20 has been cancelled. The Examiner admits that Miyashita fails to disclose that said one or more cells are selected from the group consisting of LiFePO₄, LiFePO₄, LiFeMgPO₄, LiFeYPO₄, LiCoO₂, LiMn₂O₄, LiNiCoAlO₂, LiNiMnCoO₂, Li₄Ti₅O₁₂, leadacid, NiCd, and nickel metal hydride (NiMH) batteries. The Examiner states that Smith discloses wherein the lithium-based cell is a lithium iron phosphate cell, wherein the lithium iron phosphate cell is

Serial Number 13/989,273
Attorney's Docket 4984
Art Unit 2859

selected from the group consisting of LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , and LiFeYPO_4 cells, and wherein the lithium-based cell is selected from the group consisting of LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , $\text{Li}_4\text{Ti}_5\text{O}_{12}$ cells. In the Chiang application, the cells used are Li(Mn,Fe)PO_4 , LiFePO_4 , LiMnPO_4 , Li(Ni, Co)O_2 and Li(Co,Al)O_2 . In the present invention, the different cells used are LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , LiFeYPO_4 , LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , $\text{Li}_4\text{Ti}_5\text{O}_{12}$, lead acid, NiCd, and nickel metal hydride (NiMH) batteries. As per the above, only the LiFePO_4 cell is common in the Chiang and in the present case but all of the other cells used are different. For this reason, and because Claim 16 depends from Claim 12, Claim 16 is clearly allowable.

By the present response, the Applicant has amended Claims 1 and 12 to distinguish the novel features of this application from Castillo, Chiang, Miyashita, Smith, Takano and Wu. With respect to dependent claims 2-7, 9-10, and 13-16, these claims each depend directly or indirectly from Claims 1 or 12 and are thus equally allowable with Claims 1 and 12 for the reasons set forth above.

New claims 21 through 36 are presented. Claims 21 through 26 each depend from claim 12, and provide further limitations thereto, and thus are equally patentable with Claim 12 for the reasons set forth above.

Claims 27 through 36 are illustrated in Figures 16-23. Claims 27 through 36 each require multiple pairs of solid state switches in parallel in a battery pack housing, and sources and drains connected in a unique configuration which are not taught by the references.

Independent claim 27 specifies a battery pack having a positive terminal and a negative terminal in a housing, a circuit board within said housing configured to balance each individual cell within said housing, and having a cutoff function incorporated therein, said circuit board including at least one pair

Serial Number 13,989,273
Attorney's Docket 4984
Art Unit 2859

of solid state switches connected in parallel, each switch having a source and a drain, with sources connected; and said solid state switches being connected to said negative pole of said one or more cells in series; and to said negative terminal, said positive pole of said one or more cells being connected to said positive terminal. As discussed above, none of the cited references show these features in this arrangement. Thus claim 27 and claims 28 through 36, which depend from new claim 27, are equally patentable with claims 1 and 12.

Independent claim 37 specifies a battery pack having a positive terminal and a negative terminal in a housing, a circuit board within said housing having a cutoff function incorporated therein, said circuit board including a plurality of pairs of solid state switches with each pair of solid state switches connected in a parallel configuration to another pair of solid state switches, each switch having a source and a drain, with either the drains or the sources of each pair of solid state switches being connected; and the parallel configuration of the plurality of solid state switches being connected in series with said one or more cells between said positive and negative terminals of the battery pack. As discussed above, none of the cited references show these features in this arrangement. Thus claim 27 and claims 28 through 36, which depend from new claim 27, are equally patentable with claims 1 and 12 for the reasons set forth above.

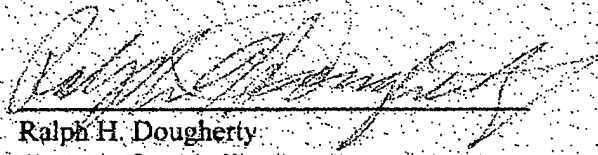
No new matter is presented in the newly presented claims.

Since the amendment to the claims adds more claims than previously paid for, an additional claim fee is submitted herewith.

Serial Number 13/989,273
Attorney's Docker 4984
Art Unit 2859

In view of the foregoing amendment and these remarks, this application is now believed to be in condition for allowance and such favorable action is respectfully requested on behalf of Applicant. The Examiner is invited to call Applicant's undersigned attorney if, in the opinion of the Examiner, a telephone conference will expedite prosecution of this application.

Respectfully submitted,



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RE Dkt 4984 - Examiner Nathaniel R. PELTON, Art Unit 2859

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FROM: Ralph H. Dougherty

No. of Pages: 26 (counting cover sheet)

Art Unit: 2859 (Examiner: Nathan PELTON)

Applicant: MARTIN KOEBLER

Serial No: 13/989,273

Filed: May 23, 2013

Title: LITHIUM STARTER BATTERY AND SOLID STATE SWITCH
THEREFOR

Our File: Docket 4984

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Thank you for your prompt attention to this matter.

Very truly yours,

Ralph H. Dougherty
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FEE TRANSMITTAL		Complete if known	
☒ Applicant asserts small entity status. See 37 CFR 1.27.		Application Number	13/989,273
☐ 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.		Filing Date	May 23, 2013
		First Named Inventor	Martin KOEBLER
		Examiner Name	Nathan PELTON
		Art Unit	2859
TOTAL AMOUNT OF PAYMENT	(\$) 440.00	Practitioner Pocket No.	4984

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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

Application Type	FILING FEES			SEARCH FEES			EXAMINATION FEES			Fees Paid (\$)
	U (\$)	S (\$)	M (\$)	U (\$)	S (\$)	M (\$)	U (\$)	S (\$)	M (\$)	
Utility	280	140*	70	600	300	150	720	360	180	
Design	180	90	45	120	60	30	460	230	115	
Plant	180	90	45	380	190	95	580	290	145	
Reissue	280	140	70	600	300	150	2,160	1,080	540	
Provisional	260	130	65	0	0	0	0	0	0	

* The \$140 small entity status filing fee for a utility application is further reduced to \$70 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	Undiscounted Fee (\$)	Small Entity Fee (\$)	Micro Entity Fee (\$)
Each claim over 20 (including Reissues)	80	40	20
Each independent claim over 3 (including Reissues)	420	210	105
Multiple dependent claims	780	390	195
Total Claims			
31 -20 or HP =	31	X	40
HP = highest number of total claims paid for, if greater than 20.			
Indep. Claims			
3 -3 or HP =	3	X	0
HP = highest number of independent claims paid for, if greater than 3.			

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is \$400 (\$200 for small entity) (\$100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
100	/ 50 =	(round up to a whole number)	X	

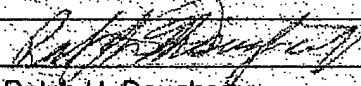
4. OTHER FEE(S)

Non-English specification, \$130 fee (no small or micro entity discount)

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, \$400 fee (\$200 small or micro entity)

Other (e.g., late filing surcharge):

SUBMITTED BY

Signature		Registration No. (Attorney/Agent)	25,851	Telephone	704-940-3988
Name (Print/Type)	Ralph H. Dougherty	Date	06 April 2016		

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/989,273	05/23/2013	Martin Koebler	4984	4437

68151 7590 01/06/2016
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CHARLOTTE, NC 28210

EXAMINER

PELTON, NATHANIEL R

ART UNIT	PAPER NUMBER
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2859

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01/06/2016

PAPER

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.

Office Action Summary	Application No. 13/989,273	Applicant(s) KOEHLER, MARTIN	
	Examiner NATHANIEL PELTON	Art Unit 2859	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

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- 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 05/23/2013.
☐ 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) 1-20 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) 1-20 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 05/23/2013 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) | 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date _____ | 4) ☐ Other: _____ |

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Claim Objections

Claims 12-20 are objected to because of the following informalities: the claims do not begin with “A/An” or “The”. Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1 and 6-9 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. [US 2006/0087280] in view of Castillo et al. [US 2010/0320961].

With respect to claim 1, A battery pack for driving an electrical device in a 12 volt to 120 volt operating system, said battery pack comprising: a battery pack housing [**16 Figs 1-3; par. 0068-0069**]; and at least one lithium-based rechargeable cell within said

Art Unit: 2859

housing [**abstract**];and charging voltage per one cell is 3.0 to 4.2 V [**par. 0080**].

However, fails to explicitly disclose wherein a total discharging amount of each lithium-based cell in the battery pack is from three (3) Ah to 5000 Ah.

It is well-known in the art to for lithium-based cells to discharge 3Ah, for example, Castillo teaches wherein a total discharging amount of each lithium-based cell in a battery pack is from three (3) Ah to 5000 Ah [**par. 0063**]

Therefore it would have been obvious to a person having ordinary skill in the art at the time the invention was to modify Miyashita to discharge 3Ah for the benefit of using a lithium based cell that can store/provide more power.

With respect to claim 6, Miyashita further discloses wherein said battery pack comprises an even number of lithium-based rechargeable cells in said housing [**abstract**].

With respect to claim 7, Miyashita further discloses wherein said electrical device is an internal combustion engine starting device connected to an internal combustion engine [**abstract**].

With respect to claim 8, Miyashita further discloses a protection circuit board within said housing [**par. 0067-0070; circuits formed on boards**].

With respect to claim 9, Miyashita further discloses wherein said protection circuit board is a cut-off board or a cell balancing circuit board [**i.e., see claim 6**].

Claims 2-4 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. [US 2006/0087280] and Castillo et al. [US 2010/0320961] as applied above and further in view of Chiang et al. [US 2009/0123813].

With respect to claims 2-4, Miyashita as applied above fails to explicitly disclose the types of lithium cells, However, Chiang further discloses wherein the lithium-based cell is a lithium iron phosphate cell, wherein the lithium iron phosphate cell is selected from the group consisting of LiFePO, LiFePO₄, LiFeMgPO₄, and LiFeYPO₄ cells [**par. 0066-0069**], and wherein the lithium-based cell is selected from the group consisting of LiCoO₂, LiMn₂O₄, LiNiCoA₁₀₂, LiNiMnCoO₂, and Li₄Ti₅O₁₂ cells [**par. 0066-0069**].

Therefore, it would have been obvious to a person having ordinary skill in that art at the time the invention was made to modify Miyashita as applied above to include the lithium-based cells selected from the above groups for the benefit of improving the desired operating ranges of the battery pack.

Claim 5 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. [US 2006/0087280] and Castillo et al. [US 2010/0320961] as applied above and further in view of Takano et al. [US 2012/0139456].

With respect to claim 5, Miyashita as applied above fails to explicitly disclose wherein said battery pack comprises four lithium-based rechargeable cells in series in said housing. However, this is well-known, for example Takano teaches a battery pack comprises four lithium-based rechargeable cells in series in said housing [**par. 0189**].

Therefore it would have been obvious to a person having ordinary skill in the art at the time the invention was made to modify Miyashita to include four cells as taught by Takano for the benefit of providing a higher potential battery pack [**i.e. holds more power and/or supplying power to a higher operating system such as 12-120V**].

Claim 10 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. [US 2006/0087280] and Castillo et al. [US 2010/0320961] as applied above and further in view of Wu [US 2007/0080662].

With respect to claim 10, Miyashita fails to explicitly disclose 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.

Wu teaches a 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

Art Unit: 2859

said device, and means for turning on said switch to provide power to the electrical device to restart the device [114 Fig. 4; par. 0070-076].

Therefore it would have been obvious to a person having ordinary skill in the art at the time the invention was made to modify Miyashita to have the controller as claimed above as and as taught by Wu for the benefit of achieving safe operation from the battery pack.

Claim 11 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. [US 2006/0087280] and Castillo et al. [US 2010/0320961] as applied above and further in view of Smith [US 5,635,821].

With respect to claim 11, Miyashita fails to explicitly disclose 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.

Smith teaches a 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 [col. 1 lines 24-37; col. 3 lines 9-40; col. 7 lines 39-42].

Therefore it would have been obvious to a person having ordinary skill in the art at the time the invention was made to modify Miyashita to have the controller as claimed

above as and as taught by Smith for the benefit of achieving safe operation from the battery pack and insuring the circuit has an adequate power supply.

Claims 12-15, 18, and 19 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. [US 2006/0087280] in view of Smith [US 5,635,821].

With respect to claims 12 and 18, Miyashita discloses a switching apparatus for one or more cells in a battery pack encased in a battery pack housing, said 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 switches within said battery pack housing [**par. 0066-0069; batteries inherently have positive and negative pole; see also 20,23 Fig. 1**]. However, Miyashita fails to explicitly disclose the switches are solid state switches, each switch having a source and a drain with drains connected, said solid state switches being connected to the positive/negative pole of said one or more cells in series and to said positive/negative terminal, the negative/positive pole of said one or more cells being connected to said negative/positive terminal.

Smith teaches a switching apparatus for a battery pack wherein the switches are solid state switches [**abstract, FETS**], each switch having a source and a drain with drains/sources connected [**col. 9 line 64 to col. 10 line 8; col. 3 lines 40-64**]; said solid state switches being connected to the positive pole of said one or more cells in series [**140 Fig. 6; col. 9 lines 58-62; col. 10 lines 45-62; col. 5 lines 4-9**], and to said

Art Unit: 2859

positive terminal [**col. 8 lines 30-42; Figs. 5-6**], the negative pole of said one or more cells being connected to said negative terminal [**col. 5 lines 4-9**].

It would have been obvious to a person having ordinary skill in the art at the time the invention was made to modify Miyashita as taught by Smith for the benefit of providing circuitry in order to insure that the power protection circuit has an adequate power supply as disclosed by Smith [**col. 1 lines 23-37**].

With respect to claims 13-15, 17, and 19, Miyashita fails to explicitly disclose the type of solid state switch, however, this is well-known in the art. For example, Smith further discloses wherein the solid state switches are MOSFETs or IGBTs, wherein the solid state switches are transistors, FET, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET, wherein the solid state switches are either n-type or p-type [**col. 4 lines 1-5**], further comprising a housing for said one or more cells, batteries, wherein said solid state switches are within said housing [**col. 9 line 56 to col. 10 line 7; see also Fig. 6**].

Therefore, it would have been obvious to a person having ordinary skill in the art at the time the invention was made to modify Miyashita as taught by Smith for the benefit of providing circuitry in order to insure that the power protection circuit has an adequate power supply as disclosed by Smith [**col. 1 lines 23-37**].

Claims 16 and 20 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Miyashita et al. [US 2006/0087280] and Smith [US 5,635,821] as applied above, and further in view of Chiang et al. [US 2009/0123813].

With respect to claims 16 and 20, Miyashita fails to explicitly disclose wherein said one or more cells are selected from the group consisting of LiFePO, LiFePO₄, LiFeMgPO₄, LiFeYPO₄, LiCoO₂, LiMn₂O₄, LiNiCoA₁₀₂, LiNiMnCoO₂, Li₄TiO₁₂, lead-acid, NiCd, and nickel metal hydride (NiMH) batteries. However, Chiang further discloses wherein the lithium-based cell is a lithium iron phosphate cell, wherein the lithium iron phosphate cell is selected from the group consisting of LiFePO, LiFePO₄, LiFeMgPO₄, and LiFeYPO₄ cells [par. 0066-0069], and wherein the lithium-based cell is selected from the group consisting of LiCoO₂, LiMn₂O₄, LiNiCoA₁₀₂, LiNiMnCoO₂, and Li₄TiO₁₂ cells [par. 0066-0069].

Therefore, it would have been obvious to a person having ordinary skill in that art at the time the invention was made to modify Miyashita as applied above to include the lithium-based cells selected from the above groups for the benefit of improving the desired operating ranges of the battery pack.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to NATHANIEL PELTON whose telephone number is (571)270-1761. The examiner can normally be reached on M-F 9:00-5:00 and by e-mail

Art Unit: 2859

at nathaniel.pelton@uspto.gov (please include authorization to communicate via e-mail).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard Isla-Rodas can be reached on 571-272-5056. 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 <http://pair-direct.uspto.gov>. 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.

/NATHANIEL PELTON/
Examiner, Art Unit 2859

Notice of References Cited	Application/Control No. 13/989,273		Applicant(s)/Patent Under Reexamination KOEBLER, MARTIN	
	Examiner NATHANIEL PELTON		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-2006/0087280 A1	04-2006	Miyashita; Satoshi	H01M2/1072	320/104
*	B	US-2010/0320961 A1	12-2010	Castillo; Armando	H02J7/0044	320/107
*	C	US-2009/0123813 A1	05-2009	CHIANG; Yet-Ming	C01B25/45	429/50
*	D	US-2012/0139456 A1	06-2012	Takano; Nobuhiro	G05B19/048	318/139
*	E	US-2007/0080662 A1	04-2007	Wu; Deping	B60L3/0046	320/110
*	F	US-5,635,821 A	06-1997	Smith; Gregory J.	H02J7/0031	320/103
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	V	
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	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.



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BIB DATA SHEET

CONFIRMATION NO. 4437

SERIAL NUMBER 13/989,273	FILING or 371(c) DATE 05/23/2013 RULE	CLASS 320	GROUP ART UNIT 2859	ATTORNEY DOCKET NO. 4984	
APPLICANTS INVENTORS Martin Koebler, Davidson, NC; ** CONTINUING DATA ***** This application is a 371 of PCT/US11/01937 11/28/2011 which claims benefit of 61/458,657 11/29/2010 and claims benefit of 61/463,736 02/22/2011 ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED *** SMALL ENTITY ** 06/10/2013					
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /NATHANIEL R PELTON/ Acknowledged Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY NC	SHEETS DRAWINGS 10	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS RALPH H. DOUGHERTY 4219 KRONOS PLACE CHARLOTTE, NC 28210 UNITED STATES					
TITLE LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR					
FILING FEE RECEIVED 560	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit		

<i>Index of Claims</i> 	Application/Control No. 13989273	Applicant(s)/Patent Under Reexamination KOEBLER, MARTIN
	Examiner NATHANIEL PELTON	Art Unit 2859

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant		☐ CPA		☐ T.D.		☐ R.1.47			
CLAIM		DATE							
Final	Original	12/28/2015							
	1	✓							
	2	✓							
	3	✓							
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	18	✓							
	19	✓							
	20	✓							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	"20130241498".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:04
S2	25	((Martin) near2 (Koebler)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/12/28 14:06
S3	90	US-4433278-\$.DID. OR US-7858234-\$.DID. OR US-8643991-\$.DID. OR US-4484130-\$.DID. OR US-7880432-\$.DID. OR US-8647774-\$.DID. OR US-5550861-\$.DID. OR US-7881737-\$.DID. OR US-5652502-\$.DID. OR US-7887949-\$.DID. OR US-5773958-\$.DID. OR US-7923152-\$.DID. OR US-5874825-\$.DID. OR US-7927740-\$.DID. OR US-5883498-\$.DID. OR US-7969120-\$.DID. OR US-6020721-\$.DID. OR US-7972730-\$.DID. OR US-6181103-\$.DID. OR US-8003255-\$.DID. OR US-6215274-\$.DID. OR US-8018182-\$.DID. OR US-6215281-\$.DID. OR US-8039151-\$.DID. OR US-6225778-\$.DID. OR US-6225780-\$.DID. OR US-6320389-\$.DID. OR US-6397965-\$.DID. OR US-6486636-\$.DID. OR US-6495991-\$.DID. OR US-6565836-\$.DID. OR US-6639385-\$.DID. OR US-6683440-\$.DID. OR US-6759034-\$.DID. OR US-6871410-\$.DID. OR US-8102152-\$.DID. OR US-6963359-\$.DID. OR US-8114535-\$.DID. OR US-6998819-\$.DID. OR US-8133619-\$.DID. OR US-7004289-\$.DID. OR US-8137843-\$.DID. OR US-7012406-\$.DID. OR US-8153301-\$.DID. OR US-7026788-\$.DID. OR US-8207740-\$.DID. OR US-7190171-\$.DID. OR US-8247101-\$.DID. OR US-7253588-\$.DID. OR US-8271060-\$.DID. OR US-7283230-\$.DID. OR US-8274261-\$.DID. OR US-7324902-\$.DID. OR US-8318351-\$.DID. OR US-7354677-\$.DID. OR US-8334074-\$.DID. OR US-7381066-\$.DID. OR US-8334676-\$.DID. OR US-7419744-\$.DID. OR US-8344675-\$.DID. OR US-7501797-\$.DID. OR US-8349495-\$.DID. OR US-7550949-\$.DID. OR US-8358099-\$.DID. OR US-7570017-\$.DID. OR US-8404387-\$.DID. OR US-7582386-\$.DID. OR US-8415053-\$.DID. OR US-7592815-\$.DID. OR US-8420262-\$.DID. OR US-7595134-\$.DID. OR US-8427105-\$.DID. OR US-7656125-\$.DID. OR US-8431272-\$.DID. OR US-7659692-\$.DID. OR US-8445124-\$.DID. OR US-7679873-\$.DID. OR US-	US-PGPUB; USPAT; USOCR	OR	OFF	2015/12/28 14:07

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S5	188	(320/135.ccls. or h02j7/00.cpc.) and lithium and (switch\$3 near5 terminal)	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:09
S6	96	S5 and @ad<"20101129"	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:09
S7	131	h02h3/26.cpc. or h02h7/18.cpc. and lithium and (switch\$3 near5 terminal)	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:10
S8	45	S7 and @ad<"20101129"	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:10
S9	130	S6 or S8	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:10
S10	4	"20060087280".pn. or "20090123813".pn. or "5635821".pn. or "20070080662".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:14
S11	0	S6 and ((S3 or "3000") near3 (mah or ah))	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:26
S12	44	"320".clas. and ((S3 or "3000") near3 (mah or ah))	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:26
S13	35	S12 and lithium	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:27
S14	20	S13 and @ad<"20101129"	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:27
S15	1282	h02j7/00.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:53
S16	39	h02j7/\$\$.cpc. and ((S3 or "3000") near3 (mah or ah))	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:54
S17	20	S16 and @ad<"20101129"	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:54
S18	2	S17 and (12v or 120v)	US-PGPUB; USPAT; USOCR	OR	ON	2015/12/28 14:55
S19	725	h02j7/\$\$.cpc. and ((S4 or four) with cells with	US-	OR	ON	2015/12/28

		(series or serial\$3))	PGPUB; USPAT; USOCR			15:19
S20	442	S19 and @ad<"20101129"	US- PGPUB; USPAT; USOCR	OR	ON	2015/12/28 15:20

EAST Search History (Interference)

< This search history is empty >

12/ 28/ 2015 4:02:54 PM
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Search Notes 	Application/Control No. 13989273	Applicant(s)/Patent Under Reexamination KOEBLER, MARTIN
	Examiner NATHANIEL PELTON	Art Unit 2859

CPC- SEARCHED		
Symbol	Date	Examiner
H02J 7/00	12-28-15	nrp
H02H 3/26, 7/18	12-28-15	nrp

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
320	135	12-28-15	nrp

SEARCH NOTES		
Search Notes	Date	Examiner
requested PLUS search on spec and claims	12-28-15	nrp
performed inventor search	12-28-15	nrp
text searched for key concepts	12-28-15	nrp

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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PLUS Search Results for S/N 13989273, Searched Tue Jan 20 12:54:02 EST 2015
 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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PLUS Search Results for S/N 13989273, Searched Tue Jan 20 12:54:06 EST 2015

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/989,273	05/23/2013	Martin Koebler	4984

68151
RALPH H. DOUGHERTY
4219 KRONOS PLACE
CHARLOTTE, NC 28210

CONFIRMATION NO. 4437
PUBLICATION NOTICE



OC00000063884453

Title:LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

Publication No.US-2013-0241498-A1

Publication Date:09/19/2013

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <http://pair.uspto.gov/>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

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INTERNATIONAL APPLICATION NO.	
PCT/US11/01937	
I.A. FILING DATE	PRIORITY DATE
11/28/2011	11/29/2010

CONFIRMATION NO. 4437
371 ACCEPTANCE LETTER



Date Mailed: 06/12/2013

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office in its capacity as a Designated / Elected Office (37 CFR 1.495), has determined that the above identified international application has met the requirements of 35 U.S.C. 371, and is ACCEPTED for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above and the relevant dates are:

05/23/2013
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1),
(c)(2) and (c)(4) REQUIREMENTS

05/29/2013
DATE OF COMPLETION OF ALL
35 U.S.C. 371 REQUIREMENTS

A Filing Receipt (PTO-103X) will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE " FILING DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1), (c)(2) and (c)(4) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN ABOVE.** *The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363).* Once the Filing Receipt has been received, send all correspondence to the Group Art Unit designated thereon.

The following items have been received:

- Indication of Small Entity Status
- Copy of the International Application filed on 05/23/2013
- Copy of the International Search Report filed on 05/23/2013
- Oath or Declaration filed on 05/23/2013
- U.S. Basic National Fees filed on 05/23/2013
- Priority Documents filed on 05/23/2013
- Power of Attorney filed on 05/23/2013

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

FREDERICK SMITH

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United States Patent and Trademark Office
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
13/989,273	05/23/2013		560	4984	20	3

CONFIRMATION NO. 4437

68151
RALPH H. DOUGHERTY
4219 KRONOS PLACE
CHARLOTTE, NC 28210

FILING RECEIPT



Date Mailed: 06/12/2013

Receipt is acknowledged of this non-provisional 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 APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Martin Koebler, Davidson, NC;

Applicant(s)

Martin Koebler, Davidson, NC;

Power of Attorney: The patent practitioners associated with Customer Number 68151

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/US11/01937 11/28/2011
which claims benefit of 61/458,657 11/29/2010
and claims benefit of 61/463,736 02/22/2011

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.

If Required, Foreign Filing License Granted: 06/10/2013

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/989,273**

Projected Publication Date: 09/19/2013

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

Preliminary Class

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

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number
13/989,273

APPLICATION AS FILED - PART I

(Column 1)		(Column 2)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	140		N/A	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	60		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *	x 210 =	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			
			TOTAL	560		TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	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))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	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))							OR		
	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".

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POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS	Application Number	
	Filing Date	
	First Named Inventor	KOEBLER, Martin
	Title	LITHIUM STARTER BATTERY AND SOLID STATE SWI
	Art Unit	
	Examiner Name	
	Attorney Docket Number	4984

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

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☒ Applicant/Inventor.

OR

☐ Assignee of record of the entire interest. See 37 CFR 3.71.

Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on _____

SIGNATURE of Applicant or Assignee of Record

Signature	<i>Martin Koebler</i>	Date	May 22 2013
Name	MARTIN KOEBLER	Telephone	704-804-4464
Title and Company	Applicant/Inventor		

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. 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 1.31, 1.32 and 1.33. 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 3 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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Electronic Patent Application Fee Transmittal

Application Number:

Filing Date:

Title of Invention:

LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

First Named Inventor/Applicant Name:

MARTIN KOEBLER

Filer:

Ralph Dougherty

Attorney Docket Number:

4984

Filed as Small Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Basic National Stage Fee	2631	1	140	140
Natl Stage Search Fee - U.S. was the ISA	2641	1	60	60
Natl Stage Exam Fee - all other cases	2633	1	360	360

Pages:

Claims:

Miscellaneous-Filing:

Petition:

Patent-Appeals-and-Interference:

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				560

Electronic Acknowledgement Receipt

EFS ID:	15857085
Application Number:	13989273
International Application Number:	PCT/US11/01937
Confirmation Number:	4437
Title of Invention:	LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR
First Named Inventor/Applicant Name:	MARTIN KOEBLER
Customer Number:	68151
Filer:	Ralph Dougherty
Filer Authorized By:	
Attorney Docket Number:	4984
Receipt Date:	23-MAY-2013
Filing Date:	
Time Stamp:	16:02:21
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$560
RAM confirmation Number	2911
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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1	Transmittal Letter	Transmittal.pdf	783207	no	1
			a17efeb47e14453fca62fb105eeb40389d042148		
Warnings:					
Information:					
2		Application.pdf	89651	yes	26
			d32a5ae842ea5d6ffa2a1330b7fa8798f4926411		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	21	
	Claims		22	25	
	Abstract		26	26	
Warnings:					
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3	Drawings-only black and white line drawings	Drawings.pdf	2914063	no	10
			b0b77d9efd544c81df7b6359f2cae82e57a79f5		
Warnings:					
Information:					
4	Oath or Declaration filed	Declaration.pdf	1543432	no	2
			c851a4fb82c743d0b236a3ec435bb51f08465d5e		
Warnings:					
Information:					
5	Power of Attorney	Power.pdf	767287	no	1
			c0503f7a9ff16f6128e330118fd82c010d32b7f1		
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UTILITY PATENT APPLICATION TRANSMITTAL <i>(Only for new nonprovisional applications under 37 CFR 1.53(b))</i>		Attorney Docket No. 4984	
		First Named Inventor KOEBLER, Martin	
		Title LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR	
		Express Mail Label No. _____	

APPLICATION ELEMENTS <i>See MPEP chapter 600 concerning utility patent application contents.</i>	Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450
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 <u>26</u>] 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 <u>10</u>] 6. Inventor's Oath or Declaration [Total Pages <u>2</u>] (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 1.75 (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	ACCOMPANYING APPLICATION PAPERS 10. ☐ Assignment Papers (cover sheet & document(s)) Name of Assignee _____ 11. ☐ 37 CFR 3.73(c) Statement ☒ Power of Attorney (when there is an assignee) 12. ☐ English Translation Document (if applicable) 13. ☐ Information Disclosure Statement (PTO/SB/38 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).

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Name (Print/Type) RALPH H. DOUGHERTY		Registration No. (Attorney/Agent)	25,851

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SPECIFICATION**LITHIUM STARTER BATTERY
AND SOLID STATE SWITCH THEREFOR****MARTIN KOEBLER****CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims the benefit of priority of the following applications:

PCT Application PCT/US2011/001937, filed 28 November 2011; US Provisional Patent

Application Serial No. 61/458,657, filed 29 November 2010; and US Provisional Patent

5 Application Serial No. 61/463,736, filed 22 February 2011.

FIELD OF THE INVENTION

[0002] 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

[0003] 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.

[0004] In order to turn off power terminals in presently known starter batteries, expensive
5 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
10 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
15 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 energy needs to be extracted, even if it damages the battery.

[0005] 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
20 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
5 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.

[0006] 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.

10 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
15 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.

[0007] 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
20 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 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.

[0008] 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

[0009] Applicant is aware of the following U. S. Patent concerning battery packs for starting engines:

<u>US Patent No.</u>	<u>Issue Date</u>	<u>Inventor</u>	<u>Title</u>
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

[0010] 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 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.

[0011] 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.

[0012] No separate nor special charging system is needed with the invented system

[0013] 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 battery 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.

5 [0014] 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
10 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
15 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.

[0015] By connecting the "Sources" or the "Drains" together using a minimum of two solid state
20 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.

[0016] 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

[0017] 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.

[0018] 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.

[0019] 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.

[0020] Another object of the invention is to provide a starter battery for an internal combustion engine that can be used in existing vehicles.

[0021] 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.

[0022] Another object of the invention is to provide an improved apparatus for protecting a single cell or battery from being overcharged or over-discharged.

[0023] Another object of the invention is to provide apparatus for charging a cell having a very low charge.

[0024] Another object of the invention is to provide apparatus for short circuit protection for one or more cells or batteries.

5 [0025] Another object of the invention is to provide apparatus for discharging a cell having too high a charge.

[0026] 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

10 [0027] The foregoing and other objects will become more readily apparent by referring to the following detailed description and the appended drawings in which:

[0028] Figure 1 is an exploded isometric view of one embodiment of the invention, in which 4 cells are arranged into a starter battery pack.

[0029] Figure 2 is an exploded isometric view of another embodiment of the invention, in which 8
15 cells are arranged into a starter battery pack.

[0030] 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.

[0031] Figure 4 is a front view of the assembled battery pack of Figure 3, the rear view being identical.

[0032] Figure 5 is a top view of the assembled battery pack of Figure 3.

5 [0033] Figure 6 is a right end view of the assembled battery pack of Figure 3, the left end view being a mirror image thereof.

[0034] Figure 7 is a schematic diagram of a block of 4 lithium prismatic cells in series connected to a balancing circuit board.

[0035] Figure 8 is a schematic diagram of a block of 4 lithium prismatic cells in series connected to a balancing and cutoff circuit board

10 [0036] Figure 9 is an isometric view of an alternative embodiment of a housing showing contacts for switches.

[0037] Figure 10 is a top view of the housing of Figure 9 showing the contact locations.

[0038] Figure 11 is a front view of the housing of Figure 9, the rear view being identical.

[0039] Figure 12 is an end view of the housing of Figure 9, the opposite end being identical.

15

[0040] 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.

[0041] Figure 14 is a schematic diagram of a Solid State Switch with "Drain" connection.

[0042] Figure 15 is a schematic diagram of a Solid State Switch with "Source" connection.

5 [0043] 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.

[0044] 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.

10 [0045] 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 switches.

[0046] 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.

[0047] 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.

15 [0048] 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.

[0049] 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.

[0050] 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.

5 [0051] Figure 24 is a schematic diagram illustrating the invention utilized in engine restarting.

[0052] Figure 25 is a schematic diagram illustrating short circuit protection of a battery.

DETAILED DESCRIPTION

[0053] 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
10 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.

[0054] 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
15 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 ($\text{Li}_4\text{Ti}_5\text{O}_{12}$).

[0055] 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 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.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] Referring now to the drawings, and particularly to Figure 1, the invented battery pack comprises a housing, 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.

[0061] 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.

[0062] 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 welded connection can be used instead of screws.

[0063] 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.

[0064] Starter battery systems can utilize a greater number of lithium cells as desired for greater capacity.

[0065] 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.

[0066] Lithium cell self discharge rate is less than 2% monthly, whereas the self discharge rate for a lead-acid cell is 10% monthly.

[0067] 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.

[0068] Lithium cells are 98% energy efficient (energy going in and out of the cell), whereas lead-acid cells are only 90% energy efficient.

[0069] For each 12 volt increment, four LiFePO₄ cells are required in series, and some cases fewer cells with other lithium chemistries. The following Table compares the lead-acid battery voltages to the LiFePO₄ cell requirements and for other lithium-based battery cells:

TABLE I

5	Nominal Lead-Acid Voltage	LiFePO ₄ (3.3V nominal)	(LiCoO ₂), (LiMn ₂ O ₄), (LiNiCoAlO ₂), (LiNiMnCoO ₂), or (Li ₄ Ti ₅ O ₁₂) (3.7V nominal)
	12V	3 to 4 cells in series	2 to 4 cells in series
10	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
15	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

[0070] 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.

[0071] 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.

[0072] 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.

[0073] 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 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.

[0074] 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.

[0075] 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.

[0076] 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.

[0077] 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.

[0078] 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.

[0079] 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.

5 [0080] 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.

[0081] 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
10 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.

[0082] When the controller drives the base of Q3 high through R1, Q3 and Q4 turn on. When Q4
15 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
20 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.

[0083] 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, 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.

[0084] 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.

[0085] 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)

5 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
10 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.

[0086] 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
15 metal-oxide-semiconductors), VMOS (Vertical Metal Oxide Silicon), TMOS transistors, vertical DMOS (Double-Diffused MOS), or HEXFET.(hexagonal shape MOSFET).

[0087] 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.

20 [0088] The solid state devices all need to be the same (N) or (P) type used in the same circuit, as illustrated.

**SUMMARY OF THE ACHIEVEMENT
OF THE OBJECTS OF THE INVENTION**

[0089] 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.

[0090] 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.

What is claimed is:

1. A battery pack for driving an electrical device in a 12 volt to 120 volt operating system, said battery pack comprising:

a battery pack housing; and

5 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 three (3) 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.

10 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 $\text{Li}_4\text{Ti}_5\text{O}_{12}$ cells.

15 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.

5 9. A battery pack according to claim 8, wherein said protection circuit board is a cut-off board or a cell balancing circuit board.

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
10 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,

15 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 encased in a battery pack housing, said 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 within said battery pack housing, 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, LiFePO₄, LiFeMgPO₄, LiFeYPO₄, LiCoO₂, LiMn₂O₄, LiNiCoAlO₂,

LiNiMnCoO₂, Li₄Ti₅O₁₂, lead-acid, NiCd, and nickel metal hydride (NiMH) batteries.

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 encased in a battery pack housing, said 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 within said battery pack housing, 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.

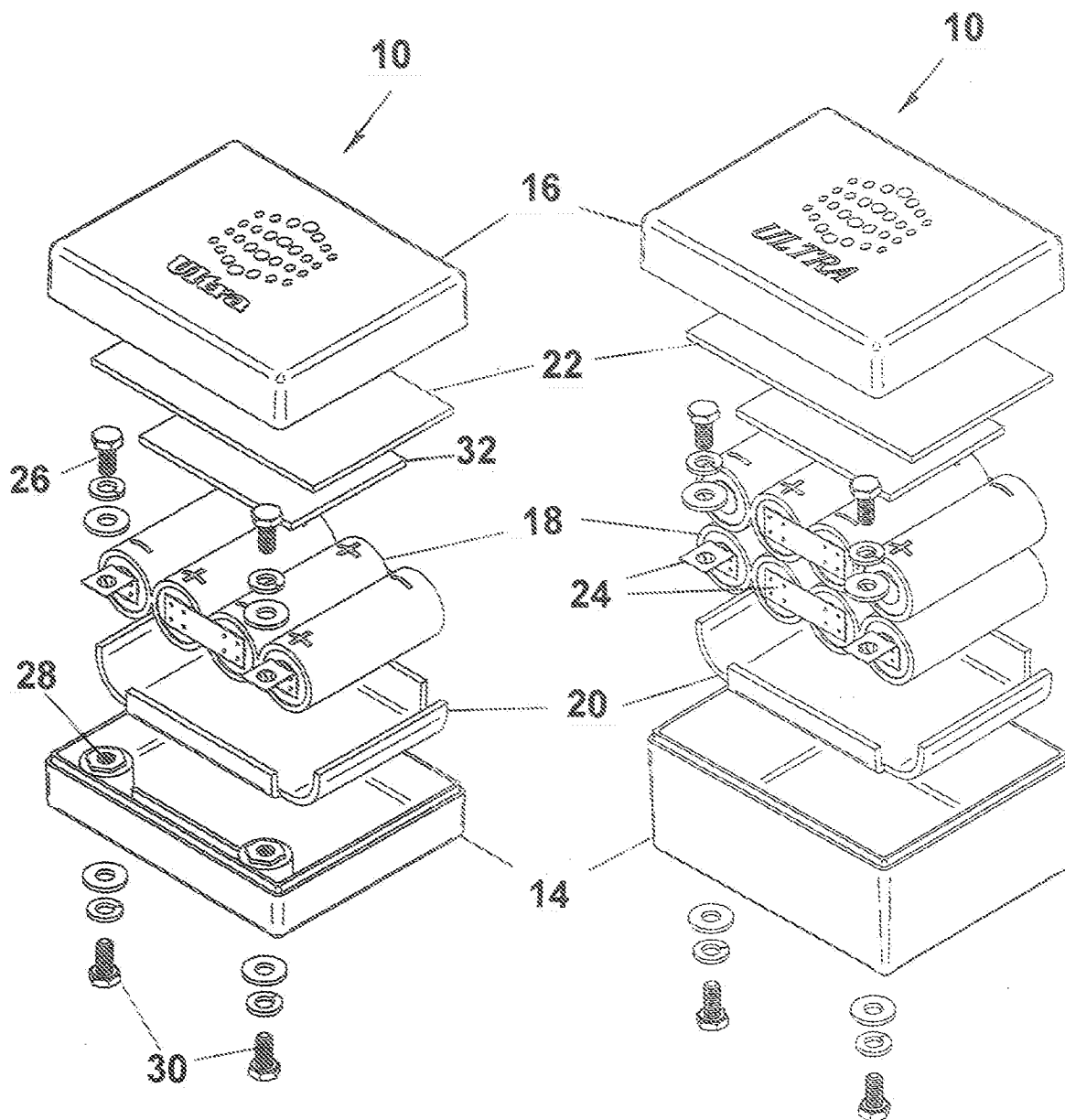
19. Apparatus according to claim 18, wherein the solid state switches are transistors, FET, MOSFET, IGBT, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET.

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 , $\text{Li}_4\text{Ti}_5\text{O}_{12}$, lead-acid, NiCd, and nickel metal hydride (NiMH) batteries.

ABSTRACT OF THE DISCLOSURE

[0091] 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.

5

*Fig. 1**Fig. 2*

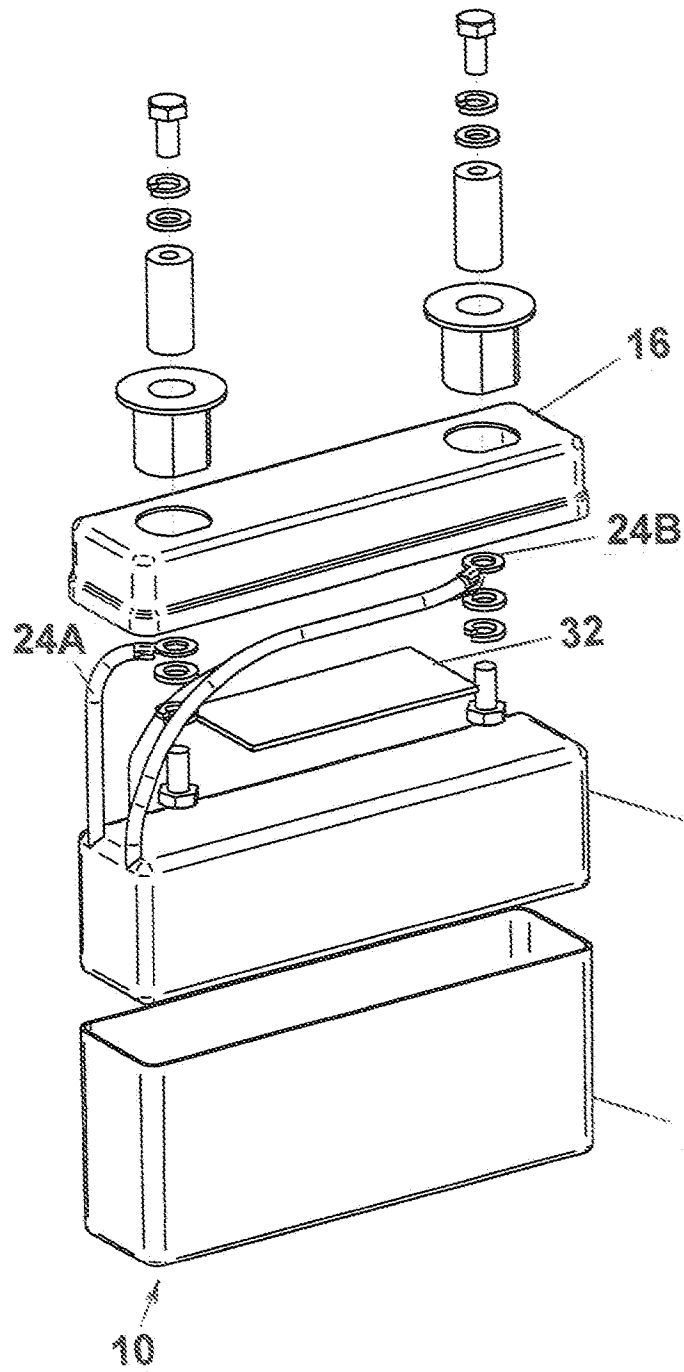
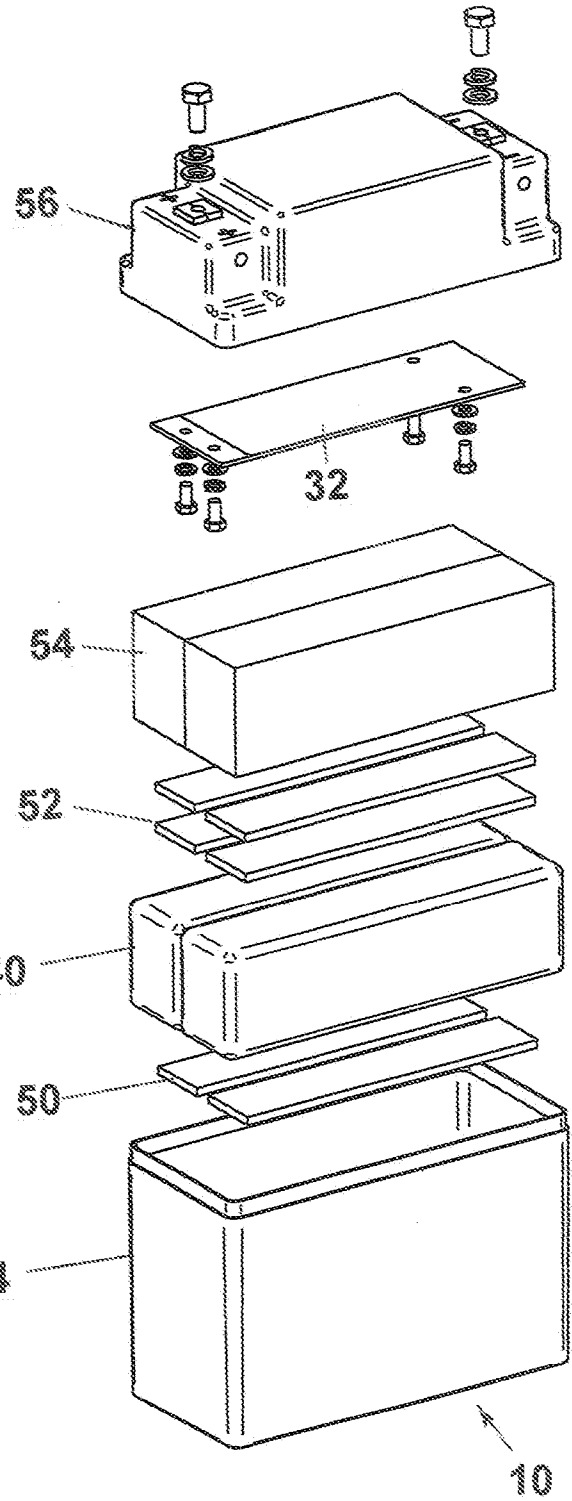
*Fig. 3**Fig. 13*

Fig. 5

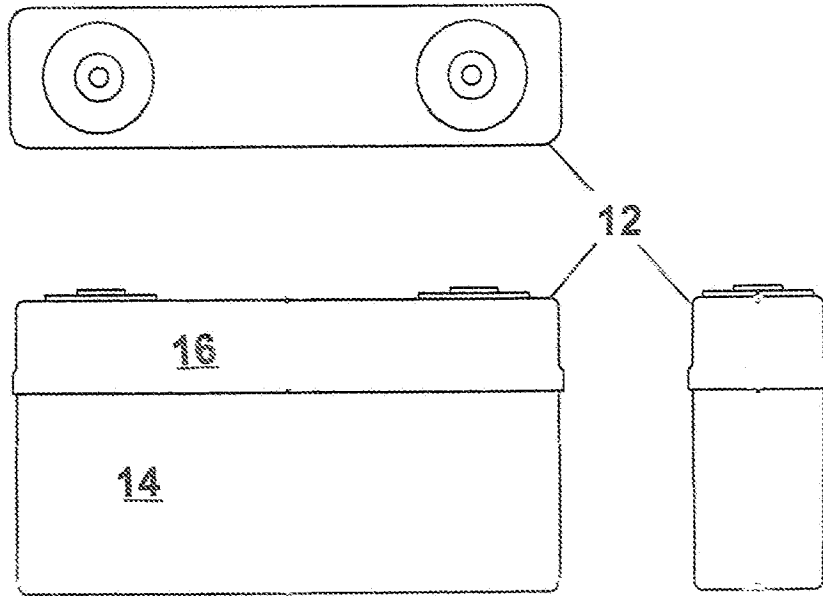


Fig. 4

Fig. 6

Fig. 7

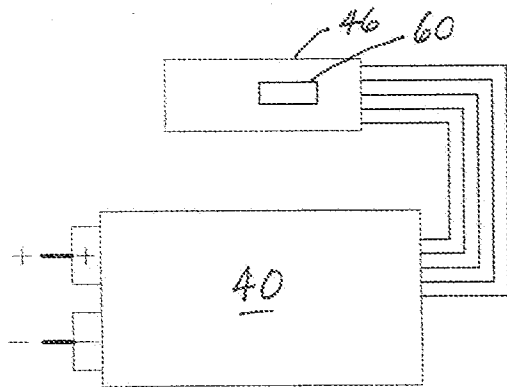
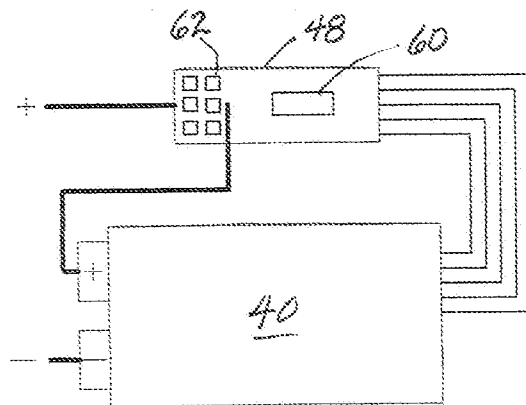


Fig. 8



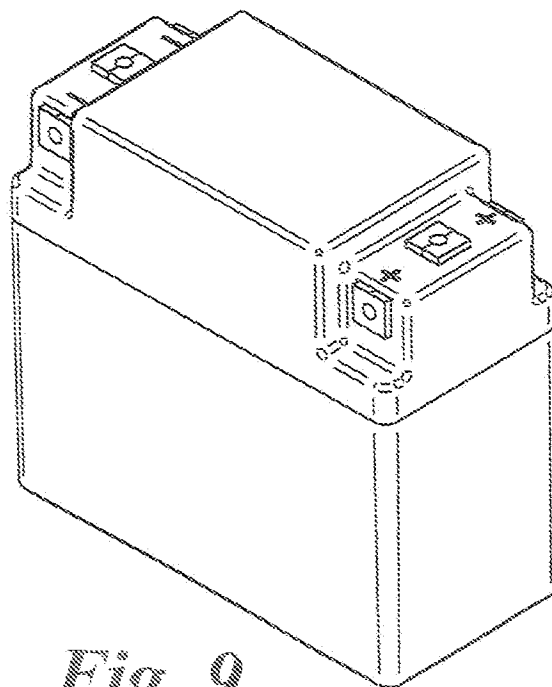


Fig. 9

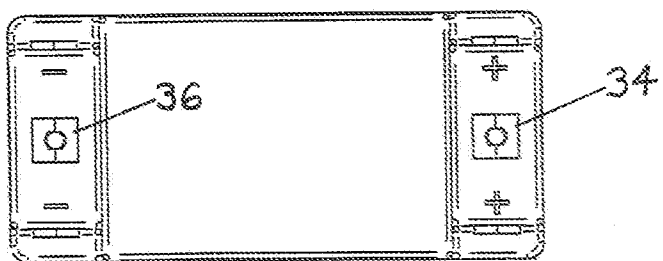


Fig. 10

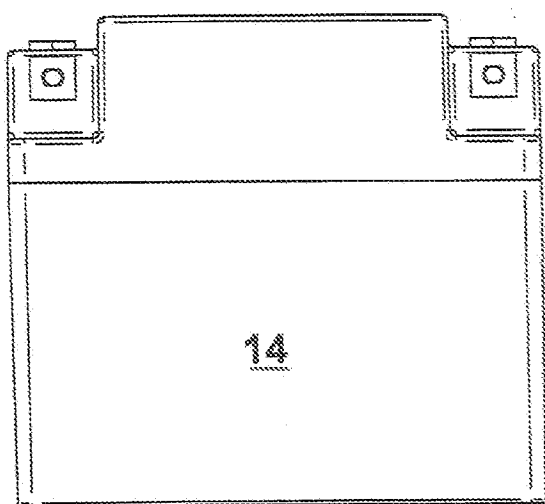


Fig. 11

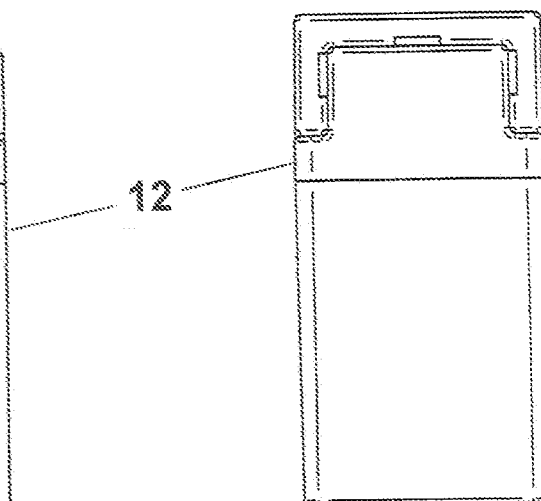


Fig. 12

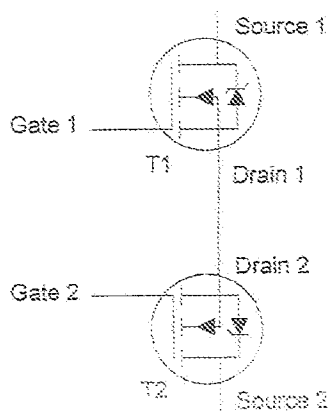


Fig. 14

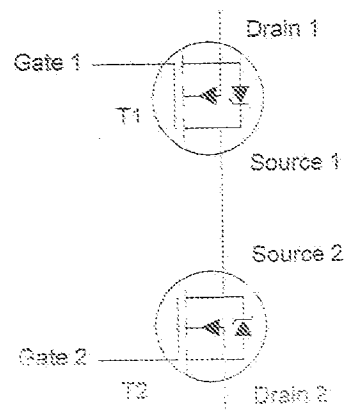


Fig. 15

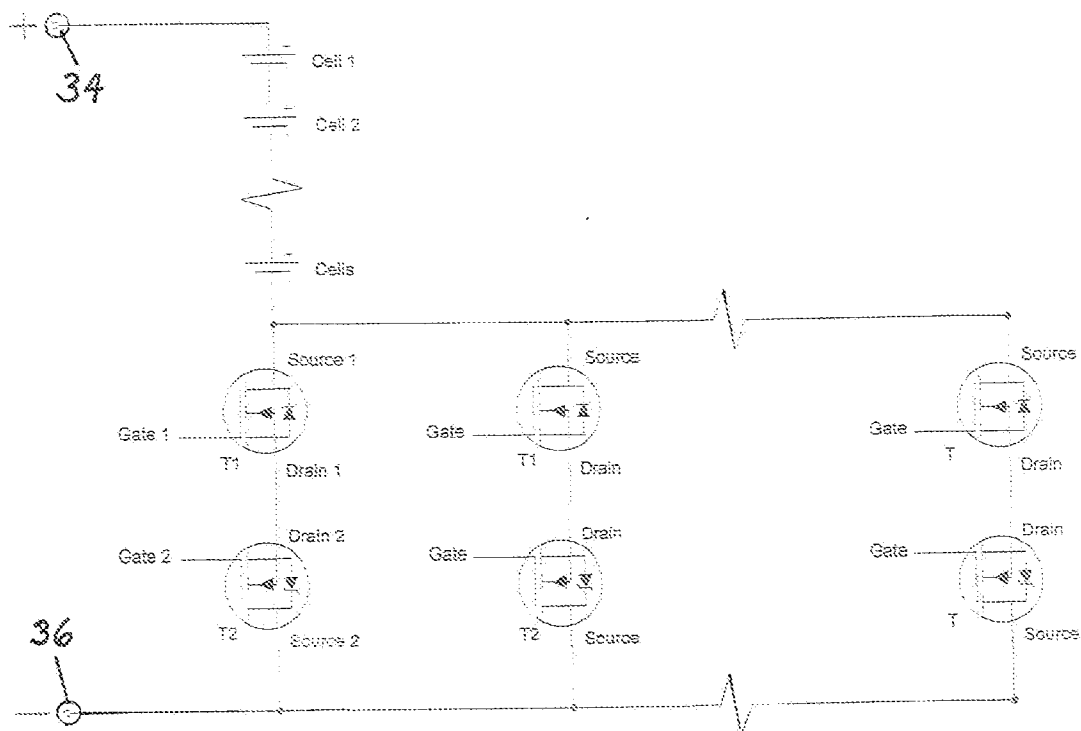
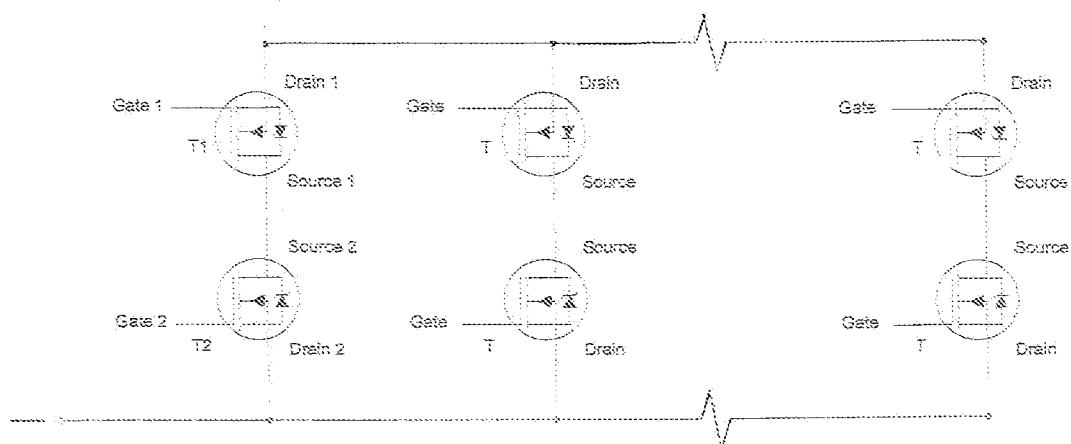
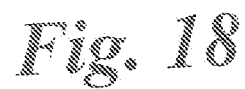
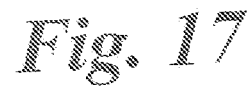


Fig. 16



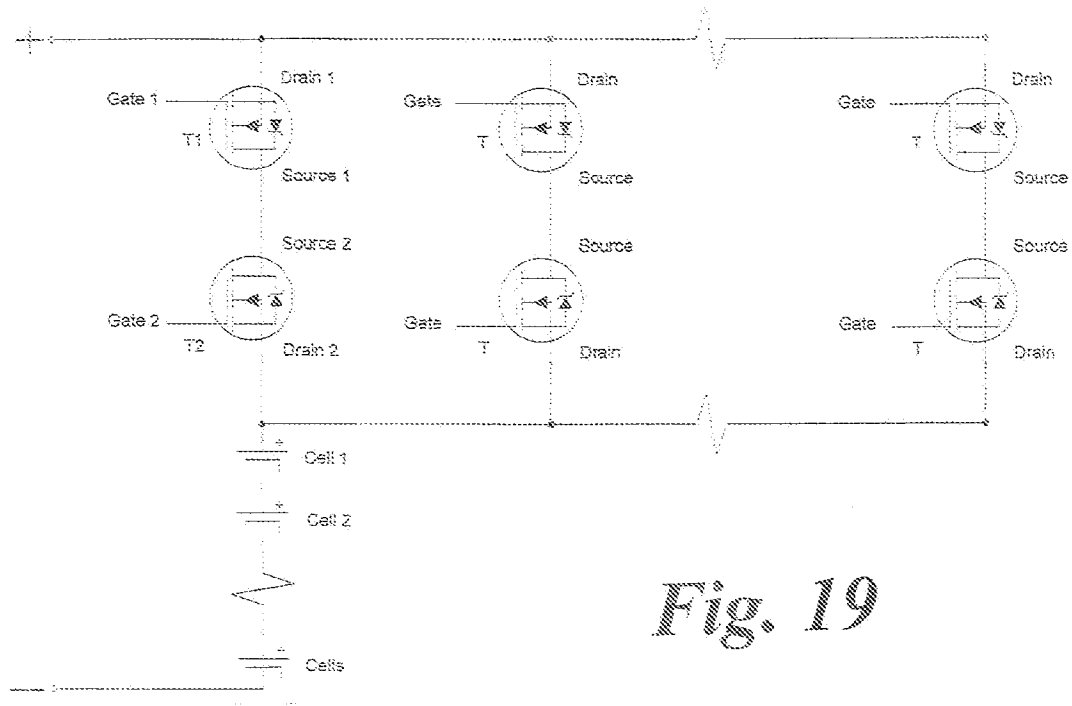


Fig. 19

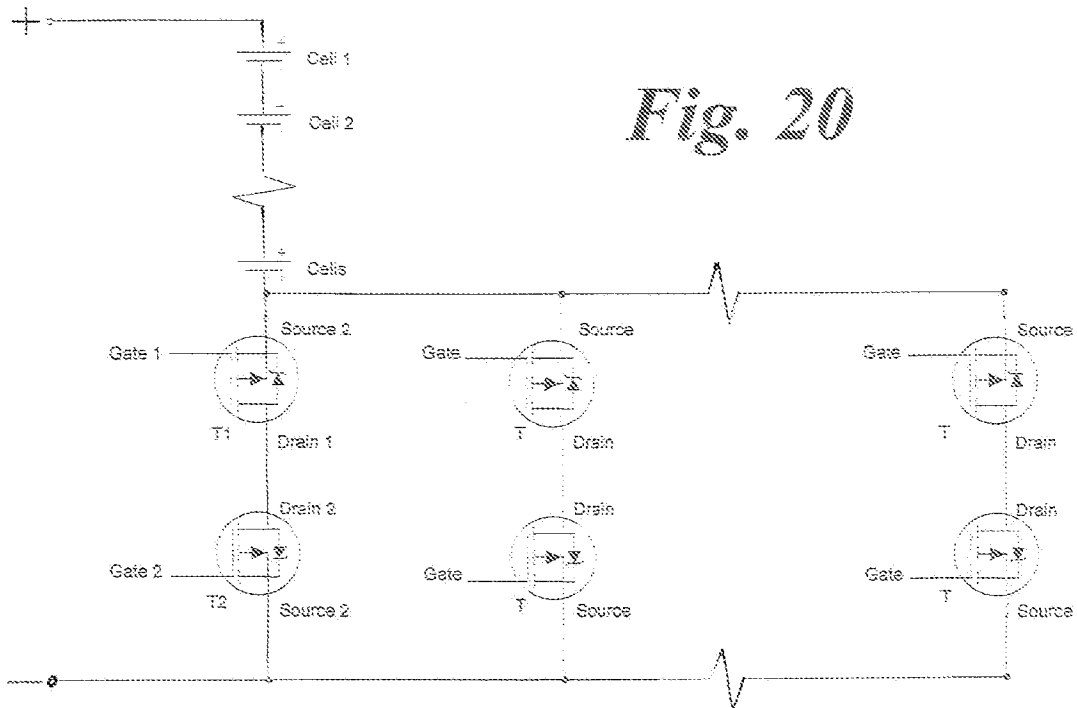


Fig. 20

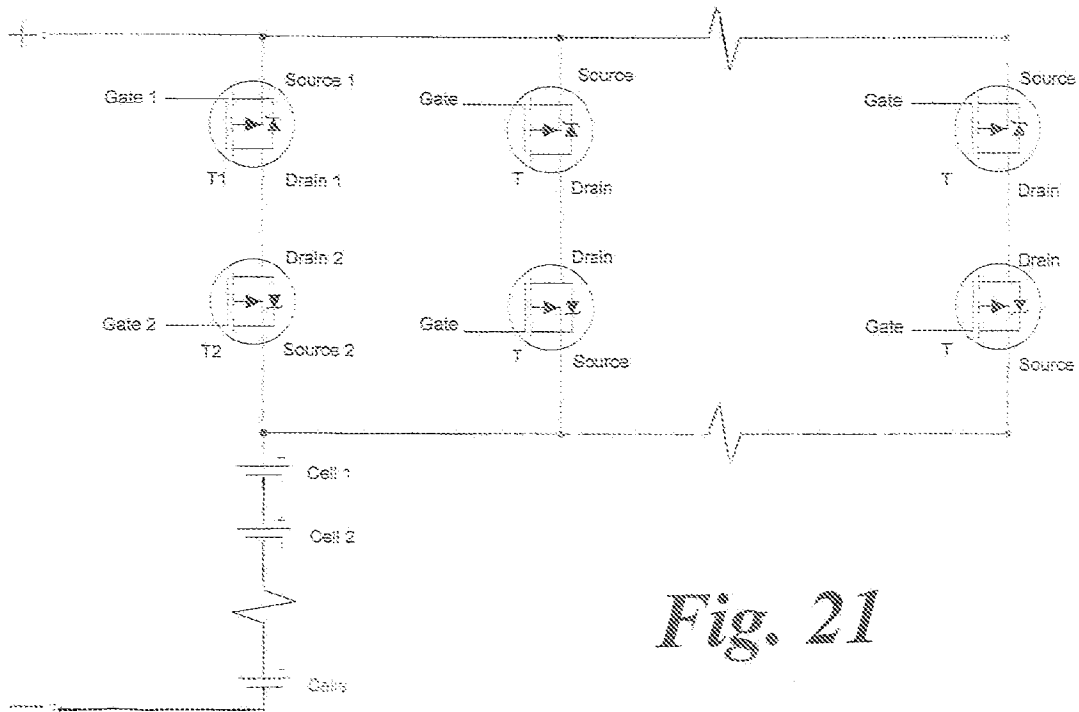


Fig. 21

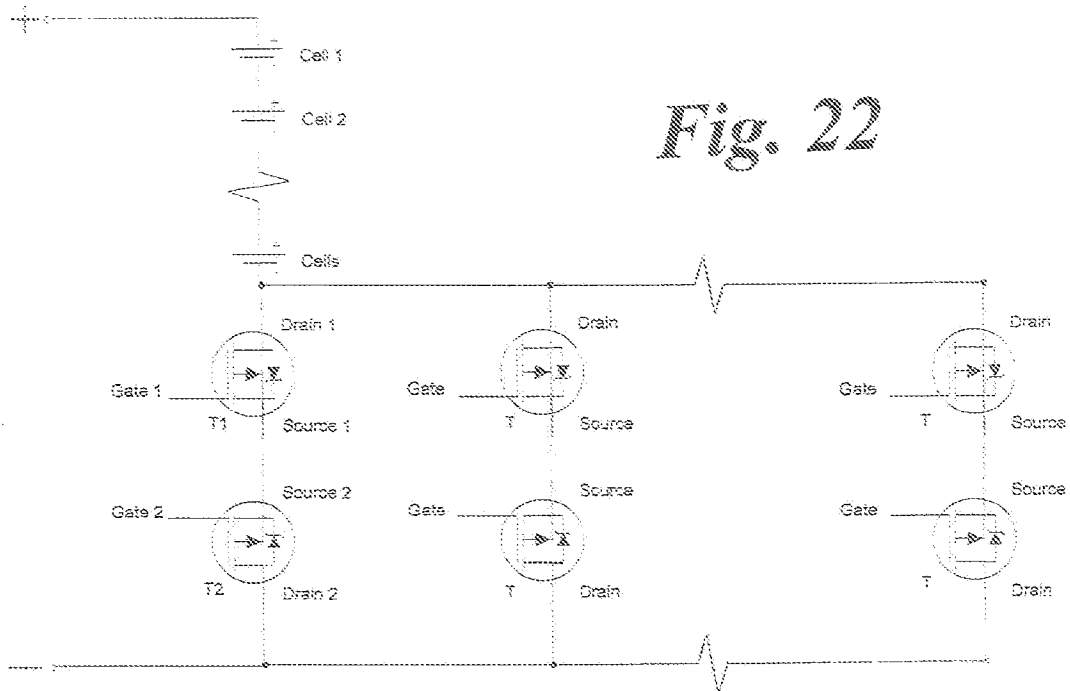


Fig. 22

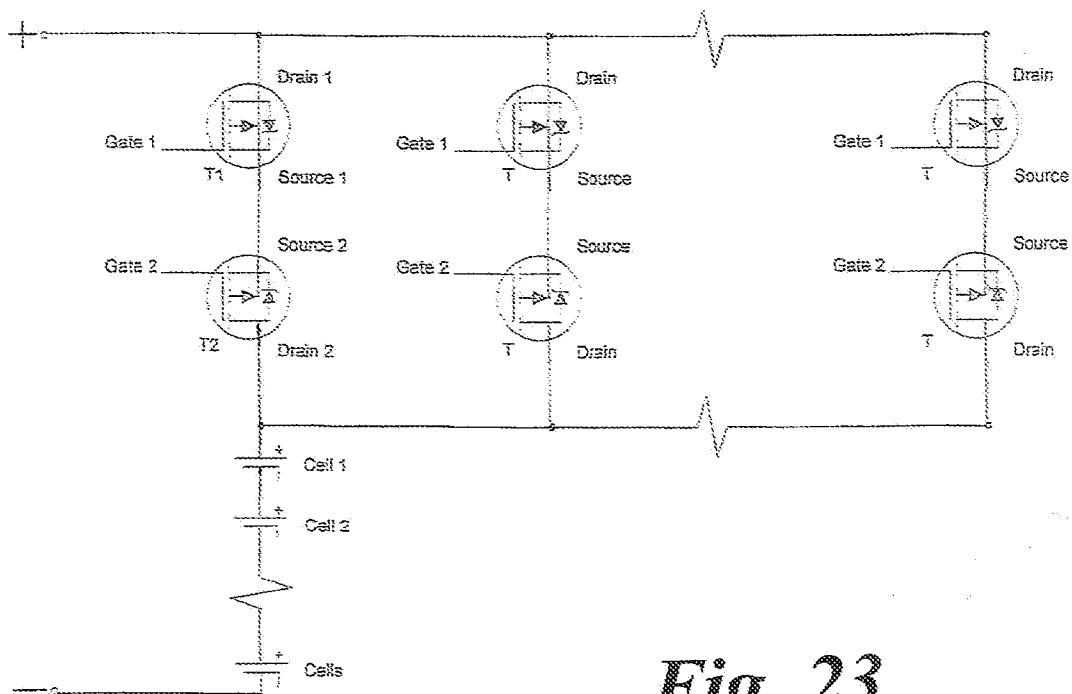


Fig. 23

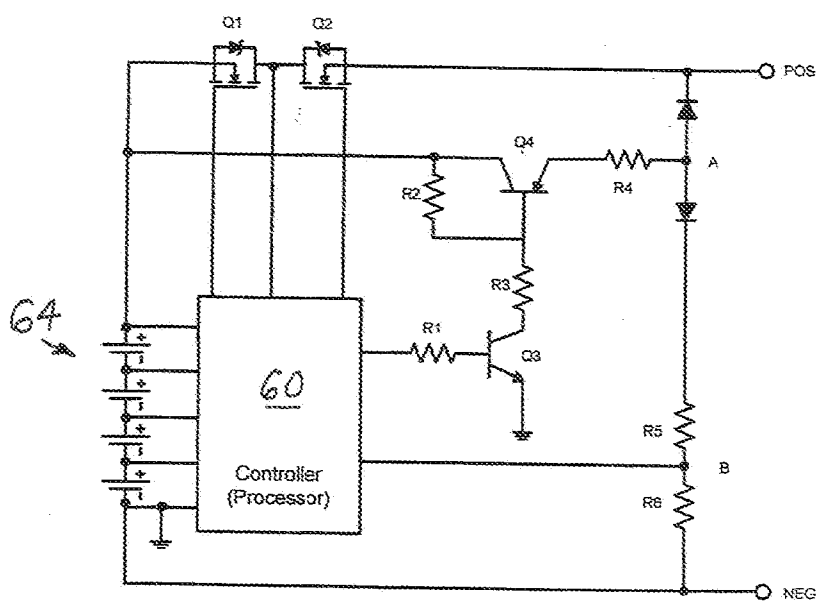


Fig. 24

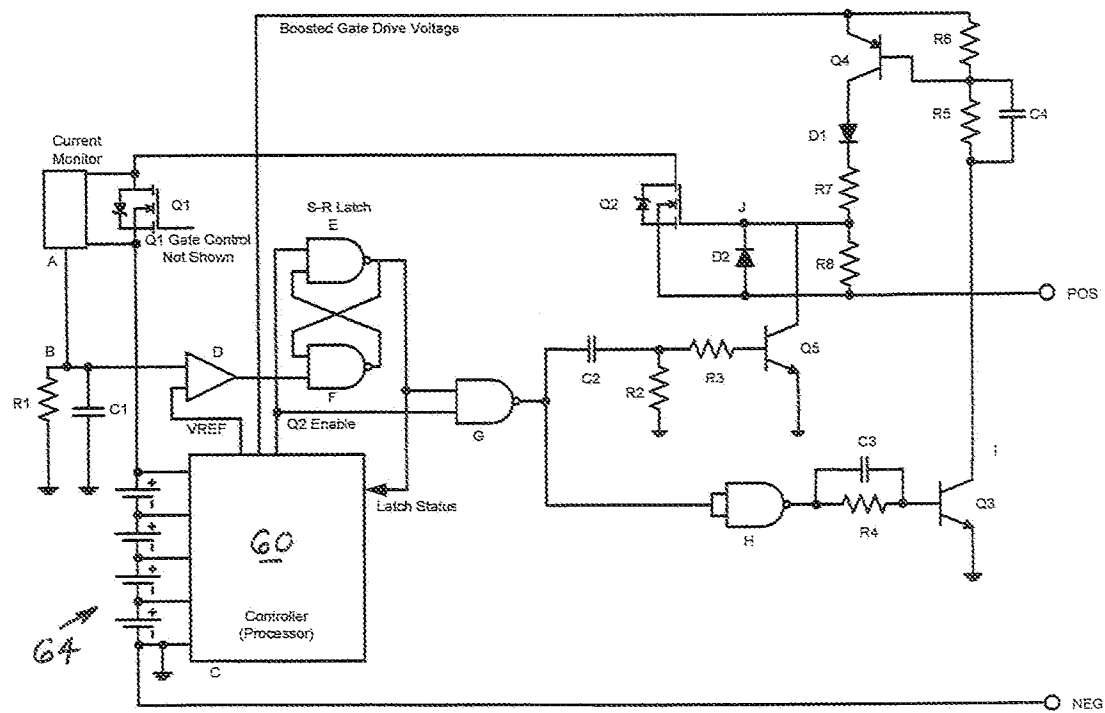


Fig. 25

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)		Attorney Docket Number	4984
		First Named Inventor	KOEBLER, Martin
☒ Declaration Submitted With Initial Filing OR ☐ Declaration Submitted After Initial Filing (surcharge (37 CFR 1.16(f)) required)		COMPLETE IF KNOWN	
		Application Number	
		Filing Date	
		Art Unit	
		Examiner Name	

LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR

(Title of the Invention)

As a below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application,

OR

☒ United States Application Number or PCT International application number PCT/US2011/001937
filed on 28 November 2011

The above-identified application was made or authorized to be made by me.

I believe I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the above-identified patent application with respect to: 1) the above-identified patent application-as-filed; 2) any foreign application to which the above-identified patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the above-identified patent application; and 3) any U.S. application-as-filed from which benefit is sought in the above-identified patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing the Authorization to Permit Access to Application by Participating Offices.

[Page 1 of 2]

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 21 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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LEGAL NAME OF SOLE OR FIRST INVENTOR:				
(E.g., Given Name (first and middle (if any)) and Family Name or Surname)				
Martin Koebler				
Inventor's Signature		Date (Optional)		
<i>Martin Koebler</i>		May 22 2013		
Residence: City	State	Country		
Davidson	NC	US		
Mailing Address				
630 Portside Drive				
City	State	Zip	Country	
Davidson	NC	28036	US	
☐ Additional inventors are being named on the _____ supplemental sheet(s) PTO/AIA/10 attached hereto				

[Page 2 of 2]

Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)
The declaration must conform to the following standardized wording provided for in Section 214; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (iv). If this Box is not used, this sheet should not be included in the request.

**Declaration of inventorship (Rules 4.17(iv) and 51bis.1(a)(iv))
 for the purposes of the designation of the United States of America:**

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. PCT/..... (if furnishing declaration pursuant to Rule 26ter).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

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.

Name: Martin KOEBLER

Residence: Davidson, NC

Mailing Address: 630 Portside Drive

Davidson, NC 28036

Citizenship: German

Inventor's Signature: Martin Koebler Date: 28 Nov. 2011

(The signature must be that of the inventor, not that of the agent)

Name:

Residence:

(city and either US state, if applicable, or country)

Mailing Address:

Citizenship:

Inventor's Signature: Date:

(The signature must be that of the inventor, not that of the agent)

☐ This declaration is continued on the following sheet, "Continuation of Box No. VIII (iv)".

446635

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

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United States Patent and Trademark Office

February 03, 2012

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: 61/458,657

FILING DATE: November 29, 2010

RELATED PCT APPLICATION NUMBER: PCT/US11/01937

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US61/458,657



Certified by

David J. Kappas

Under Secretary of Commerce
for Intellectual Property
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PTO/SB/16 (12-08)

Approved for use through 09/30/2010. OMB 0651-0032

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

U.S. PTO

61/458657

11/29/2010

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
MARTIN	KOEHLER	DAVIDSON, NC

Additional inventors are being named on the _____ separately numbered sheets attached hereto.

TITLE OF THE INVENTION (500 characters max):

LITHIUM STARTER BATTERY

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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ENCLOSED APPLICATION PARTS (check all that apply)

☐ Application Data Sheet. See 37 CFR 1.76
 ☐ CD(s), Number of CDs _____

☒ Drawing(s) Number of Sheets 4
☐ Other (specify) _____

☒ Specification (e.g. description of the invention) Number of Pages 14

Fees Due: Filing Fee of \$220 (\$110 for small entity). If the specification and drawings exceed 100 sheets of paper, an application size fee is also due, which is \$270 (\$135 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).

METHOD OF PAYMENT OF THE FILING FEE AND APPLICATION SIZE FEE FOR THIS PROVISIONAL APPLICATION FOR PATENT

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 110.00

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PROVISIONAL APPLICATION COVER SHEET
Page 2 of 2

PTO/SB/16 (12-08)

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

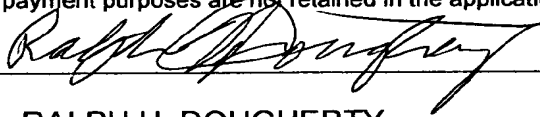
☒ No.

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SIGNATURE _____



Date **NOVEMBER 24, 2010**

TYPED or PRINTED NAME **RALPH H. DOUGHERTY**

REGISTRATION NO. **25,851**
(if appropriate)

TELEPHONE **704-940-3988**

Docket Number: **P-4984**

SPECIFICATION

MARTIN KOEBLER

LITHIUM STARTER BATTERY

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 arrangement for starting such engines.

BACKGROUND OF THE INVENTION

Presently, internal combustion engines (ICE) 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.

5 These circuits also induce heat losses and electrical losses that can be large, as well as taking up additional space. Often (noise) spikes falsely 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 to reactivate once they have been triggered. For example, if an under-voltage condition happens and the cells are still in under-voltage
10 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 energy needs to be extracted, even if it damages the battery.

DESCRIPTION OF THE PRIOR ART

15 Applicant is aware of the following U. S. Patent concerning battery packs for starting engines:

<u>US Patent No.</u>	<u>Issue Date</u>	<u>Inventor</u>	<u>Title</u>
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

20

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-iron-phosphate (LiFePO_4 or LiFePO) 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. Connecting four cells in series, each of which have a standard industry cell format size of both 18650 ($< 3\text{Ah}$) or 26650 ($< 4\text{Ah}$), enough current is available to penetrate to starter motor rated for 12V system to start large IC engines that use 1, 2, 3, 4, 5, 6, 8, or 12 cylinders. Stronger cells up to 5Ah may be utilized in the invention.

With a configuration of 4 cells in series, no protection circuit board is needed to protect the individual cells from overvoltage or undervoltage, unlike larger system using more cells which require the 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
5 board may be placed within the upper casing fore safety protection.

OBJECTS OF THE INVENTION

The principal object of the present invention is to provides 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
10 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
15 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.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The foregoing and other objects will become more readily apparent by referring to the 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.

10 Figure 2 is an isometric bottom view of an assembled starter battery pack of the embodiment of Figure 1..

Figure 3 is a front of the assembled battery pack of Figure 2, the rear view being identical.

Figure 4 is a bottom view of the assembled battery pack of Figure 2..

Figure 5 is a right end view of the housing for the invented battery pack, the left end view being a mirror image thereof.

Figure 6 is an exploded isometric view of another embodiment of the invention, in which 8 cells are arranged into a starter battery pack.

Figure 7 is a top view of the housing for the battery pack of Figure 6.

Figure 8 is a front view of the housing for the battery pack of Figure 6 (omitting the bottom screws), with the top and bottom of the housing mated, the rear view being identical.

Figure 9 is a right end view of the housing for the invented battery pack of Figure 6, the left end view being identical.

Figure 10 is an exploded isometric view of another embodiment of the invention, in which 16 cells are arranged into a starter battery pack

Figure 11 is a an exploded isometric view of another embodiment of the invention, in which 40 cells are arranged into a starter battery pack

Figure 12 is an exploded isometric view of another embodiment of the invention, in which 56 cells are arranged into a starter battery pack

The wording and decoration on the top of the battery pack form no part of the invention.

DETAILED DESCRIPTION

Lithium containing LiFePO and LiFePO_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 12V system voltage when 4 cells are used in series. With the higher cell voltages, most existing 12V direct replacement system will not be able to charge other Lithium cell chemistries above 60% of their capacity.

LiFePO_4 and LiFePO cells also have a higher thermal runaway condition. 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 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 placed inside each individual cylindrical cell casing (flat prismatic

cells also exist) to minimize the chances of explosion. The venting cap allows the electrolyte of a cell to leak out before an internal fire can occur.

The present invention can operate 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
5 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
10 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 invention varies in depth to accommodate varying numbers of cells which provides for different capacity. The lid structure of the housing (or casing) is the same for most battery packs, but cells can be stacked in parallel to allow for larger capacity for different battery
15 packs to be assembled. The tooling cost is minimized for plastic mold injection casing to be formed by only having one or two top tools. The lid of the housing also incorporates a threaded bushing made from aluminum to minimize weight, but that has similar electrical properties to copper or brass, or an internally threaded hole to receive an electrical connector screw.

The lower casing is divided into sections that allows different casings to be manufactured from the same tooling. The tooling is simply stacked to the appropriate height needed for the correct cell capacity. The assembled batter pack has a height H, a width W, and a depth D as shown in Figures 4, 5, 7, and 8.

5 Referring now to the drawings, and particularly to Figure 1, the invented battery pack 10 comprises a housing, having a lower receptacle 12 and a mating top 14, at least one lithium-based rechargeable battery 16, or cell, within the housing, with appropriate electrical connections. The total discharging amount of each lithium-based cell in the battery pack is 500 to 5000 mAh, and charging voltage per one cell is 3.0 to 4.2 V.

10 The lower portion of the housing can be provided with a bottom padding 18 which fits therein, receives the cell or cells, and mates with the lower receptacle. A top pad 20 can be provided in the top 14 of the housing, as desired.

Electrical connections 22 are provided between the cells, as shown, positive to negative, with screws 24 connecting the cells through holes 26 the bottom of the housing to electrical leads, not shown, but which leads connect to bottom screws 28. Alternatively, a welded connection can be used instead of screws 24.

Optionally, a protection circuit board 30 may be placed within the upper casing or top 14 for safety protection.

The starter battery systems utilizing a greater number of lithium cells as shown in Figures 6, 10, 11, and 12, operate in the same way as the starter battery system of Figure 1. Although not shown, 12 lithium cells could be assembled into a battery pack, and higher numbers of cells depending on the number desired for a particular application. The cells can be oriented horizontally as in Figure 10 or vertically as in Figure 11.

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 lead acid 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 is only 90% energy efficient.

**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.

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.

What is claimed is:

1. A battery pack for driving an internal combustion engine starting device connected to an internal combustion engine, 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 500 to 5000 mAh, 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 (LiFePO_4 or LiFePO) cell.
3. A battery pack according to claim 1, wherein said battery pack comprises four lithium-based rechargeable cells in said housing.
4. A battery pack according to claim 1, wherein said battery pack comprises eight lithium-based rechargeable cells in said housing.
5. A battery pack according to claim 1, wherein said battery pack comprises twelve lithium-based rechargeable cells in said housing.

6. A battery pack according to claim 1, wherein said battery pack comprises sixteen lithium-based rechargeable cells in said housing.
7. A battery pack according to claim 1, wherein said battery pack comprises forty lithium-based rechargeable cells in said housing.
8. A battery pack according to claim 1, wherein said battery pack comprises fifty-six lithium-based rechargeable cells in said housing.
9. A battery pack according to claim 1 wherein said housing comprises a lower receptacle for receiving said cell and a top cover for mating with said lower receptacle.
10. A battery pack according to claim 1, wherein said housing includes a bottom pad within said lower receptacle for receiving said cell.
11. A battery pack according to claim 9 wherein said housing includes a top pad arranged within said top cover above said cell.
12. A battery pack according to claim 9 further comprising means for connecting said cell to said lower receptacle.

13. A battery pack according to claim 1 having no protection circuit board.

14. A battery pack according to claim 1 further comprising a protection circuit board within said housing.

Fig. 1

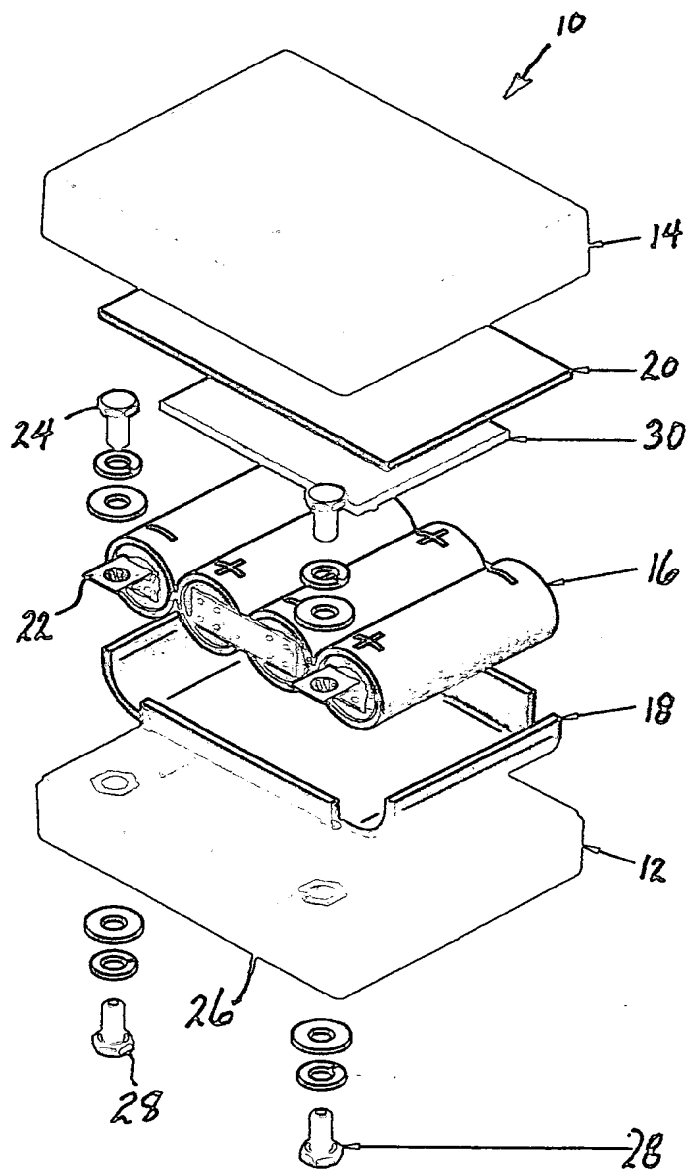


Fig. 10

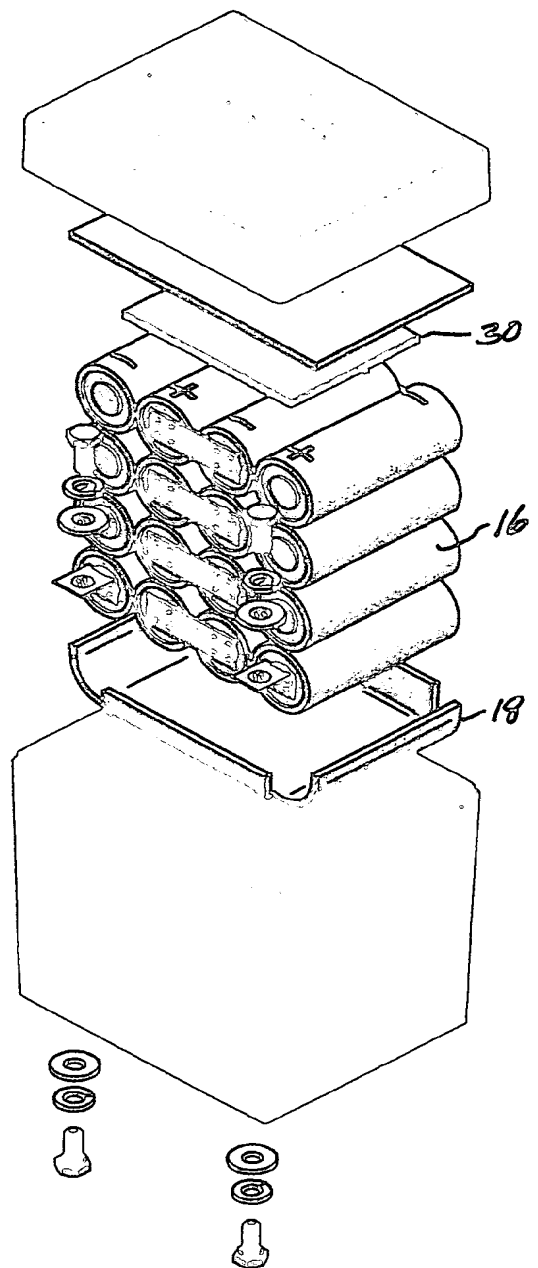


Fig. 3

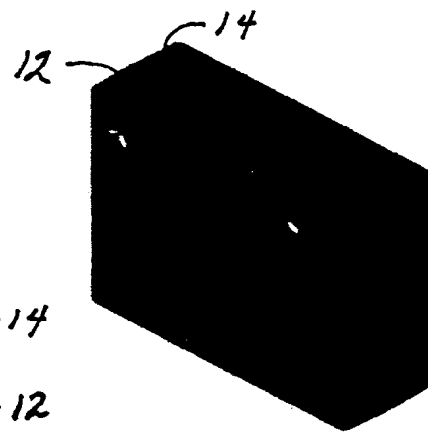
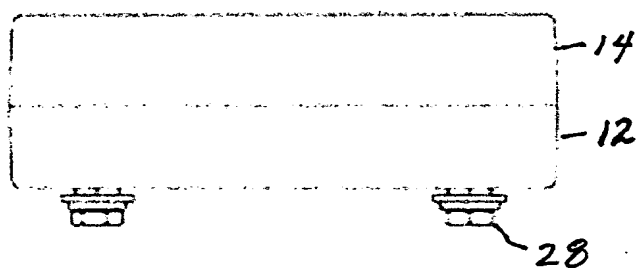


Fig. 2

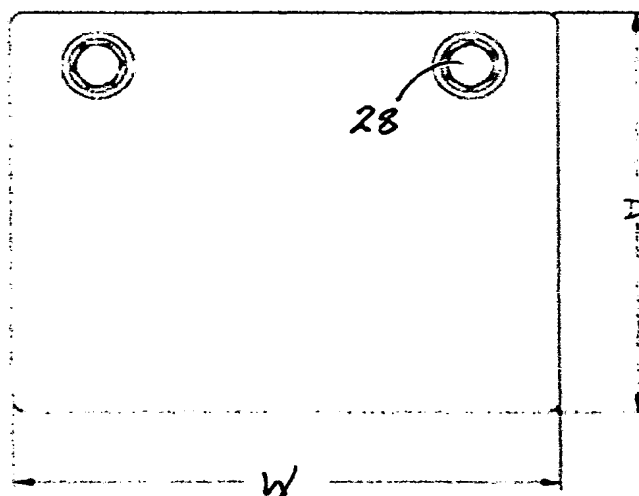


Fig. 4

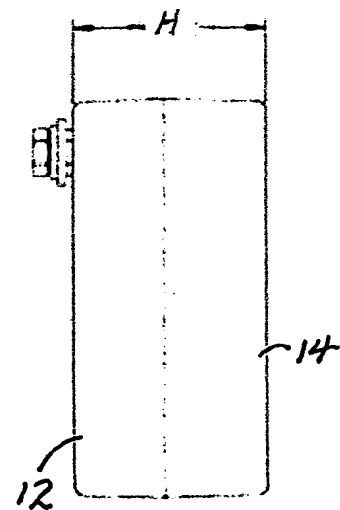


Fig. 5

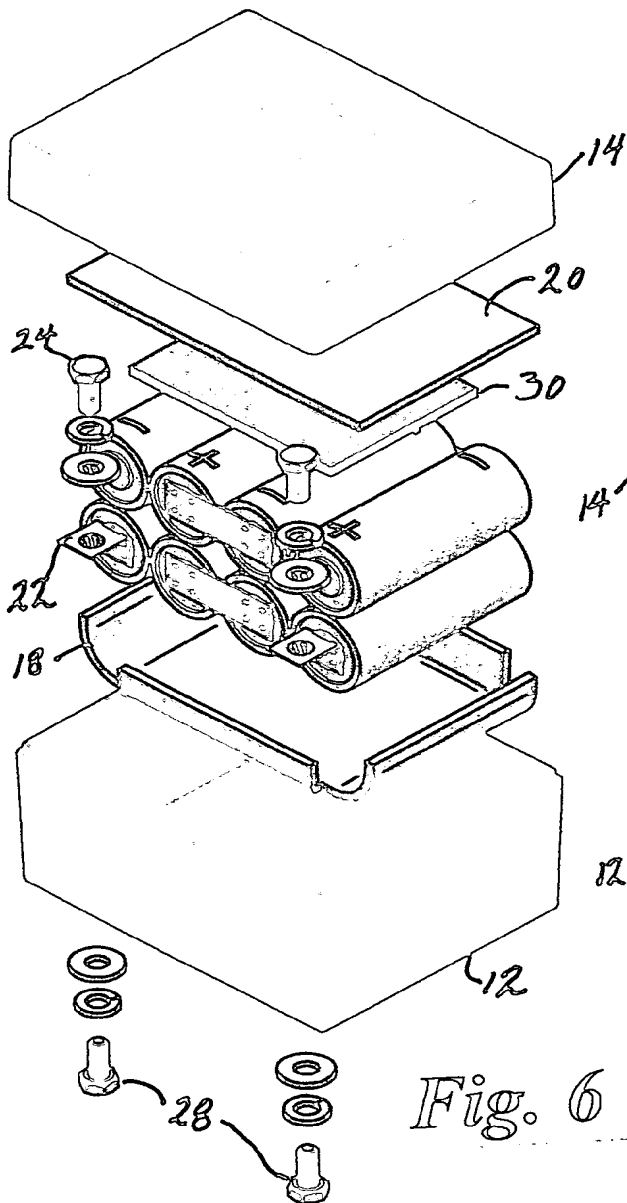


Fig. 6

Fig. 7

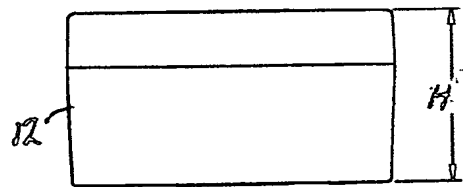
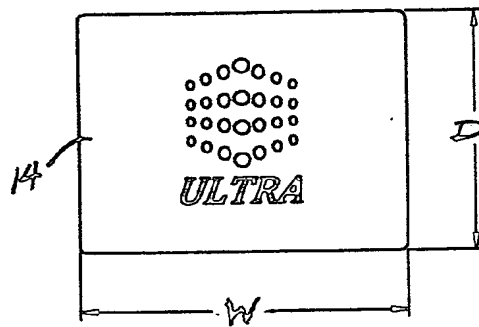


Fig. 8

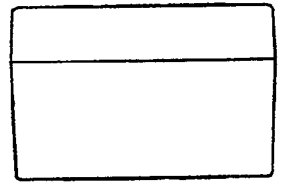


Fig. 9

Fig. 11

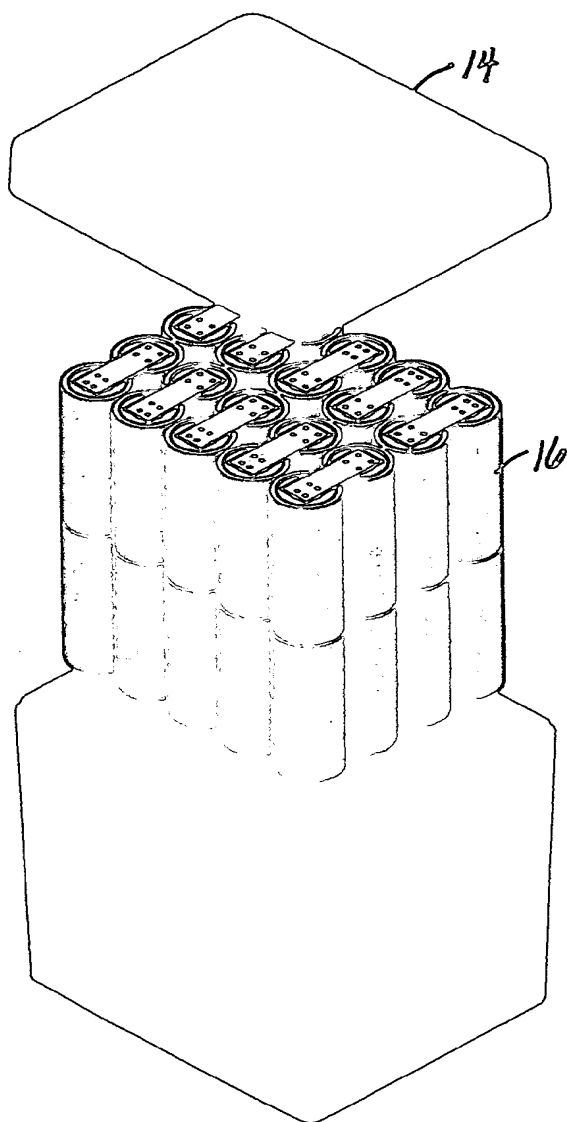
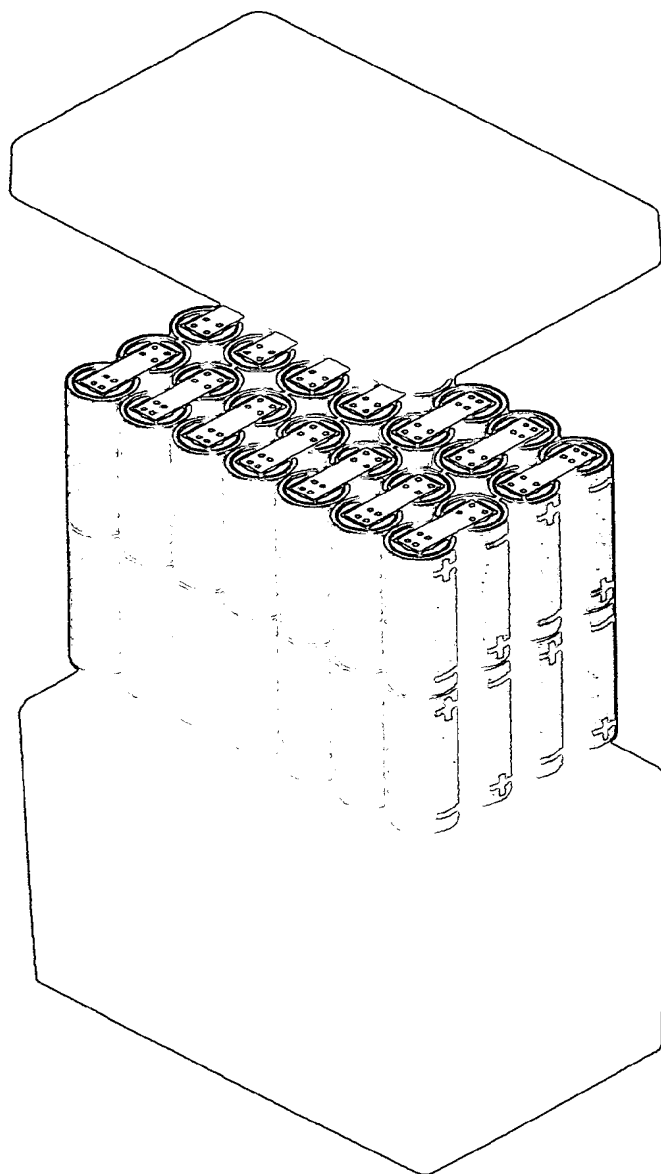


Fig. 12

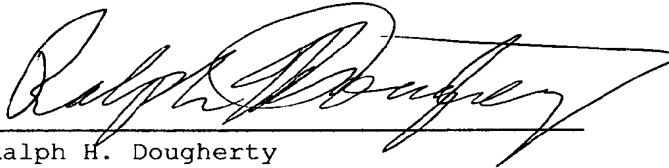


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Date of Deposit November 29, 2010

I hereby Certify that the attached Provisional Patent Application of Inventor MARTIN KOEBLER, entitled "LITHIUM STARTER BATTERY" is being deposited with the U.S. Postal Service Express Mail Post Office to Addressee Service under 37 CFR 1.10 on the date indicated above and addressed to the Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450.



Ralph H. Dougherty
Registration No. 25,851
4219 Kronos Place
Charlotte, North Carolina 28210
Tel: 704/940-3988

DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:	PCT/US2011/001937
International filing date:	28 November 2011 (28.11.2011)
Document type:	Certified copy of priority document
Document details:	Country/Office: US
	Number: 61/458,657
	Filing date: 29 November 2010 (29.11.2010)
Date of receipt at the International Bureau:	04 February 2012 (04.02.2012)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-bis)

PCT**REQUEST**

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

PCT/US 11/01937
International Application No.

International Filing Date 28 NOV 2011 (28.11.11)

RO/US

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum) 4984-PCT

Box No. I	TITLE OF INVENTION	
LITHIUM STARTER BATTERY AND SOLID STATE SWITCH THEREFOR		
Box No. II	APPLICANT	
☒ This person is also inventor		
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.) KOEBLER, Martin 630 Portside Drive Davidson, NC 28036 US		Telephone No. 704-804-4464 Facsimile No. Applicant's registration No. with the Office
E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so. ☐ as advance copies followed by paper notifications; or ☐ exclusively in electronic form (no paper notifications will be sent). E-mail address:		
State (that is, country) of nationality: DE		State (that is, country) of residence: US
This person is applicant for the purposes of: ☒ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box		
Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)		
☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.		
Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE		
The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative		
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) DOUGHERTY, Ralph H. RALPH H. DOUGHERTY, P.A. 4219 Kronos Place Charlotte, NC 28209 US		Telephone No. 704-940-3988 Facsimile No. 704-631-4996 Agent's registration No. with the Office 25,851
E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so. ☒ as advance copies followed by paper notifications; or ☐ exclusively in electronic form (no paper notifications will be sent). E-mail address: ralph@ralphdougherty.com		
☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.		

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However,

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- ☐ JP Japan is not designated for any kind of national protection
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(The check-boxes above may only be used to exclude (irrevocably) the designations concerned if, at the time of filing or subsequently under Rule 26bis.1, the international application contains in Box No. VI a priority claim to an earlier national application filed in the particular State concerned, in order to avoid the ceasing of the effect, under the national law, of this earlier national application.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application: regional Office	international application: receiving Office
item (1) 29 November 2010	61/458,657	US		
item (2) 22 February 2011	61/463,736	US		
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

☐ The International Bureau is requested to obtain from a digital library, a certified copy of the earlier application(s) (if the earlier application(s) is available to it from a digital library) identified above as:*

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (if the earlier application(s) was filed with the Office which for the purposes of this international application is the receiving Office) or to obtain a certified copy of the earlier application(s) from a digital library and transmit a copy of it to the International Bureau (if the earlier application(s) is available to the receiving Office from a digital library), identified above as:*

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Restore the right of priority: the receiving Office is requested to restore the right of priority for the earlier application(s) identified above or in the Supplemental Box as item(s) (_____). (See also the Notes to Box No. VI; further information must be provided to support a request to restore the right of priority.)

Incorporation by reference: where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.

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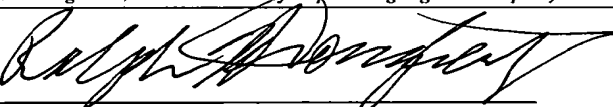
Choice of International Searching Authority (ISA) (if more than one International Searching Authority is competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

ISA/ US

Continuation of Box No. VII USE OF RESULTS OF EARLIER SEARCH, REFERENCE TO THAT SEARCH		
☐ The ISA indicated in Box No. VII is requested to take into account the results of the earlier search(es) indicated below (<i>see also Notes to Box VII; use of results of more than one earlier search</i>).		
Filing date (day/month/year)	Application Number	Country (or regional Office)
☐ Statement (Rule 4.12(ii)): this international application is the same, or substantially the same, as the application in respect of which the earlier search was carried out except, where applicable, that it is filed in a different language.		
☐ Availability of documents: the following documents are available to the ISA in a form and manner acceptable to it and therefore do not need to be submitted by the applicant to the ISA (Rule 12bis.1(f)): ☐ a copy of the results of the earlier search,* ☐ a copy of the earlier application, ☐ a translation of the earlier application into a language which is accepted by the ISA, ☐ a translation of the results of the earlier search into a language which is accepted by the ISA, ☐ a copy of any document cited in the results of the earlier search. (<i>If known, please indicate below the document(s) available to the ISA</i>):		
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* Where the results of the earlier search are neither available from a digital library nor transmitted by the receiving Office, the applicant is required to submit them to the receiving Office (Rule 12bis.1(a)) (<i>See item 11. in the check-list and also Notes to Box No. VII</i>).		
☐ Further earlier searches are indicated on a continuation sheet.		
Box No. VIII DECLARATIONS		
The following declarations are contained in Boxes Nos. VIII (i) to (v) (<i>mark the applicable check-boxes below and indicate in the right column the number of each type of declaration</i>):		Number of declarations
☐ Box No. VIII (i)	Declaration as to the identity of the inventor	:
☐ Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	:
☐ Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	:
☒ Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America)	:
☐ Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	:
		1

Box No. IX CHECK LIST for PAPER filings – this sheet is only to be used when filing an international application on PAPER			
This international application contains the following:	Number of sheets	This international application is accompanied by the following item(s) (mark the applicable check-boxes below and indicate in right column the number of each item):	Number of items
(a) request form PCT/RO/101 (including any declarations and supplemental sheets) :	5	1. ☒ fee calculation sheet :	1
(b) description (excluding any sequence listing part of the description, see (f), below) :	14	2. ☒ original separate power of attorney :	1
(c) claims :	3	3. ☐ original general power of attorney :	
(d) abstract :	1	4. ☐ copy of general power of attorney; reference number: :	
(e) drawings (if any) :	10	5. ☐ statement explaining lack of signature :	
(f) sequence listing part of the description (if any) :		6. ☐ priority document(s) identified in Box No. VI as item(s) :	
Total number of sheets :	33	7. ☐ Translation of international application into (language): :	
		8. ☐ separate indications concerning deposited microorganism or other biological material :	
		9. ☐ copy in electronic form (Annex C/ST.25 text file) on physical data carrier(s) of the sequence listing, not forming part of the international application, which is furnished only for the purposes of international search under Rule 13ter (type and number of physical data carriers) :	
		10. ☐ a statement confirming that "the information recorded in electronic form submitted under Rule 13ter is identical to the sequence listing as contained in the international application" as filed on paper. :	
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		12. ☒ other (specify): Post Card Receipt :	
Figure of the drawings which should accompany the abstract:	13	Language of filing of the international application:	English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE
Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).


Ralph H. Dougherty
Agent

28-11-2011

For receiving Office use only	
1. Date of actual receipt of the purported international application:	IAP01Rec'd PCT 28 NOV 2011
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	
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February 03, 2012

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APPLICATION NUMBER: 61/463,736

FILING DATE: February 22, 2011

RELATED PCT APPLICATION NUMBER: PCT/US11/01937

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US61/463,736



Certified by

David J. Kappas

Under Secretary of Commerce
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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U.S. PTO
61/463736
02/22/2011

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
MARTIN	KOEBLER	DAVIDSON, NC

Additional inventors are being named on the _____ separately numbered sheets attached hereto.

TITLE OF THE INVENTION (500 characters max):

SOLID STATE SWITCH

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☒ The address corresponding to Customer Number: 68151

OR

☐ Firm or Individual Name

Address

City	State	Zip
Country	Telephone	Email

ENCLOSED APPLICATION PARTS (check all that apply)

☐ Application Data Sheet. See 37 CFR 1.76	☐ CD(s), Number of CDs _____
☒ Drawing(s) Number of Sheets <u>5</u>	☐ Other (specify) _____
☒ Specification (e.g. description of the invention) Number of Pages <u>10</u>	

Fees Due: Filing Fee of \$220 (\$110 for small entity). If the specification and drawings exceed 100 sheets of paper, an application size fee is also due, which is \$270 (\$135 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).

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☒ Applicant claims small entity status. See 37 CFR 1.27.	110.00 TOTAL FEE AMOUNT (\$)
☐ A check or money order made payable to the <i>Director of the United States Patent and Trademark Office</i> is enclosed to cover the filing fee and application size fee (if applicable).	
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PROVISIONAL APPLICATION COVER SHEET
Page 2 of 2

PTO/SB/16 (12-08)

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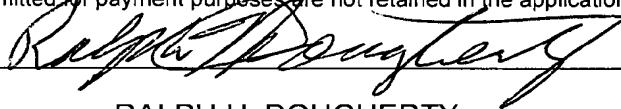
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SIGNATURE



Date FEBRUARY 21, 2011

TYPED or PRINTED NAME

RALPH H. DOUGHERTY

REGISTRATION NO. 25,851
(if appropriate)

TELEPHONE

704-940-3988

Docket Number:

4997-P

SPECIFICATION

MARTIN KOEBLER

SOLID STATE SWITCH

FIELD OF THE INVENTION

The present invention relates to a solid state switching configuration for high powered battery systems, and more particularly to a method and apparatus for protecting against over-charging, over- discharging and short circuiting of batteries, especially starter batteries for internal combustion engines (ICE).

BACKGROUND OF THE INVENTION

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 other 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 coming into 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 would be 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, thus the solid state switch would automatically turn off the current flow leaving 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 would to use a solid state switch either as MOSFET (metal–oxide–semiconductor field-effect transistor) or IGBT (insulated gate bipolar transistor) format but not limited to those two, in a very unique configuration. The unique configuration involved connecting two solid state devices such as MOSFET or IGBT with the “Sources” or “Drains” tied together. 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. Figure 1 shows the “Drain” of each gate being connected, and Figure 2 shows the “Source” of each gate 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.

SUMMARY OF THE INVENTION

The invention provides solid state switch apparatus for allowing 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.

The present invention 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.

The invention can be used with any battery application in which charging and discharging is required. More sophisticated equipment, that a battery may be attached to, 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.

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 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 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 if the battery terminals are too short.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects will become more readily apparent by referring to the following detailed description and the appended drawings in which:

Figure 1 is a schematic diagram of a Solid State Switch with "Drain" connection.

Figure 2 is a schematic diagram of a Solid State Switch with "Source" connection.

Figure 3 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 4 is a schematic diagram example of connecting the "Drain" of each gate together using N type MOSFET or IGBT with the cells being below the solid state switches.

Figure 5 is a schematic diagram illustrating connecting the "Source" of each gate together using N type MOSFET or IGBT with the cells being above the solid state switches.

Figure 6 is a schematic diagram illustrating connecting the "Source" of each gate together using N type MOSFET or IGBT with the cells being below the solid state switches.

Figure 7 is a schematic diagram illustrating connecting the "Drain" of each gate together using P type MOSFET or IGBT with the cells being above the solid state switches.

Figure 8 is a schematic diagram illustrating connecting the "Drain" together using P type MOSFET or IGBT with the cells being below the solid state switches.

Figure 9 is a schematic diagram illustrating connecting the "Source" together using P type MOSFET or IGBT with the cells being above the solid state switches.

Figure 10 is a schematic diagram illustrating connecting the "Source" together using P type MOSFET or IGBT with the cells being below the solid state switches.

DETAILED DESCRIPTION

A battery pack is formed from individual cells put together of any chemistry. Cells are usually placed in series or in parallel inside a battery housing to make a battery. More cells can be connected to form larger system, in the form of connecting more batteries or modules to reach a system target operating voltage and capacity.

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 1 and 2 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 3, 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 for discharging to occur.

Using solid state switching in the configuration shown in Figure 3 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 EMBODIMENTS

Alternative switch and gate arrangements are set forth in Figures 4 through 10. Each such arrangement works in a similar manner as that describing the Figure 3 operation.

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 need to be the same (N) or (P) type used in the same circuit, as illustrated.

SUMMARY OF THE ACHIEVEMENT
OF THE OBJECTS OF THE INVENTION

From the foregoing, it is readily apparent that I have invented an improved method and 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.

What is claimed is:

1. Solid state switching apparatus for one or more batteries, comprising:
 - at least a pair of solid state switches with drains connected;
 - said solid state switches being connected to the negative pole of one or more cells in series;
 - and a source of power for transmission from the positive through the one or more cells, and through the solid state switches to the negative source of power.
2. Apparatus according to claim 1, wherein the solid state switches are MOSFETs or IGBTs.
3. Apparatus according to claim 2, wherein the solid state switches are transistors, FET, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET.
4. Apparatus according to claim 1, wherein the solid state switches are either n-type or p-type.

ABSTRACT OF THE DISCLOSURE

An improved solid state switch apparatus arranged in a unique configuration, which allows current to flow in a controlled manner bidirectionally.

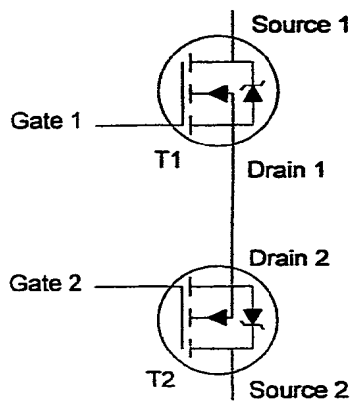


Fig. 1

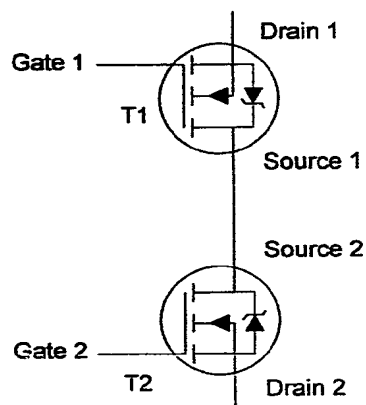


Fig. 2

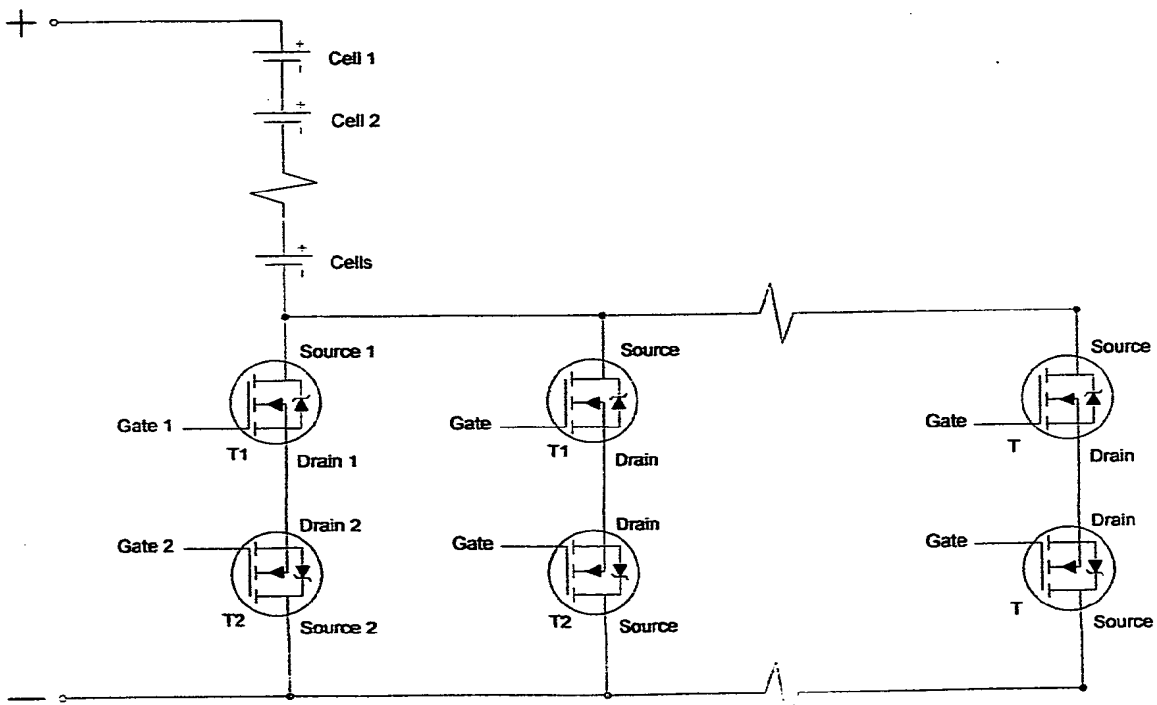


Fig. 3

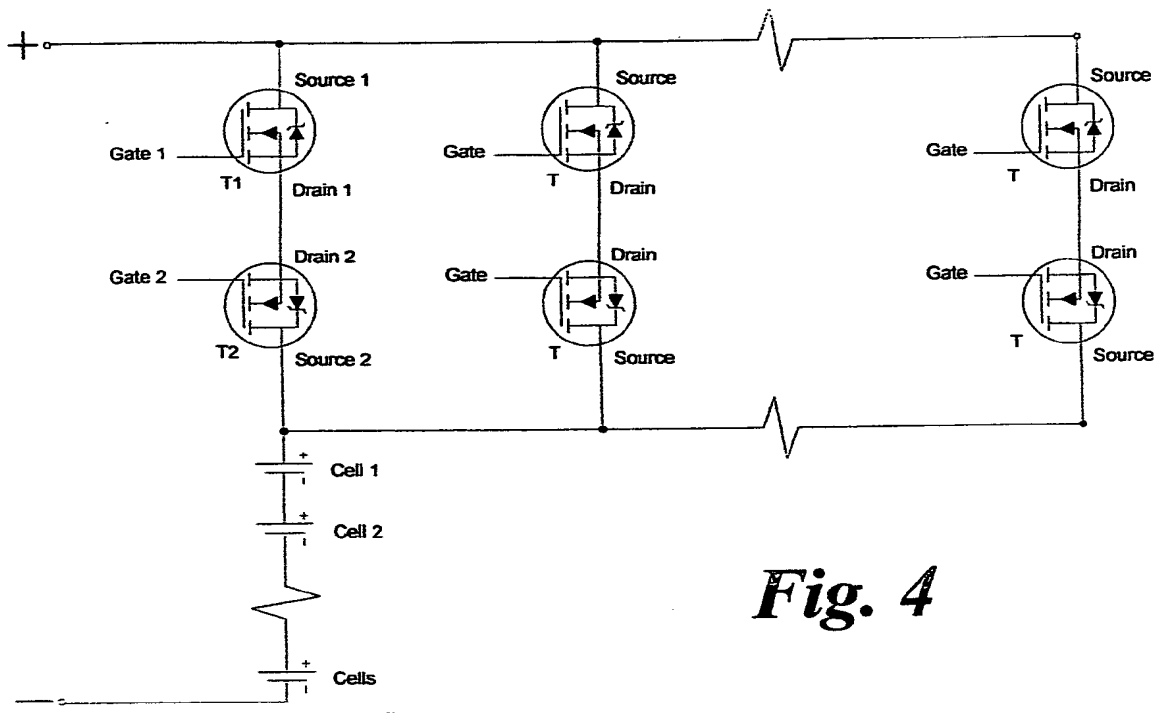


Fig. 4

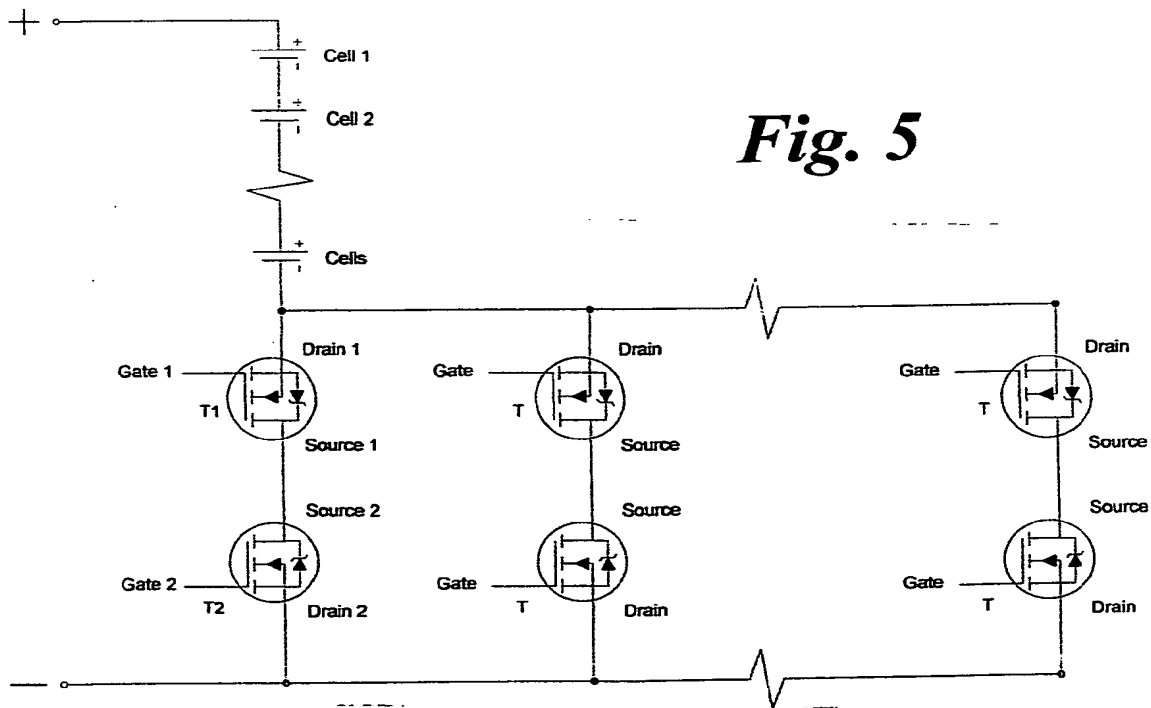


Fig. 5

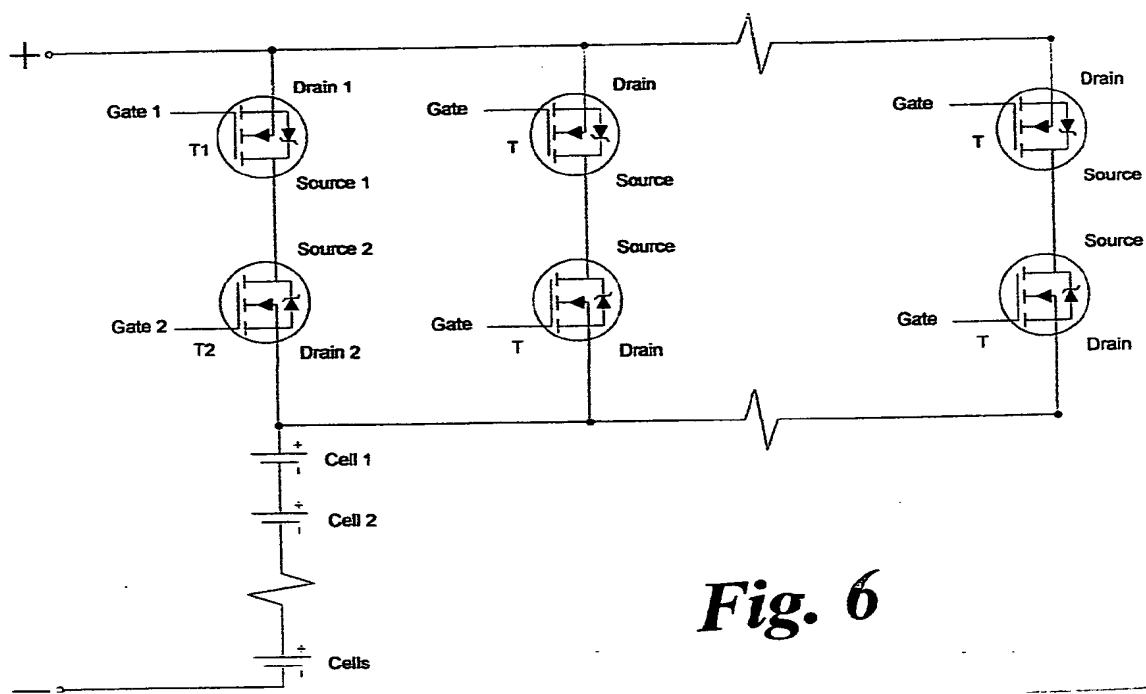


Fig. 6

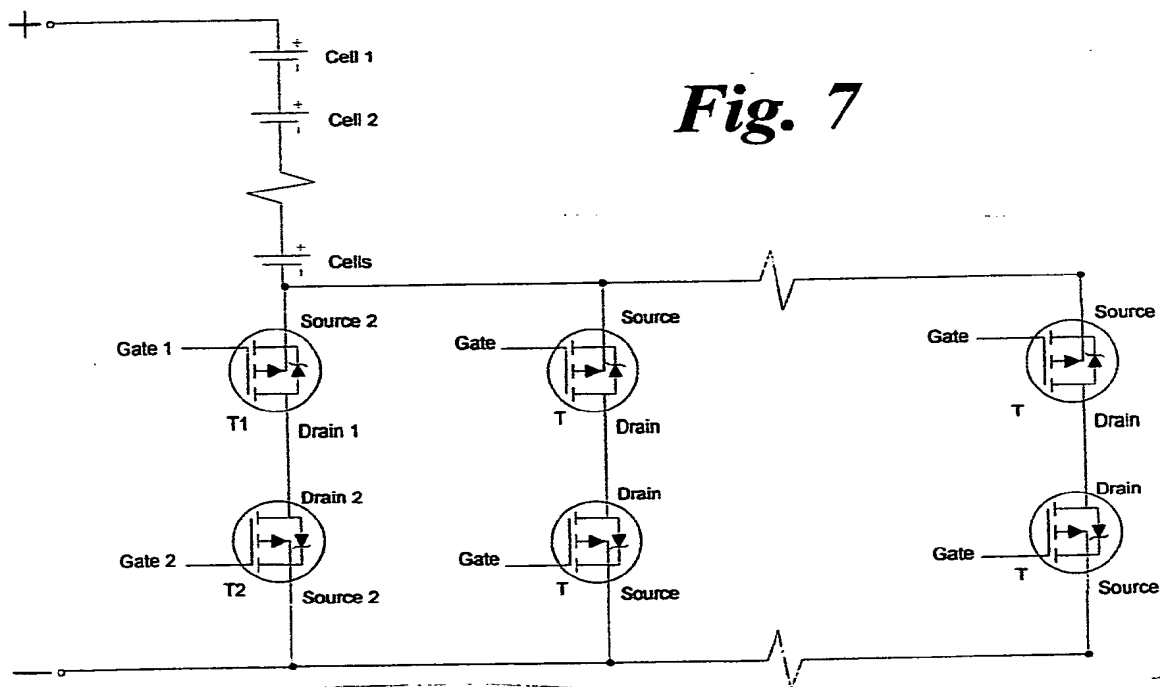


Fig. 7

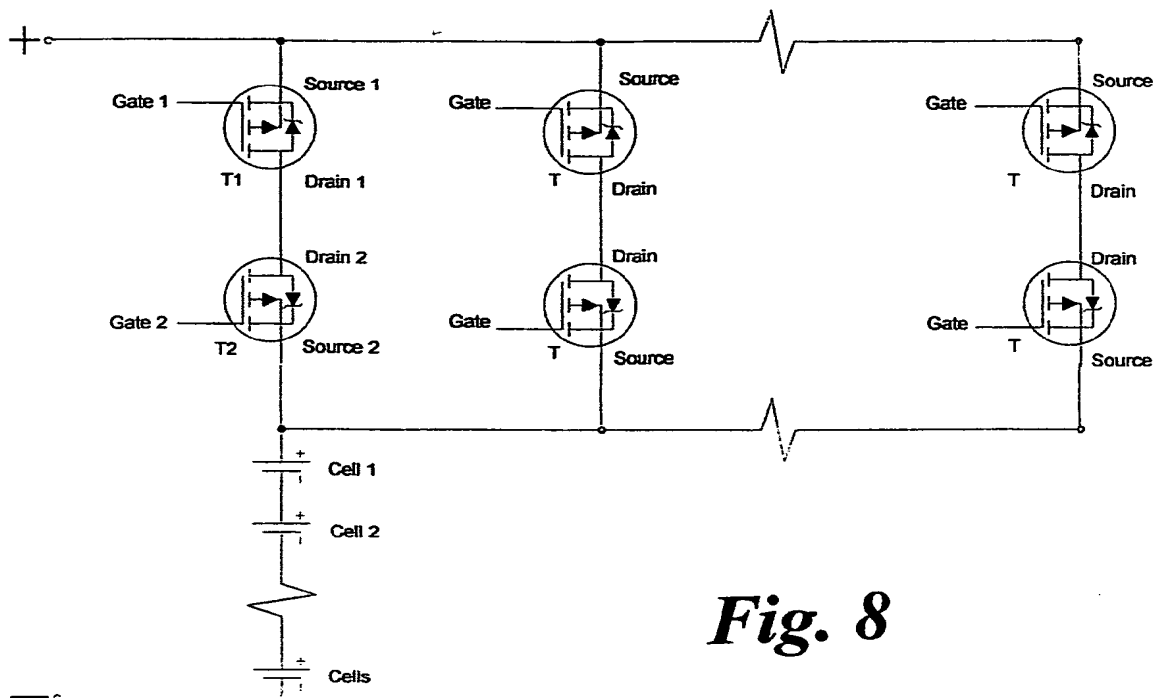


Fig. 8

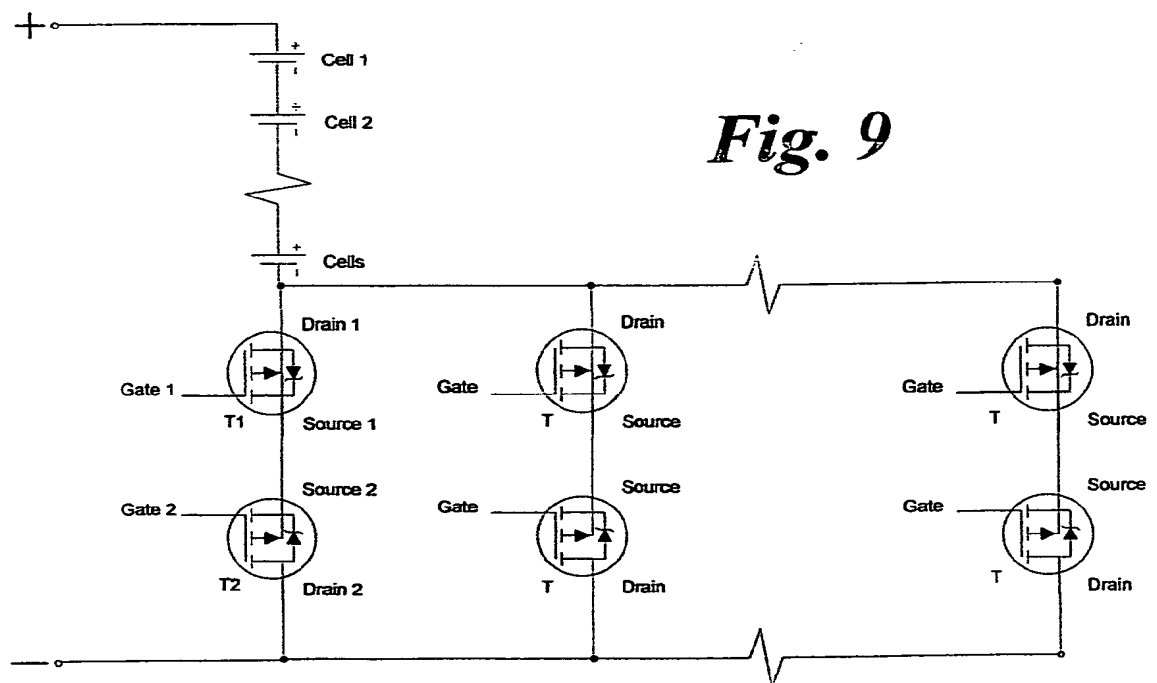


Fig. 9

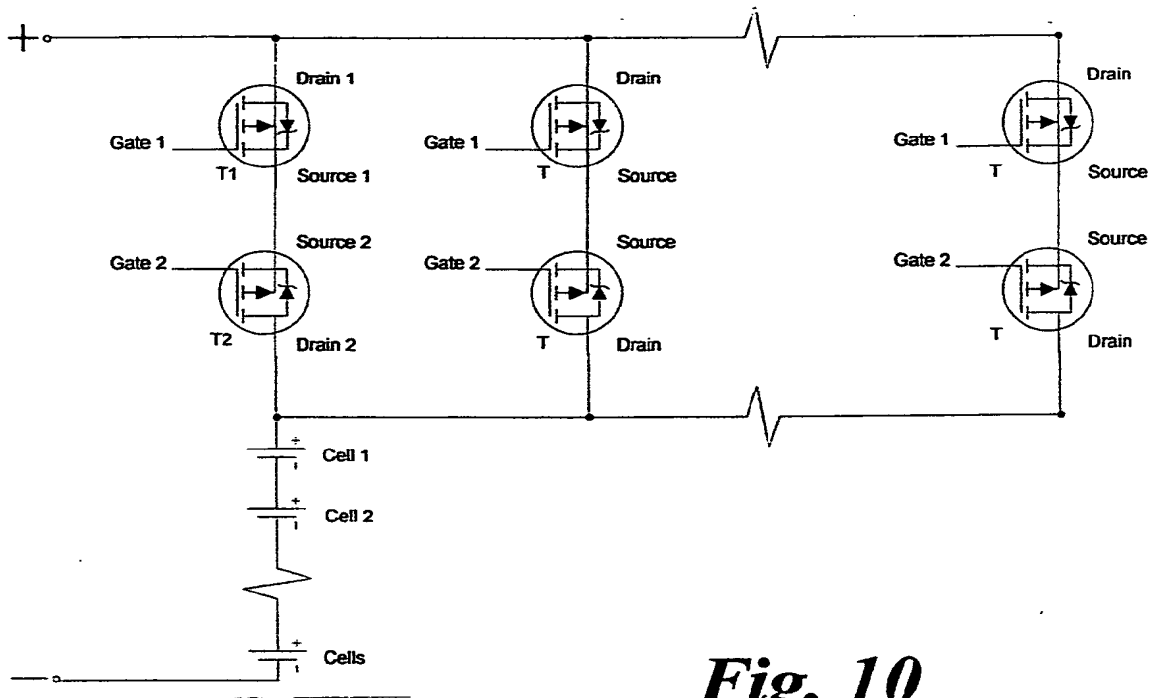


Fig. 10

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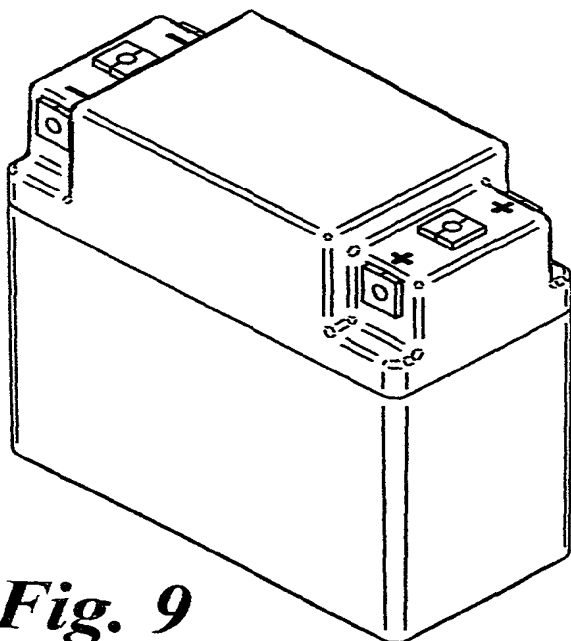


Fig. 9

(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.



1 **LITHIUM STARTER BATTERY**
2 **AND SOLID STATE SWITCH THEREFOR**

3 **FIELD OF THE INVENTION**

4 The present invention relates to a method and apparatus for starting an internal
5 combustion (IC) engine. More particularly, the invention is a lithium-based cell for starting
6 such engines. The invention includes a solid state switching configuration for high powered
7 battery systems for protecting against over-charging, over- discharging and short circuiting
8 of batteries, especially starter batteries for internal combustion engines (ICE).

9 **BACKGROUND OF THE INVENTION**

10 Presently, internal combustion engines use a starter battery comprised of lead-acid to
11 turn over an electric motor to start an IC engine. Lead-acid batteries are heavy, bulky, and
12 have short cycle life, short calendar life, and low turn around efficiency. Lead-acid batteries
13 also have a high internal impedance (resistance) that is greater in cold weather making it more
14 difficult to start an IC engine in cold weather with less current available. To overcome these
15 variables, lead-acid starter batteries are provided with oversized battery capacity in order to
16 produce the necessary current needed for an electric starter to start an IC engine. The
17 oversized lead-acid battery increases the weight, space requirement, and cost needed to start
18 an IC engine.

19 In order to turn off power terminals in presently known starter batteries, expensive
20 electronic/electrical components are required to handle the high current loads that a starter
21 motor needs to turn over an IC engine. These embody electronic protection circuitry for upper
22 voltage cut-off (overcharging), lower level voltage cut-off (over discharging) and temperature
23 measurements. These circuits also induce heat losses and electrical losses that can be large,
24 as well as taking up additional space. (Noise) spikes can trigger false voltage, temperature
25 or current readings that can terminate the battery system's operation, when in fact all the cells
26 are working within safe specifications. Some of these protection circuits are temperamental
27 and difficult to reactivate once they have been triggered. For example, if an under-voltage
28 condition happens and the cells are still in under-voltage condition with a relay approach,
29 current can not be provided to the cells since a path has been broken thus another button needs
30 to be pressed to activate the system for a short duration in order to allow the cells to charge.
31 Also, in some cases such as a military application or racing application, every last bit of

1 energy needs to be extracted, even if it damages the battery.

2 With any type of rechargeable (secondary) battery used, the battery does not operate
3 well in a low state of charge (SOC), which in most cases is a low battery voltage. Whenever
4 a battery is at a low voltage level, the battery can suffer internal damage permanently or the
5 battery life can be drastically reduced. With battery chemistries such as lithium, over-
6 charging a battery can be even more dangerous, potentially leading to an exothermal runaway
7 reaction, which can create a fire. With a solid state switch placed in-line with the battery
8 output power terminals, the solid state switch can be electronically controlled to open or close
9 the current pathway leaving or entering the battery. This can prevent battery damage from
10 happening if the battery voltage is brought too low or too high. This can be applied to any
11 type of battery chemistry at any voltage. An example is to apply the solid state switch to a
12 12V car battery that starts a vehicle. A vehicle might have a voltage drain source left on, in
13 which case the solid state switch would automatically turn off the current flow from the
14 battery before the battery is damaged.

15 A relay or contactor could be used as well, but has the following disadvantages:

16 1) A relay or contactor continuously needs current to keep the contactor open or
17 closed. That requires energy to do so.

18 2) A relay or contactor having a closed pathway allows current to flow in both
19 directions and can not be controlled for a single direction.

20 3) A relay or contactor can only be ON or OFF. During a switching process for large
21 currents large arcing can occur inside the relay or contactor, and that can cause the relay or
22 contactor to "weld" shut. Once a relay or contactor is welded shut, no switching can occur at
23 that point, which can be a safety issue, i.e., by not allowing switching to occur when needed.

24 4) Relays and contactors are large and bulky for larger current applications.

25 A better approach is to use a solid state switch either a FET, a MOSFET
26 (metal-oxide-semiconductor field-effect transistor), or IGBT (insulated gate bipolar
27 transistor) format, but not limited to these, in a unique configuration. The unique
28 configuration involves connecting two solid state devices such as MOSFET or IGBT with the
29 "Sources" or "Drains" tied together electrically. These solid state devices can be either N or
30 P type. A doped semiconductor containing excess holes is called "p-type", and when it
31 contains excess free electrons it is known as "n-type", where p (positive for holes) or n
32 (negative for electrons) is the sign of the charge of the majority mobile charge carriers. This
33 arrangement simplifies the control electronics needed and also allows current to flow in one
34 direction but not the other with the internal diode. An FET (field-effect transistor) is a

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:

<u>US Patent No.</u>	<u>Issue Date</u>	<u>Inventor</u>	<u>Title</u>
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

1 cell format size of both 18650 (less than 3Ah) or 26650 (less than 4Ah), or prismatic flat or
2 other type cells, enough current is available to penetrate to a starter motor rated for 12V
3 system to start large IC engines that use 1, 2, 3, 4, 5, 6, 8, or 12 cylinders. Larger cells may
4 be utilized in the invention, from 1 Ah to 5000 Ah, common sizes being 5Ah, 10Ah, 20 Ah,
5 50Ah, 100Ah, 400Ah, and 500 Ah.

6 With a configuration of 4 cells in series, no protection circuit board is needed to
7 protect the individual cells from over-voltage or undervoltage, unlike larger system using
8 more cells which require a protection circuit board in them for safety protection. Individual
9 cell balancing is also not needed for such a small starter battery but may be included to
10 increase the product life. A smaller and lighter starter battery increases the performance of
11 mobile systems that use starter batteries. The resulting increase of cycle life and calendar life
12 reduces user costs.

13 No separate nor special charging system is needed with the invented system

14 The invention also comprises a housing for the lithium-based cells, with upper and
15 lower mating casings, a contoured pad within the lower casing for receiving at least one
16 lithium-based cell, and electrical connections from the at least one lithium-based batter to the
17 exterior of the housing. Optionally, an upper battery pad may be placed in the upper casing,
18 and, if desired, a protection circuit board, such as a balancing board or a cut-off circuit, may
19 be placed within the upper casing for safety protection.

20 The invented solid state switch apparatus allows current to flow in one direction and
21 not the other. A minimum of two solid state switches are arranged in a unique configuration,
22 which allows current to flow in a controlled manner bidirectionally when needed. This is
23 particularly useful for preventing overcharging or over- discharging an entire battery pack.
24 A separate cell balancing circuit is used to balance out the individual cells. The solid state
25 switch can be used on each individual cell, if desired, to prevent overcharging or
26 over-discharging of the individual cell. It can be used with any battery application in which
27 charging and discharging is required, and is particularly useful with lithium-based batteries.
28 It can also be used with lead-acid batteries, nickel-cadmium (NiCd) batteries, and low
29 self-discharge nickel metal hydride (NiMH) batteries. More sophisticated items of equipment
30 to which a battery may be attached have programmable shut-off settings, but less sophisticated
31 equipment does not have shut-off parameters in place. Using a battery in a starter applications
32 (for instance, to start an IC engine) will prevent the battery from overcharging, as well as
33 prevent the battery from being discharged to too low a level if a current drain (leakage) is
34 present in the system, even though everything is turned off.

1 By connecting the "Sources" or the "Drains" together using a minimum of two solid
2 state devices allows for automation and simplification to fully and partially switch the
3 batteries power terminals ON and OFF. The two solid state devices can either be N or P type
4 and connected either on the Positive or Negative side of the battery terminal and controlled
5 by simple electronic circuit to control the drivers of the solid state devices.

6 This invented switch configuration also allows for short circuit protection across the
7 battery power terminals, along with allowing the maximum current control when charging.

8 OBJECTS OF THE INVENTION

9 The principal object of the present invention is to provide means for increasing the
10 performance of a starter battery for a starter motor of an internal combustion engine.

11 Another object of the invention is to provide a starter battery for an internal
12 combustion engine that is lighter, more reliable, has less bulk, longer cycle life, longer
13 calendar life, and higher turn around efficiency than lead-acid batteries.

14 A further object of this invention is to provide a starter battery system for an internal
15 combustion engine that is easy to assemble, waterproof, and maintenance free.

16 Another object of the invention is to provide a starter battery for an internal
17 combustion engine that can be used in existing vehicles.

18 Another object of the invention is to provide a starter battery for an internal
19 combustion engine that has a wide operating temperature range with exceptional cold-weather
20 cranking performance.

21 Another object of the invention is to provide an improved apparatus for protecting a
22 single cell or battery from being overcharged or over-discharged.

23 Another object of the invention is to provide apparatus for charging a cell having a
24 very low charge.

25 Another object of the invention is to provide apparatus for short circuit protection for
26 one or more cells or batteries.

27 Another object of the invention is to provide apparatus for discharging a cell having
28 too high a charge.

29 A further object of the invention is to provide an apparatus for short circuit protection
30 in case a metal object causes a short circuit across the terminals.

31 BRIEF DESCRIPTION OF THE DRAWINGS

32 The foregoing and other objects will become more readily apparent by referring to the

1 following detailed description and the appended drawings in which:

2 Figure 1 is an exploded isometric view of one embodiment of the invention, in which
3 4 cells are arranged into a starter battery pack.

4 Figure 2 is an exploded isometric view of another embodiment of the invention, in
5 which 8 cells are arranged into a starter battery pack.

6 Figure 3 is an exploded isometric view of another embodiment of the invention, in
7 which a prismatic cell is arranged into a starter battery pack.

8 Figure 4 is a front view of the assembled battery pack of Figure 3, the rear view being
9 identical.

10 Figure 5 is a top view of the assembled battery pack of Figure 3.

11 Figure 6 is a right end view of the assembled battery pack of Figure 3, the left end
12 view being a mirror image thereof.

13 Figure 7 is a schematic diagram of a block of 4 lithium prismatic cells in series
14 connected to a balancing circuit board.

15 Figure 8 is a schematic diagram of a block of 4 lithium prismatic cells in series
16 connected to a balancing and cutoff circuit board

17 Figure 9 is an isometric view of an alternative embodiment of a housing showing
18 contacts for switches.

19 Figure 10 is a top view of the housing of Figure 9 showing the contact locations.

20 Figure 11 is a front view of the housing of Figure 9, the rear view being identical.

21 Figure 12 is an end view of the housing of Figure 9, the opposite end being identical.

22 Figure 13 is an exploded isometric view of an alternative embodiment of the invention
23 of Figure 3, in which 2 blocks of prismatic cells and a control board of cutoff switch are
24 arranged into the housing of Figure 9.

25 Figure 14 is a schematic diagram of a Solid State Switch with "Drain" connection.

26 Figure 15 is a schematic diagram of a Solid State Switch with "Source" connection.

27 Figure 16 is a schematic diagram showing a preferred embodiment of the invention
28 in which the "Drain" of each gate is connected together using N type MOSFET or IGBT with
29 the cells being above the solid state switches.

30 Figure 17 is a schematic diagram example of connecting the "Drain" of each gate
31 together using N type FET, MOSFET, or IGBT with the cells being below the solid state
32 switches.

33 Figure 18 is a schematic diagram illustrating connecting the "Source" of each gate
34 together using N type FET, MOSFET or IGBT with the cells being above the solid state

1 switches.

2 Figure 19 is a schematic diagram illustrating connecting the "Source" of each gate
3 together using N type FET, MOSFET or IGBT with the cells being below the solid state
4 switches.

5 Figure 20 is a schematic diagram illustrating connecting the "Drain" of each gate
6 together using P type FET, MOSFET or IGBT with the cells being above the solid state
7 switches.

8 Figure 21 is a schematic diagram illustrating connecting the "Drain" together using P
9 type FET, MOSFET or IGBT with the cells being below the solid state switches.

10 Figure 22 is a schematic diagram illustrating connecting the "Source" together using
11 P type FET, MOSFET or IGBT with the cells being above the solid state switches.

12 Figure 23 is a schematic diagram illustrating connecting the "Source" together using
13 P type FET, MOSFET or IGBT with the cells being below the solid state switches.

14 Figure 24 is a schematic diagram illustrating the invention utilized in engine restarting.

15 Figure 25 is a schematic diagram illustrating short circuit protection of a battery.

16 DETAILED DESCRIPTION

17 Lithium containing LiFePO , LiFePO_4 , LiFeMgPO_4 , and LiFeYPO_4 cells have a low
18 nominal cell voltage (3.2V-3.3V) that match directly with existing 12V lead-acid equivalent
19 systems. Four LiFePO cells in series have a nominal voltage of 13.2V. Thus they can directly
20 replace existing 12V lead-acid equivalent systems without requiring any electrical
21 modification.

22 Other lithium chemistries have a higher nominal voltage, such as: lithium-cobalt
23 (3.6V), lithium-manganese (3.7V-3.8V), lithium-nickel-cobalt-manganese (3.7V). Each of
24 these thus have a higher system voltage when 4 cells are used in series. With the higher cell
25 voltages, most existing 12V direct replacement systems will not be able to charge other
26 lithium cell chemistries above 60% of their capacity. Other lithium-based cells that can be
27 utilized in this invention are lithium-cobalt-oxide (LiCoO_2), lithium-manganese-oxide
28 (LiMn_2O_4), lithium-nickel-cobalt-manganese-oxide (LiNiCoAlO_2), lithium-nickel-manganese-
29 cobalt-oxide (LiNiMnCoO_2), and lithium-titanate ($\text{Li}_4\text{Ti}_5\text{O}_{12}$).

30 LiFePO , LiFePO_4 , LiFeMgPO_4 , and LiFeYPO_4 cells also have a higher thermal
31 runaway condition than lead-acid cells. For a thermal runaway to occur, the cell temperature
32 must be extremely hot (over 200°C). When a cell reaches a certain temperature, mostly
33 caused by overcharging, then the cell will start producing more heat by an internal reaction

1 that fuels itself in most cases with a fire, which phenomenon is known as "thermal runaway".
2 All other Lithium cell chemistries have a lower thermal runaway temperature making those
3 cells more prone to catch on fire.

4 A thermal venting cap is usually placed inside each individual cylindrical cell casing
5 to minimize the chances of explosion. The venting cap allows the electrolyte of a cell to leak
6 out before an internal fire can occur.

7 Although it is advantageous to use protective circuitry, it is possible to operate the
8 present invention without protective circuitry, which simplifies the system to allow charging
9 or discharging. Omitting all of the electronic protection circuitry for upper voltage cut-off
10 (overcharging), lower level voltage cut-off (over discharging) and temperature measurements
11 reduces the overall manufacturing cost of the starter battery. This also simplifies the system
12 to allow charging or discharging in all conditions and not be restricted by any suggested or
13 specified operating range.

14 By using lithium cells, a battery housing structure is both smaller and lighter than with
15 lead-acid cells. Any time less internal mass is involved the housing structure size can be
16 reduced, which also results in reducing cost.

17 The housing structure of the embodiment of Figures 1 and 2 may vary in depth to
18 accommodate varying numbers of cells which provides for different capacity. The lid structure
19 of the housing (or casing) for cylindrical cells is the same for most battery packs, as shown.
20 Such cells can be stacked in parallel to allow for larger capacity for different battery packs to
21 be assembled. The lid of the housing also incorporates a threaded bushing made from
22 aluminum to minimize weight, but that has similar electrical properties to aluminum, copper
23 or brass, or an internally threaded hole to receive an electrical connector screw.

24 Referring now to the drawings, and particularly to Figure 1, the invented battery pack
25 10 comprises a housing 12, having a lower receptacle 14 and a mating top 16, at least one
26 lithium-based rechargeable battery 18, or cell, within the housing, with appropriate electrical
27 connections. The total discharging amount of each lithium-based cell in the battery pack is
28 one (1) to 5000 Ah, and charging voltage per one cell is 3.0 to 4.2 V.

29 The lower portion of the housing 16 can be provided with bottom padding 20 which
30 fits therein, receives the cell or cells, and mates with the lower receptacle 14. A top pad 22
31 can be provided in the top 16 of the housing, as desired.

32 Electrical connections 24 are provided between the cells, as shown, positive to
33 negative, with screws 26 connecting the cells through holes 28 the bottom of the housing to
34 electrical leads, not shown, but which leads connect to bottom screws 30. Alternatively, a

1 welded connection can be used instead of screws.

2 Optionally, a protection circuit board 32 may be placed within the upper casing or top
3 14 for safety protection. Such a protection circuit board may be a cutoff board or a cell-
4 balancing circuit board. A cell-balancing circuit board may include a cutoff function. A
5 lithium iron battery having two or more cells in series has a battery voltage equal to the sum
6 of the individual cell voltages. Over the life of the battery, it may be charged and discharged
7 for hundreds or thousands of cycles. The individual cells may age differently. Some cells may
8 become mismatched with respect to the others. This phenomenon is corrected, by balancing.
9 Balancing is the process of forcing all of the cells to have identical voltages. This is
10 accomplished by a balancing circuit.

11 Starter battery systems can utilize a greater number of lithium cells as desired for
12 greater capacity.

13 Lithium cells have substantially less weight than a lead-acid cell, and are 80% smaller.
14 A lithium cell will last about 3 times as long as a lead-acid cell with 100% full discharge
15 cycles. Lithium cells are maintenance free, whereas lead-acid cells need to be refilled with
16 distilled water to maintain the acid level above the plates. Lithium cells do not freeze. They
17 have a discharge power 8 times that of lead-acid. Their charging time is less than 2 hours.

18 Lithium cell self discharge rate is less than 2% monthly, whereas the self discharge
19 rate for a lead-acid cell is 10% monthly.

20 Lithium cells can operate at very high temperature, up to 70°C without major
21 degradation. They can also operate at very low temperature, down to -30°C with slight
22 capacity degrade at that temperature, but power is available.

23 Lithium cells are 98% energy efficient (energy going in and out of the cell), whereas
24 lead-acid cells are only 90% energy efficient.

25 For each 12 volt increment, four LiFePO_4 cells are required in series, and some cases
26 fewer cells with other lithium chemistries. The following Table I compares lead-acid battery
27 voltages to the LiFePO_4 cell requirements and for other lithium-based battery cells:

TABLE I

	Nominal Lead-Acid Voltage	LiFePO ₄ (3.3V nominal)	(LiCoO ₂), (LiMn ₂ O ₄), (LiNiCoAlO ₂), (LiNiMnCoO ₂), or (Li ₄ Ti ₅ O ₁₂) (3.7V nominal)
1			
2			
3			
4			
5			
6			
7	12V	3 to 4 cells in series	2 to 4 cells in series
8	24V	5 to 9 cells in series	5 to 8 cells in series
9	36V	8 to 13 cells in series	7 to 12 cells in series
10	48V	11 to 17 cells in series	10 to 16 cells in series
11	60V	14 to 22 cells in series	12 to 19 cells in series
12	72V	16 to 26 cells in series	15 to 23 cells in series
13	84V	19 to 31 cells in series	17 to 27 cells in series
14	96V	22 to 35 cells in series	19 to 31 cells in series
15	108V	25 to 39 cells in series	22 to 35 cells in series
16	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

1 a headlight or electrical component on for an extended period of time while the engine is off.
2 Enough reserve power is left in the battery, to automatically detect (by measuring a change
3 in resistivity) a starting effort and allow the user to start the engine again. This avoids the
4 cyclist being stranded or the headache of replacing a battery. The auto-detect apparatus has
5 at least one lithium-based cell, a voltage detector, an associated switch such as a cutoff board,
6 or a micro-controller in a balancing circuit connected to a solid state switch, such as an FET.
7 One function turns off an FET in the circuit when the voltage drops to a preselected level,
8 leaving sufficient reserve capacity for starting the engine. A second function detects a "keying
9 cycle" or the resistance change upon attempting to start the engine, which turns on the FET.
10 This resistance change is a reaction to a key turn, push button, or remote activator.

11 To control the solid state switches, electronic controls are needed for the different
12 voltages, currents and/or temperature with specified parameters in which cells work to prevent
13 damage. The control electronics used in battery systems are often referred to a Battery
14 Management System (BMS) or Battery Management Unit (BMU). The BMS or BMU can
15 individual monitor all the cell or battery voltages, and/or temperatures. To protect a single
16 cell or battery from being over charged, that might lead to an exothermal runaway reaction
17 creating a fire and/or to prevent the cell from damaging when discharging them too low, the
18 solid state switch would close or open the current pathway to prevent cell damage from
19 occurring.

20 The arrangement of devices shown in Figures 15 and 16 are examples of how solid
21 state switches can be configured to connect the "Drains" or "Sources" together which is an
22 unconventional approach. The solid state switches in parallel are examples to increase the
23 current capabilities.

24 Referring particularly to Figure 17, under normal operations both T1 and T2 are ON
25 allowing power pathway to go in both directions: discharge and charge. Should a cell be
26 outside of its specified working specification (cell voltage), both D1 and D2 can be turned off
27 but current can still flow through the internal diode to allow for added functionality.

28 In the event that the cell voltage drops too low, below the set voltage configuration,
29 from a drain on the battery, T1 will turn off, preventing further discharge from occurring.
30 However, with the internal diode in place of T1, and T2 still on, the circuit will allow charging
31 to occur.

32 If the cell voltage goes too high, above the set voltage configuration, T2 will turn off,
33 preventing further over charging from occurring. However, with the internal diode in place
34 of T2, and T1 still on, the circuit will allow discharging to occur.

1 Using solid state switching in the configuration shown in Figure 17 allows for user
2 friendly reactivation of the circuit without any pushbuttons or reset buttons. Both Charge and
3 Discharge current can go through the internal MOSFET or IGBT diode to bring the cell back
4 to the specified operating voltage.

5 Alternative switch and gate arrangements are set forth in Figures 18 through 23. Each
6 such arrangement works in a similar manner as that describing the Figure 17 operation.

7 The invention's restart function is illustrated by Figure 24. Controller 60 is connected
8 to a battery pack having a block of cells 64 and to MOSFETs Q1 and Q2. After a low voltage
9 cutoff, the controller periodically tests the load to detect a change in the load impedance.
10 When an abrupt change in the load impedance is detected, for example connecting or
11 disconnecting a load such as the headlight(s), the ignition switch, or the starter switch, the
12 controller 60 turns on power MOSFETs Q1 and Q2, which reconnects the battery to the
13 vehicle and allows the vehicle to be restarted.

14 When the controller drives the base of Q3 high through R1, Q3 and Q4 turn on. When
15 Q4 turns on, it connects the battery to the load through R4 and D1. R4 and the load
16 impedance form a voltage divider, and the resulting voltage at node A will depend on the load
17 impedance. D2 steers the node A voltage to the R5/R6 voltage divider which scales down the
18 voltage at node B to a level that the controller can read using an analog-to-digital converter
19 (ADC). The ADC may be of the type commonly included as a built-in peripheral in a micro-
20 controller or a digital signal processor; alternatively the ADC may be a standalone device.
21 After turning on Q4, the controller may make one or more ADC readings after one or more
22 fixed or variable delay periods. By reading the ADC at different times after turn-on, the
23 controller can infer not only the resistive, but also the inductive and/or capacitive components
24 of the load impedance. By tracking the periodic ADC readings and applying the appropriate
25 digital filtering, abrupt changes in the load impedance can be determined. Gradual changes
26 in the ADC readings, which may be caused for example by temperature changes or battery
27 charge depletion, are disregarded (i.e., filtered out). Immediately after making the required
28 ADC reading(s) the Controller turns off Q3 and Q4 to minimize battery drain. It should be
29 noted that while Q3 and Q4 are shown here as bipolar junction transistors, a number of other
30 types of electronic devices could be used to accomplish the switching function of Q4,
31 including but not limited to one or more MOSFETs or a relay.

32 In order to conserve battery charge as long as possible in low voltage cutoff mode, the
33 controller tests the load impedance only as often as necessary. The testing period is
34 determined by the application, and is approximately 1 to 5 seconds. In a vehicle application,

1 this period represents the maximum time that a user would have to hold a starter switch in the
2 start position in order to effect a restart after a low voltage cutoff. To further reduce drain on
3 the battery, the testing period may be extended if the battery remains in low voltage shutdown
4 mode for a long time, or if the battery voltage (in one or more cells) continues to drop.

5 The invention is useful for short circuit protection as shown in Figure 25. Cross-
6 coupled NAND gates E and F form a set-reset (SR) latch that controls the gate drive of power
7 MOSFET Q2. The latch is set when the controller 60 drives Q2 ENABLE low. When Q2
8 ENABLE is driven high again, the output of NAND gate G is low and NAND gate H turns
9 on Q3, which turns on Q4, which supplies the boosted gate drive voltage to turn on Q2. C3
10 and C4 help ensure fast turn-on of Q2 even with the relatively high value resistors for R4, R5,
11 and R8 required to satisfy the application's low power requirements.

12 Current monitor A monitors the voltage drop across the drain-source ON resistance
13 ($R_{DS(on)}$) of power MOSFET Q1 and sources a current into node B that is proportional to the
14 MOSFET current. R1 converts this current to a voltage that is compared to VREF at
15 comparator D. When a short circuit occurs, the voltage at node B will exceed VREF (at least
16 momentarily) and cause the output of D to go low, resetting the S-R latch. When the S-R
17 latch is reset the output of G will go high, and C2 will differentiate a positive going pulse into
18 the base of Q5, causing Q5 to turn on for a few microseconds and rapidly discharge the gate
19 of Q2. Rapid turn-off of Q2 is essential to limiting the energy associated with a short circuit
20 event. By monitoring the status of the S-R latch, the controller 60 can determine when a short
21 circuit cut-off event has occurred. C1 low pass filters the signal at node B so that extremely
22 short duration overcurrent conditions can be tolerated if desired. The controller 60 may adjust
23 VREF to compensate for Q2's $R_{DS(on)}$ variation with temperature if desired, or to adjust the
24 over current trip threshold.

25 The solid state switches can be transistors, FET (field-effect transistors), JFET or
26 JUGFET (junction gate field-effect transistors), BJT bipolar junction transistors, CMOS
27 (complementary metal-oxide-semiconductors), VMOS (Vertical Metal Oxide Silicon),
28 TMOS transistors, vertical DMOS (Double-Diffused MOS), or HEXFET.(hexagonal shape
29 MOSFET).

30 It should be noted that the invented solid state switch apparatus can also be used in any
31 battery system that requires charging and discharging in order to extend the battery life, and
32 for safety. This is extremely useful and is a first for starter batteries.

33 The solid state devices all must be the same (N) or (P) type used in the same circuit,
34 as illustrated.

**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.

1 What is claimed is:

2 1. A battery pack for driving an electrical device, said battery pack comprising:

3 a housing; and

4 at least one lithium-based rechargeable cell within said housing;

5 wherein a total discharging amount of each lithium-based cell in the battery pack is
6 from one (1) Ah to 5000 Ah, and charging voltage per one cell is 3.0 to 4.2 V.

7 2. A battery pack according to claim 1 wherein the lithium-based cell is a lithium iron
8 phosphate cell.

9 3. A battery pack according to claim 2, wherein the lithium iron phosphate cell is selected
10 from the group consisting of LiFePO_4 , LiFePO_4 , LiFeMgPO_4 , and LiFeYPO_4 cells.

11 4. A battery pack according to claim 1 wherein the lithium-based cell is selected from the
12 group consisting of LiCoO_2 , LiMn_2O_4 , LiNiCoAlO_2 , LiNiMnCoO_2 , and $\text{Li}_4\text{Ti}_5\text{O}_{12}$ cells.

13 5. A battery pack according to claim 1, wherein said battery pack comprises four lithium-
14 based rechargeable cells in series in said housing.

15 6. A battery pack according to claim 1, wherein said battery pack comprises an even number
16 of lithium-based rechargeable cells in said housing.

17 7. A battery pack according to claim 1 wherein said electrical device is an internal
18 combustion engine starting device connected to an internal combustion engine.

19 8. A battery pack according to claim 1, further comprising a protection circuit board within
20 said housing.

21 9. A battery pack according to claim 8, wherein said protection circuit board is a cut-off board
22 or a cell balancing circuit board.

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 , $\text{Li}_4\text{Ti}_5\text{O}_{12}$, lead-acid, NiCd, and nickel metal hydride (NiMH) batteries.

1 17. Apparatus according to claim 12, further comprising a housing for said one or more cells,
2 batteries, wherein said solid state switches are within said housing.

3 18. Solid state switching apparatus for one or more cells in a battery pack having a positive
4 terminal and a negative terminal, each of said cells having a positive pole and a negative pole,
5 said apparatus comprising:

6 at least a pair of solid state switches, each switch having a source and a drain, with
7 sources connected;

8 said solid state switches being connected to the negative pole of said one or more cells
9 in series, and to said negative terminal, the positive pole of said one or more cells being
10 connected to said positive terminal.

11 19. Apparatus according to claim 18, wherein the solid state switches are transistors, FET,
12 MOSFET, IGBT, JFET, BJT, CMOS, VMOS, TMOS, vertical DMOS or HEXFET.

13 20. Apparatus according to claim 18, wherein said one or more cells are selected from the
14 group consisting of LiFePO, LiFePO₄, LiFeMgPO₄, LiFeYPO₄, LiCoO₂, LiMn₂O₄,
15 LiNiCoAlO₂, LiNiMnCoO₂, Li₄Ti₅O₁₂, lead-acid, NiCd, and nickel metal hydride (NiMH)
16 batteries.

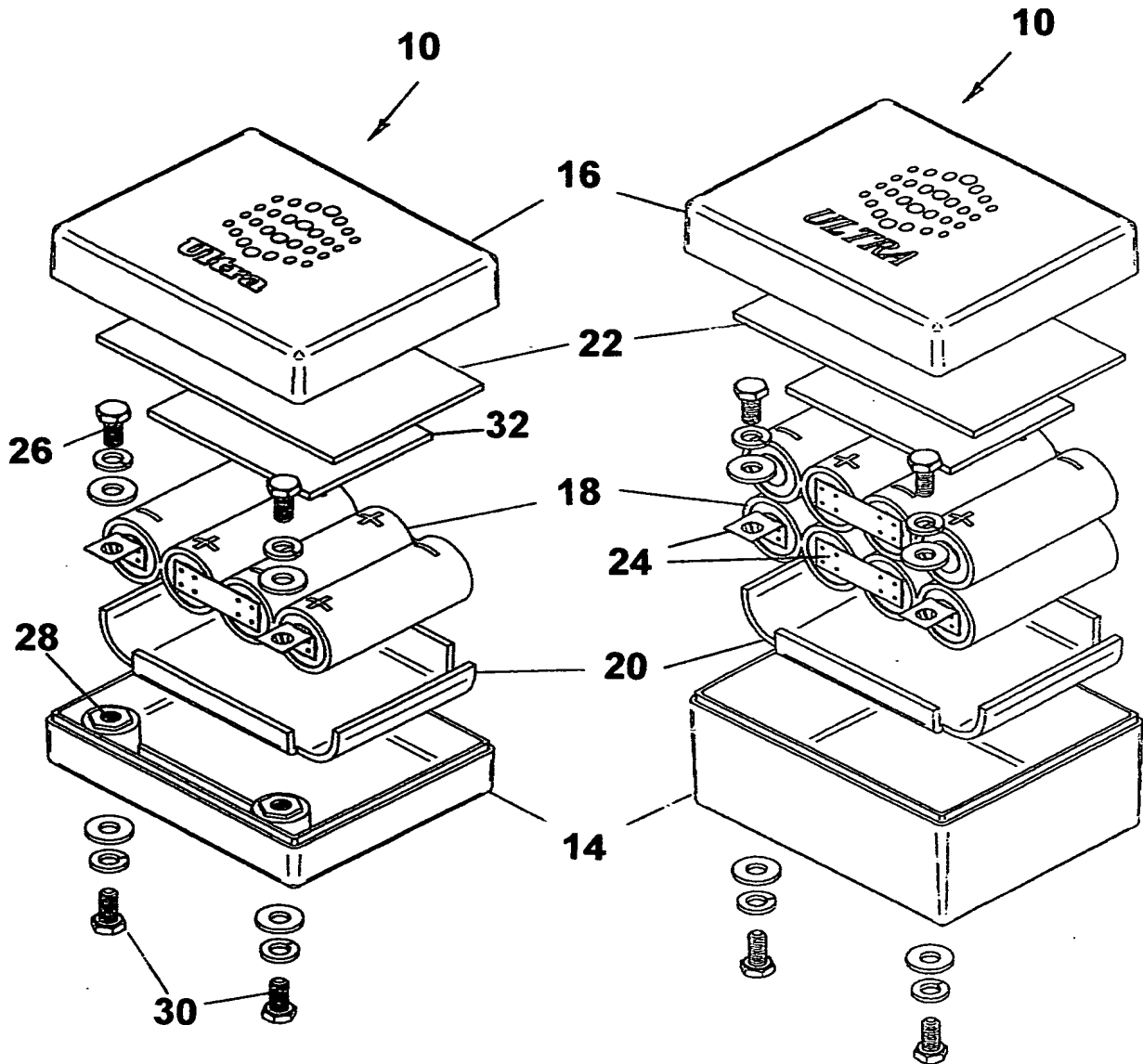


Fig. 1

Fig. 2

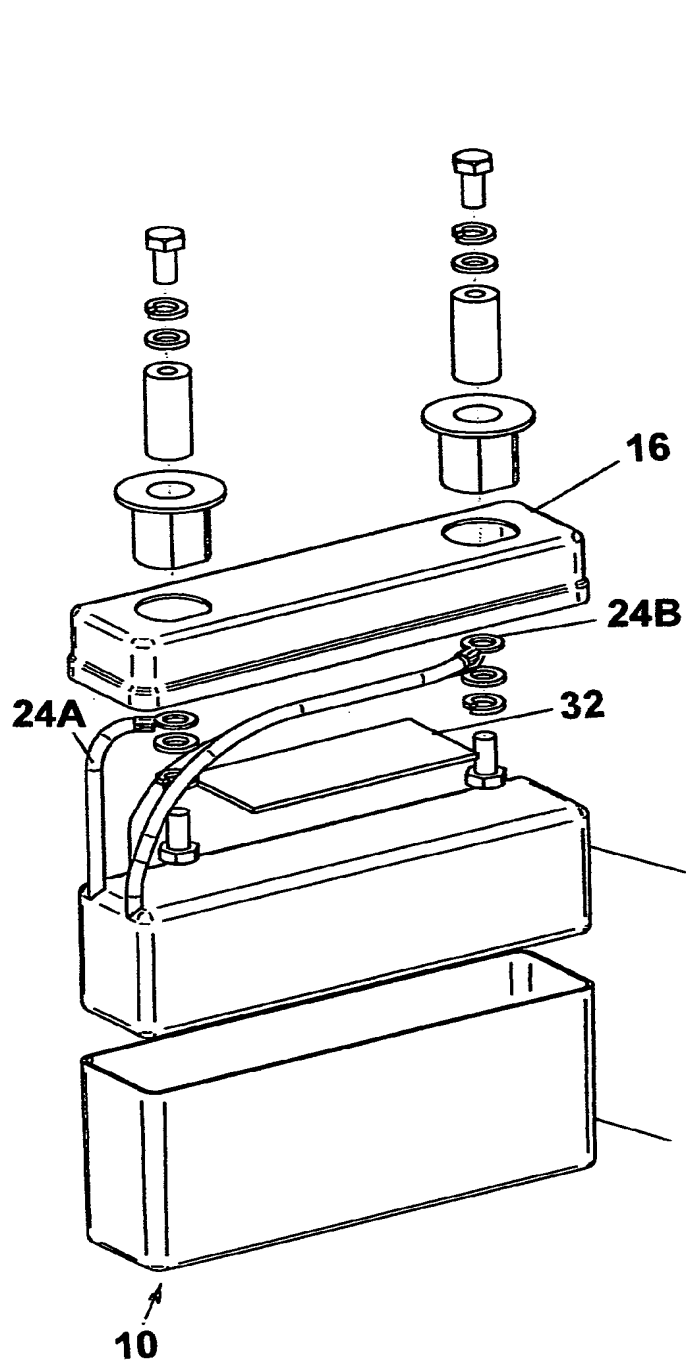


Fig. 3

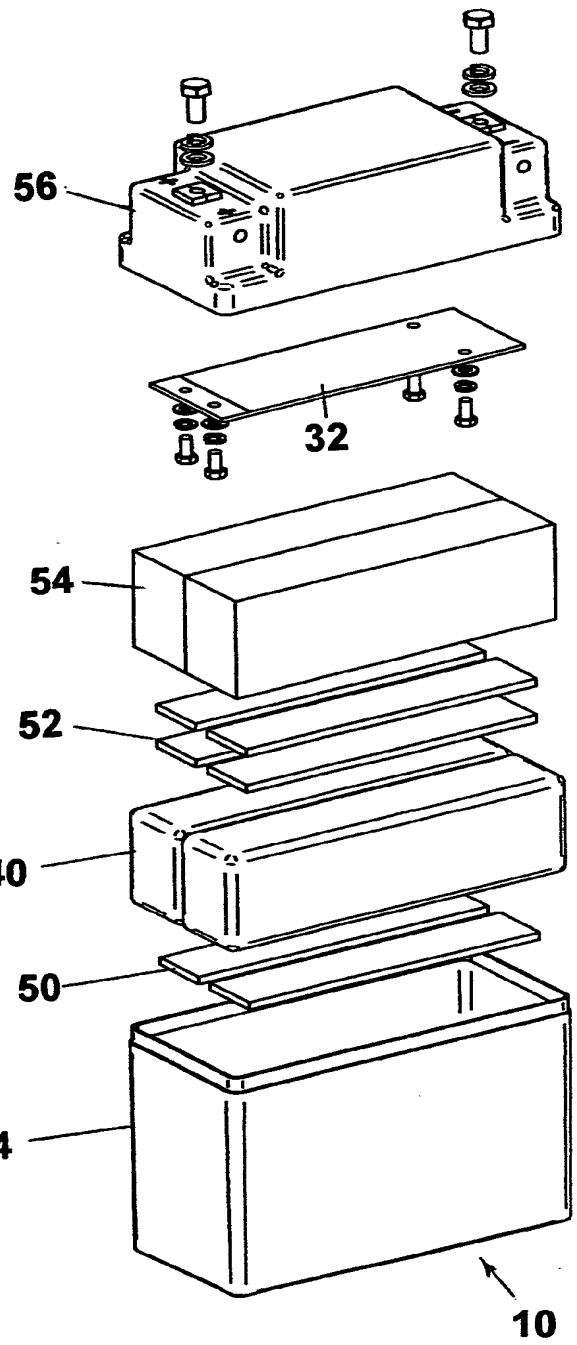


Fig. 13

Fig. 5

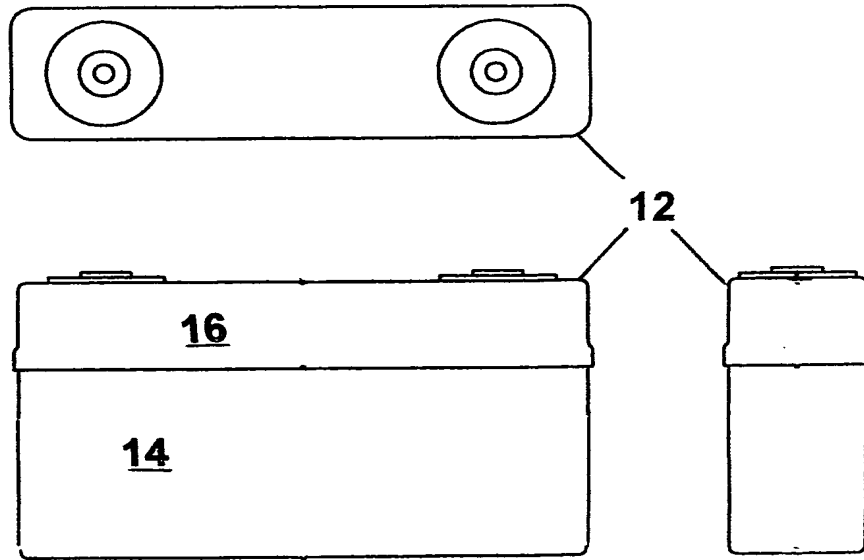


Fig. 4

Fig. 6

Fig. 7

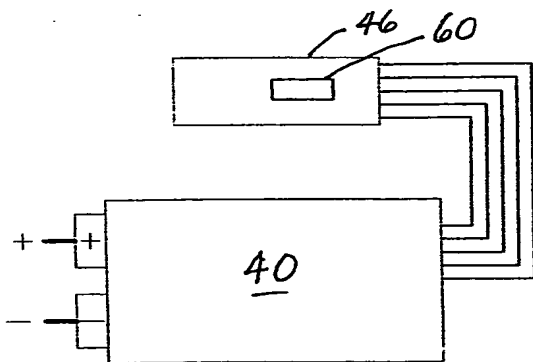
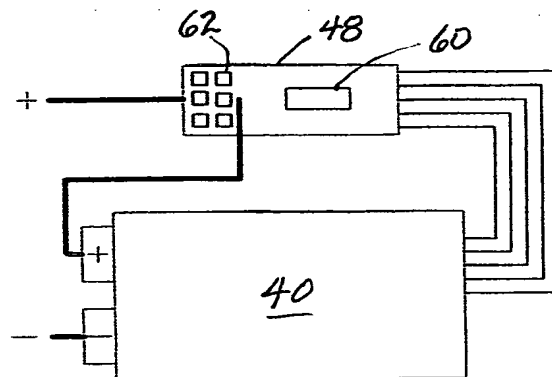


Fig. 8



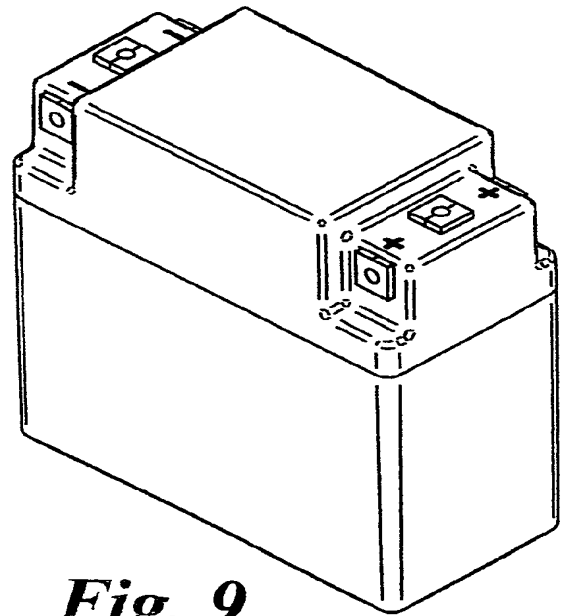


Fig. 9

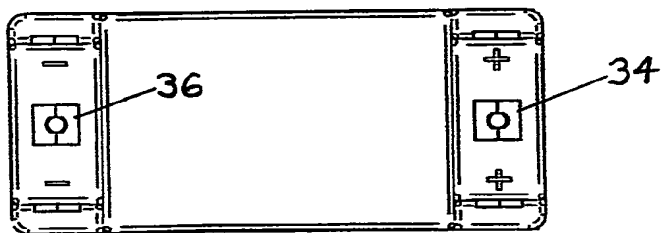


Fig. 10

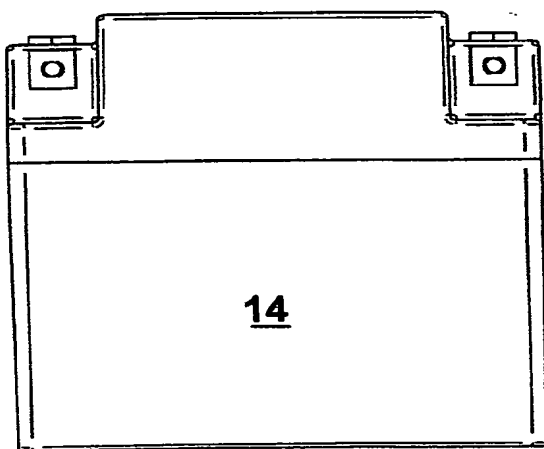


Fig. 11

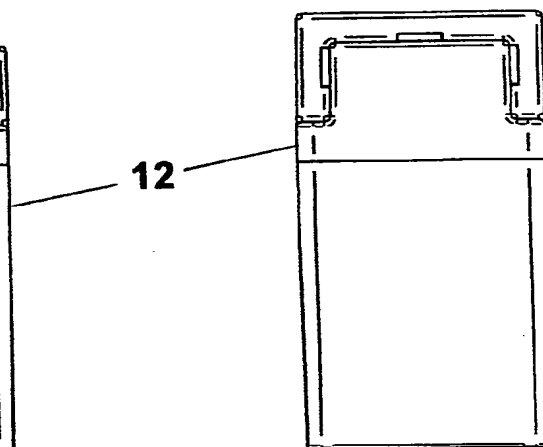


Fig. 12

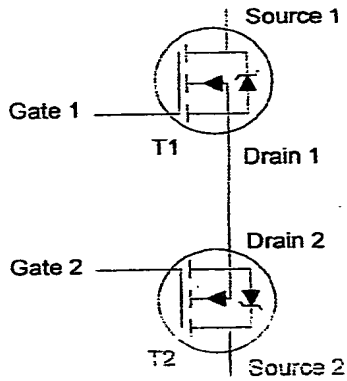


Fig. 14

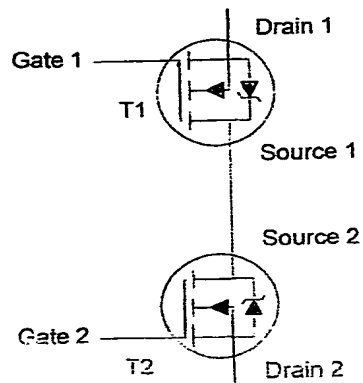


Fig. 15

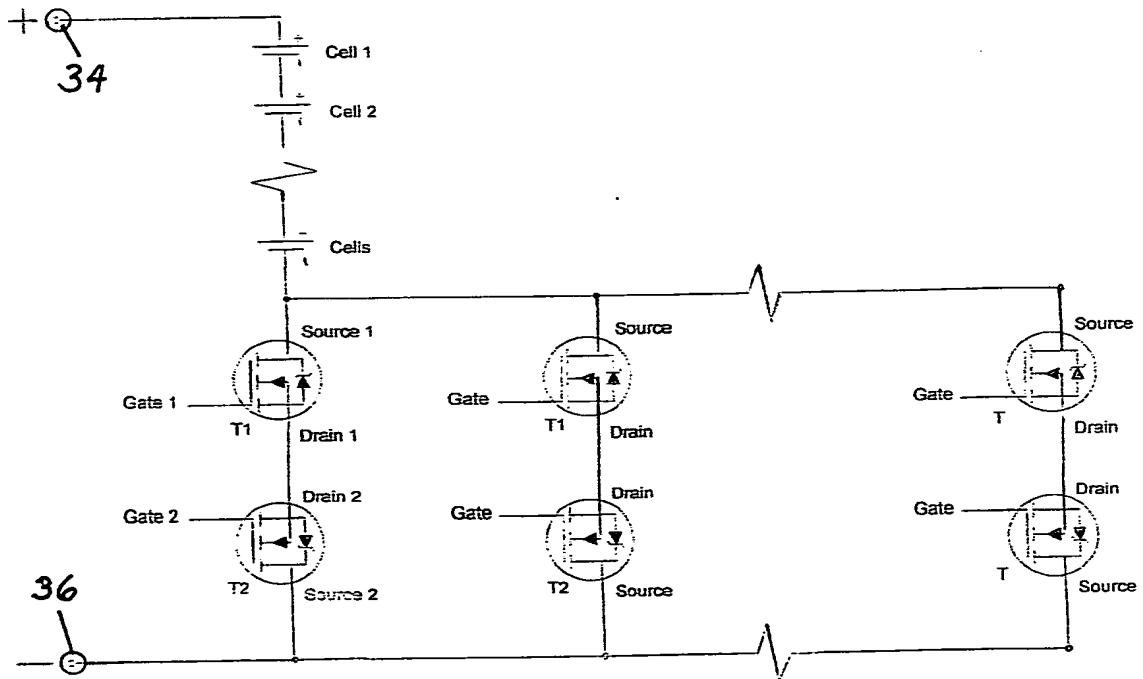


Fig. 16

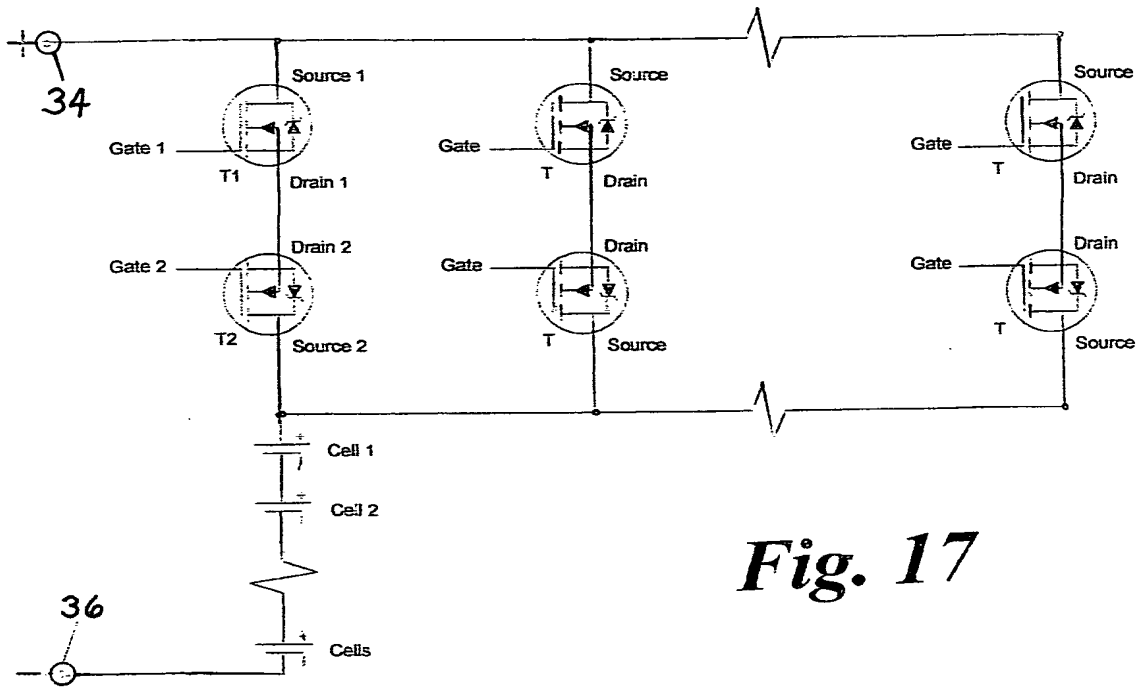


Fig. 17

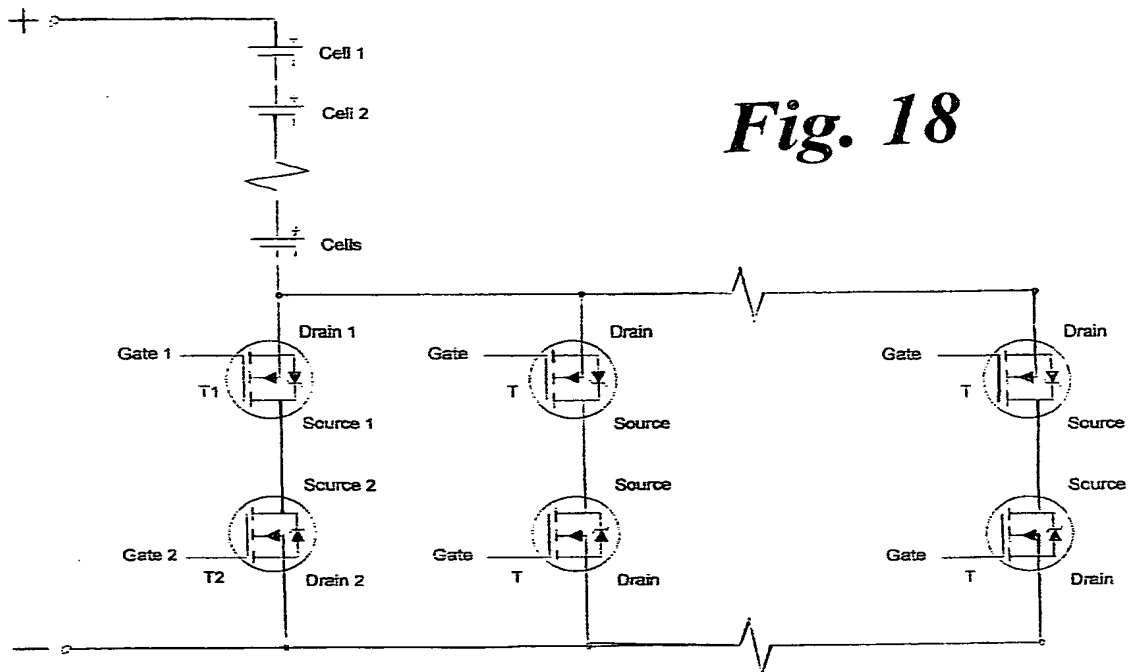
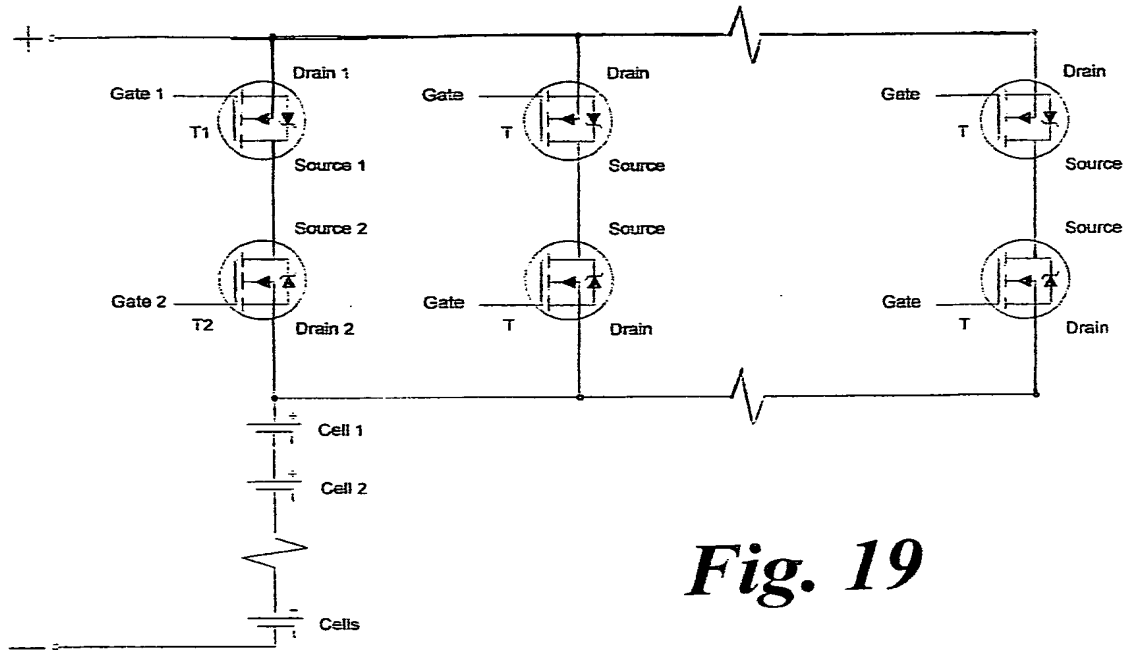
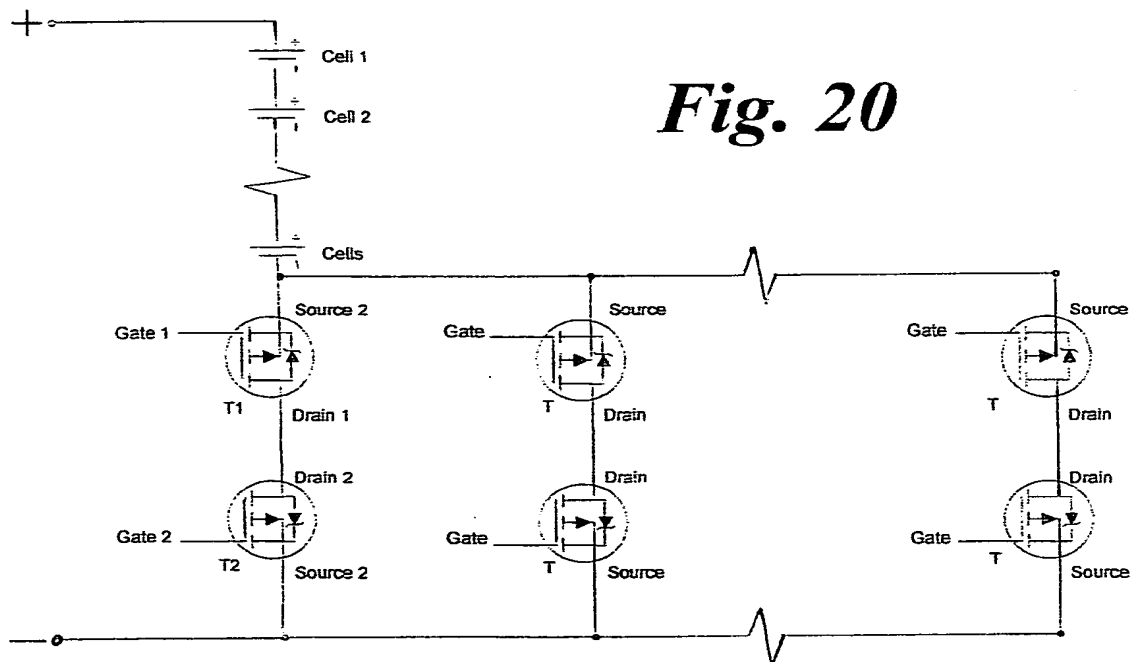
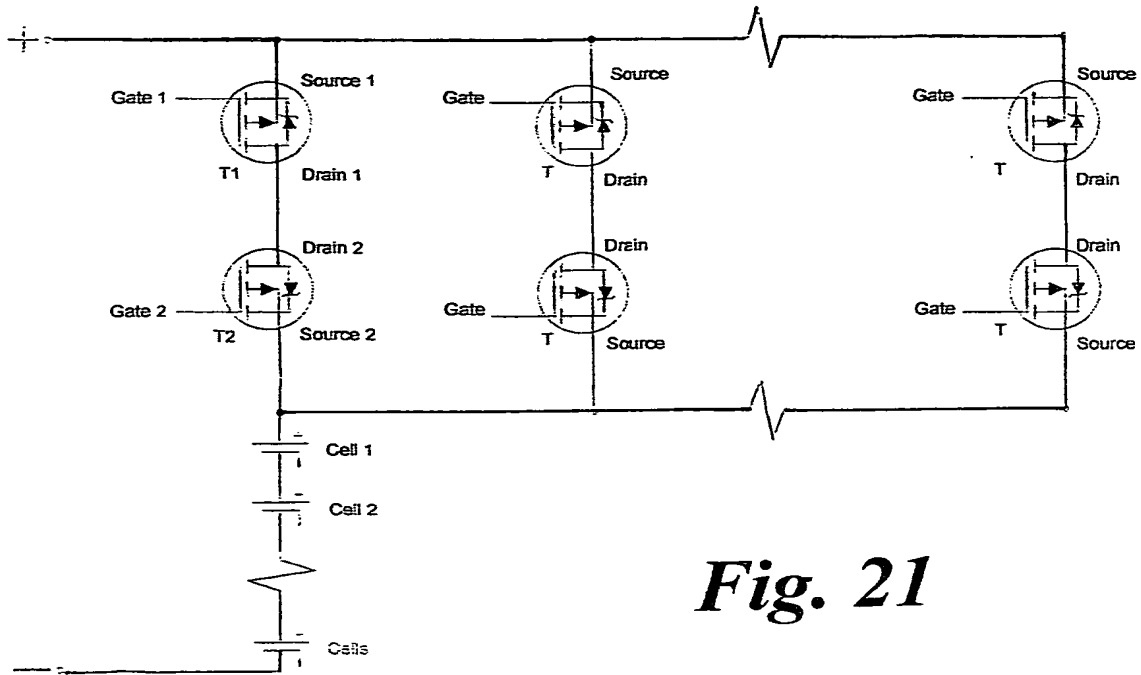
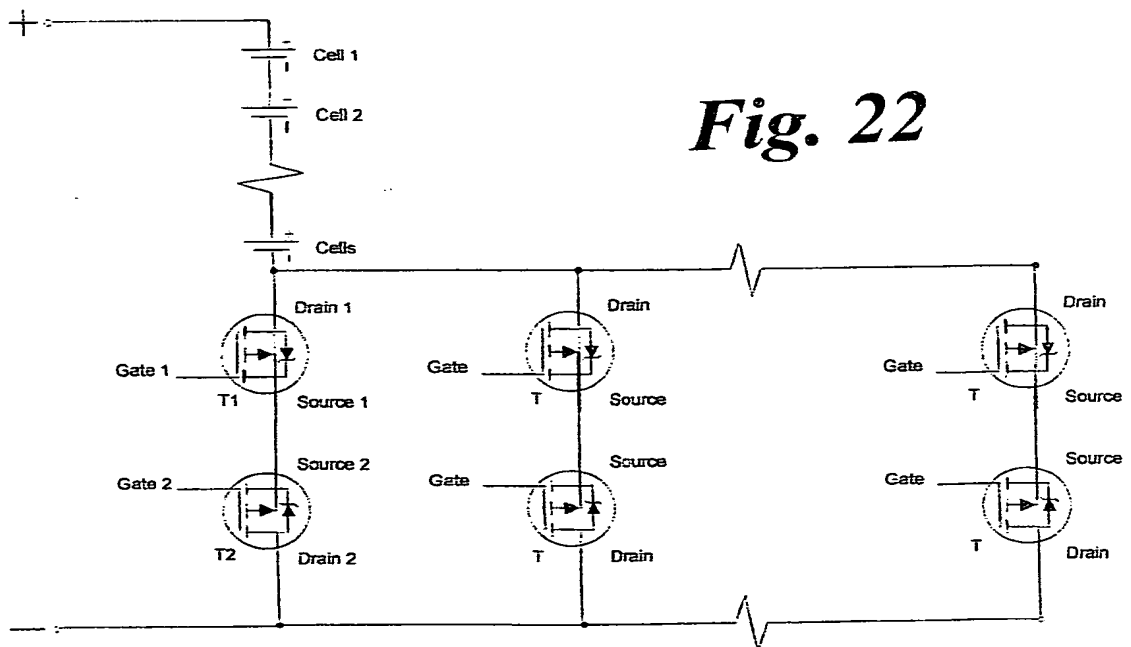


Fig. 18

*Fig. 19**Fig. 20*

*Fig. 21**Fig. 22*

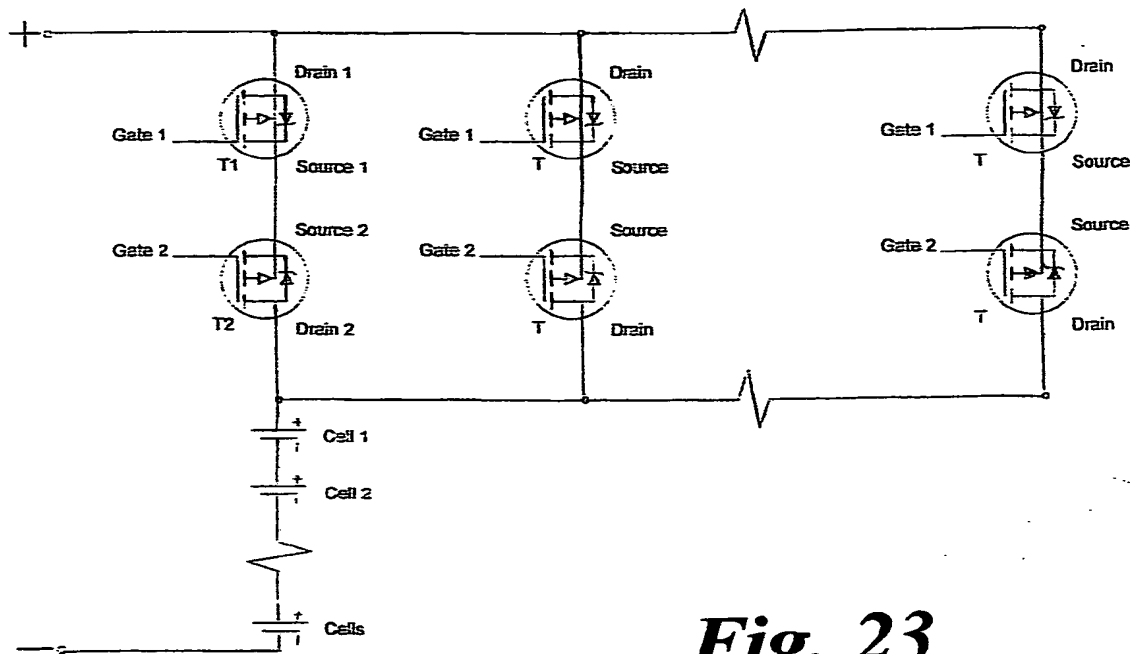


Fig. 23

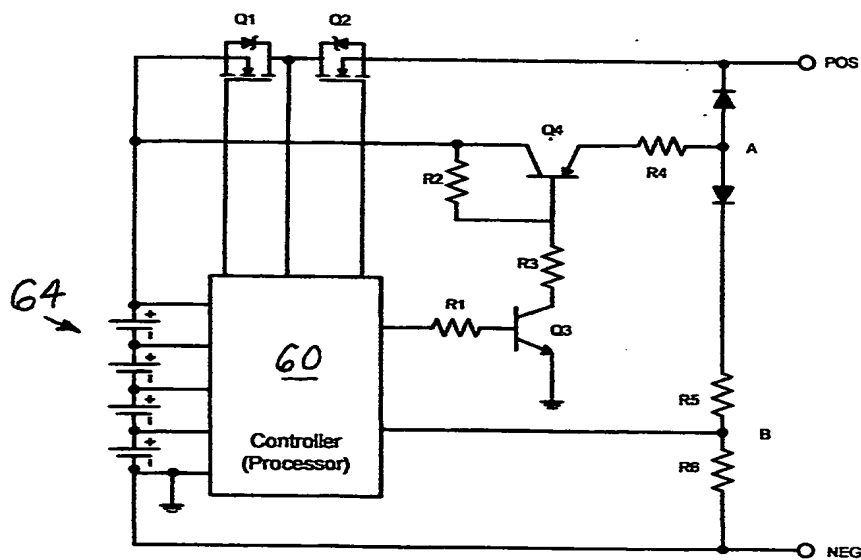


Fig. 24

