the density of the section of fibrous material is more or less similar to what would be produced by allowing the material to settle in the tube under the action of its own weight alone if there were no friction between the tube and the material. A certain amount of skill, derived from experience, is consequently required to provide a tube satisfactorily with the filling, and therefore for the convenience of the users of vaporizing apparatus there are constructed what are herein called cartridges, each comprising a suitable envelope, formed it may be with a wire-gauze outlet end and adapted to fit into a vaporizing tube and containing the fibrous material and the coarse material, together with, it may be, the layer or one of the layers of gauze, so that if a cartridge be suitably inserted into a vaporizing tube the latter will be provided with a filling such as hereinbefore described. The length of the cartridge and the character of its charge may vary with the quality of the oil to be used: thus, in some cases I find it sufficient to provide quite a short cartridge (of a length of say from two and a half to five centimetres for a vaporizing tube of from fifteen to twenty centimetres long) the envelope of which is suitably charged with the fibrous material but with none of the course material; when a filling without an envelope is used its length and character may similarly vary.

An incandescence vapour lamp, the vaporizing tube of which is provided with such a filling or cartridge, will burn for a very considerable time without serious diminution

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diminution of light, and when necessary the cartridge can be removed and another substituted therefor with a of time. A further advantage of the use of such fillings is that the cost of manufacture of vapour burning apparatus in which they are to be used is considerably reduced, since the expensive moulding devices can be with.

Fig. 1 of the accompanying illustrative drawings is a longitudinal section of an example of a vaporizing tube provided with a filling such as hereinbefore described and Figs. 2 and 3 and Figs. 4 and 5 are respectively views of two examples of vaporizing tubes provided with cartridges such as hereinbefore described, Figs. 2 and 4 being longitudinal sections and Figs. 3 and 5 cross sections corresponding respectively to the lines III and V of Figs. 2 and 4. In the example shown in Fig. 1, 1 is the tube and 2 the orifice thereof. 3 is the fibrous material; 4, 4 are two discs of wire gauze arranged between the fibrous material 3 and the orifice 2 of the vaporizing tube; and 5 is the coarsely divided material between the fibrous material 3 and the inlet end of the tube 1, in which the material 3 is shown as confined by a gauze cap 6 fitting into the tube 1.

Figs. 2 and 3 show in longitudinal section a vaporizing tube 1 provided with an example of a cartridge such as hereinbefore described. The envelope comprises a tube 7 of brass and two wire gauze caps 8 that fit in and are brazed to the tube 7. The envelope contains fibrous material 3, a wire gauze disc 4, and

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and coarse material 5 so that when, as shown, it is placed in a vaporizing tube, which it fits, the latter is provided with a filling like that shown in Fig. 1. If a tube were charged with the fibrous material by pushing it into the tube through one of the ends thereof, the density of the fibrous mass, instead of being uniform, would naturally be greater at the part or parts at which the pressure had been applied than at other parts: in order to obviate such ununiformity of density, it is preferred to form the tube 7 with a slit 9 as shown in Figs. 2 and 3 and to charged the tube, through that slit, which is temporarily opened sufficiently for the purpose; the slit 9, moreover, enables the tube 7 to

ffered slightly in their diameters. To enable the cartridge to be drawn into the vaporizing tube instead of being pushed thereinto, the cap 6 at its outlet end may, as shown, be provided with a ring or eyelet 9 into which the bent end of a wire passed through the vaporizing tube may be inserted.

Figs. 4 and 5 show a vaporizing tube provided with a cartridge like that shown in Figs 2 and 3 except that it is shorter and contains none of the coarse material 5. The cap 6 remote from the gauze disc 4 may in this case be omitted.

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WHAT I CLAIM AS MY INVENTION IS:-

1. A vapour-burning apparatus vaporising tube or chamber containing a charge of suitable fibrous material, as fibrous asbestos or slag wool, somewhat loosely arranged and extending from near the outlet of said tube or chamber towards the inlet thereof, a layer or layers of wire gauze located between said fibrous material and said outlet, and suitable coarsely divided material, as pomice-stone, brick, flint, or coke, or iron or copper filings, located between said fibrous material and said inlet.

2. A cartridge adapted to fit in a vapour-burning-apparatus vaporising tube or chamber and comprising an envelope having a wire-gauze end closure and containing adjacent to said closure a charge of suitable fibrous material, as fibrous asbestos or slag wool, somewhat loosely arranged therein.

3. A cartridge adapted to fit in a vapour-burning-apparatus vaporising tube or chamber and comprising an envelope having a wire-gauze end closure and containing adjacent to said closure a charge of suitable fibrous material, as fibrous asbestos or slag wool, somewhat loosely arranged therein and suitable coarsely divided material, as pomice-stone, brick, flint, or coke, or iron or copper filings, located adjacent to said fibrous material and with said fibrous material between it and said closure.

4. A cartridge adapted to fit in a vapour-burning-apparatus vaporising tube or chamber and comprising an envelope having a wire-gauze end closure and containing adjacent to said closure a

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charge of suitable fibrous material, as fibrous asbestos or slag wool, somewhat loosely arranged therein and provided with an attachment adapted to enable said cartridge to be drawn into the vaporising tube or chamber by means of a bent wire.

5. A cartridge adapted to fit in a vapour-burning- apparatus vaporising tube or chamber and comprising a tubular envelope split longitudinally and having a wire-gauze closure and containing adjacent to said closure a charge of suitable fibrous material, as fibrous asbestos or slag wool somewhat loosely arranged therein.

6. A vapour-burning-apparatus vaporising tube or chamber containing a cartridge fitting therein and comprising an envelope having a wire-gauze and closure and containing adjacent to said closure a charge of suitable fibrous material, as fibrous asbestos or slag wool, somewhat loosely arranged therein.

7. A vapour-burning-apparatus vaporising tube or chamber containing a cartridge fitting therein and comprising an envelope having a wire-gauze end closure and containing adjacent to said closure a charge of suitable fibrous material, as fibrous asbestos or slag wool, somewhat loosely arrangedtherein and extending from near the outlet of said tube or chamber towards the inlet thereof for at least one third of the length of said tube or chamber.

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Fig.1.

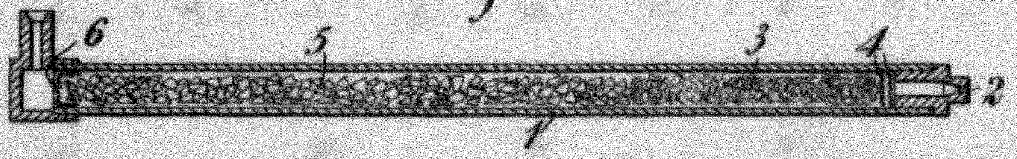


Fig.2.

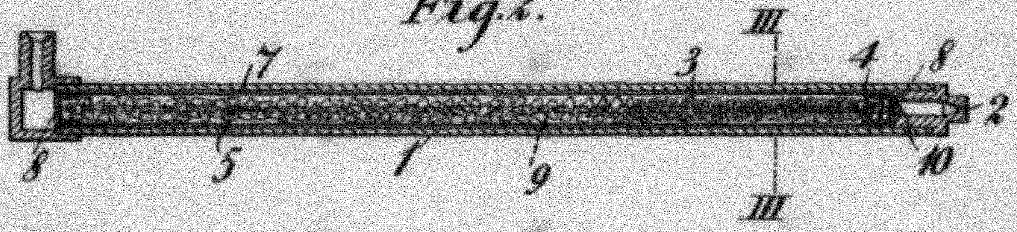


Fig.3.

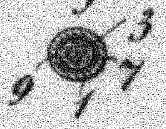


Fig.4.

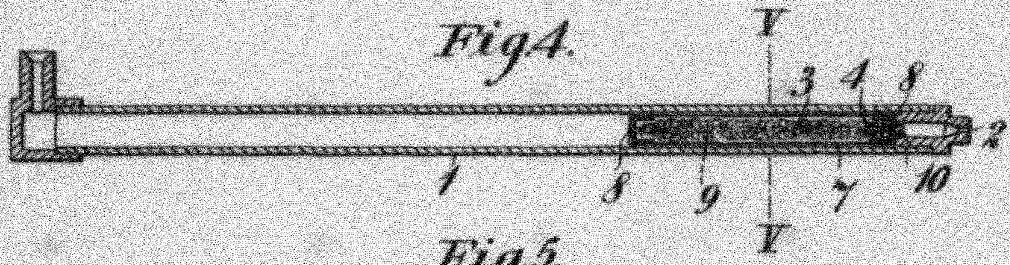
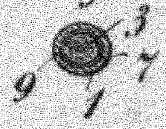


Fig.5.



Certified to be the Drawings referred to in the specification hereunto annexed.

Witnesses.
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Ottawa April 8th 1907 Inventor
J. H. Meiss.

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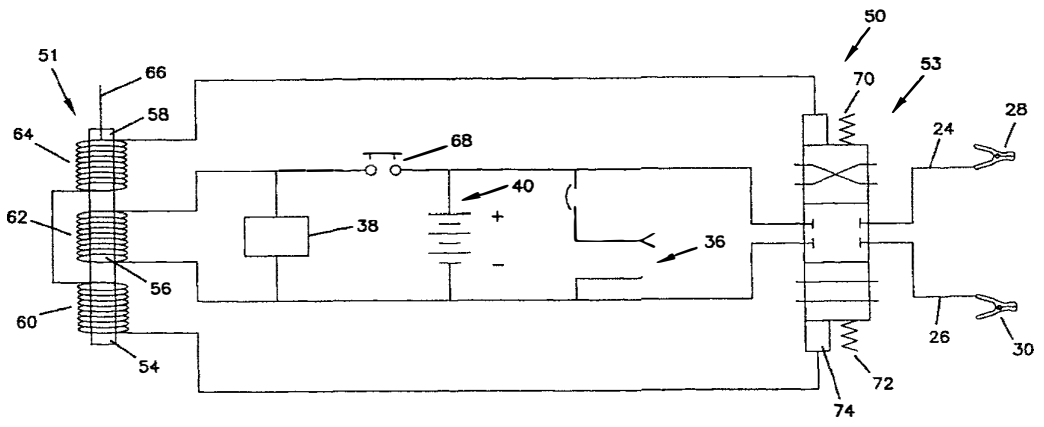
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(54) Title: PORTABLE BATTERY CHARGER INCLUDING AUTO–POLARITY SWITCH



(57) Abstract

A portable hand–carrying auto–polarity battery booster apparatus includes a power storage device which is capable of providing power to an electrical system such as a battery. For example, the portable apparatus can be used to jump start a vehicle with a dead battery. The apparatus is compact in size which encloses the power storage device, the at least four connecting cables, and many other electrical circuits in a compact housing. The portable apparatus also includes an auto–polarity switch in the housing which ensures a proper polarity connection between the power storage device of the apparatus and the electrical system.

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PORTABLE BATTERY CHARGER INCLUDING AUTO-POLARITY SWITCH

Field of the Invention

This invention relates generally to portable charging systems, and more specifically to portable charging systems including an auto-polarity switch for providing a proper polarity connection in charging batteries or jump starting an automobile which has a discharged battery.

Background of the Invention

Most automobiles or other devices powered by an internal combustion engine, such as watercraft, etc., rely at least in part on a battery as part of its power source. For example, an automobile needs a battery to start the engine operating (the engine must be spun up to speed externally before they can operate). Once the engine is operating or running, the battery is charged by a generator connected to the engine. The battery is usually able to store enough charge for the periods that the engine is not running in order to start the engine when needed.

There are many things that will cause a battery to lose its charge, such as leaving the lights on or playing the radio after the engine is turned off, or a short circuit in the battery which drains the battery. When there is not enough charge in the battery, the engine cannot be started, i.e. the battery is discharged. As a result, the battery must be recharged or boosted by another power source. Very often another vehicle is brought to the vicinity of the vehicle with the discharged battery to jump start the vehicle. Another solution was proposed by U.S. Patent 5,589,292 which provides a portable booster battery to recharge the discharged battery.

One concern in using a portable battery such as the portable booster battery disclosed U.S. Patent No. 5,589,292 to charge batteries that have been discharged is making sure that proper polarity between the portable battery and the battery to be charged is proper. It is imperative to connect the portable battery and the battery to be charged with proper polarity, i.e. positive to positive terminal connections and negative to negative terminal connections. Failure to do so will rapidly drain the portable battery and further cause serious damage to either or both electrical systems

that the two batteries are used in. However, it is often difficult to determine which battery terminal is positive and which is negative because of the accumulation of dirt or lack of lighting.

The polarity problem has been solved by a variety of methods in the battery jumper cable arrangement environment, such as the technique disclosed in U.S. Patent No. 4,400,658. There is a need for a portable battery charging system that has the polarity problem solved. Such a portable charging system would need to provide a charge or boost to another battery regardless of the charging terminals of the battery to be charged to which the positive or negative terminals of the portable charging system are connected. Such a system would eliminate the problems and dangers associated with incorrect charging battery to discharged battery terminal connections.

Summary of the Invention

The present invention relates to a portable battery with an auto-polarity switch for providing a proper polarity connection in charging a battery of a device, such as an automobile, i.e. jump starting an automobile, etc.

The present invention provides for a portable, auto-polarity battery booster apparatus. The portable apparatus in accordance with the present invention includes a power storage device, such as a battery, which is capable of providing power to an electrical system such as another battery. The portable apparatus can also be used in many other power supply applications or battery charging applications. For example, it can be used to jump start a vehicle with a dead battery. The apparatus can also be recharged by an outside power source. Further, the portable apparatus ensures a proper polarity connection between the power storage device of the apparatus and the electrical system.

Brief Description of the Drawings

Referring to the drawings wherein like numerals represent like parts throughout the several views:

FIGURE 1 is a schematic view of a general embodiment of the auto-polarity battery booster apparatus;

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FIGURE 2 is a front view of a portable, auto-polarity battery booster apparatus in accordance with the present invention;

FIGURE 3 is a back view of the battery booster apparatus of FIGURE 2;

FIGURE 4 is a top view of the battery booster apparatus of FIGURE 2;

FIGURE 5 is a bottom view of the battery booster apparatus of FIGURE 2;

FIGURE 6 is a plane view of the inside of the battery booster apparatus of FIGURE 2;

FIGURE 7 is a schematic view of a specific embodiment of the auto-polarity battery booster apparatus;

FIGURE 8 is a plane view of one embodiment of an auto-polarity switch of the battery booster apparatus;

FIGURE 9 is a perspective view of the auto-polarity switch;

FIGURE 10 is an exploded view of the auto-polarity switch;

FIGURE 11 is a front view of the auto-polarity switch; and

FIGURE 12 is a cross-sectional view of the auto-polarity switch along line A-A of FIGURE 11.

General Description

In one embodiment constructed according to the principles of the present invention, a portable battery booster apparatus for boosting an electrical system with a first terminal and a second terminal, comprises a battery having a first terminal and a second terminal, a housing enclosing the battery and the first and second terminals of the battery, an automatic switch having a first pair of contacts and a second pair of contacts, the switch being enclosed in the housing, a first cable with a first end connected to the first terminal of the battery and a second end selectively connected to a first contact of the first pair of contacts of the switch, the first cable being enclosed in the housing, a second cable with a first end connected to the second terminal of the battery and a second end selectively connected to a second contact of the first pair of contacts of the switch, the second cable being enclosed in the housing, a third cable with a first end connected to a first contact of the second pair of contacts of the switch, the first end of the third cable being partially enclosed in the housing, a fourth cable with a first end connected to a second contact of the second pair of contacts of the switch, the first end of the fourth cable being partially

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enclosed in the housing, a first clamp connecting to a second end of the third cable, the first clamp being detachably mounted onto a first side of outside of the housing, a second clamp connecting to a second end of the fourth cable, the second clamp being detachably mounted onto a second side of the outside of the housing, and wherein when the electrical system is boosted by the battery booster apparatus, the first clamp and the second clamp connect to the first terminal and the second terminal of the electrical system, respectively, such that the first and second terminals of the battery are electrically connected to the first and second terminals of the electrical system, the switch switches connections between the first pair of contacts and the second pair of the contacts to ensure that the first terminal of the battery and the first terminal of the electrical system have the same polarity, and the second terminal of the battery and the second terminal of the electrical system have the same polarity.

In one aspect of the invention, the apparatus may also include an ON/OFF switch. The ON/OFF switch is connected between the battery and the switch. When the ON/OFF switch is off, the switch is in a neutral, non-contacting position, and the first pair of contacts are not electrically connected with the second pair of contacts. When the ON/OFF switch is on, the electrical system is boosted by the battery.

In another aspect of the invention, in a first embodiment the auto-polarity switch comprises three coils which are wound around two cores and a plunger, respectively. The plunger is moved to a first contacting position when the first terminals of the battery and the electrical system have the same polarity and the second terminals of the battery and the electrical system have the same polarity. The plunger is moved to a second contacting position when the first terminals of the battery and the electrical system have the opposite polarity and the second terminals of the battery and the electrical system have the opposite polarity. In one embodiment, the switch is a double pole double throw switch.

In the first embodiment of the switch in accordance with the invention, the coil assembly has a bobbin shape with two dividers for separating the first, second, and third coils from each other. In addition, the switch may include an enclosure for enclosing the coil assembly. The plunger extends from the enclosure and connects to a double pole double throw switch.

In the first embodiment of the switch in accordance with the present invention, the first pair of contacts are arranged and configured to be a pair of bottom switch contacts and a pair of top switch contacts. When the plunger is in the first contacting position, the bottom switch contacts are connected to the second pair of contacts, and when the plunger is in the second contacting position, the top switch contacts are connected to the second pair of contacts.

In a second embodiment, the auto-polarity switch includes a polarity sensing circuit, and a reversing relay operated by the sensing circuit. The sensing circuit includes a full wave rectifier electrically connected to a differential amplifier circuit which is electrically connected to external cables having clamps electrically connected thereto, which are to be removably attached to the battery to be charged. The full wave rectifier provides a positive voltage to the polarity sensing circuit regardless of the polarity connection of the clamps to the source to be charged. The differential amplifier circuit is electrically connected to a first relay coil and a second relay coil which are electrically connected to the relay control circuit and cause selective activation of movable contacts in the relay to so that the reversing relay acts as a switch in switching the connections between a first pair of contacts and a second pair of the contacts to ensure that a first terminal of the battery and a first terminal of the electrical system have the same polarity, and a second terminal of the battery and a second terminal of the electrical system have the same polarity.

In other embodiments, such as the embodiment shown in Figure 1, the auto-polarity switch may be an electromechanical type, or an electronic type comprised of solid state devices or microprocessor type, all of which would include a type of change-over switch 50. In such other embodiments the auto-polarity switch 50 would include a polarity detector comprised of a electric differential type, a processing circuit and two sets of pairs of electrical transmission conducting wires terminals. The switch would be installed between the portable charger battery 50 and the external charging source connection cables 24 and 26 to provide for switching between two pair of contacts connected to a pair of electrical transmission conducting wires terminals 28 and 30.

It will be appreciated that other types of suitable auto-polarity switches can be used without departing from the present invention. The examples of the other

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types of switches, but not limited to these examples, are solid-state switches or other electro-mechanical switching devices. It will be also appreciated that other conventional polarity detection/protection devices, or automatic polarity sensing battery charger devices can be used without departing from the present invention.

In another aspect of the invention, the housing includes switch retention grooves for retaining the switch in one side of the housing. The housing also includes cable retention grooves for retaining the first, second, third, and fourth cables to the housing. Further, the housing includes battery retention grooves for retaining the battery to the housing.

In yet another aspect of the invention, the apparatus includes a first holster for receiving and covering the first clamp and a second holster for receiving and covering the second clamp. In one embodiment, the first and second holsters are attached to the outside of the housing. Further, the first and second holsters are pivotably connected to the housing.

In an additional aspect of the present invention, a plurality of accessories can be included to provide additional features and advantages of the invention. For example, a display can be included to display a level of charge remaining in the battery. A cigarette lighter female receptacle member can also be added to provide power to an electrical system which is equipped with a male cigarette lighter plug. Further, a male cigarette lighter plug member can be added to the present invention to provide it with the ability to connect the battery in the housing to a power source outside the housing to recharge the battery. Furthermore, a handle can be included to carry the battery booster apparatus such that the housing and the handle form a portable box unit.

While the invention will be described with respect to a preferred embodiment configuration and with respect to particular components, it will be understood that the invention is not to be construed as limited by such configurations or components. Further, while the preferred embodiment of the invention will be described in relation to boosting or recharging a vehicle or automobile battery, it will be understood that the scope of the invention is not to be limited by this environment in which the preferred embodiment is described herein.

These and various other advantages and features which characterize the invention are pointed out with particularity in the claims annexed hereto and forming a part hereof. However, for a better understanding of the invention, its advantages and objectives obtained by its use, reference should be had to the drawings which form a further part hereof and to the accompanying descriptive matter, in which there is illustrated and described a preferred embodiment to the invention.

Detailed Description of the Preferred Embodiment

The present invention provides for a portable, auto-polarity battery booster apparatus. The portable apparatus in accordance with the present invention includes a power storage device which is capable of providing power to an electrical system such as a battery. The portable apparatus can also be used in many other power supply applications or battery charging applications. For example, it can be used to jump start a vehicle with a dead battery. The apparatus can also be recharged by an outside power source. Further, the portable apparatus ensures a proper polarity connection between the power storage device of the apparatus and the electrical system.

In the following description of the exemplary embodiment, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration the specific embodiment in which the invention may be practiced. It is to be understood that other embodiments may be utilized when structural and other changes may be made without departing from the scope of the present invention.

Turning now to Figures 1-4, there is illustrated front, back, top, and bottom views of a preferred battery booster apparatus designated by the reference numeral 20. The apparatus 20 includes a housing 22 preferably made out of plastic. Electrical cables 24,26 extend out of the housing 22 and are retained along outside grooves 25,27 of the housing 22. Extra outside grooves 25', 27' can be arranged to wrap long cables and/or for aesthetic purposes. One end of each cable 24,26 is connected to a clamp 28,30 (best seen in Figure 6), respectively. Each of the cables 24,26 is connected to either the positive terminal or the negative terminal of a power storage device, such as a battery 40 (best seen in Figure 5), in the housing 22.

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Accordingly, one of the clamps can be called positive clamp (marked as "+" in Figures 3 and 4), and the other one can be called negative clamp (marked as "-" in Figures 3 and 4). As it will be discussed later, since the apparatus 20 has an auto-polarity switch 50 (best seen in Figures 5 and 6), it does not matter which clamp is positive and which is negative when the clamps are in use.

The clamps 28,30 are preferably received and covered by holsters 32,34, respectively, and are removably clamped to a bit within the holster. The holsters 28,30 help avoiding accidental electrical contacts between the clamps and adjacent items. A cigarette lighter receptacle member 36 can also be included in the apparatus 20 to provide power to electrical systems such as cell-phones, lighting, etc. A charge status display 38 can also be included in the apparatus 20 to display the level of charge remaining in the power storage device, such as the battery 40 (best seen in Figure 5), in the housing 22. The display 38 can be arranged and configured preferably in a plurality of LED lights to show a series of charge status. It will be appreciated that other suitable display means can be used to indicate the charge status within the scope of the invention. Further, a handle 42 can be molded into the housing 22 to allow easy carrying of the apparatus 20 to the vicinity of the dead battery. It will be appreciated that other types of handles can be used within the principles of the invention. For example, an extra handle piece can be attached to the housing, etc.

Figure 5 shows the internal details of the housing 22 (opened from the back side by removing the mounting screws 21). The battery 40 has a positive terminal 44 and a negative terminal 46. An electrical cable 48 is connected to the positive terminal 44 at one end of the cable 48. The other end of the cable 48 is connected to the auto-polarity switch 50. An electrical cable 52 is connected to the negative terminal 46 at one end of the cable 52. The other end of the cable 52 is connected to the switch 50. Also, it can be seen that the cable 24 extends from outside of the housing 22 to inside of the housing and is retained in the grooves of the housing. The other end of the cable 24 connects to the switch 50. Similarly, the cable 26 extends from outside of the housing 22 to inside of the housing and is retained in the grooves of the housing. The other end of the cable 26 connects to the switch 50. The details of the cigarette lighter receptacle member 38 and the display 38 are

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preferably shown in Figure 5. It will be appreciated that other suitable arrangements of the cigarette lighter receptacle member 36 and the display 38 can be used without departing from the principles of the invention.

Figure 6 illustrates a schematic, functional view of the battery booster apparatus 20. The apparatus 20 has the auto-polarity switch 50 interfacing with the battery 40. The switch 50 preferably includes a coil assembly 51 and a switching assembly 53. The coil assembly 51 has three coils 60, 62, 64 wound around three core members 54, 56, 58, wherein the central core member 56 is a plunger, respectively. The three coils 60, 62 64, the outside cores 54, 58 and the central core (plunger) 56 are disposed along a longitudinal axis 66. The plunger 56 is placed between the outside cores 54, 58. The coil windings and three core assembly makes up two solenoids, a center solenoid 63 comprised of core member 56 and windings 62 wound around the central core member 56 and an outside solenoid 65, 67, comprised of outside core members 54 and 58 and windings 60 and 64 would around the outside core members 54, 56. The outside coil windings 60 and 64 of the outside solenoid are each wound with an equivalent number of turns. The center coil windings 62 of the central solenoid are wound with two times as many turns as either of outside coil windings 60, 64. Further, the windings of the first outside coil member 60 are opposite to the windings of the second outside coil member 64. The windings of the central coil 62 can be in the same direction as the windings of the first outside coil member 60 or in the same as the winding of the second outside coil member 64.

Accordingly, when the internal battery energizes the center coil windings 62, an electrical current flows through the center coil windings 62 (i.e. an ON/OFF switch 68 is closed) and the plunger 56 which is preferably comprised of a ferrous metal becomes magnetized. When there is no current flowing through the external coil windings 60 and 64 and the battery has energized the center coil windings 62, plunger 56 and switch contacts are held at a neutral position. This is because the center coil windings 62 is centered over the plunger 56 and there is no magnetic force being applied to the plunger 56 by either member of the outside solenoid 65, 67. Outside coil windings 60 and 64 are connected in series and wound in opposite directions. The ends of outside coil windings 60 and 64 that are not connected in

series are electrically connected to cables 24 and 26 and clamps 28 and 30. When the external clamps 28 and 30 are connected to the power source to be charged, current flows through the outside coil windings 60 and 64, causing outside core members 54 and 58 to be magnetized. The magnetization of outside core members 54 and 58 creates a force pulling or pushing central core member 56, depending on the polarity connection of clamps 28 and 30 to the power source to be charged, and the direction of the turns in coil windings 60, 62 and 64. When the outside coil windings 60 and 64 and the central coil winding 64 are all energized, current flowing through the outside coil windings 64 can either flow in the same direction as the current through the central coil windings 62 or in the opposite direction and current flowing through the outside coil windings 60 can either flow in the same direction as the current through central coil windings 62 or in the opposite direction. When current is flowing through the central coil windings 62 in a clockwise direction and through the outside coil windings 64 in a clockwise direction, it is flowing through outside coil windings 60 in a counter clockwise direction. Or, when current is flowing through central coil windings 62 in a clockwise direction and through the outside coil windings 64 in a counter clockwise direction, it is flowing through the outside coil windings 60 in a clockwise direction. The direction of current flowing through outside coil windings 60 and 64 depends on the polarity connection of clamps 28 and 30 to the power source to be charged.

Assuming that current is flowing through central coil windings 62 in a clockwise direction and through the outside coil windings 64 in a clockwise direction, it is flowing through outside coil windings 60 in a counter clockwise direction. Accordingly, the magnetic field in core 54 is opposite the magnetic field within central core 56. The opposing magnetic forces causes the magnetic field in core 54 to negate half the magnetic force in the central core 56. The magnetic field generated by core 58 is in the same direction as that within central core 56 and adds its magnetic energy to core 54, causing full coil strength to be centered in the direction of core 58. This causes the central core 56 to be pulled in the direction of outside core 58.

When the central core 56 is pulled in the direction of outside core 58, the two cores 56 and 58 are very close but do not touch. This is because if either the outside

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coils 60 and 64 or central coil 62 are no longer energized, by way of removing clamps 28 and 30 from the power source to be charged or opening switch 68, the air space provides the central core 56 with the positioning necessary to return back to its neutral position. The same would also be true when the central core 56 is pulled in the direction of core 54. The two cores 54 and 56 are very close, but do not touch. The air space between the two cores 54 and 56 provides the central core 56 with the positioning necessary to return back to its neutral position.

A switch rod 74 is mounted on one end of the plunger 56 (best seen in Figure 9). The plunger 56 is held between the two cores 60,64 by two springs 70,72. The springs 70,72 are shown schematically in Figure 6. In one preferred embodiment, the springs 70,72 are attached to the switch rod 74, and the switch rod 74 is disposed proximate the center of the switch assembly 53. In this case, since the pulling forces are equal, the springs keep the plunger centered, i.e. the switch 50 is in a neutral, non-contacting position. To preserve the charges stored in the battery 40, the ON/OFF switch 68 is normally open.

Figures 7-11 illustrate details of the switch assembly 53. The coils 60, 62, 64 are wound around outside core members 54 and 58 and central core member 56. The coils 60 and 62 are separated by a divider 78. An insulating member 80 is mounted on the divider 78 to help insulate the magnetic fields generated by each of the coils 60, 62. Similarly, the coils 62 and 64 are separated by a divider 82. An insulating member 84 is mounted on the divider 82 to help insulate the magnetic fields generated by each of the coils 62, 64.

As shown in Figures 7 and 11, the switch rod 74 is mounted in the plunger 56 at one end, extends through a center bore 86 of the core 58, is mounted on a bottom switch plate 88 which links a pair of bottom switch contacts 90,92, is attached to the two springs 70,72 (only spring 72 is shown in Figure 9), and is mounted on a top switch plate 94 which links a pair of top switch contacts 96,98. The coils, the plunger, and the cores are preferably disposed in an enclosure 100 with a cover 102. The bottom switch plate 88, the bottom switch contacts 90,92, the springs 70,72, the top switch plate 94, and the top switch contacts 96,98 are retained in an enclosure 104. The enclosure 104 has a pair of top slots 106,108 and a pair of bottom slots (not shown). A pair of top bus bars or terminals 110,112 are inserted in

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the top slots 106,108 and retained by the enclosure 104. A pair of bottom bus bars or terminals 114,116 are inserted in the bottom slots and retained by the enclosure 104.

In one embodiment, the terminal 110 is electrically connected to the positive terminal of the internal power storage device or the battery 40 via the cable 48 as shown in Figure 5. The terminal 116 is electrically connected to the negative terminal of the internal power storage device or the battery 40 via the cable 52 as shown in Figure 5. The terminals 112 and 114 are electrically connected to the terminals of the external power source, e.g. a dead battery, via the cable 24 and the cable 26 and via the clamps 28,30, respectively. It is generally required that a proper polarity be established between the external power source and the internal power source, i.e. the positive terminals are electrically connected to each other, and the negative terminals are electrically connected to each other. In the present invention, the switch 50 connects the terminals with proper polarity in an automatic fashion. First, it is assumed that the positive terminal of the external power source is connected to the bus bar or terminal 112 and the negative terminal of the external power source is connected to the bus bar or terminal 114. When the ON/OFF switch 68 is closed, the plunger 62 is attracted toward the core 64 and repelled from the core 60. This action translates the movement of the switch rod 74 toward the enclosure 104. Accordingly, the spring 70 is compressed (not shown), and the spring 72 is expanded. Thus, the bottom contact 90 is connected between the top bus bar 110 and the top bus bar 112, i.e. the positive terminals of the internal and external power source devices are electrically connected. Meanwhile, the bottom contact 92 is connected between the bottom bus bar 114 and the bottom bus bar 116, i.e. the negative terminals of the internal and external power source devices are electrically connected.

Similarly, if the negative terminal of the external power source is connected to the bus bar or terminal 112 and the positive terminal of the external power source is connected to the bus bar or terminal 114, when the ON/OFF switch 68 is closed, the plunger 62 is attracted toward the core 60 and repelled from the core 64. This action translates the movement of the switch rod 74 toward the enclosure 100. Accordingly, the spring 70 is expanded (not shown), and the spring 72 is

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compressed. Thus, the top contact 96 is connected between the top bus bar 110 and the bottom bus bar 114, i.e. still the positive terminals of the internal and external power source devices are electrically connected. Meanwhile, the top contact 98 is connected between the top bus bar 112 and the bottom bus bar 116, i.e. still the negative terminals of the internal and external power source devices are electrically connected.

It will be appreciated that the arrangement of the bottom switch contacts 90,92, the top switch contacts 96,98, the top bus bars 110,112, and the bottom bus bars 114,116 can be varied within the scope and spirit of the invention. It will also be appreciated that connection arrangement of the positive and negative terminals of the internal power storage source or battery 40 can be varied within the scope and spirit of the invention. For example, the positive terminal of the internal battery 40 can be connected to the top bus bar 112, and the negative terminal of the internal battery 40 can be connected to the bottom bar 114, etc. It will be appreciated by a person skilled in the art that the connection arrangement can be varied as long as the positive and negative terminals of the internal power source are disposed in a diagonal position.

Therefore, even if a user applies the clamps to the wrong terminal connections, i.e. negative to positive or positive to negative between the external and the internal power sources, the switch 50 automatically switches to a proper polarity.

Further, as shown in Figures 7-11, the switch 50 is arranged and configured in such a manner that the switch 50 is able to fit in the housing 22. The housing 22 provides inside grooves to retain the switch 50 as well as many other components, such as cables, cigarette lighter wires, and the display wires, etc.

It will be appreciated that other types of suitable switches can be used without departing from the present invention. The examples of the other types of switches, but not limited to these examples, are solid-state switches, other electro-mechanical switching devices. It will be also appreciated that other conventional polarity detection/protection devices, or automatic polarity sensing battery charger devices can be used without departing from the present invention.

While a particular embodiment of the invention has been described with respect to its application for providing power to a battery, such as jump starting a

vehicle, etc., it will be understood by those of skill in the art that the invention is not limited by such application or embodiment for the particular components disclosed and described herein. It will be appreciated by those skilled in the art that other circuit configurations that embody the principles of this invention and other applications therefor can be configured within the spirit and intent of this invention. The circuit configuration described herein is provided as only one example of an embodiment that incorporates and practices the principles of this invention. Other modifications and alterations are well within the knowledge of those skilled in the art and are to be included within the broad scope of the appended claims.

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WE CLAIM:

1. A portable battery booster apparatus for boosting an electrical system with a first terminal and a second terminal, comprising:

a) a battery having a first terminal and a second terminal;

b) a housing enclosing the battery and the first and second terminals of the battery;

c) a switch having a first pair of contacts and a second pair of contacts, the switch being enclosed in the housing;

d) a first cable with a first end connected to the first terminal of the battery and a second end selectively connected to a first contact of the first pair of contacts of the switch, the first cable being enclosed in the housing;

e) a second cable with a first end connected to the second terminal of the battery and a second end selectivley connected to a second contact of the first pair of contacts of the switch, the second cable being enclosed in the housing;

f) a third cable with a first end connected to a first contact of the second pair of contacts of the switch, the first end of the third cable being partially enclosed in the housing;

g) a fourth cable with a first end connected to a second contact of the second pair of contacts of the switch, the first end of the fourth cable being partially enclosed in the housing;

h) a first clamp connecting to a second end of the third cable, the first clamp being detachably mounted onto a first side of outside of the housing;

i) a second clamp connecting to a second end of the fourth cable, the second clamp being detachably mounted onto a second side of the outside of the housing; and

j) wherein when the electrical system is boosted by the battery booster apparatus, the first clamp and the second clamp connect to the first terminal and the second terminal of the electrical system,

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respectively, such that the first and second terminals of the battery are electrically connected to the first and second terminals of the electrical system, the switch switches connections between the first pair of contacts and the second pair of the contacts to ensure that the first terminal of the battery and the first terminal of the electrical system have the same polarity, and the second terminal of the battery and the second terminal of the electrical system have the same polarity.

2. The apparatus of claim 1, further comprising an ON/OFF switch connected between the battery and the switch, wherein when the ON/OFF switch is off, the switch is in a neutral, non-contacting position, the first pair of contacts are not electrically communicated with the second pair of contacts, when the ON/OFF switch is on, the electrical system is boosted by the battery.

3. The apparatus of claim 1, wherein the electrical system is another battery.

4. The apparatus of claim 1, wherein the switch comprises:

a coil assembly having a longitudinal axis, the coil assembly including:

a first coil, disposed around outside of the coil assembly, winding around a first core which is disposed inside of the coil assembly;

a second coil, disposed around outside of the coil assembly, winding around a second core which is disposed inside the coil assembly; and

a third coil, disposed around outside of the coil assembly and between the first coil and the second coil, winding around a plunger, the plunger being movable along the longitudinal axis between the first and second cores;

wherein the plunger is moved to a first contacting position when the first terminals of the battery and the electrical system have the same polarity and the second terminals of the battery and the electrical system have the same polarity, the plunger is moved to a second contacting position when the first terminals of the battery and the electrical system have the opposite polarity and the second terminals of the battery and the electrical system have the opposite polarity.

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5. The apparatus of claim 4, wherein the switch is arranged and configured by a double pole double throw switch.

6. The apparatus of claim 4, further comprising an ON/OFF switch connected between the battery and the switch, wherein when the ON/OFF switch is off, the switch is in a neutral, non-contacting position, the first pair of contacts are not electrically communicated with the second pair of contacts, when the ON/OFF switch is on, the electrical system is boosted by the battery, the ON/OFF switch is operated outside of the housing.

7. The apparatus of claim 6, wherein the switch is arranged and configured by a double pole double throw switch.

8. The apparatus of claim 7, wherein the first pair of contacts are arranged and configured to be a pair of bottom switch contacts and a pair of top switch contacts, wherein when the plunger is in the first contacting position, the bottom switch contacts are connected to the second pair of contacts, and when the plunger is in the second contacting position, the top switch contacts are connected to the second pair of contacts.

9. The apparatus of claim 1, further comprising switch retention grooves for retaining the switch in one side of the housing.

10. The apparatus of claim 9, further comprising cable retention grooves for retaining the first, second, third, and fourth cables to the housing.

11. The apparatus of claim 10, further comprising battery retention grooves for retaining the battery to the housing.

12. The apparatus of claim 1, further comprising a first holster for receiving and covering the first clamp and a second holster for receiving and covering the second

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clamp, wherein the first and second holsters are attached to the outside of the housing.

13. The apparatus of claim 12, wherein the first and second holsters are pivotably connected to the housing.

14. The apparatus of claim 4, wherein the coil assembly has a bobbin shape with two dividers for separating the first, second, and third coils from each other.

15. The apparatus of claim 14, further comprising an enclosure for enclosing the coil assembly, wherein the plunger extends from the enclosure and connects to a double pole double throw switch.

16. The apparatus of claim 1, further comprising a display for displaying a level of charge remaining in the battery.

17. The apparatus of claim 1, further comprising a cigarette lighter receptacle member disposed on the housing and electrically connected to the battery, the receptacle member providing power to an electrical system which equips with a cigarette lighter plug.

18. The apparatus of claim 1, further comprising a cigarette lighter plug member extending from the housing and electrically connected to the battery, the plug member being connectable to a power source outside the housing to recharge the battery inside the housing.

19. The apparatus of claim 1, further comprising a handle for carrying the battery booster apparatus, wherein the housing and the handle form a portable box unit.

20. A portable, auto-polarity battery booster apparatus for boosting an electrical system with a positive terminal and a negative terminal, comprising:

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a) a power storage device having a positive terminal and a negative terminal;

b) a housing enclosing the power storage device and the positive and negative terminals of the power storage device;

c) an auto-polarity switch enclosed in the housing for connecting between the power storage device and the electrical system;

d) a first cable with one end connected to the positive terminal of the power storage device and another end selectively connected to the switch, the first cable being enclosed in the housing;

e) a second cable with one end connected to the negative terminal of the power storage device and another end selectively connected to the switch, the second cable being enclosed in the housing;

f) a third cable with one end connected to the switch;

g) a fourth cable with one end connected to the switch;

h) a first clamp connecting to another end of the third cable and disposed outside of the housing;

i) a second clamp connecting to another end of the fourth cable and disposed outside of the housing; and

j) wherein when the positive and negative terminals of the electrical system are electrically connected to the first and second clamps, respectively, the switch switches to a first contacting position to ensure the positive terminal of the battery is electrically connected to the positive terminal of the electrical system, and the negative terminal of the battery is electrically connected to the negative terminal of the electrical system.

21. A portable, auto-polarity battery booster apparatus for boosting an electrical system with a positive terminal and a negative terminal, comprising:

a) a housing;

b) a battery, the battery having charges to provide power to the electrical system, the battery having a positive terminal and a negative terminal, the battery being enclosed in the housing;

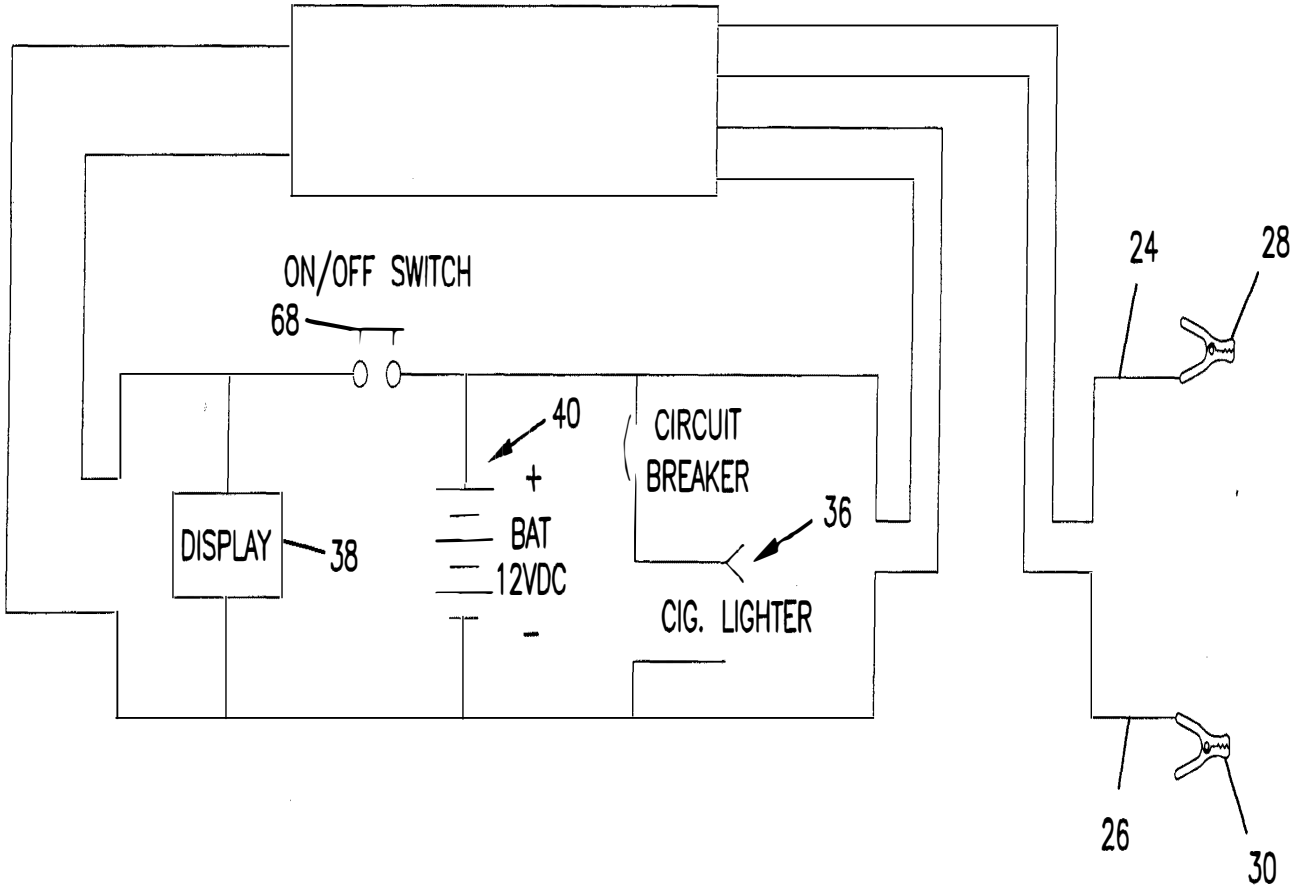
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c) a plurality of connecting members, the connecting members electrically connecting between the terminals of the battery and the terminals of the electrical system, the plurality of connecting members being enclosed in the housing, two of the plurality of connecting members being partially extended from the housing; and

d) a switch, the switch being arranged and configured to electrically connect between the battery and the electrical system, the switch being enclosed in the housing, the switch automatically switching between a first connecting position and a second connecting position to ensure that the positive terminal of the electrical system is electrically connected to the positive terminal of the battery and that the negative terminal of the electrical system is electrically connected to the negative terminal of the battery.

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FIG. 1



SUBSTITUTE SHEET (RULE 26)

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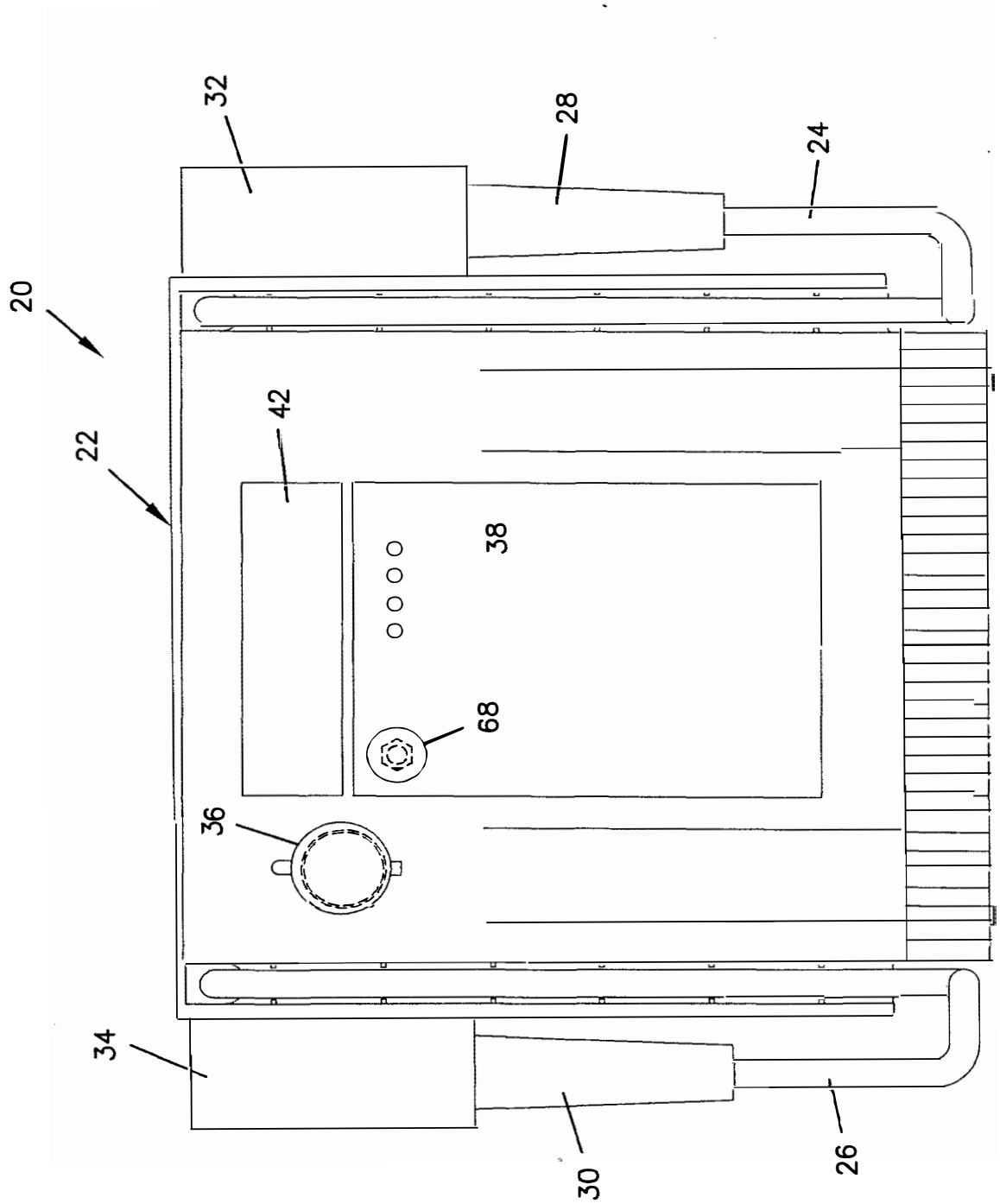


FIG. 2

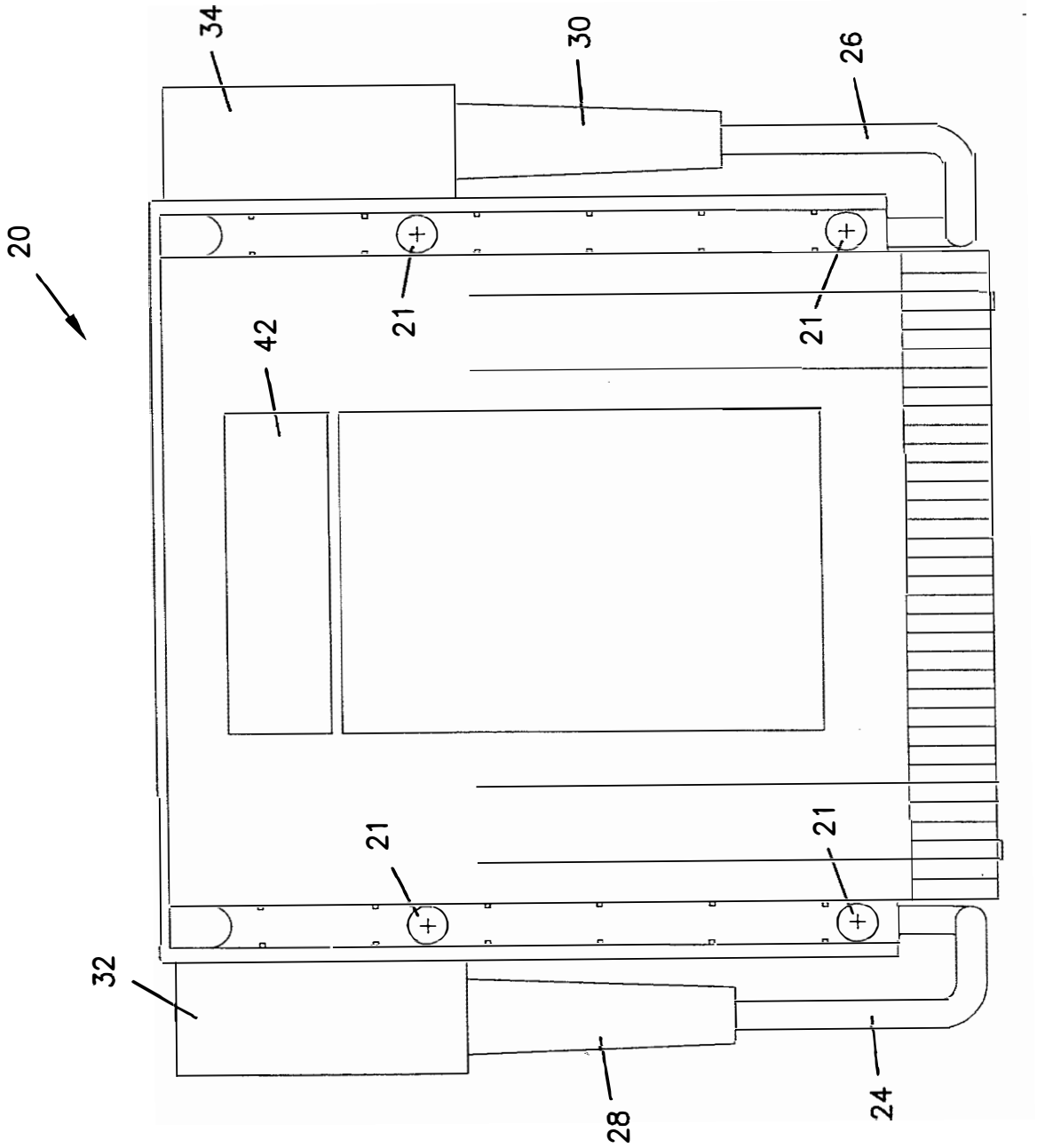


FIG. 3

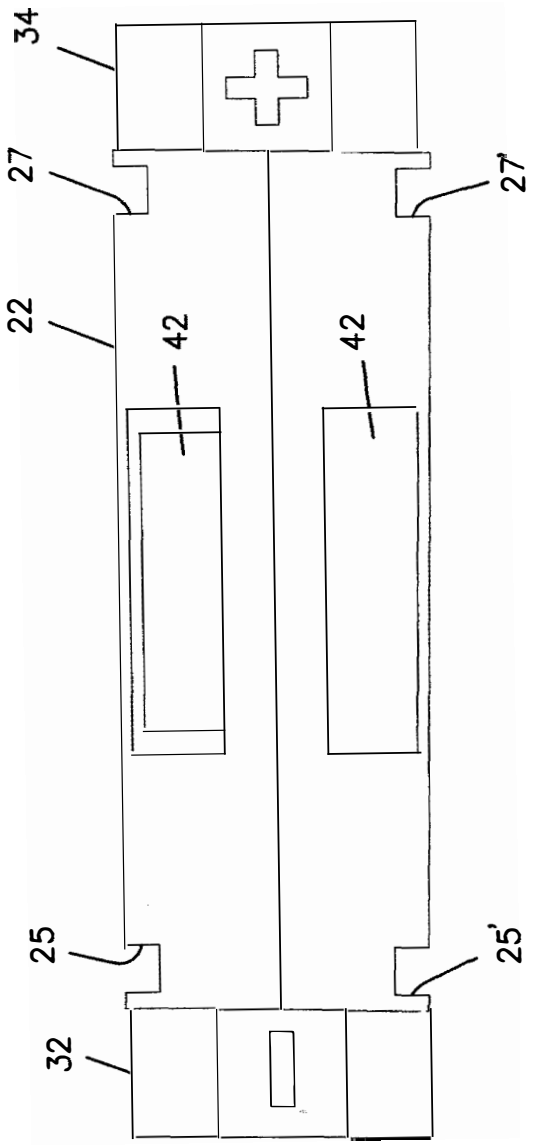


FIG. 4

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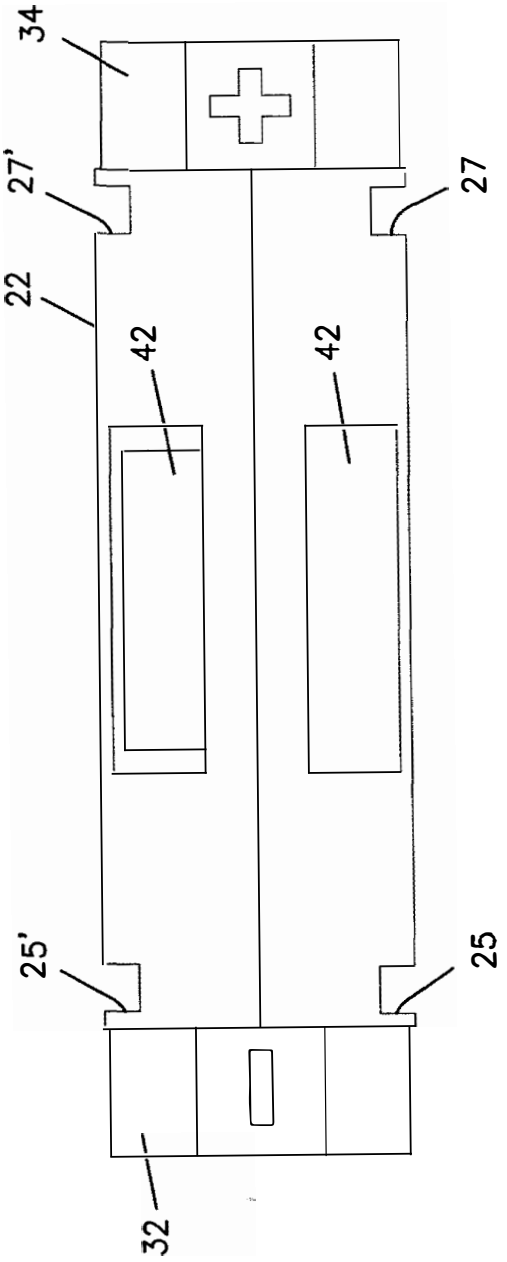


FIG. 5

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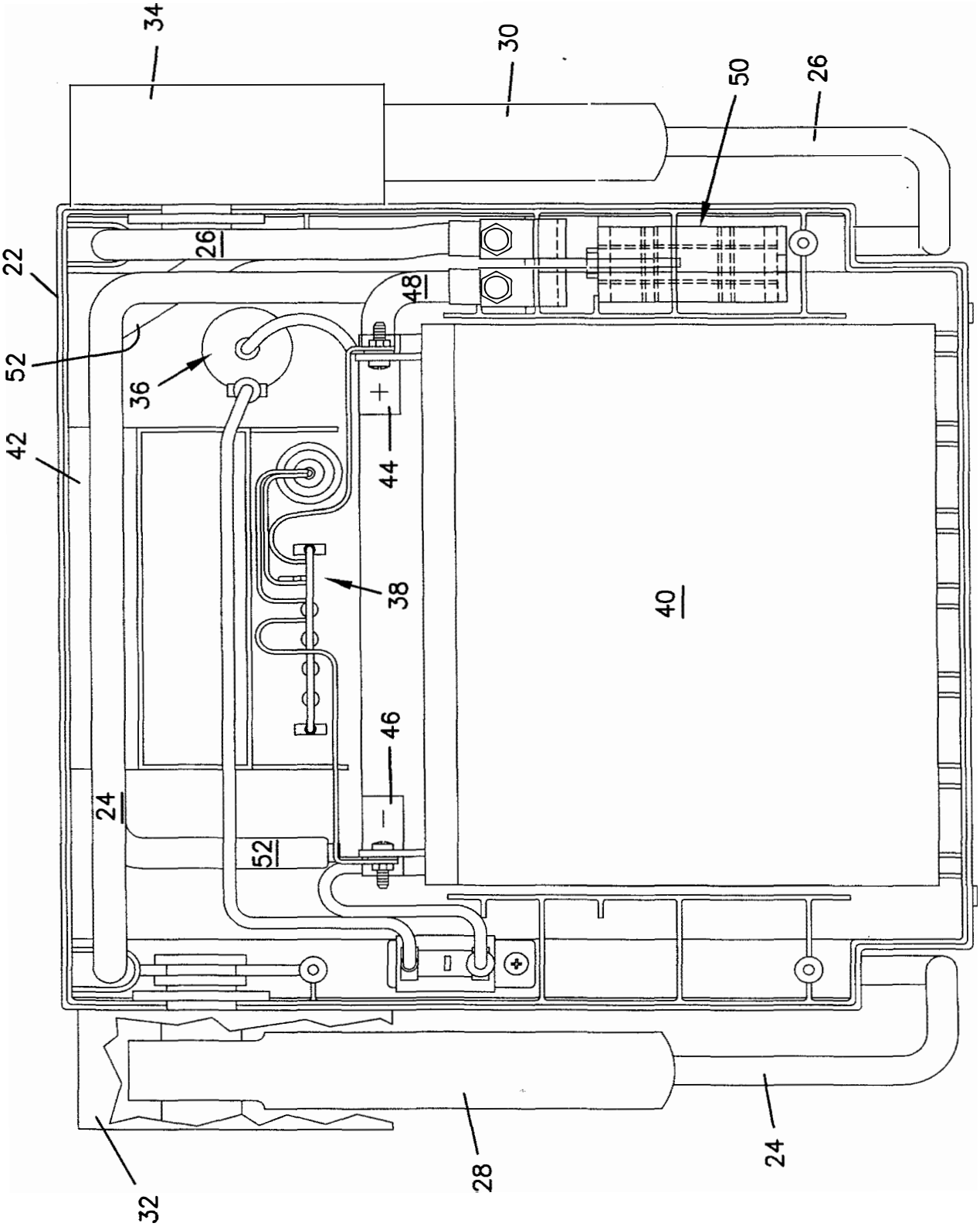


FIG. 6

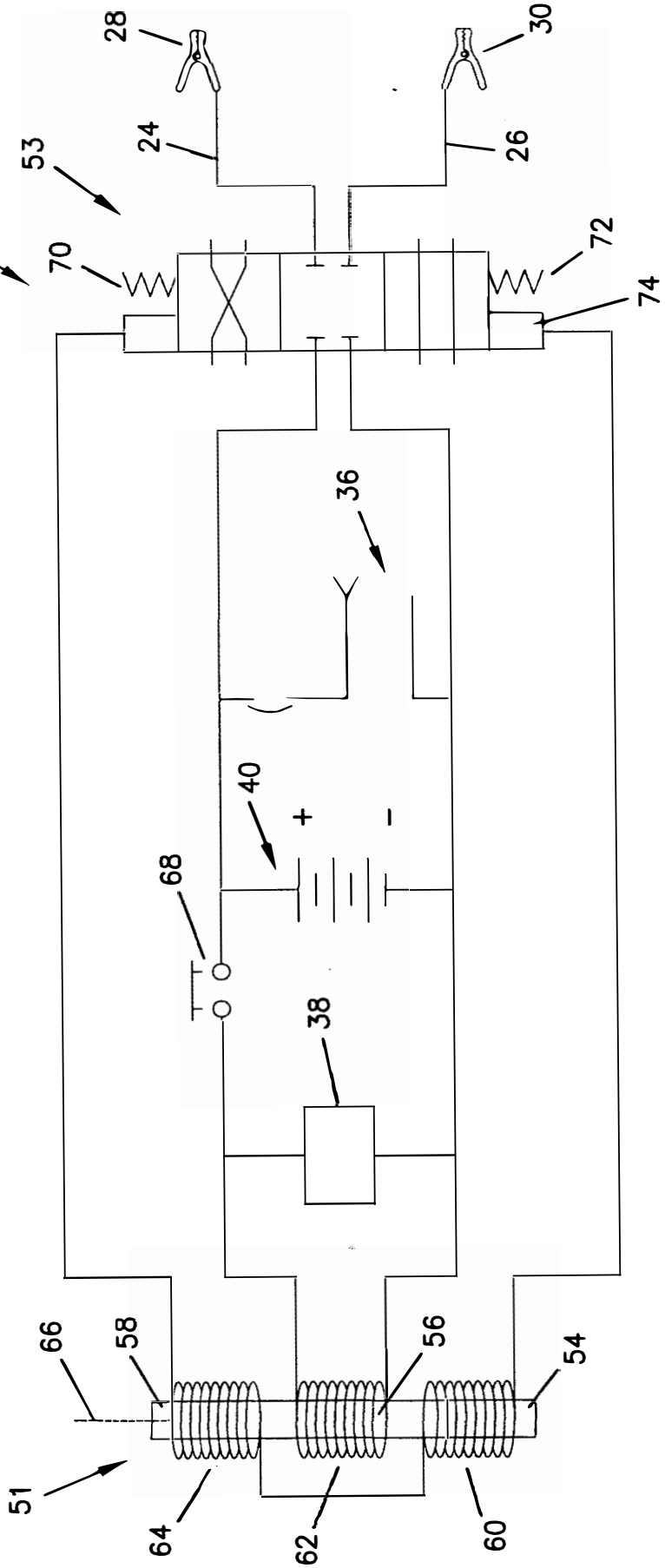


FIG. 7

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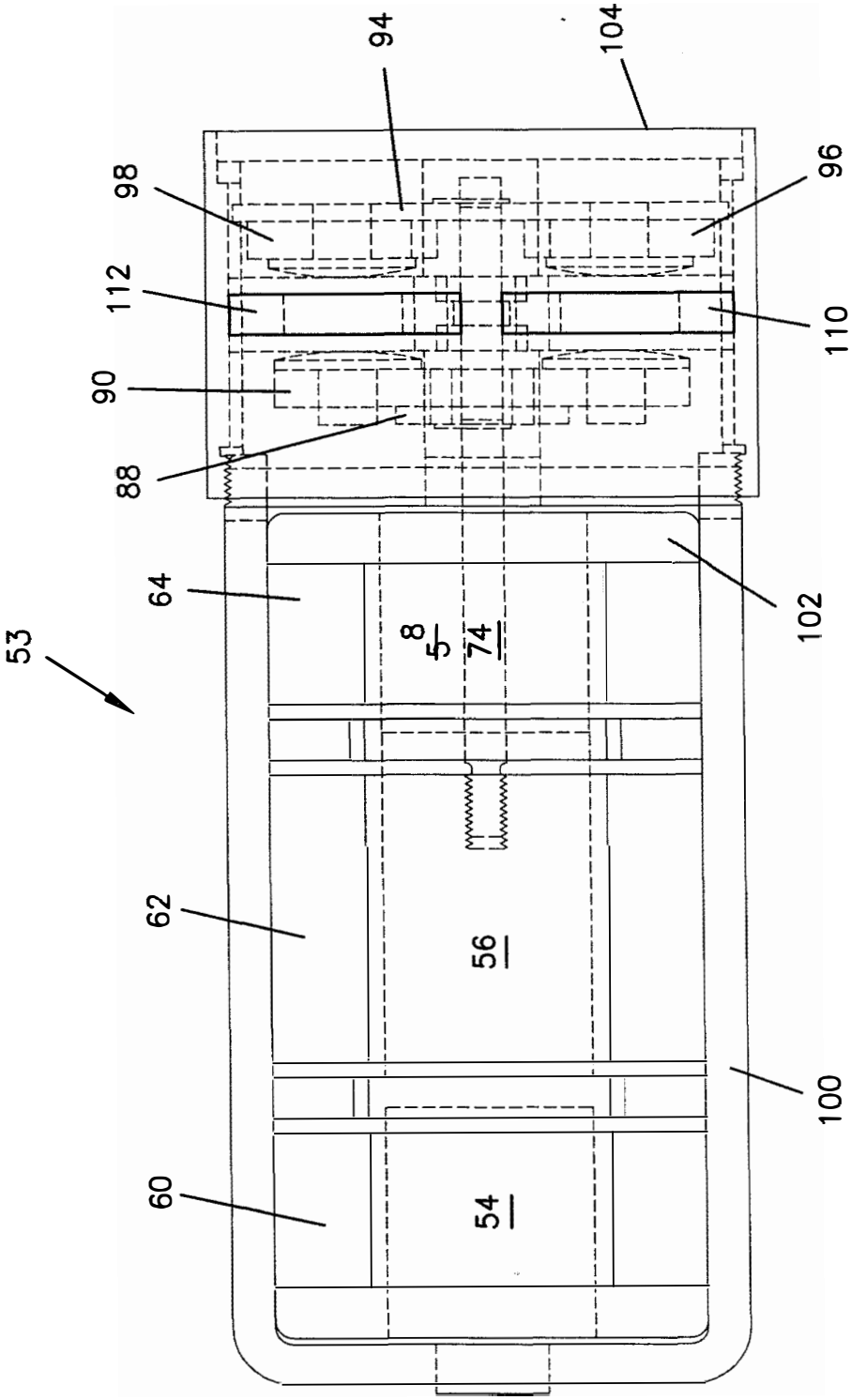


FIG. 8

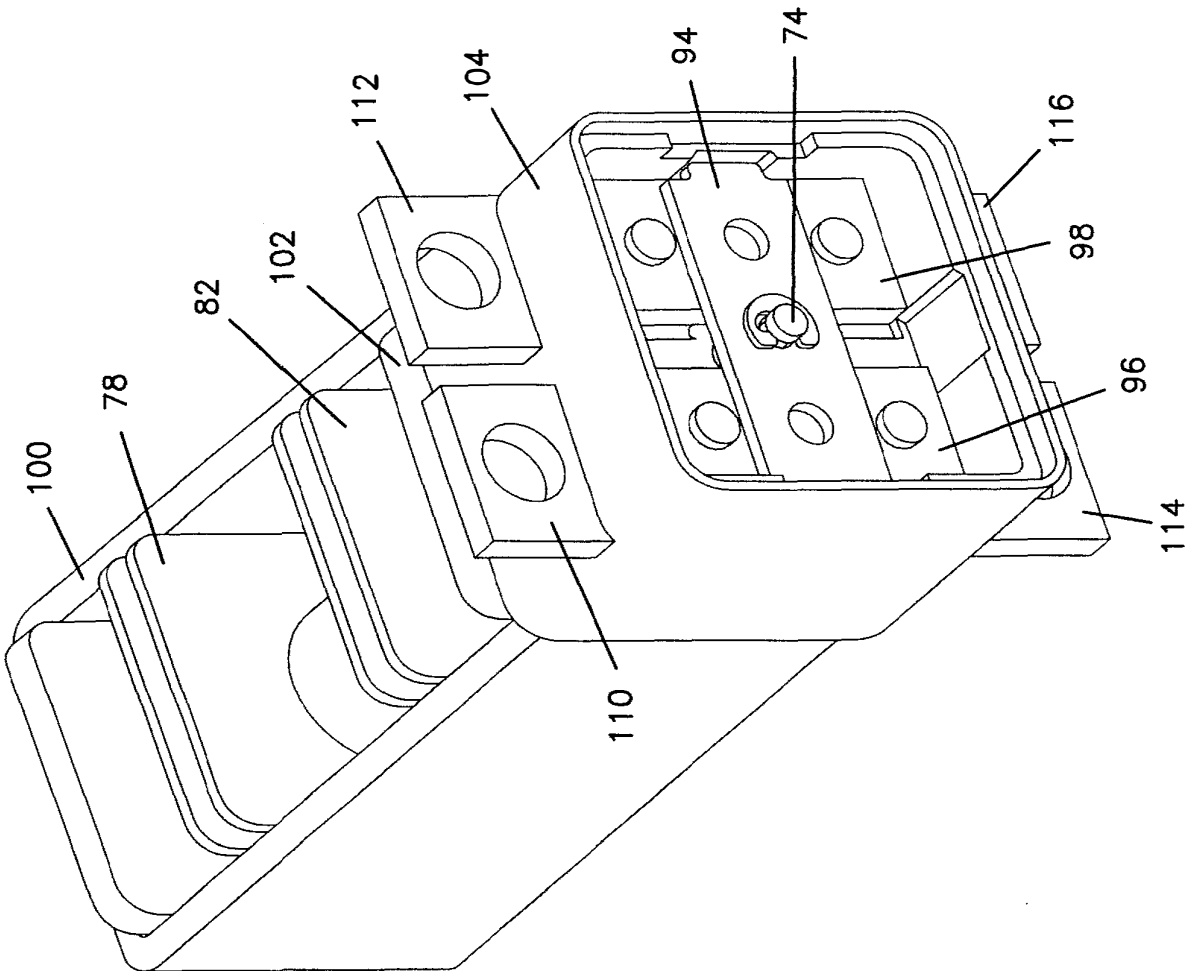


FIG. 9

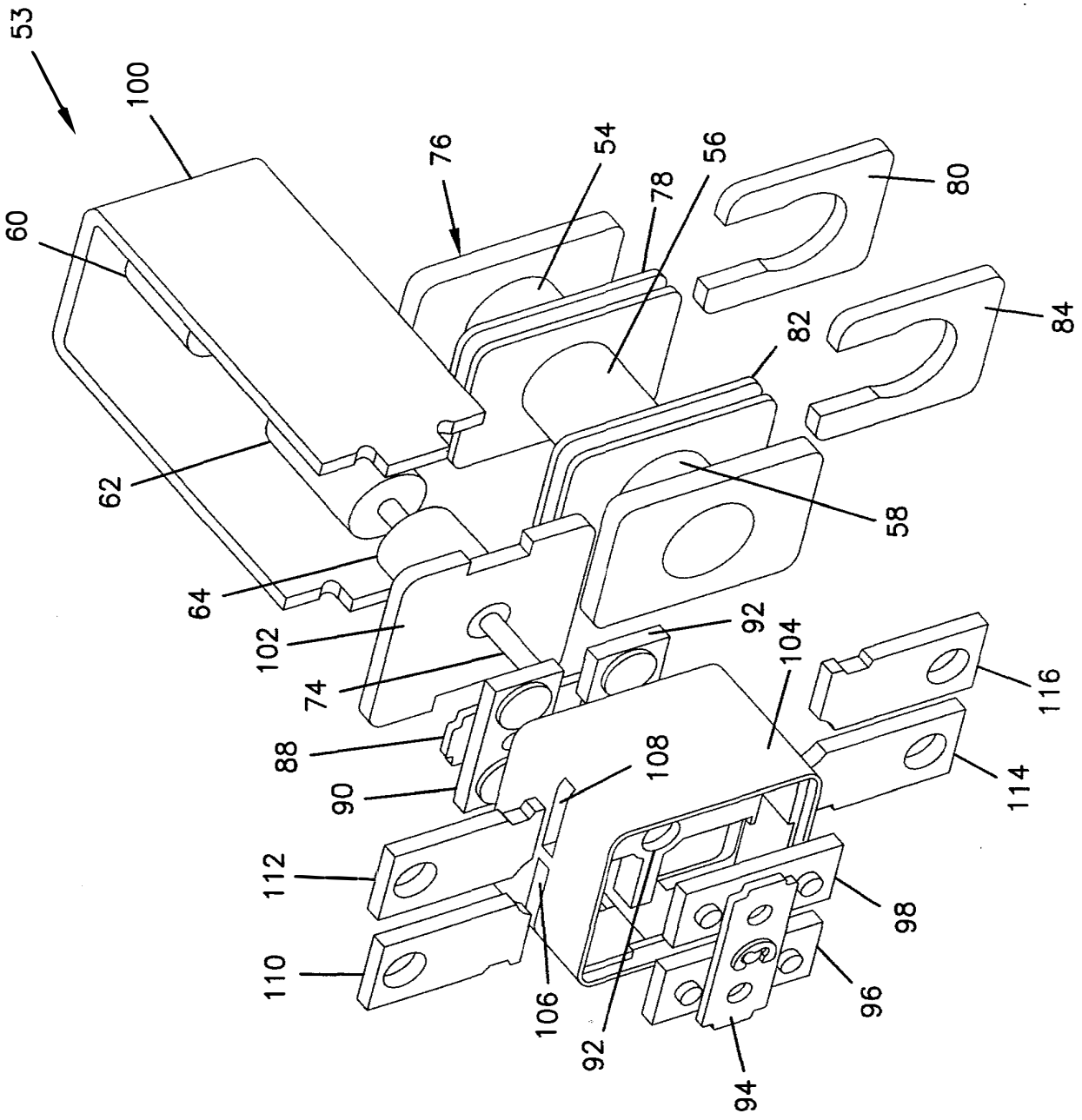


FIG. 10

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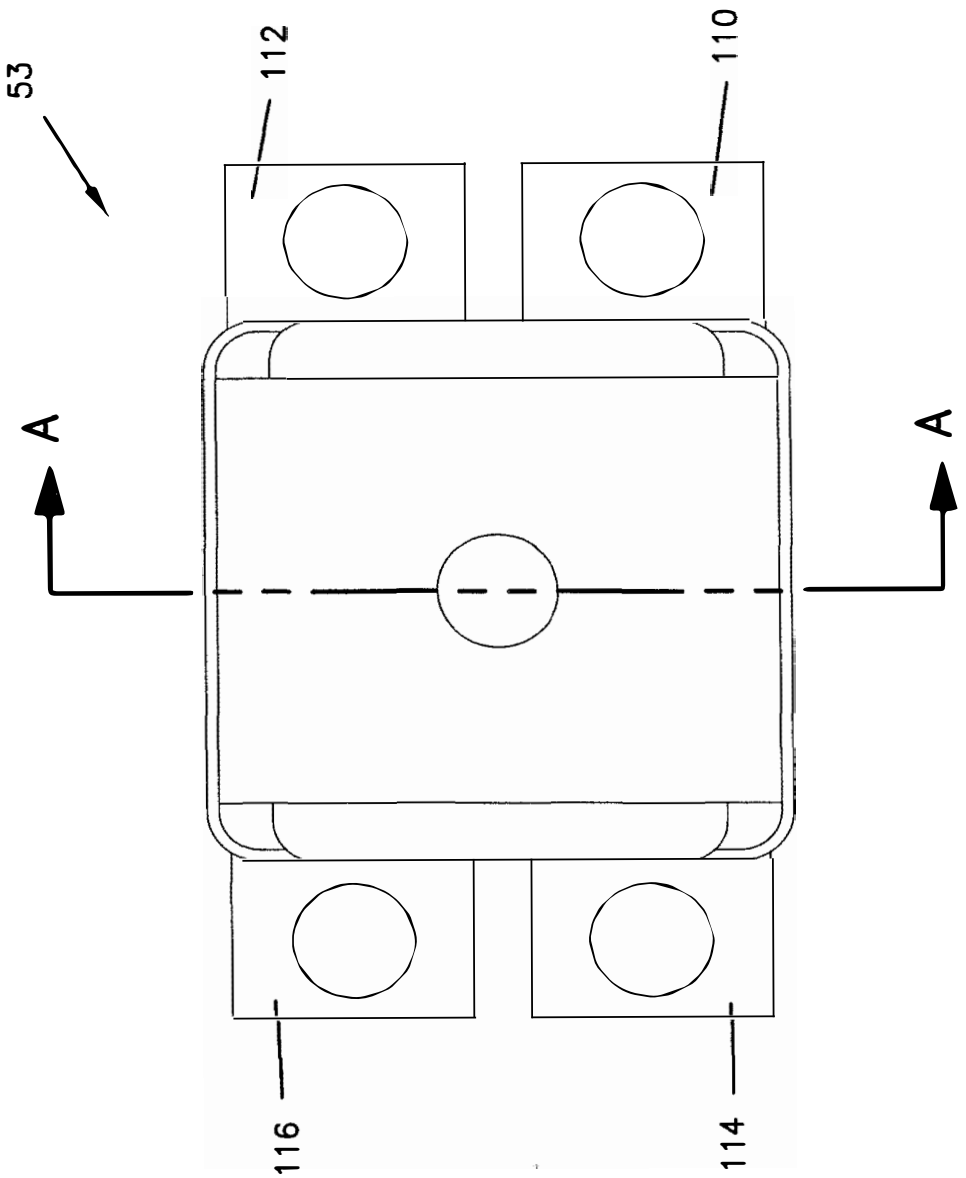


FIG. 11

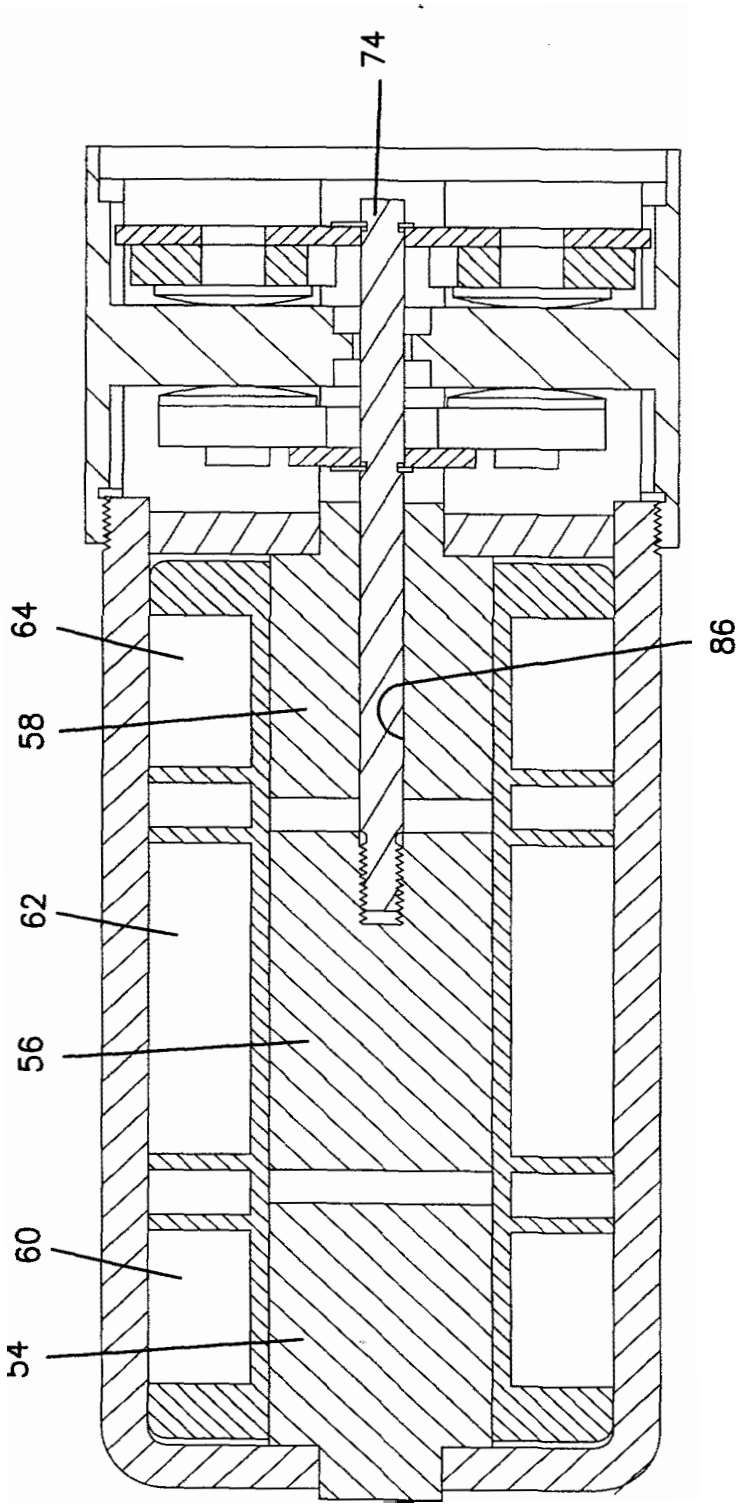


FIG. 12

INTERNATIONAL SEARCH REPORT

Inte. ial Application No
PCT/US 99/21926

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02J7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 667 141 A (STEELE LEONARD B) 19 May 1987 (1987-05-19) the whole document	1-7,12, 16,20,21
Y	WO 98 01928 A (SMITH JERRY R) 15 January 1998 (1998-01-15) the whole document	1-7,16, 20,21
A		8,14,15
Y	US 5 589 292 A (ROZON LUC) 31 December 1996 (1996-12-31) cited in the application the whole document	1,12
A	US 5 083 076 A (SCOTT CLYDE A) 21 January 1992 (1992-01-21) the whole document	1-21

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[X] Further documents are listed in the continuation of box C. [X] Patent family members are listed in annex.

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"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 January 2000	28/01/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Moyle, J

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INTERNATIONAL SEARCH REPORT

Inte[illegible]al Application No
PCT/US 99/21926

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 767 661 A (WILLIAMS CARLOS) 16 June 1998 (1998-06-16) the whole document	1-21

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte nal Application No
PCT/US 99/21926

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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WO 9801928	A	15-01-1998	AU	3800397 A	02-02-1998
US 5589292	A	31-12-1996	CA	2109166 A	26-04-1995
			AU	709769 B	09-09-1999
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US 5083076	A	21-01-1992	NONE		
US 5767661	A	16-06-1998	NONE		

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

(Not for submission under 37 CFR 1.99)

Application Number	16450422
Filing Date	2019-06-24
First Named Inventor	NOOK
Art Unit	2859
Examiner Name	DIAO
Attorney Docket Number	054985-000055-US-05

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16450422
	Filing Date	2019-06-24
	First Named Inventor	NOOK
	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

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	Art Unit	2859
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	Attorney Docket Number	054985-000055-US-05

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	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

	1	Copy of Exhibit 1008, www.xcar360.com	
	2	Copy of Exhibit 1009, www.electronicshub.org	
	3	Copy of the Petition for Inter Partes Review of U.S. Patent No. 9,007,015; IPR 2020-00944, filed May 14, 2020, 105 pages	
	4	Copy of Exhibit 1013, Model: Epower-21 brochure, 2 pages	
	5	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. Shenzhen Valuelink E-Commerce Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division,1 page.	
	6	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. Shenzhen ChangXin Yang Technology Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page.	
	7	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. SZ Jingxinghui Electronics Technology Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page	
	8	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/19/17, The NOCO Company, Inc. v. Shenzhen Anband Technology Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page.	
	9	Copy of Report on the filing or determination of an action regarding a patent or trademark, filed 10/30/17, The NOCO Company, Inc. v. Shenzhen Dika Na'er E-Commerce Co., Ltd., U.S. District Court for the Northern District of Ohio, Eastern Division, 1 page.	
	10	Copy of PTAB notice regarding petition filed in Patent Number 9007015, Application Number 14/325938, filed on 01/15/2018, IPR2018-00503, 1 page	
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	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

	12	Copy of Notice of Filing Date Accorded to Petition and Time for Filing Patent Owner Preliminary Response, mailed May 21, 2020, Shenzhen Carku Technology Co., Ltd. v. The NOCO Company, IPR2020-00944, Patent 9,007,015, 4 pages.	
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	24	Statement of Defence and Counterclaim - Defendant: Canadian Tire Corporation, Limited, Court File No. T-34320, 17 pages, August 4, 2020.	

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	First Named Inventor	NOOK
	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/William L. Klima/	Date (YYYY-MM-DD)	2022-06-10
Name/Print	William L. Klima	Registration Number	32422

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

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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)).

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EXHIBIT 1002
Petitioner ADC (IPR2024-00577)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 March 2012 (22.03.2012)

PCT

(10) International Publication Number
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H01R 13/60 (2006.01)

(21) International Application Number:
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(22) International Filing Date:
13 September 2011 (13.09.2011)

(25) Filing Language: Norwegian

(26) Publication Language: English

(30) Priority Data:
20101286 13 September 2010 (13.09.2010) NO

(71) Applicant *(for all designated States except US)*: **DEFA AS AUTOMOTIVE DIVISION** [NO/NO]; P.O. Box 370, N-1301 Sandvika (NO).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **EIDSVIG, Didrik** [NO/NO]; c/o Defa AS, Postboks 370, N-1301 Sandvika (NO).

(74) Agent: **PROTECTOR IP CONSULTANTS AS**; Oscarsgate 20, N-0352 Oslo (NO).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

[Continued on next page]

(54) **Title**: DEVICE FOR CHARGING OF RECHARGEABLE BATTERIES

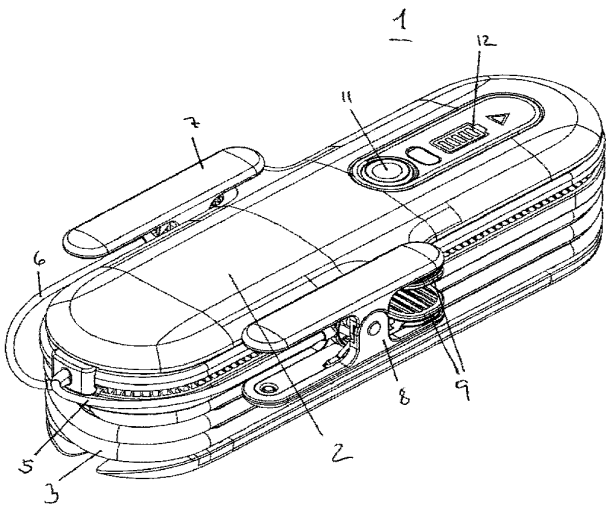


FIG. 1

(57) **Abstract**: Present invention relates to a device (1) for charging of rechargeable batteries, comprising a house (2) with a transformer, cable (3) with a plug (4) for mains input, cables (5, 6) for supplying electric power to the battery, clamping devices (7, 8) for connection to the poles of a battery, switch (11) for activation and deactivation of the charging device (1) and at least one visual indicator (12) to give the user an indication of the charging progress, said house (2) has such a design that the cables (3,5,6) and the plug (4) are completely or partially situated in the house (2), and the clamping devices (7, 8) are attached to holding means (9, 10) which protrude from the house (2), said holding means (9, 10) comprise two protruding elements, said cables (5, 6) for are winded around the circumference of the house (2) between each of the protruding elements of respective holding means.

WO 2012/036556 A1

EXHIBIT 1002
Petitioner ADC (IPR2024-00577)

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

EXHIBIT 1002
Petitioner ADC (IPR2024-00577)

DEVICE FOR CHARGING OF RECHARGEABLE BATTERIES

The present invention relates to a charging device for charging of lead batteries and other rechargeable battery types. The invention relates in particular to so called "domestic chargers" which can be used especially for the charging of lead batteries for vehicles.

Many different types of devices for charging of lead batteries and other batteries are known. What is common for many of these chargers is that the charging device is fitted with a long row of buttons/switches, where the user is faced with a number of choices that must be made to start the charging process. Furthermore, a well known problem with many chargers is that sparks are generated when making the connection to the battery. Another problem is that the cable ends, both for connection to the battery and to the mains, are not easily handled in a simple and sensible way when the product shall be tidied away and be stored after use.

Therefore, the inventor has provided a charging device where focus is given to the user and to the ease of operation. The charging device is characterised in that a simple, clean and functional design which takes into consideration that the connection cables are coiled and fastened to the product housing. The coiling and fastening steps are integrated in a new and innovative way. The user only needs to uncoil the cables and then to connect the crocodile clamps to the battery and make the connection to the mains. Thereafter the charging is initiated by pushing the on/off button. This will be regarded as very safe as the user is not exposed to unnecessary sparks and the like in the connection process. The charger will itself detect and adjust the charging process according to the size of the battery and the surrounding temperature. During charging and after completion of the charging the indicator on the charger will, at any time, give the status of the charging. The charging will finish on its own or in that the user presses stop to terminate.

For this purpose a software program is developed that is adapted to a charging process for batteries of any size and condition. In addition, attention is given to a simple, clear and, not least, user-friendly interface with the help of the on/off button of the unit and the display.

The form of the charging device and the mechanical design of its components are very demanding as both the mains cable and the battery cables are easily coiled round after use and fastened to the product so that these are firmly secured during storage. Both the clamps and the mains plug are fastened to the housing. These considerations mean that special adaptations are made on the electronic components and the edb board.

It has also been an assumption that in the design a compact unit is made with corresponding layout and choice of components so that the unit is as small as possible. This means that the heat loss through the housing of the product has been a critical parameter. The collaboration between electronics and mechanics is carried out in such a way that it does not lead to overheating of the electronic parts.

In addition, some extra equipment for connecting has been developed. For this purpose a watertight plug that can be taken out and inserted again is formed on the battery cable. This gives the possibility of connection of the additional equipment that, among other things, comprises cables with eyelet terminals and a plug to the battery charger. This means that the user can fit a series of permanent cables, with a corresponding plug on the batteries, to a part of the motorised equipment that requires regular charging. The charger can then be easily transported from location to location to carry out the charging job. A small, removable battery indicator is also developed that can be connected to this equipment to indicate whether a battery needs charging or not.

These, and other aims and advantages are achieved with a charging device for charging of lead batteries and other rechargeable battery types, encompassing

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a housing with a transformer, cable with a plug for connection to the mains, cables for supply of electric power to the battery, clamping means for connection to the poles of a battery, a switch for the activation and deactivation of the charging device and at least one visual indicator to give the user an indication of the charging progress, characterised in that the housing has a shape so that the cables and the plug are completely, or partly, lying in the housing and the clamping devices are fastened to the holding means that protrudes from the housing, when the device is not in use, as each holding means comprises two protruding elements, that the cables for the connection of the battery are coiled around the circumference of the housing between each of the protruding elements of the respective holding means.

The cable for connection to the mains is preferably coiled around the periphery of the housing and the plug is preferably placed in a recess in the housing when the device is not in use.

The paths of the coiling of the cable with the plug and the cables for connection to the battery are preferably, in the main, in parallel and axially displaced in relation to each other.

Furthermore, the device preferably comprises an electronic unit that measures/senses which type of battery that is to be charged, the surrounding temperature and the battery capacity.

The electronic unit preferably controls the charging voltage and the charging process as a function of the measured parameters.

The device comprises an indicator that gives the user a visual indication of the charging process.

The charging device is preferably adapted to charging open and closed lead batteries, AMG batteries and gel batteries with a capacity of 4-225 Ah.

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The indicator preferably comprises at least one LED.

The invention will now be explained in more detail with the help of an embodiment example with reference to the enclosed figures, where:

Figs. 1-3 show a charging device according to the present invention, seen in perspective from different directions.

Fig. 4 shows an example of a typical course of charging at a charge current of 4 A.

An embodiment of the charging unit according to the present invention is shown in the figures 1-3.

The charging unit, referred to as 1, comprises a housing 2, connected to said housing 2 is a mains cable 3 with a plug 4 for connection to a mains socket, and two cables 5, 6, for connection to respective battery poles. The cables 5, 6 are connected to their own clamping device 7, 8. The clamping devices 7, 8 are shaped so that they can engage with respective poles on a battery. Furthermore, the clamping devices 7, 8 are formed so that they can be fastened to respective holding means 9, 10 on the housing 2 when the charging unit 1 is not in use. Each holding means 9, 10 comprises two protruding elements, to which elements respective clamping devices can be fastened when the device is not in use. The cable 3 for connection to the mains is coiled around the periphery of the housing 2 and the plug 4 is placed in a recess in the housing 2 when the device is not in use. The coil paths of the cable 3 for connection to the mains and the cables 5, 6 for connection to the battery are, in the main, in parallel and axially displaced with respect to each other.

This means that the device will be very compact and all cables will be kept in place when the device is not in use, so that it is simple to store the device and it

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will be very simple to remove the cables and the clamping devices when the charging unit is to be used.

Furthermore, a switch 11 is arranged on the housing 2 with which the charging unit can be activated. Furthermore, the charging unit 2 is fitted with an indicator 12 that shows the operating state of the charging device.

Furthermore, an electronic unit (not shown) is placed in the housing 2 that measures/senses the type of battery which is to be charged, controls the charging process and switches off the device after the charging is completed.

The electronic unit will automatically detect the size of the battery (battery capacity) and find a suitable charge voltage. Furthermore, the surrounding temperature will be detected and the electronic unit will compensate the charge voltage accordingly.

The charging device can be used for batteries with a capacity of 4 – 225 Ah and battery types that can be charged with the help of the device are open and closed lead batteries, so called AGM batteries and gel batteries.

The charging device according to the invention functions as follows:

The charger is connected to the battery that is to be charged with the help of the clamping devices 8, 9 and the plug 4 is placed in a wall socket or the like, which supplies a voltage of 230V. The charging commences when the switch 11 is activated. The charging device can also be used as a current supply for a limited period, and this time period is determined by the electronic unit.

Example

A typical course of charging at 4 A is shown in fig. 4.

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The X-axis gives the different steps described below, while the Y-axis gives the current in A.

	4 amp
Charging step	
1) Analyse the state	Measure the voltage at I=0 1 second 5 sec. Batt. Stat. ind. Time
2) Soft start Find battery size (Ah capacity)	Start charging at constant current 1, 2, 4 A measure voltage Increase current if $\Delta V < 0.2V$ 15 sec on (always wait 15 sec to the next current level) 15 sec off x3 If $\Delta V >= 0.2V$ charge directly with existing current 1-2-4 A
3) Main charging	Start main charging at correct current level according to battery size. Max time 4 amp 12 h 2 amp 8 h 1 amp 2 h
4) Top charging	Constant. Voltage 14.4 V until I<1A Max time 4 amp 6 h 2 amp 4 h 1 amp 3 h
5) Maintenance charging	13. 8V min at 4 h max 24 h from step 1
6) Analyse	Turn off charging measure voltage
7) Rest mode	Rest until next week If Vbat < 12.7 V go to step 8
8) Waking	Waking, start new charge cycle

In this embodiment example the indicator comprises five LED lamps and one warning lamp. These will give the user the following indications:

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Step 0 Check output charge line
1st the crocodile
2nd the 12 V plug

Step 1 Analyse
Start timer counter
Measure battery voltage
Indicate battery status green light
>12.65 V all five segments light up
12.55 V -12.65 V four segments light up
12.45 V - 12.55 V three segments light up
12.35 V - 12.45 V two segments light up
3.5 V - 12.35 V one segment lights up
< 3.5 V Error mode Warning Triangle red light

Step 2 Soft Start
LED indication
1 amp: one LED blinking
2 amp: two LEDs blinking
4 amp: three LEDs blinking

Step 3 Main Charge
1st, 2nd, 3rd LEDs/charging indication

If battery not connected the warning light will light up.
If wrong polarity the warning light will light up.

Step 4 Top Charge
1st, 2nd, 3rd, 4th LEDs/charging indication

Step 5 Maintain charge

All five segments light Green (no blinking)
After 24 h Go to sleep I=0A Step 7

All segments pulsing from low to high intensity.
2 sec increase intensity
Turn off 1sec
and so on

Step 6 Analyse

1st, 2nd 3rd, 4th, 5th LEDs/charging indication

Measure the voltage after 2 mins, I=0A
If Vbat > 13.0 V after 2 mins OK Go to step 6

If Vbat < 13.0 V after 2 mins OK Go to Error RED warning

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turns on (no blinking)

Step 7 Sleep

No special indication

Step 8 Wake up

Go to Step 1 for new charging cycle.

14.7 V Button

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Claims

1.

Charging device (1) for charging of lead batteries and other rechargeable battery types, encompassing a housing (2) with a transformer, cable (3) with a plug (4) for connecting to the mains, cables (5, 6) for supply of electric power to a battery, clamping devices (7, 8) for connection to the poles of a battery, switch (11) for the activation and deactivation of the charging device (1) and at least one visual indicator (12) to give the user an indication of the charging progress, characterised in that the housing (2) is of such design that the cables (3, 5, 6) and the plug (4) are completely or partly lying inside the housing (2) and the clamping devices (7, 8) are fastened to the holding means (9, 10) that protrude from the housing when the device is not in use, as each holding means (9, 10) encompasses two protruding elements, that the cables (5, 6) for connection to the battery are coiled around the circumference of the housing (2) between each of the protruding elements of the respective holding means (9, 10).

2.

Charging device according to claim 1,
characterised in that the cable (3) for connecting to the mains is coiled around the periphery of the housing (2) and that the plug (4) is placed in a recess in the housing (2) when the device is not in use.

3.

Charging device (1) according to any of the preceding claims,
characterised in that the path of the coiling of the cable (3) with the plug (4) and the cables (5, 6) for connection to the battery are, in the main, in parallel and axially displaced in relation to each other.

4.

Charging device (1) according to any of the preceding claims,

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characterised in that the device (1) further incorporates an electronic unit that measures/senses which type of battery that is to be charged, the surrounding temperature and the capacity of the battery.

5. Charging device (1) according to claim 3, characterised in that the electronic unit controls the charging voltage and the charging process as a function of the measured parameters.

6. Charging device (1) according to any of the preceding claims, characterised in that the device (1) encompasses an indicator (12) that gives the user a visual indication of the charging process.

7. Charging device (1) according to any of the preceding claims, characterised in that it is adapted to charging of open and closed lead batteries, AMG batteries and gel batteries with a capacity of 4-225 Ah.

8. Charging device (1) according to any of the preceding claims, characterised in that the indicator (12) comprises at least one LED.

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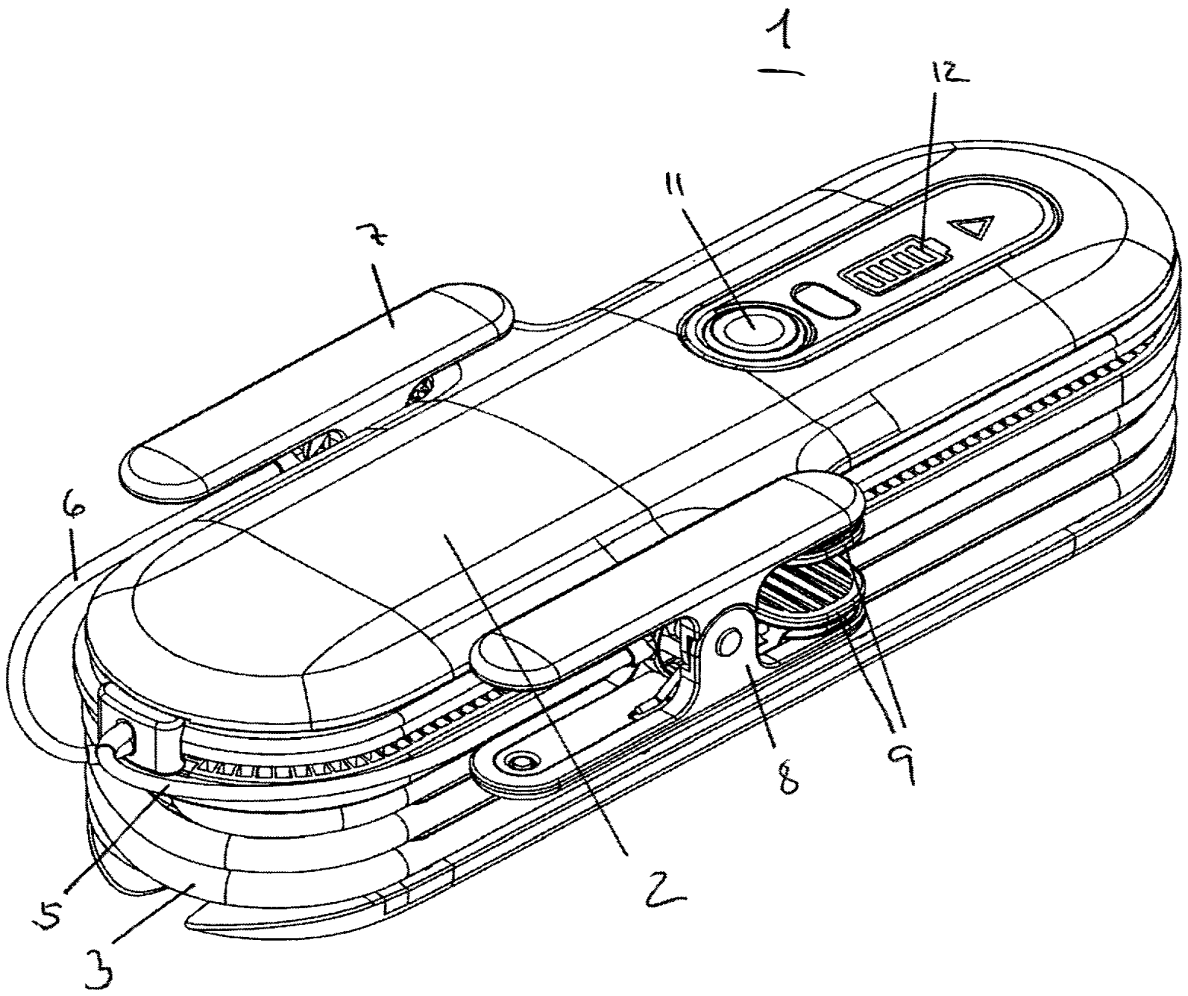


FIG. 1

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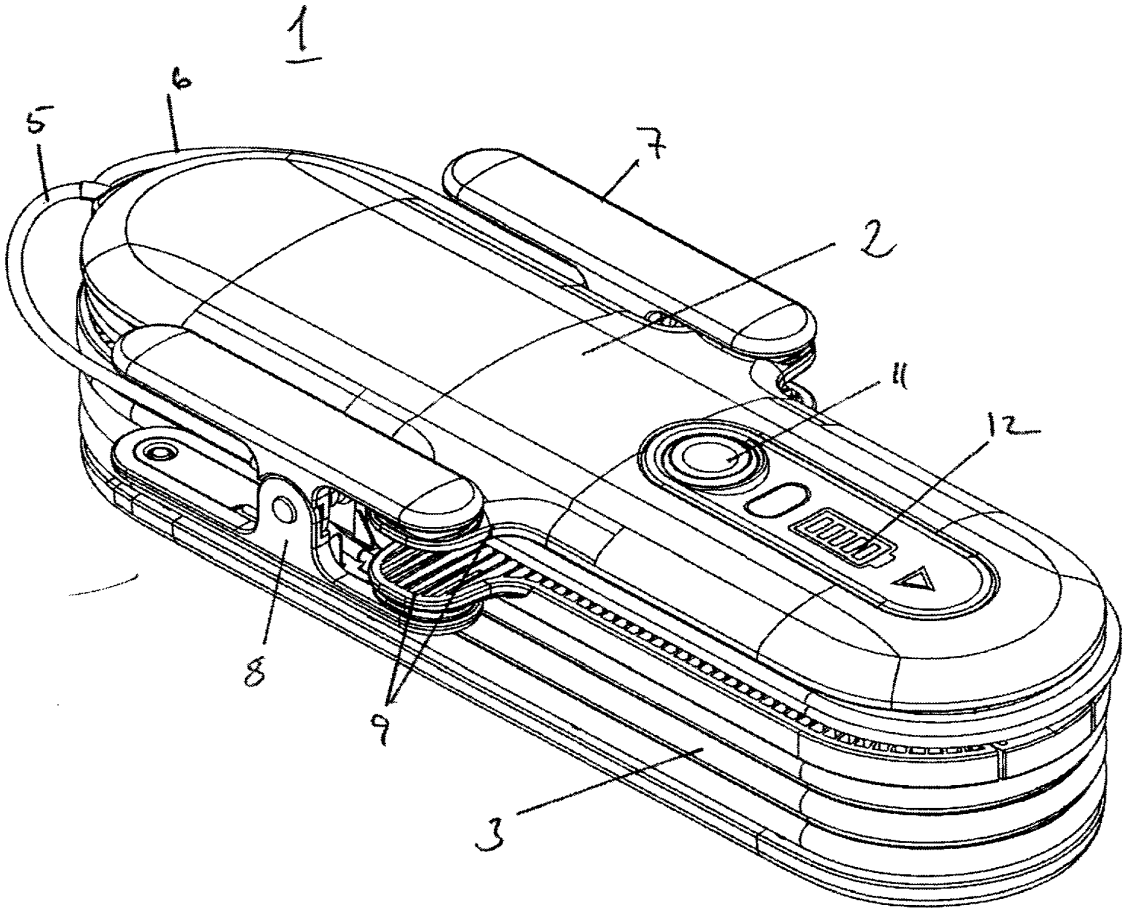


FIG. 2

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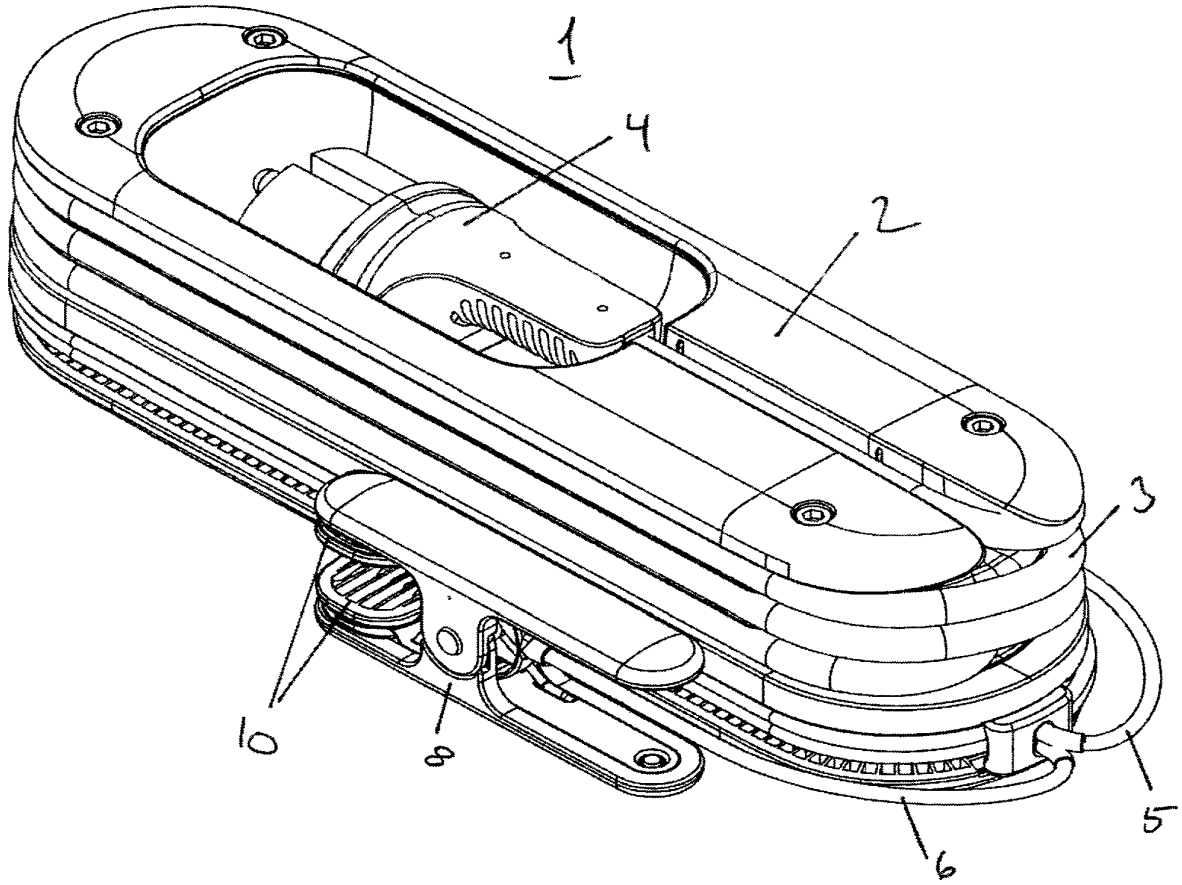


FIG. 3

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FIG. 4

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO2011/000245

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01R, H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Tomas Erlandsson Telephone No. + 46 8 782 25 00

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Continuation of: second sheet

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H01R 13/60 (2006.01)
H01R 13/72 (2006.01)

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METHOD OF RECHARGING A PAIR OF VEHICLE BATTERIES OF DIFFERENT NOMINAL VOLTAGES, AND ASSOCIATED SYSTEM

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CPCA	Y02T10/72	2013-01-01
CPCA	Y02T10/72	2013-01-01
CPCA	Y02T10/7072	2013-01-01

Abstract

A system for supplying electrical power to a vehicle comprises: - a network of electricity consuming units, which is able to be powered in a range of voltages less than or equal to a maximum network voltage (Vmax_network), - a first electrical accumulation battery connected to the network, and exhibiting a first maximum voltage when unloaded (V0max_Batt1) which is less than the maximum network voltage (Vmax_network), - a second electrical accumulation battery connected to the network, exhibiting a second maximum voltage when unloaded (V0max_Batt2), which is greater than the maximum voltage when unloaded of the first battery (V0max_Batt1), and a minimum acceptable voltage when unloaded (V0mini_Batt2) which is below the maximum network voltage (Vmax_network), - a drivable alternator connected to the network, and able to deliver to the second battery an electrical energy under a setpoint voltage drivable to various setpoint values (Valt_low, Valt_high). The system furthermore comprises an electronic management facility, configured to impose at least two different setpoint voltages successively on the alternator when the vehicle is running, namely a low alternator voltage (Valt_low) which is strictly greater than the first maximum voltage when unloaded of the first battery (V0max_Batt1), and a high alternator voltage (Valt_high) which is strictly greater both than the minimum voltage when unloaded of the second battery (V0mini_Batt2), and than the low alternator voltage (Valt_low).

Description

METHOD FOR RECHARGING A BATTERY TORQUE S OF A VEHICLE OF DIFFERENT NOMINAL VOLTAGES AND ASSOCIATED SYSTEM The invention relates to power supply systems for motor vehicles propelled by a thermal engine or with a hybrid electric - electric propulsion, and in particular to power supply systems comprising several batteries of different types.

It may indeed be desirable to use different types of batteries in parallel in order to take advantage, for example, of the good capacity of a lead-acid battery to supply energy for a cold start, and of the high specific

energy as well as the the greatest endurance in terms of charging and discharging cycles of a lithium-ion type battery.

The patent application US 201 1 00 1352 thus describes a system in which both types of batteries are present, the no-load voltages and the internal resistances of the two batteries being chosen so that, for a constant alternator voltage, this or preferably the lithium battery which discharges and recharges, the lead battery thus undergoing a lower number of charging and discharging cycles.

The use of the lead battery is then preferentially reserved for the starting phases of the vehicle.

To achieve such a configuration, the maximum no - load voltage of the lithium battery must remain relatively close to the maximum no - load voltage of the lead - acid battery. The maximum energy capacity of the lithium battery is therefore limited.

Such a system makes it possible to increase the lifetime of the lead-acid battery, but makes it necessary to limit the performance of the lithium batteries used. In addition, the constant voltage of the alternator must be chosen high enough to allow simultaneous charging of the lead-acid battery and the lithium battery, which induces overconsumption of fuel compared to a system with only a lead-acid battery. . --> The aim of the invention is to propose a system for powering a vehicle comprising two batteries, this system not only increasing the lifetime of the lead battery, but also reducing the average fuel consumption of the battery. vehicle.

For this purpose, a system for supplying electrical energy to a vehicle comprises:

a dc network, of at least one electrical consumer element, able to be supplied in a voltage range less than or equal to a maximum network voltage,

a first electric storage battery connected to the network, and having a first maximum voltage at no load less than the maximum network voltage,

a second electric accumulator battery connected to the network, having a second maximum voltage unladen, greater than the maximum no-load voltage of the first battery, and a minimum acceptable voltage not exceeding the maximum mains voltage,

a controllable alternator connected to the network, and capable of delivering to the second battery an electrical energy under a setpoint voltage that can be controlled at different setpoint values.

The system further comprises an electronic management unit, configured to impose on the alternator during the rolling of the vehicle, successively at least two different setpoint voltages, namely a low alternator voltage which is strictly greater than the first maximum voltage. empty of the first battery, and a high alternator voltage which is strictly greater than both the minimum voltage of the second battery empty, and the alternator low voltage. According to some embodiments, the alternator may be an alternator system comprising an alternator associated with a DC / DC transformer (direct current / direct current, also called "DC / DC converter"). The alternator can then be controllable itself in tension. According to another embodiment, the setpoint voltage can be controllable by modifying only the setpoint of the DC / DC transformer, the alternator being not controllable in voltage. In yet another embodiment, the --> The nominal voltage can be controlled by modifying both the voltage delivered by the alternator and the setpoint of the DC / DC transformer.

According to an improved embodiment, the system further comprises a DC / DC voltage transformer adapted to lower the voltage delivered by the second battery to the network. The second fully charged operating voltage of the second battery can then be greater than the maximum mains voltage.

Advantageously, the voltage transformer is bidirectional, and is able to supply the second battery at a voltage greater than the maximum voltage of the network when the alternator delivers a current under the high alternator voltage.

The first battery may be a lead-acid battery, and the second battery may be a lithium battery, particularly a lithium-ion type battery. The second battery may also be a lead acid battery (conventional or reinforced lead or VRLA according to the English "Valve Regulated Lead Acid Battery") with different characteristics of the first battery.

The electronic management unit can be configured to open a switch of the second battery when the vehicle is in a parking mode, that is to say engine stopped, and can be configured, if the voltage of the first battery goes under a first threshold and simultaneously the voltage of the second battery is above a second threshold, to close the switch for a predetermined period before performing the next start of the vehicle. This predetermined period makes it possible to partially recharge the first battery.

According to another aspect, in a management method of a motor vehicle equipped with a first battery and a second battery for supplying electrical energy, the two batteries having maximum voltages with different voids and being connected to the same alternator and to the same DC electrical network of the vehicle, it imposes a low alternator voltage during the first rolling phases of the vehicle, and imposes a high alternator voltage higher than the alternator low voltage during second vehicle taxiing phases such as regenerative braking phases, less --> fuel consumers than the first phases. The first rolling phases correspond to rolling phases out of deceleration. Advantageously, this method can be applied to a motor vehicle where the first battery, the second battery and the alternator are connected in parallel.

Preferably, the high alternator voltage is imposed when the vehicle is in a recuperative deceleration phase, and the low alternator voltage is imposed when the vehicle is in an acceleration phase of the engine.

It is possible to impose an alternator intermediate voltage that is strictly greater than the alternator low voltage and less than or equal to the alternator high voltage, when a charge level of the second battery becomes lower than a threshold load, and / or when a certain mo of vehicle running other than the deceleration, is detected, and / or if the current delivered by the second battery to the network exceeds a certain threshold. The level of the intermediate alternator voltage may be different in the different cases mentioned.

For example, it is possible to supply the second battery with a DC / DC transformer by bringing the voltage across the battery to a value between 15V and 17V during the vehicle's regenerative deceleration phases.

The system may include solar panels embedded on the vehicle, and connected to the network.

The system may also include an electrical outlet adapted for recharging the second battery on a network outside the vehicle.

According to a preferred embodiment, the second battery may be a refurbished lithium battery that has already been used to provide automotive propulsion energy. Typically the second lithium battery is composed of two "worn" modules of a traction battery for an electric vehicle, that is to say whose state of charge is between 70% and 80% of their initial capacity. The system according to the invention uses these modules in a voltage range corresponding to a state of charge of between 5% and 30% of their initial capacitance. To avoid unloading these modules below their state of use, a switch is --> placed between the lithium battery and the rest of the system, this switch being open as soon as the state of charge of the battery reaches a state of charge of 5% and is no longer recharged by the system according to the invention, so typically in "parking" mode, that is to say when the vehicle engine is stopped.

The electronic management unit may for example be configured to impose a low alternator voltage which is less than or equal to 1.05 times the maximum no-load voltage of the first battery, or even less than 1.035 times the maximum voltage at the first battery. empty of the first battery.

The alternator low voltage can for example be between 12, 8 and 13.5V, and the alternator high voltage can be between 14 and 15V.

According to an advantageous embodiment, the second battery can be powered by a DC / DC transformer by bringing the voltage across the battery to a value between 15V and 17V during the recuperative deceleration phases of the vehicle.

Other objects, features and advantages of the invention will appear on reading the following description, given solely by way of non-limiting example, and with reference to the appended drawings, in which:

FIG. 1 is a schematic representation of a feed system according to the invention,

FIG. 2 is a graph showing the relative levels of different voltages involved in the operation of the feed system of FIG. 1,

FIG. 3 is an algorithm illustrating a possible management mode of the feed system of FIG. 1.

As illustrated in FIG. 1, a system 1 for powering a vehicle comprises an electrical network 2, an alternator 3, a first battery 4, for example a lead-acid battery, a second battery 7, for example a battery lithium-ion battery, and an electronic management unit 1 0. The second battery 7 is provided with a switch 1 1 for disconnecting the network 2. The alternator 3 is able to convert from --> the mechanical energy taken from a shaft connected to a heat engine (not shown) in electrical energy sent to the electrical network 2.

On the electrical network 2 are disposed electrical consumers 6, such as an air conditioning device, lighting means and heating means. The alternator 3 is connected to the terminals of the first battery 4. The second battery 7 is connected in parallel to the first battery 4. The electrical consumers 6 are connected in parallel to the network 2. The network 2 comprises a ground connection 5 on the chassis of the vehicle. The network 2

also supplies a starter capable of starting the engine of the vehicle to initiate the first combustion cycle.
According to the variants, the second battery 7 can be connected to a DC / DC transformer 8 connected in series with the battery 7, so that the voltage across the second battery 7 can be higher than the maximum voltage. network 2.
In the embodiments in which the second battery 7 is associated with a DC / DC transformer 8, energy production means such as solar panels 9 can be connected to the terminals of the second battery 7, which allows the maximum voltage delivered by these solar panels 9 to be higher than the maximum voltage of the network 2. The electronic management unit is connected to the alternator 3, to which it is able to impose a variable setpoint voltage and in particular, to which it is able to impose two distinct values of set values, a first value denoted Valt low and a second value denoted Valt high higher than the first value.
The electronic management unit 1 0 is also connected to the switch 11, which may be of the mechanical-electromagnetic type, or of the electronic type, for example in the form of a transistor. By opening the switch 1 1, the electronic management unit 10 can disconnect the second battery 7 from the network, and prevent an inadvertent discharge of the second battery 7.
The first battery, especially if the first battery is a lead-acid battery, can be used preferentially at --> start of the engine of the vehicle, to power a starter. The electronic management unit 1 0 disconnects the second battery 7 (for example a lithium battery, and more precisely of the lithium-ion type) using the switch 1 1, as soon as the vehicle is in "parking" mode. . In this way, the battery 7 is not discharged. The second battery 7 then remains disconnected from the network until the next start of the vehicle engine has been made.
Lead-acid batteries have excellent cold start capability, and so it is the first lead-acid battery 4 that is used when the vehicle's heat engine is started.
Lithium batteries have a better endurance in terms of cycling, and it is therefore the second battery that is used to supply the vehicle's on-board network while driving the vehicle. The voltage of the network, that is to say the measurable voltage between the terminals of the first battery 4, is imposed by that of the three elements, among the alternator 3, the first battery 4 and the second battery 7 possibly associated with a DC / DC transformer, which has the highest voltage between its two terminals.
By "terminals" of each of the elements, we mean the two connection points of this element to the network 2.
In the case where the system includes a DC / DC transformer 8, connected as described in FIG. 1, the term "voltage across the set [second battery 7, DC / DC transformer 8]" means the voltage between the two points. connecting this set to the network 2.
When the alternator 3 does not rotate, for example at the time of starting the vehicle, and the second battery 7 is disconnected by means of the switch 1 1, it is the first battery 4 which imposes the voltage on the network 2 .
When the vehicle is running and the alternator 3 is operating, it is decided to control the voltage setpoint of the alternator 3 above the maximum empty voltage of the first battery 4. In this way, it is not the first battery 4 which supplies the electrical power of the circuit 2. Depending on whether the voltage of the alternator 3 is higher or lower than the voltage of the second battery 7, this --> then will be either the alternator 3 or the second battery 7, or both simultaneously, which will provide the electrical energy of the network 2.
In the context of the invention, a second battery 7 is chosen, the maximum empty voltage of which is sufficiently greater than the maximum empty voltage of the first battery 4, so as to be able to alternatively impose two modes of operation. In the first mode of operation, the alternator voltage is set to a low value "Low_value", which is greater than the maximum open-circuit voltage of the first battery "VOmax battl", itself lower than the maximum voltage tolerated by the network "Vmax network". The alternator voltage "low valt" is lower than the maximum voltage unladen of the second battery 7 "V0max_batt2". In a second mode of operation, the alternator voltage is equal to a high voltage generator value "High Valt", which is higher than the low alternator voltage, while remaining lower than the maximum voltage tolerated by the generator. network.
In this way, when the alternator 3 is regulated to deliver the alternator low voltage, and the second battery 7 is sufficiently charged so that its voltage is greater than the low alternator voltage, it is the second battery 7. 2. When, in this mode of operation, the operating voltage of the second battery 7 drops to the level of the low alternator voltage, part of the electrical power of the network 2 is supplied. by the second battery 7, and a part of the electrical energy is supplied by the alternator 3.
When the electronic management unit 10 imposes the second mode of operation, where it is the alternator

high voltage which is imposed, if the unladen voltage of the second battery is lower than the high alternator voltage, it is is then the alternator which supplies the electrical energy to the network and which simultaneously provides energy for recharging the second battery 7.
If no other means than the alternator 3 is provided to recharge the second battery 7, the second battery 7 can be recharged during the phases where it is the high alternator voltage is imposed, and can provide the energy to the grid as long as its voltage remains higher than the alternator low voltage, --> the phases where the electronic management unit 1 0 imposes the alternator low voltage.
It is preferable to impose a low alternator voltage just above the maximum empty voltage of the first battery, so that during the phases when the low alternator voltage is imposed, the alternator takes as little as possible of mechanical energy on the motor shaft driven by the heat engine. The alternator thus creates only a limited fuel consumption, while ensuring that the first battery is constantly charged to its maximum level.
In the first mode of operation, as long as the second battery 7 is sufficiently charged (that is to say as long as its voltage is greater than the low voltage of the alternator), it is the second battery 7 which supplies the battery. electrical energy to the network 2.
The phases in which the high alternator voltage is imposed in order to recharge the second battery 7, are preferably the low fuel cost running phases, for example the recuperative deceleration phases, ie to tell if the vehicle is in a deceleration mode for using the engine brake, and to use some of the mechanical energy from the motor shaft to rotate the alternator. For example, it suffices for the setpoint of the pedal of the vehicle to correspond to a phase of engine deceleration.
Part of the kinetic energy of braking of the vehicle then serves to recharge the second battery 7. This energy recovered during the braking phases then makes it possible to save fuel, by limiting the alternator voltage imposed during the corresponding taxiing phases. in the first mode of operation.
FIG. 2 illustrates an example of relative positioning of the various voltage values mentioned previously in the description of the power supply system 1. The different levels shown in FIG. 2 illustrate the minimum empty voltage of the first battery 4, ie, V mini batt I, the maximum no-load voltage of the first battery 4, that is VOmax batt I, the minimum open-circuit voltage V 0mini_batt 2 of the second battery 7 , the maximum empty voltage V0max_batt2 of the second battery, the --> Low alternator voltage Valt low, the high alternator voltage Valt high and the maximum voltage Vmax network that the network 2 is able to withstand without being damaged.
Typically, if one operates with a lead-acid battery as the first battery 4, and with, as a second battery, a lithium-ion type battery resulting from the recovery of lithium-ion batteries used to propel electric vehicles or hybrid, the minimum vacuum voltage VOmini beat I of the first lead acid battery is of the order of 12 volts, and is substantially the minimum voltage V0mini_batt2 vacuum of the second lithium battery, or is a little lower.
The maximum voltage at no load VOmax beats the first lead acid battery is of the order of 12.8 vo lts, and the low alternator voltage Valt low which is imposed to be just above this maximum voltage at vacuum is of the order of 1 3, 2 volts.
The maximum unloaded voltage V0max_batt2 of the second lithium battery may be of the order of 16.8 volts, and the high voltage of alternator Valt high of the order of 15 volts to remain below the value. maximum accepted by the network Vmax network, which it is of the order of 1 6 volts.
It is conceivable to use other types of battery for the first and the second battery, and the maximum voltage of the second battery is not necessarily greater than the maximum voltage of the network. The alternator low voltage should preferably be greater than the maximum no-load voltage of the first battery. One could possibly consider a mo de embodiment where the low alternator voltage would be very slightly less than the maximum empty voltage of the first battery, but it would then unnecessarily impose charging and discharging cycles to the first battery by reducing the lifetime of it.
The maximum voltage of the second battery must necessarily be higher than the maximum no-load voltage of the first battery, so as to be able to define a low voltage value of alternator between these two values of maximum voltage at no load of the two batteries.
The alternator high voltage may be equal to, or greater than, the maximum empty voltage of the second battery, by --> example if the maximum voltage of the second battery is lower than the maximum voltage tolerated by the network.
The minimum empty voltage of the second battery must be lower than the high voltage of the alternator in

order to allow at least partial charging of the second battery 7 during the operating phases with the high voltage of the alternator.

The second battery 7 can be recharged, in addition during the phases when the alternator rotates to its high voltage value, by additional electrical generating means such as solar panels 9. In the case where the maximum voltage at no load of the second battery is less than the maximum voltage tolerated by the network, or in the case where the system comprises a DC / DC transformer adapted to lower the voltage delivered by the second battery to a voltage lower than the maximum voltage to the lattice, may also consider recharging the second battery 7 on a network outside the vehicle, for example on a parking area.

The maximum no-load voltage of the second battery 7, that is to say V0max_batt2, may be lower or higher than the maximum voltage accepted by the network 2. If the maximum empty voltage of the second battery is greater than the voltage The maximum voltage accepted by the network Vmax network, according to a first embodiment, operates the second battery 7 on only part of its operating range that is to say for example between the low voltage of the alternator and the high voltage alternator.

According to a second variant of operation, it is possible to exploit the second battery 7 over a wider range, for example between the low alternator voltage and the maximum empty voltage accepted by the second battery 7, if for example the system is provided with a DC / DC transformer 8, adapted to lower the voltage delivered by the second battery 7 so as to bring it to a value less than or equal to the maximum voltage tolerated by the network.

In this case, one can for example consider charging the second battery 7 at its maximum voltage when empty from a network outside the vehicle, when the vehicle is stopped. This reserve of energy is then used during the driving of the vehicle in the --> supplemented by a partial recharge of the battery at a high alternator voltage when the vehicle is recovering deceleration.

If the DC / DC transformer is bidirectional, it can even be envisaged to charge the second battery at its maximum voltage unladen by raising the voltage at the terminals of the second battery 7 relative to the high voltage of the alternator during the phases of recuperative deceleration. .

For safety, in order to avoid even a partial discharge of the first battery 4, the alternator low voltage is chosen slightly higher than the maximum empty voltage of the first battery 4.

The minimum empty voltage of the second battery 7 is preferably lower than the low voltage of the alternator so that, when the vehicle is in a running mode where the low alternator voltage is imposed by the generator unit. electronic management 10, the energy supplied by the alternator automatically comes to supplement the energy provided by the second battery 7 when the voltage thereof is decreasing. This prevents the voltage of the second battery 7 can go down to the minimum voltage tolerated V0mini_batt2.

Alternative embodiments could be envisaged where the minimum empty voltage of the second battery would be greater than the low voltage of the alternator, but it is necessary for such a variant that the electronic management unit 10 impose a high voltage of the alternator before that the voltage of the second battery 7 does not fall below its minimum value. In all cases, the minimum voltage of the second battery 7 must be lower than the high voltage of the alternator.

The alternator low voltage is preferably lower than the maximum no-load voltage of the second battery 7. It is as close as possible, by a higher value, to the maximum empty voltage of the first battery, while keeping a margin of The difference in order to be sure that the alternator regulated alternator low voltage remains above this minimum value VOmax beats I.

It is advantageous to use a second battery 7 whose maximum maximum voltage V0max_batt2 is greater than the voltage --> the maximum voltage Vmax of the network 2, which makes it possible, in order to choose the values of the low alternator voltage and the high alternator voltage, to have the entire voltage range between the maximum empty voltage of the first VOmax battery beats I and the maximum voltage accepted by network Vmax_network.

In particular, this configuration is found when there is a network 2 of the vehicle whose maximum acceptable voltage is of the order of 15 to 16 volts, and when a lead battery is used as the first battery 4, whose maximum open-circuit voltage is about 12.8 volts, and a lithium-ion battery for the second battery 7, for example a lithium-ion battery reconditioned following use for the propulsion of an electric vehicle. Such a reconditioned battery has, for example, a maximum no-load voltage of the order of 16.8 volts and an acceptable minimum voltage of not more than 12 volts.

In addition to switching to a high alternator voltage during the deceleration phases of the vehicle, additional

strategies implemented in the electronic management unit 10 may be defined, in order to avoid an excessive discharge of the second battery 7 in the case of figure where the phases of recuperative deceleration are not sufficiently frequent and / or sufficiently prolonged.
One can then choose to impose an alternator voltage intermediate between the low alternator voltage and the high alternator voltage, that is to say strictly greater than the low alternator voltage and less than or equal to the alternator voltage. high alternator voltage. One or more intermediate voltages can thus be imposed during certain driving phases that may suggest that the next decelerations are distant in time. These driving phases may include highway-type driving modes. One or more intermediate voltages may also be imposed for pre-programmed driving modes in the electronic management unit because the operating point of the engine, for these driving modes, corresponds to a lower fuel consumption than for others. driving modes. -->
The switching to an alternator alternating voltage can also be conditioned by the simultaneous detection of a given driving mode, and a state of charge lower than or equal to a threshold charge state of the second battery 7.
FIG. 3 illustrates an algorithm 1 that can be impregnated in the electronic management unit 10 of a power supply system according to the invention. At an initial time 2 1, corresponding for example to the commissioning of the vehicle or its return to service after a change of batteries, the electronic management unit 10 tests, in a step 22, if the vehicle is in mode car park.
If this is the case, the electronic management unit 10 disconnects, if it is already done, the second battery 7 of the network 2 with the switch 1 1, in a step 23.
It then tests in a step 24, if the voltage across the second battery 7 has fallen below a voltage Vmin which may, for example, be equal to the minimum voltage V0mini_batt2 vacuum of the second battery, or be a slightly higher value than this minimum vacuum voltage.
If the measured voltage is lower than the threshold voltage Vmin, the electronic management unit 10 displays an alert message warning the driver that he must change the second battery 7, to a step 25. If the voltage is higher than the threshold voltage Vmin, the electronic management unit returns to step 22.
When the test 22 indicates that the vehicle is no longer in the parking configuration, the electronic management unit 10 tests in a step 26 the health of the second battery 7. This health test may for example consist of checking whether the number cycles of charges and discharges already suffered by the second battery 7 is less than a threshold number Nmax of charges and discharges, if the different cells of the battery are sufficiently balanced, and if the voltage at the terminals of the battery is greater than or equal to the threshold voltage Vmin.
If the answer is negative, the electronic management unit 1 0 displays the warning message corresponding to step 25. If the result of the test 26 is positive, the electronic management unit carries out a test 27 to know if the The vehicle's engine is active. If this --> is not the case, the electronic management unit 10 sets up a strategy 28 for feeding the network 2 either from the first battery, or from the second battery, or from the two batteries together , then return to step 22.
When the test 27 indicates that the engine of the vehicle is active, the electronic management unit tests at a step 29 if the vehicle is in a mode of recuperative deceleration, that is to say if the vehicle is in a mode deceleration device for using the engine brake, drawing a portion of the mechanical energy from the motor shaft to rotate the alternator. For example, it suffices for the setpoint to the pedal of the vehicle corresponds to a phase of engine deceleration.
If the vehicle is in a recuperative deceleration mode, the electronic management unit 10 imposes on the alternator a high alternator voltage, for example 15 volts, in a step 31, and continues to loop on the test 29 and then on the piloting at the alternator high voltage 31, as long as the vehicle is decelerating.
If the vehicle is not in regenerative deceleration at the exit of the test step 29, the electronic management unit 10 forces the alternator 3 to operate at the alternator low voltage, for example at 13 volts, at a step 30.
Following step 30, the electronic management unit 10 tests whether the vehicle and the second battery 7 are in a "forced load" configuration. Such a forced load configuration may for example correspond to the case where the voltage across the second battery 7 drops below a threshold value Vi and where simultaneously a time counter Δί, which counts the time elapsed since the last deceleration, goes over a threshold Δΐ.Math..
In this case, it can be considered that the voltage of the second battery begins to become insufficient, and

that the driving mode detected is not a driving mode punctuated by sufficiently frequent decelerations.
If this test 32 reveals that it is in the forced-running configuration, the electronic management unit 10 imposes, at a step 33, a regulation of the alternator 3 at a voltage Valt Mid, for example equal to 14, 5 volts, and continues to impose this mode of --> charge as long as the charge level of the battery tested at a step 34 has not reached a satisfactory minimum level SOC .sub.m i .sub.n .

This minimum charge level can for example be detected by a decrease of the charging current entering the second battery 7.

When the test of step 34 indicates that the recharge level of the second battery is sufficient, the electronic management unit 10 tests at a step 35 the health of the second battery 7, for example by checking that the temperature of the battery The battery does not exceed a maximum temperature T .sub.max , verifying that the balancing level between the different cells is sufficient, or that this level still makes it possible to rebalance the different cells, and verifying that the voltage V across the second battery is greater than the threshold voltage V .sub.m i .sub.n .

If the level of health detected in step 35 is insufficient, the electronic management unit 10 displays the alert message corresponding to step 25. In the opposite case, the electronic management unit 10 tests at a step 36 if the different cells of the second battery 7 are sufficiently balanced. If this is the case, the electronic management unit returns to the test step 22 to check if the vehicle, meanwhile, is in parking mode.

In the opposite case, the electronic management unit triggers a balancing of the cells in a step 37 and also returns to the step 22.

The object of the invention is not limited to the embodiments described and may be the subject of numerous variants, both as regards the arrangement of the different elements of the system 1, the operating algorithms imp lantés in the electronic management unit 10 and / or the choice of types of batteries or other types of accumulators.

The low voltage and high voltage impeded at the terminals of the second battery 7 can be obtained either by regulating the voltage delivered by the alternator at two different levels or by raising the voltage at the terminals of the second battery using a DC / DC transformer. The high voltage can also be obtained by raising both the setpoint voltage across --> the alternator and transforming this voltage, using the DC / DC transformer, into an even higher voltage across the second battery.

The operating algorithm, an example of which is given in FIG. 3, admits of a very large number of variants, in particular as regards the succession of the various tests for determining which alternator voltage must be imposed at a given instant, or in the defining one or more modes of forced charging. These forced charging modes can be set with different Valt Mid alternator voltages depending on the modes. For example, it is possible to define different modes of forced charging according to different conditions of charge level of the second battery and different conditions of the type of running and / or operating point of the engine detected.

The electric accumulators referred to as first and second batteries may be electrochemical storage batteries, for example a first lead battery and a second lithium ion battery. It is also possible to consider using for the second battery other types of lithium batteries than lithium-ion batteries, other electrochemical batteries or one or more supercapacitors.

The invention can be used for a power supply system of a propulsion vehicle by a heat engine. It can also be used for a power system of an electric hybrid electric propulsion vehicle. In the latter case, it is possible for example to use a lithium battery as the first battery used both for starting the vehicle and for occasional propulsion of the vehicle, and a second supercapacitor type battery for accumulating energy during the phases. deceleration. It is therefore necessary to understand in this application the term "electric accumulator battery" in the broad sense since it encompasses storage systems of the supercapacitor type.

The system according to the invention makes it possible to reduce the overall fuel consumption of the vehicle, to extend the life of the first battery, and, in the case where --> as a second battery a reconditioned lithium battery, reduce the cost and the ecological footprint of the system.

It should be noted that the concept of using two batteries for different purposes can be expanded to more than two batteries. In fact, it is conceivable to also use a third battery connected to the on-board network via a DC / DC converter and a switch, this switch being closed in terms of "parking", that is to say engine stopped, to provide the necessary electrical energy to the on - board consumers. Advantageously this third battery consists of modules recovered from an electric vehicle traction battery, benefits from the best performance points of the engine and the alternator to be recharged (for example in deceleration, in the

same way as the second battery at lithium), and benefits from a complementary charging system such as a solar panel.

Similarly, the first lead battery used for starting the vehicle, can be connected to the on-board network via a switch, to further specialize its use: this switch is closed for example only at startup, and on the best performance points of the engine and the alternator when its state of charge is below a certain threshold.

It should be noted that the use of a switch between firstly a first battery and the onboard network and secondly a second battery and the onboard network makes it possible to use for these two batteries identical lead batteries. connected in parallel with the alternator without DC / DC intermediate while assigning them a specific role (starting for one, consumption of the network for the other) and having them recharge at the best points of efficiency of the engine and the alternator.

Claims

1. System (1) for supplying electrical energy to a vehicle, comprising:

a dc network (2) of at least one electrical consumer element (6) able to be supplied in a voltage range less than or equal to a maximum network voltage (Vmax_network),

a first battery (4) of electrical accumulation connected to the network (2), and having a first maximum voltage at no load (VO max Batt I) lower than the maximum network voltage (V max_network),

a second battery (7) of electrical accumulation connected to the network (2), having a second maximum voltage unladen (V0max_Batt2), greater than the maximum voltage at no load of the first battery (VOmax Battl), and a minimum voltage acceptable vacuum (V0mini_Batt2) lower than the maximum network voltage (Vmax_switch),

a controllable alternator (3) connected to the network (2), and capable of delivering to the second battery (7) an electrical energy under a setpoint voltage that can be controlled at different setpoint values (low_valve, high_valve),

characterized in that the system further comprises an electronic management unit (10), configured to impose on the alternator (3) during the rolling of the vehicle, successively at least two different setpoint voltages, namely a low voltage of alternator (Valt_basse) which is strictly greater than the first maximum empty voltage of the first battery (VOmax Batt I), and a high alternator voltage (Valt high) which is strictly greater than both the minimum empty voltage of the second battery (V0mini_Batt2), and the alternator low voltage (Valt_basse).

2. System according to claim 1, further comprising a DC / DC voltage transformer (8) adapted to lower the voltage delivered by the second battery (7) to the network, and wherein the second maximum voltage to no load (V0max_Batt2) of the second --> battery (7) is greater than the maximum mains voltage (Vmax_network).

3. System according to claim 2, wherein the voltage transformer (8) is bidirectional, and is able to supply the second battery (7) at a voltage greater than the maximum voltage of the network (Vmax network) when the alternator (3) delivers a current under the alternator high voltage (high Valt).

4. System according to one of the preceding claims, wherein the first battery (4) is a lead battery, and the second battery (7) is a lithium battery.

5. System according to one of the preceding claims, wherein the electronic management unit (10) is configured to open a switch (1 1) of the second battery (7) when the engine of the vehicle is stopped and, if the voltage of the first battery (4) goes under a first threshold and simultaneously the voltage of the second battery is above a second threshold, to close the switch (1 1) for a predetermined period before performing the next start of the vehicle.

6. A method of managing a motor vehicle equipped with a first battery (4) and a second battery (7) for supplying electrical energy, the two batteries having maximum voltages with voids (V0max_Batt I 2, V0max_Batt2) and being connected to the same alternator (3) and the same DC electrical network of the vehicle (2), characterized in that it imposes a low alternator voltage (low Valt) during early phases of of the vehicle, and imposes a higher alternator voltage (Valt high) higher than the low alternator voltage during second vehicle running phases such as regenerative braking phases, less fuel-intensive than the first phases.

7. The method as claimed in claim 6, in which the high alternator voltage (high Valt) is imposed when the vehicle is in the recuperative deceleration phase, and the low alternator voltage (low valt) is imposed when the vehicle is in the vehicle. an acceleration phase of the engine.
8. Process according to claims 6 to 7, wherein an alternator intermediate voltage (Valt Mid) is imposed, --> strictly greater than the alternator low voltage (Low valt) and lower than or equal to the high alternator voltage (High valt), when a charge level of the second battery (7) becomes lower than a threshold load, and / or when a certain mode of driving the vehicle other than the deceleration, is detected, and / or if the current delivered by the second battery (7) to the network exceeds a certain threshold.

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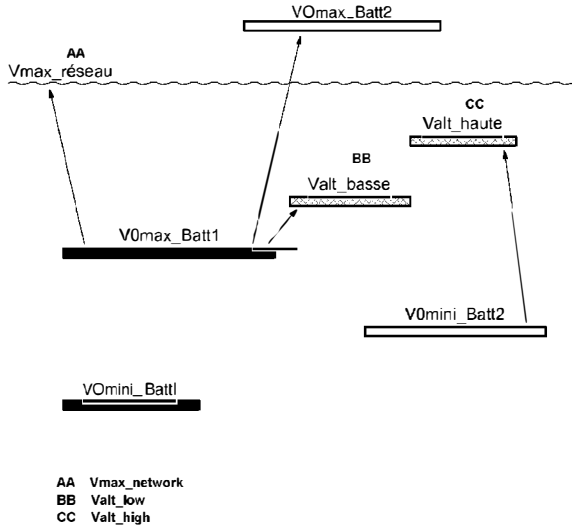
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[Suite sur la page suivante]

(54) **Title** : METHOD OF RECHARGING A PAIR OF VEHICLE BATTERIES OF DIFFERENT NOMINAL VOLTAGES, AND ASSOCIATED SYSTEM

(54) **Titre** : PROCEDE DE RECHARGEMENT D'UN COUPLE DE BATTERIES DE VEHICULE DE TENSIONS NOMINALES DIFFERENTES, ET SYSTEME ASSOCIE

FIG.2



(57) **Abstract : A** System for supplying electrical power to a vehicle comprises: - a network of electricity consuming units, which is able to be powered in a range of voltages less than or equal to a maximum network voltage (Vmax_network), - a first electrical accumulation battery connected to the network, and exhibiting a first maximum voltage when unloaded (V0max_Batt1) which is less than the maximum network voltage (Vmax_network), - a second electrical accumulation battery connected to the network, exhibiting a second maximum voltage when unloaded (V0max_Batt2), which is greater than the maximum voltage when unloaded of the first battery (V0max_Batt1), and a minimum acceptable voltage when unloaded (V0mini_Batt2) which is below the maximum network voltage (Vmax network), - a drivable alternator connected to the network, and able to deliver to the second battery an electrical energy under a setpoint voltage drivable to various setpoint values (Valt_low, Valt_high). The System furthermore comprises an electronic management facility, configured to impose at least two different setpoint voltages successively on the alternator when the vehicle is running, namely a low alternator voltage (Valt_low) which is strictly greater than the first maximum voltage when unloaded of the first battery (V0max_Batt1), and a high alternator voltage (Valt_high) which is strictly greater both than the minimum voltage when unloaded of the second battery (V0mini_Batt2), and than the low alternator voltage (Valt_low).

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Un système d'alimentation en énergie électrique d'un véhicule. comprend: -un réseau d'organes consommateurs électriques, apte à être alimenté dans une gamme de tensions inférieure ou égale à une tension maximale de réseau (Vmax_réseau), -une première batterie d'accumulation électrique counectée au réseau, et présentant une première tension maximale à vide (VOmax_Battl) inférieure à la tension maximale de réseau (Vmax_réseau), -une seconde batterie d'accumulation électrique connectée au réseau, présentant une seconde tension maximale à vide (V0max_Batt2), supérieure à la tension maximale à vide de la première batterie (V0-max_Battl), et une tension minimale à vide acceptable (V0mini_Batt2) inférieure à la tension maximale de réseau (Vmax_réseau), -un alternateur pilotable connecté au réseau, et apte à délivrer à la seconde batterie une énergie électrique sous une tension de consigne pilotable à différentes valeurs de consigne (Valt_basse, Valt_haute). Le système comprend en outre une unité de gestion électronique, configurée pour imposerà l'alternateur lors du roulage du véhicule, successivement au moins deux tensions de consigne différentes, à savoir une tension basse d'alternateur (Valt_basse) qui est strictement supérieure à la première tension maximale à vide de la première batterie (V0max_Battl), et une tension haute d'alternateur (Valt_haute) qui est strictement supérieure à la fois à la tension minimale à vide de la seconde batterie (V0mini_Batt2), et à la tension basse d'alternateur (Valt_basse).

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Petitioner ADC (IPR2024-00577)

PROCEDE DE RECHARGEMENT D'UN COUPLE DE BATTERIES DE VEHICULE DE TENSIONS NOMINALES DIFFERENTES, ET SYSTEME ASSOCIE

L'invention se rapporte aux systèmes d'alimentation électrique de véhicules automobiles à propulsion par un moteur thermique ou à propulsion hybride thermique-électrique, et notamment aux systèmes d'alimentation électrique comprenant plusieurs batteries de types différents.

On peut en effet souhaiter utiliser différents types de batteries en parallèle afin de tirer parti par exemple de la bonne capacité d'une batterie au plomb à fournir de l'énergie pour un démarrage à froid, et de la forte énergie spécifique ainsi que de la plus grande endurance en terme de cycles de charge et de décharge d'une batterie de type lithium-ion.

La demande de brevet US 2011 00 1352 décrit ainsi un système où les deux types de batteries sont présentes, les tensions à vide et les résistances internes des deux batteries étant choisies de manière à ce que, pour une tension d'alternateur constante, ce soit de manière préférentielle la batterie au lithium qui se décharge puis se recharge, la batterie au plomb subissant ainsi un moindre nombre de cycles de charge et de décharge.

L'utilisation de la batterie au plomb est alors réservée de manière préférentielle aux phases de démarrage du véhicule.

Pour permettre d'obtenir une telle configuration, la tension maximale à vide de la batterie au lithium doit rester relativement proche de la tension maximale à vidc de la batterie au plomb. La capacité énergétique maximale de la batterie au lithium s'en trouve donc limitée.

Un tel système permet d'augmenter la durée de vie de la batterie au plomb, mais oblige à limiter les performances des batteries au lithium utilisées. En outre, la tension constante de l'alternateur doit être choisie suffisamment élevée pour permettre de recharger simultanément la batterie au plomb et la batterie au lithium, ce qui induit une surconsommation de carburant par rapport à un système muni uniquement d'une batterie au plomb.

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L'invention a pour but de proposer un système d'alimentation électrique d'un véhicule comprenant deux batteries, ce système permettant non seulement d'augmenter la durée de vie de la batterie au plomb, mais également de réduire la consommation moyenne en carburant du véhicule.

A cet effet, un système d'alimentation en énergie électrique d'un véhicule, comprend :

-un réseau à courant continu, d'au moins un organe consommateur électrique, apte à être alimenté dans une gamme de tensions inférieure ou égale à une tension maximale de réseau,

-une première batterie d'accumulation électrique connectée au réseau, et présentant une première tension maximale à vide inférieure à la tension maximale de réseau,

-une seconde batterie d'accumulation électrique connectée au réseau, présentant une seconde tension maximale à vide, supérieure à la tension maximale à vide de la première batterie, et une tension minimale à vide acceptable inférieure à la tension maximale de réseau,

-un alternateur pilotable connecté au réseau, et apte à délivrer à la seconde batterie une énergie électrique sous une tension de consigne pilotable à différentes valeurs de consigne.

Le système comprend en outre une unité de gestion électronique, configurée pour imposer à l'alternateur lors du roulage du véhicule, successivement au moins deux tensions de consigne différentes, à savoir une tension basse d'alternateur qui est strictement supérieure à la première tension maximale à vide de la première batterie, et une tension haute d'alternateur qui est strictement supérieure à la fois à la tension minimale à vide de la seconde batterie, et à la tension basse d'alternateur. Selon certaines variantes de réalisation, l'alternateur peut être un système d'alternateur comprenant un alternateur associé à un transformateur CC/CC (courant continu/courant continu, encore appelé « DC/DC converter» en anglais). L'alternateur peut alors être pilotable lui-même en tension. Selon un autre mode de réalisation, la tension de consigne peut être pilotable en modifiant uniquement la consigne du transformateur CC/CC, l'alternateur n'étant pas pilotable en tension. Selon encore un autre mode de réalisation, la

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tension de consigne peut être pilotable en modifiant à la fois la tension délivrée par l'alternateur et la consigne du transformateur CC/CC.

Selon un mode de réalisation amélioré, le système comporte en outre un transformateur de tension de type CC/CC apte à abaisser la tension délivrée par la seconde batterie au réseau. La seconde tension de fonctionnement à charge complète de la seconde batterie peut alors être supérieure à la tension maximale de réseau.

Avantageusement le transformateur de tension est bidirectionnel, et est apte à alimenter la seconde batterie à une tension supérieure à la tension maximale du réseau quand l'alternateur débite un courant sous la tension haute d'alternateur.

La première batterie peut être une batterie au plomb, et la seconde batterie peut être une batterie au lithium, en particulier une batterie de type lithium-ion. La seconde batterie peut également être une batterie au plomb (classique ou au plomb renforcé ou encore VRLA d'après l'anglais « Valve Regulated Lead Acide Battery ») de caractéristiques différentes de la première batterie.

L'unité de gestion électronique peut être configurée pour ouvrir un interrupteur de la seconde batterie quand le véhicule est dans un mode parking, c'est-à-dire moteur arrêté, et peut être configurée, si la tension de la première batterie passe sous un premier seuil et simultanément la tension de la seconde batterie est au dessus d'un second seuil, pour refermer cet interrupteur pendant une période prédéterminée avant d'effectuer le démarrage suivant du véhicule. Cette période prédéterminée permet de recharger partiellement la première batterie.

Selon un autre aspect, dans un procédé de gestion d'un véhicule automobile équipé d'une première batterie et d'une seconde batterie d'alimentation en énergie électrique, les deux batteries présentant des tensions maximales à vides différentes et étant connectées à un même alternateur et à un même réseau électrique à courant continu du véhicule, on impose une tension basse d'alternateur pendant des premières phases de roulage du véhicule, et l'on impose une tension haute d'alternateur plus élevée que la tension basse d'alternateur pendant des secondes phases de roulage du véhicule telles que des phases de freinage récupératif, moins

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consommatrices en carburant que les premières phases. Les premières phases de roulage correspondent à des phases de roulage hors décélération. Avantageusement, ce procédé peut être appliqué à un véhicule automobile où la première batterie, la seconde batterie et l'alternateur sont branchés en parallèle.

De manière préférentielle, on impose la tension haute d'alternateur quand le véhicule est en phase de décélération récupérative, et on impose la tension basse d'alternateur quand le véhicule est dans une phase d'accélération du moteur.

On peut imposer une tension intermédiaire d'alternateur, strictement supérieure à la tension basse d'alternateur et inférieure ou égale à la tension haute d'alternateur, quand un niveau de charge de la seconde batterie devient inférieur à une charge seuil, et/ou quand un certain mode de roulage du véhicule autre que la décélération, est détecté, et/ou si le courant délivré par la seconde batterie au réseau dépasse un certain seuil. Le niveau de la tension intermédiaire d'alternateur peut être différent dans les différents cas cités.

On peut par exemple alimenter la seconde batterie à l'aide d'un transformateur CC/CC en amenant la tension aux bornes de la batterie à une valeur comprise entre 15V et 17V pendant les phases de décélération récupérative du véhicule.

Le système peut comprendre des panneaux solaires embarqués sur le véhicule, et connectés au réseau.

Le système peut également comprendre une prise électrique adaptée pour un rechargement de la seconde batterie sur un réseau extérieur au véhicule.

Selon un mode de réalisation préféré, la seconde batterie peut être une batterie au lithium reconditionnée ayant déjà servi à fournir de l'énergie de propulsion automobile. Typiquement la seconde batterie au lithium est composée de deux modules « usés » d'une batterie de traction pour véhicule électrique, c'est-à-dire dont l'état de charge est compris entre 70% et 80% de leur capacité initiale. Le système selon l'invention utilise ces modules dans une plage de tension correspondant à un état de charge compris entre 5% et 30% de leur capacité initiale. Pour ne pas décharger ces modules en deçà de leur état de charge d'utilisation, un commutateur est

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placé entre la batterie au lithium et le reste du système, ce commutateur étant ouvert dès que l'état de charge de la batterie atteint un état de charge de 5% et n'est plus rechargée par le système selon l'invention, donc typiquement en mode « parking », c'est-à-dire lorsque le moteur du véhicule est arrêté.

L'unité de gestion électronique peut par exemple être configurée pour imposer une tension basse d'alternateur qui est inférieure ou égale à 1,05 fois la tension maximale à vide de la première batterie, voire inférieure à 1,035 fois la tension maximale à vide de la première batterie.

La tension basse d'alternateur peut par exemple être comprise entre 12,8 et 13,5V, et la tension haute d'alternateur peut être comprise entre 14 et 15V.

Selon un mode de réalisation avantageux, on peut alimenter la seconde batterie à l'aide d'un transformateur CC/CC en amenant la tension aux bornes de la batterie à une valeur comprise entre 15V et 17V pendant les phases de décélération récupérative du véhicule.

D'autres buts, caractéristiques et avantages de l'invention apparaîtront à la lecture de la description suivante, donnée uniquement à titre d'exemple nullement limitatif, et faite en référence aux dessins annexés, sur lesquels :

- la figure 1 est une représentation schématique d'un système d'alimentation selon l'invention,
- la figure 2 est un graphique représentant les niveaux relatifs de différentes tensions intervenant dans le fonctionnement du système d'alimentation de la figure 1,
- la figure 3 est un algorithme illustrant un mode de gestion possible du système d'alimentation de la figure 1.

Tel qu'illustré sur la figure 1, un système 1 d'alimentation électrique d'un véhicule comprend un réseau électrique 2, un alternateur 3, une première batterie 4, par exemple une batterie au plomb, une seconde batterie 7, par exemple une batterie de type lithium-ion, et une unité de gestion électronique 10. La seconde batterie 7 est munic d'un interrupteur 11 permettant de la déconnecter du réseau 2. L'alternateur 3 est apte à convertir de

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l'énergie mécanique prélevée sur un arbre relié à un moteur thermique (non représenté) en énergie électrique envoyée sur le réseau électrique 2.

Sur le réseau électrique 2 sont disposés des consommateurs électriques 6, comme par exemple un dispositif de climatisation, des moyens d'éclairage et des moyens de chauffage. L'alternateur 3 est connecté aux bornes de la première batterie 4. La seconde batterie 7 est connectée en parallèle à la première batterie 4. Les consommateurs électriques 6 sont branchés en parallèle sur le réseau 2. Le réseau 2 comprend une mise à la masse 5 sur le châssis du véhicule. Le réseau 2 alimente également un démarreur apte à lancer le moteur thermique du véhicule afin d'initier le premier cycle de combustion.

Selon les variantes de réalisation, la seconde batterie 7 peut être reliée à un transformateur CC/CC 8 connecté en série à la batterie 7, de manière à ce que la tension aux bornes de la seconde batterie 7 puisse être plus élevée que la tension maximum du réseau 2.

Dans les variantes de réalisation où la seconde batterie 7 est associée à un transformateur de type CC/CC 8, des moyens de production d'énergie tels que des panneaux solaires 9 peuvent être branchés aux bornes de la seconde batterie 7, ce qui autorise la tension maximale délivrée par ces panneaux solaires 9 à être plus élevée que la tension maximum du réseau 2. L'unité de gestion électronique est reliée à l'alternateur 3, auquel elle est apte à imposer une tension de consigne variable et notamment, auquel elle est apte à imposer deux valeurs distinctes de valeurs de consigne, une première valeur notée Valt_basse et une seconde valeur notée Valt_haute plus élevée que la première valeur.

L'unité de gestion électronique 10 est également reliée à l'interrupteur 11 qui, peut être de type mécanique-électromagnétique, ou de type électronique, par exemple sous forme d'un transistor. En ouvrant l'interrupteur 11, l'unité de gestion électronique 10 peut déconnecter la seconde batterie 7 du réseau, et éviter une décharge intempestive de cette seconde batterie 7.

La première batterie, notamment si la première batterie est une batterie au plomb, peut être utilisée de manière préférentielle au

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moment des démarrages du moteur thermique du véhicule, pour alimenter un démarreur. L'unité de gestion électronique 10 déconnecte la seconde batterie 7 (par exemple une batterie lithium, et plus précisément de type lithium-ion) à l'aide de l'interrupteur 11, dès que le véhicule est en mode « parking ». On évite de cette manière de décharger la batterie 7. La seconde batterie 7 reste alors déconnectée du réseau jusqu'à ce que le prochain démarrage du moteur du véhicule ait été effectué.

Les batteries au plomb ont en effet une excellente capacité de démarrage à froid, et c'est donc la première batterie 4 au plomb qui est utilisée au moment du démarrage du moteur thermique du véhicule.

Les batteries au lithium ont une meilleure endurance en terme de cyclages, et c'est donc la seconde batterie qui est utilisée pour alimenter le réseau de bord du véhicule pendant le roulage du véhicule. La tension du réseau c'est-à-dire la tension mesurable entre les bornes de la première batterie 4, est imposée par celui des trois éléments, parmi l'alternateur 3, la première batterie 4 et la deuxième batterie 7 éventuellement associée à un transformateur CC/CC, qui présente entre ses deux bornes la tension la plus élevée.

Par « bornes » de chacun des éléments, on entend les deux points de connexion de cet élément au réseau 2.

Dans le cas où le système inclut un transformateur CC/CC 8, connecté comme décrit sur la figure 1, on entend par tension aux bornes de l'ensemble [seconde batterie 7, transformateur CC/CC 8], la tension entre les deux points de connexion de cet ensemble, au réseau 2.

Quand l'alternateur 3 ne tourne pas, par exemple au moment du démarrage du véhicule, et que la seconde batterie 7 est déconnectée au moyen de l'interrupteur 11, c'est la première batterie 4 qui impose la tension sur le réseau 2.

Quand le véhicule roule et que l'alternateur 3 fonctionne, on choisit de piloter la consigne de tension de l'alternateur 3 au dessus de la tension maximale à vide de la première batterie 4. De cette manière, ce n'est pas la première batterie 4 qui fournit l'énergie électrique du circuit 2. Selon que la tension de l'alternateur 3 est plus élevée ou plus basse que la tension de la seconde batterie 7, ce

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sera alors soit l'alternateur 3, soit la seconde batterie 7, soit les deux simultanément, qui fourniront l'énergie électrique du réseau 2.

Dans le cadre de l'invention, on choisit une seconde batterie 7 dont la tension maximale à vide est suffisamment supérieure à la tension maximale à vide de la première batterie 4, de manière à pouvoir imposer alternativement deux modes de fonctionnement. Dans le premier mode de fonctionnement, la tension d'alternateur est fixée à une valeur basse « Valt_basse », qui est supérieure à la tension à vide maximale de la première batterie « VOmax_battl », elle-même inférieure à la tension maximale tolérée par le réseau « Vmax_réseau ». La tension d'alternateur « Valt_basse » est inférieure à la tension maximale à vide de la seconde batterie 7 « V0max_batt2 ». Dans un second mode de fonctionnement, la tension d'alternateur est égale à une valeur haute de tension d'alternateur « Valt_haute », qui est supérieure à la tension basse d'alternateur, tout en restant inférieure à la tension maximale tolérée par le réseau.

De cette manière, quand l'alternateur 3 est régulé pour délivrer la tension basse d'alternateur, et que la seconde batterie 7 est suffisamment chargée pour que sa tension soit supérieure à la tension basse d'alternateur, c'est la seconde batterie 7 qui fournit l'énergie électrique au réseau 2. Quand, dans ce mode de fonctionnement, la tension de fonctionnement de la seconde batterie 7 descend au niveau de la tension basse d'alternateur, une partie de l'énergie électrique du réseau 2 est fournie par la seconde batterie 7, et une partie de l'énergie électrique est fournie par l'alternateur 3.

Quand l'unité de gestion électronique 10 impose le second mode de fonctionnement, où c'est la tension haute d'alternateur qui est imposée, si la tension à vide de la seconde batterie est inférieure à la tension haute d'alternateur, c'est alors l'alternateur qui fournit l'énergie électrique au réseau et qui fournit simultanément une énergie permettant la recharge de la seconde batterie 7.

Si aucun autre moyen que l'alternateur 3 n'est prévu pour recharger la seconde batterie 7, la seconde batterie 7 pourra donc se recharger pendant les phases où c'est la tension haute d'alternateur qui est imposée, et pourra fournir de l'énergie au réseau tant que sa tension restera supérieure à la tension basse d'alternateur, pendant

les phases où l'unité de gestion électronique 10 impose la tension basse d'alternateur.

On impose de préférence une tension basse d'alternateur tout juste supérieure à la tension maximale à vide de la première batterie, de manière à ce que, pendant les phases où la tension basse d'alternateur est imposée, l'alternateur prélève le moins possible d'énergie mécanique sur l'arbre moteur entraîné par le moteur thermique. L'alternateur ne crée ainsi qu'une surconsommation limitée de carburant, tout en assurant que la première batterie reste constamment chargée à son niveau maximal.

Dans le premier mode de fonctionnement, tant que la seconde batterie 7 est suffisamment chargée (c'est-à-dire tant que sa tension est supérieure à la tension basse d'alternateur), c'est la seconde batterie 7 qui fournit l'énergie électrique au réseau 2.

Les phases où l'on impose la tension haute d'alternateur en vue de recharger la seconde batterie 7, sont de préférence les phases de roulage à faible coût en carburant, par exemple les phases de décélération récupérative, c'est-à-dire si le véhicule est dans un mode de décélération permettant d'utiliser le frein moteur, et d'utiliser une partie de l'énergie mécanique de l'arbre moteur pour faire tourner l'alternateur. Il suffit par exemple pour cela que la consigne à la pédale du véhicule corresponde à une phase de décélération moteur.

Une partie de l'énergie cinétique de freinage du véhicule sert alors à recharger la seconde batterie 7. Cette énergie récupérée pendant les phases de freinage permet ensuite d'économiser du carburant, en limitant la tension d'alternateur imposée pendant les phases de roulage correspondant au premier mode de fonctionnement.

La figure 2 illustre un exemple de positionnement relatif des différentes valeurs de tensions mentionnées précédemment dans la description du système d'alimentation électrique 1. Les différents niveaux représentés sur la figure 2 illustrent la tension minimale à vide de la première batterie 4 soit VOmini_battl , la tension maximale à vide de la première batterie 4 soit VOmax_battl , la tension minimale à vide V0mini_batt2 de la seconde batterie 7, la tension maximale à vide V0max_batt2 de la seconde batterie, la

tension basse d'alternateur Valt_basse, la tension haute d'alternateur Valt_haute et la tension maximale Vmax_réseau que le réseau 2 est capable de supporter sans être endommagé.

De manière typique, si l'on fonctionne avec une batterie au plomb comme première batterie 4, et avec, comme seconde batterie, une batterie de type lithium-ion issue de la récupération de batteries lithium-ion ayant servi à propulser des véhicules électriques ou hybrides, la tension minimale à vide VOmini_batt1 de la première batterie au plomb est de l'ordre de 12 volts, et correspond sensiblement à la tension minimale à vide V0mini_batt2 de la seconde batterie au lithium, ou est un peu inférieure.

La tension maximale à vide VOmax_batt1 de la première batterie au plomb est de l'ordre de 12,8 volts, et la tension basse d'alternateur Valt_basse que l'on impose pour être juste au dessus de cette tension maximale à vide est de l'ordre de 13,2 volts.

La tension maximale à vide V0max_batt2 de la seconde batterie au lithium peut être de l'ordre de 16,8 volts, et la tension haute d'alternateur Valt_haute de l'ordre de 15 volts afin de rester en dessous de la valeur maximale acceptée par le réseau Vmax_réseau, qui elle, est de l'ordre de 16 volts.

Il est envisageable d'utiliser d'autres types de batterie pour la première et pour la seconde batterie, et la tension maximale de la seconde batterie n'est pas obligatoirement supérieure à la tension maximale du réseau. La tension basse d'alternateur doit de préférence être supérieure à la tension maximale à vide de la première batterie. On pourrait éventuellement envisager un mode de réalisation où la tension basse d'alternateur serait très légèrement inférieure à la tension maximale à vide de la première batterie, mais on imposerait alors inutilement des cycles de charge et de décharge à la première batterie en réduisant la durée de vie de celle-ci.

La tension maximale de la seconde batterie devra être obligatoirement supérieure à la tension maximale à vide de la première batterie, de manière à pouvoir définir une valeur de tension basse d'alternateur entre ces deux valeurs de tension maximale à vide des deux batteries.

La tension haute d'alternateur peut être égale, voire supérieure à la tension maximale à vide de la seconde batterie, par

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exemple si la tension maximale de la seconde batterie est inférieure à la tension maximale tolérée par le réseau.

La tension minimale à vide de la seconde batterie doit être inférieure à la tension haute d'alternateur afin de permettre une charge au moins partielle de la seconde batterie 7 pendant les phases de fonctionnement avec la tension haute d'alternateur.

La seconde batterie 7 peut être rechargée, outre pendant les phases où l'alternateur tourne à sa valeur de tension élevée, par des moycns de production électriques supplémentaires tels que les panneaux solaires 9. Dans le cas où la tension maximale à vide de la seconde batterie est inférieure à la tension maximale tolérée par le réseau, ou dans le cas où le système comprend un transformateur CC/CC apte à abaisser la tension délivrée par la seconde batterie à une tension inférieure à la tension maximale tolérée par le réseau, on peut également envisager de recharger la seconde batterie 7 sur un réseau extérieur au véhicule, par exemple sur une aire de stationnement.

La tension maximale à vidc de la seconde batterie 7, c'est-à-dire V0max_batt2, peut être inférieure ou supérieure à la tension maximale acceptée par lc réseau 2. Si la tension maximale à vide de la seconde batterie est supérieure à la tension maximale acceptée par le réseau Vmax_réseau, selon une première variante de réalisation, on exploite la seconde batterie 7 sur une partie seulement de son domaine de fonctionnement c'est-à-dire par exemple entre la tension basse d'alternateur et la tension haute d'alternateur.

Selon une seconde variante de fonctionnement, on peut exploiter la seconde batterie 7 sur un domaine plus large, par exemple entre la tension basse d'alternateur et la tension maximale à vide acceptée par la seconde batterie 7, si par exemple lc système est muni d'un transformateur CC/CC 8, apte à abaisser la tension délivrée par la seconde batterie 7 de manière à l'amener à une valeur inférieure ou égale à la tension maximale tolérée par le réseau.

Dans ce cas, on peut par exemple envisager de charge la seconde batterie 7 à sa tension maximale à vide à partir d'un réseau extérieur au véhicule, quand le véhicule est à l'arrêt. On utilise ensuite cette réserve d'énergie pendant le roulage du véhicule en la

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complétant par une recharge partielle de la batterie à une tension haute d'alternateur quand le véhicule est en décélération récupérative.

Si le transformateur CC/CC est bidirectionnel, on peut même envisager de charger la seconde batterie à sa tension maximale à vide en élevant la tension aux bornes de la seconde batterie 7 par rapport à la tension haute d'alternateur pendant les phases de décélération récupérative.

Par sécurité, afin d'éviter une décharge même partielle de la première batterie 4, la tension basse d'alternateur est choisie légèrement supérieure à la tension maximale à vide de la première batterie 4.

La tension minimale à vide de la seconde batterie 7 est de préférence inférieure à la tension basse d'alternateur de manière à ce que, lorsque le véhicule est dans un mode de roulage où la tension basse d'alternateur est imposée par l'unité de gestion électronique 10, l'énergie fournie par l'alternateur vienne automatiquement compléter l'énergie fournie par la seconde batterie 7 lorsque la tension de celle-ci vient à baisser. On évite ainsi que la tension de la seconde batterie 7 puisse descendre à la tension minimale tolérée V0mini_batt2.

On pourrait envisager des variantes de réalisation où la tension minimale à vide de la seconde batterie serait supérieure à la tension basse d'alternateur, mais il faut pour une telle variante que l'unité de gestion électronique 10 impose une tension haute d'alternateur avant que la tension de la seconde batterie 7 ne descende en dessous de sa valeur minimale. Il faut, dans tous les cas, que la tension minimale à vide de la seconde batterie 7 soit inférieure à la tension haute d'alternateur.

La tension basse d'alternateur est de préférence inférieure à la tension maximale à vide de la seconde batterie 7. Elle est aussi proche que possible, par valeur supérieure, de la tension maximale à vide de la première batterie, tout en gardant une marge d'écart afin d'être sûr que l'alternateur régulé en tension basse d'alternateur reste au dessus de cette valeur minimale VOmax_battl .

Il est avantageux d'utiliser une seconde batterie 7 dont la tension maximale à vide V0max_batt2 est supérieure à la tension

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maximale Vmax_réseau du réseau 2, ce qui permet, pour choisir les valeurs de la tension basse d'alternateur et de la tension haute d'alternateur, de disposer de tout l'intervalle de tension compris entre la tension maximale à vide de la première batterie VOmax_batt1 et la tension maximale acceptée par le réseau Vmax_réseau.

On se trouve en particulier dans cette configuration lorsque l'on a un réseau 2 du véhicule dont la tension maximale acceptable est de l'ordre de 15 à 16 volts, et que l'on utilise comme première batterie 4 une batterie au plomb, dont la tension maximale à vide est d'environ 12,8 volts, et une batterie lithium-ion pour la seconde batterie 7, par exemple une batterie lithium-ion reconditionnée suite à une utilisation pour la propulsion de véhicule électrique. Une telle batterie reconditionnée présente par exemple une tension maximale à vide de l'ordre de 16,8 volts et une tension minimale à vide acceptable voisine de 12 volts.

Outre le basculement à une tension d'alternateur haute pendant les phases de décélération du véhicule, des stratégies complémentaires implémentées dans l'unité de gestion électronique 10 peuvent être définies, afin d'éviter une décharge excessive de la seconde batterie 7 dans les cas de figure où les phases de décélération récupérative ne sont pas suffisamment fréquentes et/ou suffisamment prolongées.

On peut alors choisir d'imposer une tension d'alternateur intermédiaire entre la tension basse d'alternateur et la tension haute d'alternateur, c'est-à-dire strictement supérieure à la tension basse d'alternateur et inférieures ou égales à la tension haute d'alternateur. Une ou plusieurs tensions intermédiaires peuvent ainsi être imposées pendant certaines phases de roulage qui peuvent laisser supposer que les prochaines décélérations sont éloignées dans le temps. Ces phases de roulage peuvent comprendre des modes de roulage de type autoroutier. Une ou plusieurs tensions intermédiaires peuvent également être imposées pour des modes de roulage préprogrammés dans l'unité de gestion électronique parce que le point de fonctionnement du moteur, pour ces modes de roulage, correspond à une consommation en carburant moins élevée que pour d'autres modes de roulage.

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Le basculement vers une tension intermédiaire d'alternateur peut également être conditionné par la détection simultanée d'un mode de roulage donné, et d'un état de charge inférieur ou égal à un état de charge seuil de la seconde batterie 7.

La figure 3 illustre un algorithme 1 qui peut être implanté dans l'unité de gestion électronique 10 d'un système d'alimentation en énergie selon l'invention. A un instant initial 21, correspondant par exemple à la mise en service du véhicule ou à sa remise en service après un changement de batteries, l'unité de gestion électronique 10 teste, à une étape 22, si le véhicule est en mode parking.

Si c'est le cas, l'unité de gestion électronique 10 déconnecte, si ce n'est déjà fait, la seconde batterie 7 du réseau 2 à l'aide de l'interrupteur 11, à une étape 23.

Elle teste ensuite à une étape 24, si la tension aux bornes de la seconde batterie 7 est descendue en dessous d'une tension Vmin qui peut, par exemple, être égale à la tension minimale à vide V0mini_batt2 de la seconde batterie, ou être une valeur légèrement supérieure à cette tension minimale à vide.

Si la tension mesurée est inférieure à la tension seuil Vmin, l'unité de gestion électronique 10 affiche un message d'alerte avertissant le conducteur qu'il doit changer la seconde batterie 7, à une étape 25. Si la tension est supérieure à la tension seuil Vmin, l'unité de gestion électronique retourne à l'étape 22.

Quand le test 22 indique que le véhicule n'est plus en configuration de parking, l'unité de gestion électronique 10 teste à une étape 26 la santé de la seconde batterie 7. Ce test de santé peut par exemple consister à vérifier si le nombre de cycles de charges et de décharges déjà subies par la seconde batterie 7 est inférieur à un nombre seuil Nmax de charges et de décharges, si les différentes cellules de la batterie sont suffisamment équilibrées, et si la tension aux bornes de la batterie est supérieure ou égale à la tension seuil Vmin.

Si la réponse est négative, l'unité de gestion électronique 10 affiche le message d'alerte correspondant à l'étape 25. Si le résultat du test 26 est positif, l'unité de gestion électronique effectue un test 27 pour savoir si le moteur thermique du véhicule est actif. Si ce

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n'est pas le cas, l'unité de gestion électronique 10 met en place une stratégie 28 permettant d'alimenter le réseau 2 soit à partir de la première batterie, soit à partir de la seconde batterie, soit à partir des deux batteries conjointement, puis retourne à l'étape 22.

Lorsque le test 27 indique que le moteur thermique du véhicule est actif, l'unité de gestion électronique teste à une étape 29 si le véhicule est dans un mode de décélération récupérative, c'est-à-dire si le véhicule est dans un mode de décélération permettant d'utiliser le frein moteur, en puisant une partie de l'énergie mécanique de l'arbre moteur pour faire tourner l'alternateur. Il suffit par exemple pour cela que la consigne à la pédale du véhicule corresponde à une phase de décélération moteur.

Si le véhicule est en mode de décélération récupérative, l'unité de gestion électronique 10 impose à l'alternateur une tension haute d'alternateur, par exemple 15 volts, à une étape 31, et continue à boucler sur le test 29 puis sur le pilotage à la tension haute d'alternateur 31, tant que le véhicule est en décélération.

Si le véhicule n'est pas en décélération récupérative à la sortie de l'étape de test 29, l'unité de gestion électronique 10 impose à l'alternateur 3 de fonctionner à la tension basse d'alternateur, par exemple à 13 volts, à une étape 30.

Suite à l'étape 30, l'unité de gestion électronique 10 teste si le véhicule et la seconde batterie 7 sont dans une configuration « de charge forcée ». Une telle configuration de charge forcée peut par exemple correspondre au cas où la tension aux bornes de la seconde batterie 7 descend en dessous d'une valeur seuil Vi et où simultanément un compteur de temps Δi, qui comptabilise le temps écoulé depuis la dernière décélération, passe au dessus d'un seuil Δt_1.

Dans ce cas de figure, on peut considérer que la tension de la seconde batterie commence à devenir insuffisante, et que le mode de roulage détecté n'est pas un mode de roulage ponctué de décélérations suffisamment fréquentes.

Si ce test 32 révèle que l'on se trouve dans la configuration de marche forcée, l'unité de gestion électronique 10 impose, à une étape 33, une régulation de l'alternateur 3 à une tension Valt Mid par exemple égale à 14,5 volts, et continue à imposer ce mode de

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charge forcée tant que le niveau de recharge de la batterie testé à une étape 34 n'a pas atteint un niveau satisfaisant minimal SOC_{min}.

Ce niveau de charge minimal peut par exemple être détecté par une baisse du courant de recharge entrant dans la seconde batterie 7.

Quand le test de l'étape 34 indique que le niveau de recharge de la seconde batterie est suffisant, l'unité de gestion électronique 10 teste à une étape 35 la santé de la seconde batterie 7, par exemple en vérifiant que la température de la batterie ne dépasse pas une température T_{max} maximale, en vérifiant que le niveau d'équilibrage entre les différentes cellules est suffisant, ou à défaut que ce niveau permet encore de rééquilibrer les différentes cellules, et en vérifiant que la tension V aux bornes de la seconde batterie est supérieure à la tension seuil V_{min}.

Si le niveau de santé détecté à l'étape 35 est insuffisant, l'unité de gestion électronique 10 affiche le message d'alerte correspondant à l'étape 25. Dans le cas contraire, l'unité de gestion électronique 10 teste à une étape 36 si les différentes cellules de la seconde batterie 7 sont suffisamment équilibrées. Si c'est le cas, l'unité de gestion électronique revient à l'étape de test 22 permettant de vérifier si le véhicule, entre temps, se trouve en mode parking.

Dans le cas contraire, l'unité de gestion électronique déclenche un équilibrage des cellules à une étape 37 et retourne également à l'étape 22.

L'objet de l'invention ne se limite pas aux exemples de réalisation décrits et peut faire l'objet de nombreuses variantes, aussi bien en ce qui concerne l'agencement des différents éléments du système 1, les algorithmes de fonctionnement implantés dans l'unité de gestion électronique 10 et/ou le choix des types de batteries ou autres types d'accumulateurs.

La tension basse et la tension haute imposées aux bornes de la seconde batterie 7, peuvent être obtenues soit en régulant la tension délivrée par l'alternateur à deux niveaux différents, soit en élevant la tension aux bornes de la seconde batterie à l'aide d'un transformateur CC/CC. La tension haute peut également être obtenue en élevant à la fois la tension de consigne aux bornes de

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l'alternateur et en transformant cette tension, à l'aide du transformateur CC/CC, en une tension encore plus élevée aux bornes de la seconde batterie.

L'algorithme de fonctionnement, dont un exemple est donné en figure 3, admet de très nombreuses variantes, notamment en ce qui concerne la succession des différents tests pour déterminer quelle tension d'alternateur doit être imposée à un instant donné, ou dans la définition d'un ou de plusieurs modes de charge forcée. Ces modes de charge forcée peuvent être définis avec différentes tensions d'alternateur Valt Mid selon les modes. On peut par exemple définir différents modes de charge forcée suivant différentes conditions de niveau de charge de la seconde batterie et différentes conditions de type de roulage et/ou de point de fonctionnement du moteur détecté.

Les accumulateurs électriques désignés sous le terme de première et seconde batterie peuvent être des batteries d'accumulation de type électrochimique, par exemple une première batterie au plomb et une seconde batterie de type lithium-ion. On peut également envisager d'utiliser pour la seconde batterie d'autres types de batteries lithium que les batteries lithium-ion, d'autres batteries de type électrochimique ou encore un ou plusieurs supercondensateurs.

L'invention peut être utilisée pour un système d'alimentation d'un véhicule à propulsion par un moteur thermique. Elle peut également être utilisée pour un système d'alimentation électrique d'un véhicule à propulsion hybride thermique électrique. Dans ce dernier cas, on peut par exemple utiliser une batterie au lithium comme première batterie servant à la fois pour le démarrage du véhicule et pour la propulsion occasionnelle du véhicule, et une seconde batterie de type supercapacité pour accumuler de l'énergie pendant les phases de décélération. Il faut donc comprendre dans cette demande le terme « batterie d'accumulation électrique » au sens large puisqu'il englobe des systèmes de stockage de type supercapacité.

Le système selon l'invention permet de réduire la consommation globale en carburant du véhicule, de prolonger la durée de vie de la première batterie, et, dans le cas où on utilise

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comme seconde batterie une batterie au lithium reconditionnée, de réduire le coût et l'empreinte écologique du système.

Il est à noter que le concept d'utilisation de deux batteries pour des usages différents peut être élargi à plus de deux batteries. En effet il est enviseageable d'utiliser également une troisième batterie connectée au réseau de bord par l'intermédiaire d'un convertisseur CC/CC et d'un commutateur, ce commutateur étant fermé en mode « parking » c'est-à-dire moteur arrêté, pour fournir l'énergie électrique nécessaire aux consommateurs du réseau de bord. Avantageusement cette troisième batterie est constituée de modules récupérés d'une batterie de traction de véhicule électrique, bénéficie des meilleurs points de rendement du moteur et de l'alternateur pour être rechargée (par exemple en décélération, de la même manière que la deuxième batterie au lithium), et bénéficie d'un système de recharge complémentaire tel qu'un panneau solaire.

De même la première batterie plomb utilisée pour le démarrage du véhicule, peut être connectée au réseau de bord par l'intermédiaire d'un commutateur, permettant de spécialiser encore plus son utilisation : ce commutateur est par exemple fermé seulement au démarrage, et sur les meilleurs points de rendement du moteur et de l'alternateur lorsque son état de charge est en dessous d'un certain seuil.

Il est à noter que l'utilisation d'un commutateur entre d'une part une première batterie et le réseau de bord et d'autre part une deuxième batterie et le réseau de bord permet d'utiliser pour ces deux batteries des batteries plomb identiques connectées en parallèle de l'alternateur sans CC/CC intermédiaire tout en leur attribuant un rôle spécifique (démarrage pour l'une, consommation du réseau de bord pour l'autre) et en les faisant recharger aux meilleurs points de rendement du moteur et de l'alternateur.

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REVENDICATIONS

1. Système (1) d'alimentation en énergie électrique d'un véhicule, comprenant :

-un réseau (2) à courant continu, d'au moins un organe (6) consommateur électrique, apte à être alimenté dans une gamme de tensions inférieure ou égale à une tension maximale de réseau (Vmax_réseau),

-une première batterie (4) d'accumulation électrique connectée au réseau (2), et présentant une première tension maximale à vide (VOmax_Batt1) inférieure à la tension maximale de réseau (Vmax_réseau),

-une seconde batterie (7) d'accumulation électrique connectée au réseau (2), présentant une seconde tension maximale à vide (V0max_Batt2), supérieure à la tension maximale à vide de la première batterie (VOmax_Batt1), et une tension minimale à vide acceptable (V0mini_Batt2) inférieure à la tension maximale de réseau (Vmax_réseau),

-un alternateur (3) pilotable connecté au réseau (2), et apte à délivrer à la seconde batterie (7) une énergie électrique sous une tension de consigne pilotable à différentes valeurs de consigne (Valt_basse, Valt_haute),

caractérisé en ce que le système comprend en outre une unité de gestion électronique (10), configurée pour imposer à l'alternateur (3) lors du roulage du véhicule, successivement au moins deux tensions de consigne différentes, à savoir une tension basse d'alternateur (Valt_basse) qui est strictement supérieure à la première tension maximale à vide de la première batterie (VOmax_Batt1), et une tension haute d'alternateur (Valt_haute) qui est strictement supérieure à la fois à la tension minimale à vide de la seconde batterie (V0mini_Batt2), et à la tension basse d'alternateur (Valt_basse).

2. Système selon la revendication 1, comportant en outre un transformateur de tension (8) de type CC/CC apte à abaisser la tension délivrée par la seconde batterie (7) au réseau, et dans lequel la seconde tension maximale à vide (V0max_Batt2) de la seconde

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batterie (7) est supérieure à la tension maximale de réseau (Vmax_réseau).

3. Système selon la revendication 2, dans lequel le transformateur de tension (8) est bidirectionnel, et est apte à alimenter la seconde batterie (7) à une tension supérieure à la tension maximale du réseau (Vmax_réseau) quand l'alternateur (3) débite un courant sous la tension haute d'alternateur (Valt_haute).

4. Système selon l'une des revendications précédentes, dans lequel la première batterie (4) est unc batterie au plomb, et la seconde batterie (7) est une batterie au lithium.

5. Système selon l'une des revendications précédentes, dans lequel l'unité de gestion électronique (10) est configurée pour ouvrir un interrupteur (11) de la seconde batterie (7) quand le moteur du véhicule est arrêté et, si la tension de la première batterie (4) passe sous un premier seuil et simultanément la tension de la seconde batterie est au dessus d'un second seuil, pour refermer cet interrupteur (11) pendant une période prédéterminée avant d'effectuer le prochain démarrage du véhicule.

6. Procédé de gestion d'un véhicule automobile équipé d'une première batterie (4) et d'une seconde batterie (7) d'alimentation en énergie électrique, les deux batteries présentant des tensions maximales à vides (V0max_Battl2, V0max_Batt2) différentes et étant connectées à un même alternateur (3) et à un même réseau électrique à courant continu du véhicule (2), caractérisé en ce que l'on impose une tension basse d'alternateur (Valt_basse) pendant des premières phases de roulage du véhicule, et l'on impose une tension haute d'alternateur (Valt_haute) plus élevée que la tension basse d'alternateur pendant des secondes phases de roulage du véhicule telles que des phases de freinage récupératif, moins consommatrices en carburant que les premières phases.

7. Procédé selon la revendication 6, dans lequel on impose la tension haute d'alternateur (Valt_haute) quand le véhicule est en phase de décélération récupérative, et on impose la tension basse d'alternateur (Valt_basse) quand le véhicule est dans une phase d'accélération du moteur.

8. Procédé selon les revendications 6 à 7, dans lequel on impose une tension intermédiaire d'alternateur (Valt Mid),

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strictement supérieure à la tension basse d'alternateur (Valt_basse) et inférieure ou égale à la tension haute d'alternateur (Valt_haute), quand un niveau de charge de la seconde batterie (7) devient inférieur à une charge seuil, et/ou quand un certain mode de roulage du véhicule autre que la décélération, est détecté, et/ou si le courant délivré par la seconde batterie (7) au réseau dépasse un certain seuil.

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FIG.1

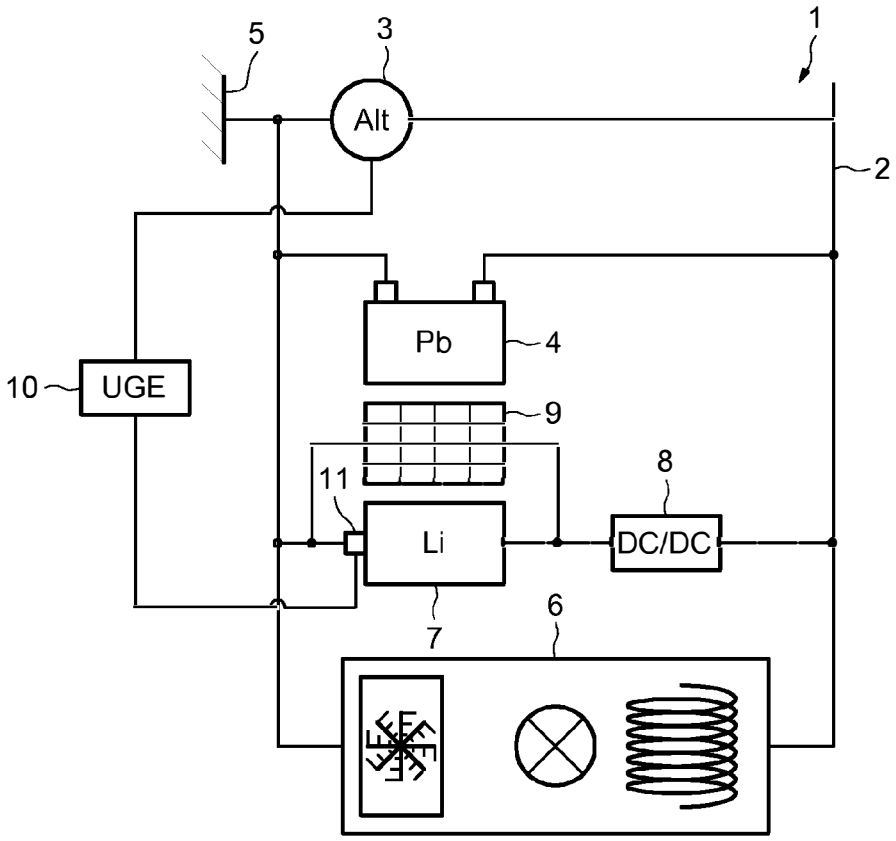


FIG.2

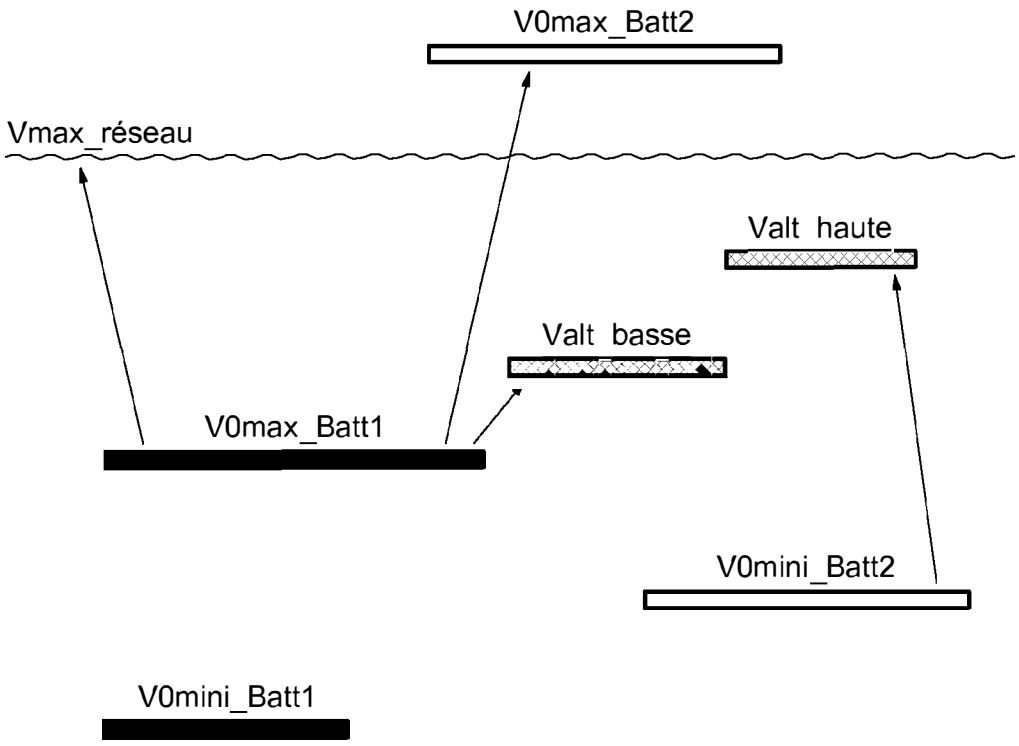


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FIG.3

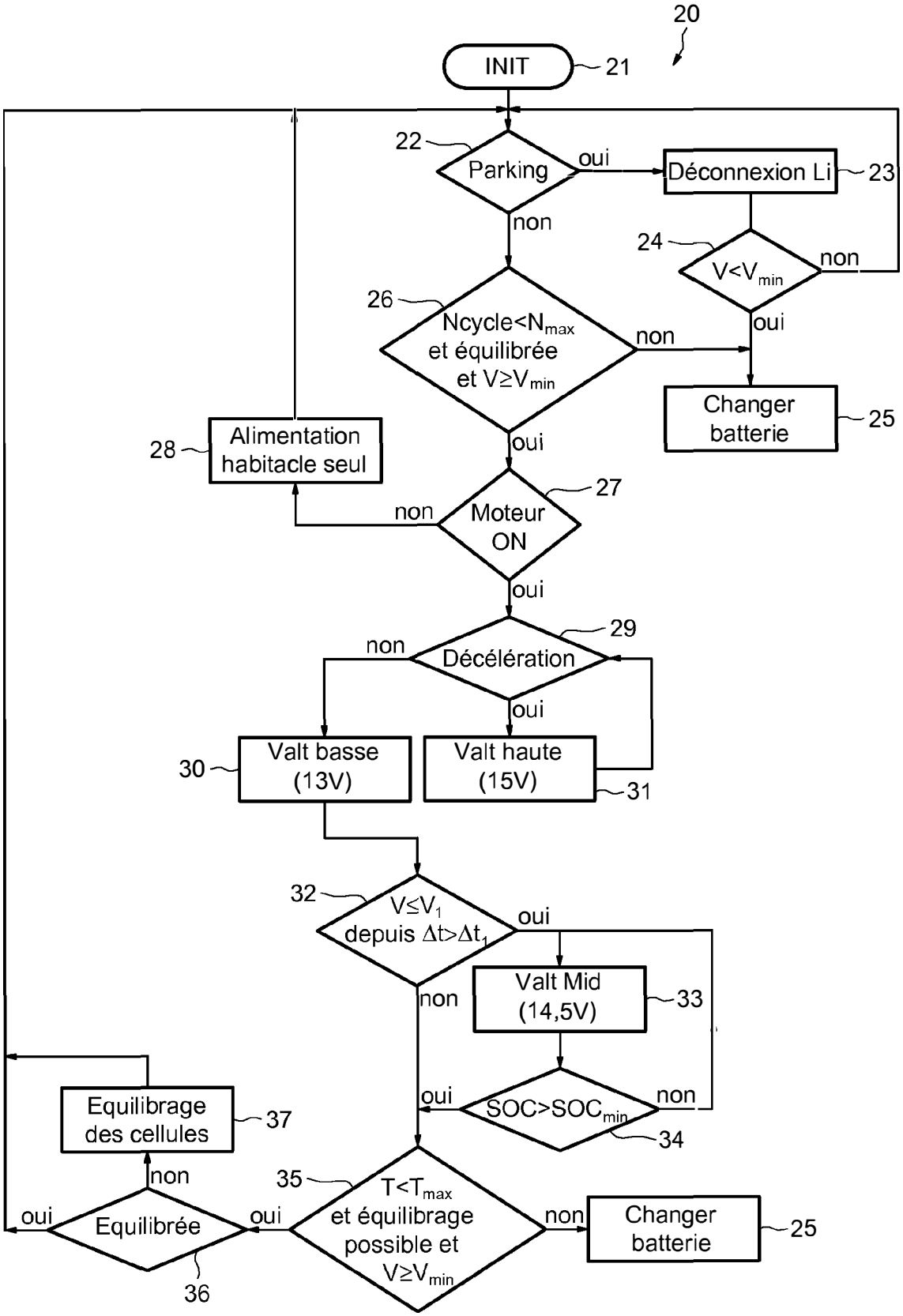


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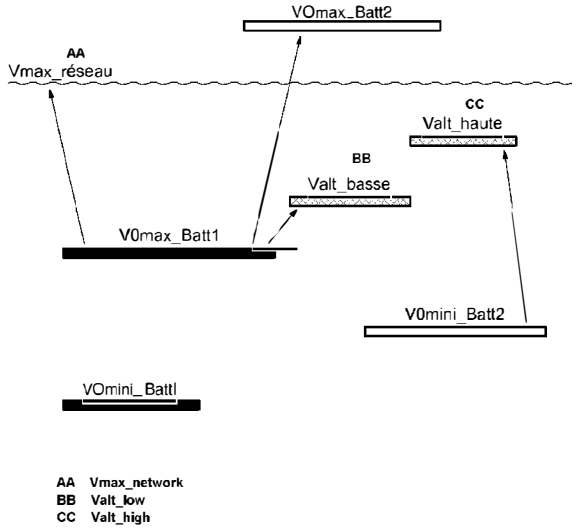
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[Suite sur la page suivante]

(54) **Title** : METHOD OF RECHARGING A PAIR OF VEHICLE BATTERIES OF DIFFERENT NOMINAL VOLTAGES, AND ASSOCIATED SYSTEM

(54) **Titre** : PROCEDE DE RECHARGEMENT D'UN COUPLE DE BATTERIES DE VEHICULE DE TENSIONS NOMINALES DIFFERENTES, ET SYSTEME ASSOCIE

FIG.2



(57) **Abstract : A** System for supplying electrical power to a vehicle comprises: - a network of electricity consuming units, which is able to be powered in a range of voltages less than or equal to a maximum network voltage (Vmax_network), - a first electrical accumulation battery connected to the network, and exhibiting a first maximum voltage when unloaded (V0max_Batt1) which is less than the maximum network voltage (Vmax_network), - a second electrical accumulation battery connected to the network, exhibiting a second maximum voltage when unloaded (V0max_Batt2), which is greater than the maximum voltage when unloaded of the first battery (V0max_Batt1), and a minimum acceptable voltage when unloaded (V0mini_Batt2) which is below the maximum network voltage (Vmax network), - a drivable alternator connected to the network, and able to deliver to the second battery an electrical energy under a setpoint voltage drivable to various setpoint values (Valt_low, Valt_high). The System furthermore comprises an electronic management facility, configured to impose at least two different setpoint voltages successively on the alternator when the vehicle is running, namely a low alternator voltage (Valt_low) which is strictly greater than the first maximum voltage when unloaded of the first battery (V0max_Batt1), and a high alternator voltage (Valt_high) which is strictly greater both than the minimum voltage when unloaded of the second battery (V0mini_Batt2), and than the low alternator voltage (Valt_low).

(57) **Abrégé** :

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Un système d'alimentation en énergie électrique d'un véhicule. comprend: -un réseau d'organes consommateurs électriques, apte à être alimenté dans une gamme de tensions inférieure ou égale à une tension maximale de réseau (Vmax_réseau), -une première batterie d'accumulation électrique counectée au réseau, et présentant une première tension maximale à vide (VOmax_Battl) inférieure à la tension maximale de réseau (Vmax_réseau), -une seconde batterie d'accumulation électrique connectée au réseau, présentant une seconde tension maximale à vide (V0max_Batt2), supérieure à la tension maximale à vide de la première batterie (V0-max_Battl), et une tension minimale à vide acceptable (V0mini_Batt2) inférieure à la tension maximale de réseau (Vmax_réseau), -un alternateur pilotable connecté au réseau, et apte à délivrer à la seconde batterie une énergie électrique sous une tension de consigne pilotable à différentes valeurs de consigne (Valt_basse, Valt_haute). Le système comprend en outre une unité de gestion électronique, configurée pour imposerà l'alternateur lors du roulage du véhicule, successivement au moins deux tensions de consigne différentes, à savoir une tension basse d'alternateur (Valt_basse) qui est strictement supérieure à la première tension maximale à vide de la première batterie (V0max_Battl), et une tension haute d'alternateur (Valt_haute) qui est strictement supérieure à la fois à la tension minimale à vide de la seconde batterie (V0mini_Batt2), et à la tension basse d'alternateur (Valt_basse).

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PROCEDE DE RECHARGEMENT D'UN COUPLE DE BATTERIES DE VEHICULE DE TENSIONS NOMINALES DIFFERENTES, ET SYSTEME ASSOCIE

L'invention se rapporte aux systèmes d'alimentation électrique de véhicules automobiles à propulsion par un moteur thermique ou à propulsion hybride thermique-électrique, et notamment aux systèmes d'alimentation électrique comprenant plusieurs batteries de types différents.

On peut en effet souhaiter utiliser différents types de batteries en parallèle afin de tirer parti par exemple de la bonne capacité d'une batterie au plomb à fournir de l'énergie pour un démarrage à froid, et de la forte énergie spécifique ainsi que de la plus grande endurance en terme de cycles de charge et de décharge d'une batterie de type lithium-ion.

La demande de brevet US 2011 00 1352 décrit ainsi un système où les deux types de batteries sont présentes, les tensions à vide et les résistances internes des deux batteries étant choisies de manière à ce que, pour une tension d'alternateur constante, ce soit de manière préférentielle la batterie au lithium qui se décharge puis se recharge, la batterie au plomb subissant ainsi un moindre nombre de cycles de charge et de décharge.

L'utilisation de la batterie au plomb est alors réservée de manière préférentielle aux phases de démarrage du véhicule.

Pour permettre d'obtenir une telle configuration, la tension maximale à vide de la batterie au lithium doit rester relativement proche de la tension maximale à vidc de la batterie au plomb. La capacité énergétique maximale de la batterie au lithium s'en trouve donc limitée.

Un tel système permet d'augmenter la durée de vie de la batterie au plomb, mais oblige à limiter les performances des batteries au lithium utilisées. En outre, la tension constante de l'alternateur doit être choisie suffisamment élevée pour permettre de recharger simultanément la batterie au plomb et la batterie au lithium, ce qui induit une surconsommation de carburant par rapport à un système muni uniquement d'une batterie au plomb.

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L'invention a pour but de proposer un système d'alimentation électrique d'un véhicule comprenant deux batteries, ce système permettant non seulement d'augmenter la durée de vie de la batterie au plomb, mais également de réduire la consommation moyenne en carburant du véhicule.

A cet effet, un système d'alimentation en énergie électrique d'un véhicule, comprend :

-un réseau à courant continu, d'au moins un organe consommateur électrique, apte à être alimenté dans une gamme de tensions inférieure ou égale à une tension maximale de réseau,

-une première batterie d'accumulation électrique connectée au réseau, et présentant une première tension maximale à vide inférieure à la tension maximale de réseau,

-une seconde batterie d'accumulation électrique connectée au réseau, présentant une seconde tension maximale à vide, supérieure à la tension maximale à vide de la première batterie, et une tension minimale à vide acceptable inférieure à la tension maximale de réseau,

-un alternateur pilotable connecté au réseau, et apte à délivrer à la seconde batterie une énergie électrique sous une tension de consigne pilotable à différentes valeurs de consigne.

Le système comprend en outre une unité de gestion électronique, configurée pour imposer à l'alternateur lors du roulage du véhicule, successivement au moins deux tensions de consigne différentes, à savoir une tension basse d'alternateur qui est strictement supérieure à la première tension maximale à vide de la première batterie, et une tension haute d'alternateur qui est strictement supérieure à la fois à la tension minimale à vide de la seconde batterie, et à la tension basse d'alternateur. Selon certaines variantes de réalisation, l'alternateur peut être un système d'alternateur comprenant un alternateur associé à un transformateur CC/CC (courant continu/courant continu, encore appelé « DC/DC converter» en anglais). L'alternateur peut alors être pilotable lui-même en tension. Selon un autre mode de réalisation, la tension de consigne peut être pilotable en modifiant uniquement la consigne du transformateur CC/CC, l'alternateur n'étant pas pilotable en tension. Selon encore un autre mode de réalisation, la

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tension de consigne peut être pilotable en modifiant à la fois la tension délivrée par l'alternateur et la consigne du transformateur CC/CC.

Selon un mode de réalisation amélioré, le système comporte en outre un transformateur de tension de type CC/CC apte à abaisser la tension délivrée par la seconde batterie au réseau. La seconde tension de fonctionnement à charge complète de la seconde batterie peut alors être supérieure à la tension maximale de réseau.

Avantageusement le transformateur de tension est bidirectionnel, et est apte à alimenter la seconde batterie à une tension supérieure à la tension maximale du réseau quand l'alternateur débite un courant sous la tension haute d'alternateur.

La première batterie peut être une batterie au plomb, et la seconde batterie peut être une batterie au lithium, en particulier une batterie de type lithium-ion. La seconde batterie peut également être une batterie au plomb (classique ou au plomb renforcé ou encore VRLA d'après l'anglais « Valve Regulated Lead Acide Battery ») de caractéristiques différentes de la première batterie.

L'unité de gestion électronique peut être configurée pour ouvrir un interrupteur de la seconde batterie quand le véhicule est dans un mode parking, c'est-à-dire moteur arrêté, et peut être configurée, si la tension de la première batterie passe sous un premier seuil et simultanément la tension de la seconde batterie est au dessus d'un second seuil, pour refermer cet interrupteur pendant une période prédéterminée avant d'effectuer le démarrage suivant du véhicule. Cette période prédéterminée permet de recharger partiellement la première batterie.

Selon un autre aspect, dans un procédé de gestion d'un véhicule automobile équipé d'une première batterie et d'une seconde batterie d'alimentation en énergie électrique, les deux batteries présentant des tensions maximales à vides différentes et étant connectées à un même alternateur et à un même réseau électrique à courant continu du véhicule, on impose une tension basse d'alternateur pendant des premières phases de roulage du véhicule, et l'on impose une tension haute d'alternateur plus élevée que la tension basse d'alternateur pendant des secondes phases de roulage du véhicule telles que des phases de freinage récupératif, moins

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consommatrices en carburant que les premières phases. Les premières phases de roulage correspondent à des phases de roulage hors décélération. Avantageusement, ce procédé peut être appliqué à un véhicule automobile où la première batterie, la seconde batterie et l'alternateur sont branchés en parallèle.

De manière préférentielle, on impose la tension haute d'alternateur quand le véhicule est en phase de décélération récupérative, et on impose la tension basse d'alternateur quand le véhicule est dans une phase d'accélération du moteur.

On peut imposer une tension intermédiaire d'alternateur, strictement supérieure à la tension basse d'alternateur et inférieure ou égale à la tension haute d'alternateur, quand un niveau de charge de la seconde batterie devient inférieur à une charge seuil, et/ou quand un certain mode de roulage du véhicule autre que la décélération, est détecté, et/ou si le courant délivré par la seconde batterie au réseau dépasse un certain seuil. Le niveau de la tension intermédiaire d'alternateur peut être différent dans les différents cas cités.

On peut par exemple alimenter la seconde batterie à l'aide d'un transformateur CC/CC en amenant la tension aux bornes de la batterie à une valeur comprise entre 15V et 17V pendant les phases de décélération récupérative du véhicule.

Le système peut comprendre des panneaux solaires embarqués sur le véhicule, et connectés au réseau.

Le système peut également comprendre une prise électrique adaptée pour un rechargement de la seconde batterie sur un réseau extérieur au véhicule.

Selon un mode de réalisation préféré, la seconde batterie peut être une batterie au lithium reconditionnée ayant déjà servi à fournir de l'énergie de propulsion automobile. Typiquement la seconde batterie au lithium est composée de deux modules « usés » d'une batterie de traction pour véhicule électrique, c'est-à-dire dont l'état de charge est compris entre 70% et 80% de leur capacité initiale. Le système selon l'invention utilise ces modules dans une plage de tension correspondant à un état de charge compris entre 5% et 30% de leur capacité initiale. Pour ne pas décharger ces modules en deçà de leur état de charge d'utilisation, un commutateur est

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placé entre la batterie au lithium et le reste du système, ce commutateur étant ouvert dès que l'état de charge de la batterie atteint un état de charge de 5% et n'est plus rechargée par le système selon l'invention, donc typiquement en mode « parking », c'est-à-dire lorsque le moteur du véhicule est arrêté.

L'unité de gestion électronique peut par exemple être configurée pour imposer une tension basse d'alternateur qui est inférieure ou égale à 1,05 fois la tension maximale à vide de la première batterie, voire inférieure à 1,035 fois la tension maximale à vide de la première batterie.

La tension basse d'alternateur peut par exemple être comprise entre 12,8 et 13,5V, et la tension haute d'alternateur peut être comprise entre 14 et 15V.

Selon un mode de réalisation avantageux, on peut alimenter la seconde batterie à l'aide d'un transformateur CC/CC en amenant la tension aux bornes de la batterie à une valeur comprise entre 15V et 17V pendant les phases de décélération récupérative du véhicule.

D'autres buts, caractéristiques et avantages de l'invention apparaîtront à la lecture de la description suivante, donnée uniquement à titre d'exemple nullement limitatif, et faite en référence aux dessins annexés, sur lesquels :

- la figure 1 est une représentation schématique d'un système d'alimentation selon l'invention,
- la figure 2 est un graphique représentant les niveaux relatifs de différentes tensions intervenant dans le fonctionnement du système d'alimentation de la figure 1,
- la figure 3 est un algorithme illustrant un mode de gestion possible du système d'alimentation de la figure 1.

Tel qu'illustré sur la figure 1, un système 1 d'alimentation électrique d'un véhicule comprend un réseau électrique 2, un alternateur 3, une première batterie 4, par exemple une batterie au plomb, une seconde batterie 7, par exemple une batterie de type lithium-ion, et une unité de gestion électronique 10. La seconde batterie 7 est munic d'un interrupteur 11 permettant de la déconnecter du réseau 2. L'alternateur 3 est apte à convertir de

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l'énergie mécanique prélevée sur un arbre relié à un moteur thermique (non représenté) en énergie électrique envoyée sur le réseau électrique 2.

Sur le réseau électrique 2 sont disposés des consommateurs électriques 6, comme par exemple un dispositif de climatisation, des moyens d'éclairage et des moyens de chauffage. L'alternateur 3 est connecté aux bornes de la première batterie 4. La seconde batterie 7 est connectée en parallèle à la première batterie 4. Les consommateurs électriques 6 sont branchés en parallèle sur le réseau 2. Le réseau 2 comprend une mise à la masse 5 sur le châssis du véhicule. Le réseau 2 alimente également un démarreur apte à lancer le moteur thermique du véhicule afin d'initier le premier cycle de combustion.

Selon les variantes de réalisation, la seconde batterie 7 peut être reliée à un transformateur CC/CC 8 connecté en série à la batterie 7, de manière à ce que la tension aux bornes de la seconde batterie 7 puisse être plus élevée que la tension maximum du réseau 2.

Dans les variantes de réalisation où la seconde batterie 7 est associée à un transformateur de type CC/CC 8, des moyens de production d'énergie tels que des panneaux solaires 9 peuvent être branchés aux bornes de la seconde batterie 7, ce qui autorise la tension maximale délivrée par ces panneaux solaires 9 à être plus élevée que la tension maximum du réseau 2. L'unité de gestion électronique est reliée à l'alternateur 3, auquel elle est apte à imposer une tension de consigne variable et notamment, auquel elle est apte à imposer deux valeurs distinctes de valeurs de consigne, une première valeur notée Valt_basse et une seconde valeur notée Valt_haute plus élevée que la première valeur.

L'unité de gestion électronique 10 est également reliée à l'interrupteur 11 qui, peut être de type mécanique-électromagnétique, ou de type électronique, par exemple sous forme d'un transistor. En ouvrant l'interrupteur 11, l'unité de gestion électronique 10 peut déconnecter la seconde batterie 7 du réseau, et éviter une décharge intempestive de cette seconde batterie 7.

La première batterie, notamment si la première batterie est une batterie au plomb, peut être utilisée de manière préférentielle au

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moment des démarrages du moteur thermique du véhicule, pour alimenter un démarreur. L'unité de gestion électronique 10 déconnecte la seconde batterie 7 (par exemple une batterie lithium, et plus précisément de type lithium-ion) à l'aide de l'interrupteur 11, dès que le véhicule est en mode « parking ». On évite de cette manière de décharger la batterie 7. La seconde batterie 7 reste alors déconnectée du réseau jusqu'à ce que le prochain démarrage du moteur du véhicule ait été effectué.

Les batteries au plomb ont en effet une excellente capacité de démarrage à froid, et c'est donc la première batterie 4 au plomb qui est utilisée au moment du démarrage du moteur thermique du véhicule.

Les batteries au lithium ont une meilleure endurance en terme de cyclages, et c'est donc la seconde batterie qui est utilisée pour alimenter le réseau de bord du véhicule pendant le roulage du véhicule. La tension du réseau c'est-à-dire la tension mesurable entre les bornes de la première batterie 4, est imposée par celui des trois éléments, parmi l'alternateur 3, la première batterie 4 et la deuxième batterie 7 éventuellement associée à un transformateur CC/CC, qui présente entre ses deux bornes la tension la plus élevée.

Par « bornes » de chacun des éléments, on entend les deux points de connexion de cet élément au réseau 2.

Dans le cas où le système inclut un transformateur CC/CC 8, connecté comme décrit sur la figure 1, on entend par tension aux bornes de l'ensemble [seconde batterie 7, transformateur CC/CC 8], la tension entre les deux points de connexion de cet ensemble, au réseau 2.

Quand l'alternateur 3 ne tourne pas, par exemple au moment du démarrage du véhicule, et que la seconde batterie 7 est déconnectée au moyen de l'interrupteur 11, c'est la première batterie 4 qui impose la tension sur le réseau 2.

Quand le véhicule roule et que l'alternateur 3 fonctionne, on choisit de piloter la consigne de tension de l'alternateur 3 au dessus de la tension maximale à vide de la première batterie 4. De cette manière, ce n'est pas la première batterie 4 qui fournit l'énergie électrique du circuit 2. Selon que la tension de l'alternateur 3 est plus élevée ou plus basse que la tension de la seconde batterie 7, ce

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sera alors soit l'alternateur 3, soit la seconde batterie 7, soit les deux simultanément, qui fourniront l'énergie électrique du réseau 2.

Dans le cadre de l'invention, on choisit une seconde batterie 7 dont la tension maximale à vide est suffisamment supérieure à la tension maximale à vide de la première batterie 4, de manière à pouvoir imposer alternativement deux modes de fonctionnement. Dans le premier mode de fonctionnement, la tension d'alternateur est fixée à une valeur basse « Valt_basse », qui est supérieure à la tension à vide maximale de la première batterie « VOmax_battl », elle-même inférieure à la tension maximale tolérée par le réseau « Vmax_réseau ». La tension d'alternateur « Valt_basse » est inférieure à la tension maximale à vide de la seconde batterie 7 « V0max_batt2 ». Dans un second mode de fonctionnement, la tension d'alternateur est égale à une valeur haute de tension d'alternateur « Valt_haute », qui est supérieure à la tension basse d'alternateur, tout en restant inférieure à la tension maximale tolérée par le réseau.

De cette manière, quand l'alternateur 3 est régulé pour délivrer la tension basse d'alternateur, et que la seconde batterie 7 est suffisamment chargée pour que sa tension soit supérieure à la tension basse d'alternateur, c'est la seconde batterie 7 qui fournit l'énergie électrique au réseau 2. Quand, dans ce mode de fonctionnement, la tension de fonctionnement de la seconde batterie 7 descend au niveau de la tension basse d'alternateur, une partie de l'énergie électrique du réseau 2 est fournie par la seconde batterie 7, et une partie de l'énergie électrique est fournie par l'alternateur 3.

Quand l'unité de gestion électronique 10 impose le second mode de fonctionnement, où c'est la tension haute d'alternateur qui est imposée, si la tension à vide de la seconde batterie est inférieure à la tension haute d'alternateur, c'est alors l'alternateur qui fournit l'énergie électrique au réseau et qui fournit simultanément une énergie permettant la recharge de la seconde batterie 7.

Si aucun autre moyen que l'alternateur 3 n'est prévu pour recharger la seconde batterie 7, la seconde batterie 7 pourra donc se recharger pendant les phases où c'est la tension haute d'alternateur qui est imposée, et pourra fournir de l'énergie au réseau tant que sa tension restera supérieure à la tension basse d'alternateur, pendant

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les phases où l'unité de gestion électronique 10 impose la tension basse d'alternateur.

On impose de préférence une tension basse d'alternateur tout juste supérieure à la tension maximale à vide de la première batterie, de manière à ce que, pendant les phases où la tension basse d'alternateur est imposée, l'alternateur prélève le moins possible d'énergie mécanique sur l'arbre moteur entraîné par le moteur thermique. L'alternateur ne crée ainsi qu'une surconsommation limitée de carburant, tout en assurant que la première batterie reste constamment chargée à son niveau maximal.

Dans le premier mode de fonctionnement, tant que la seconde batterie 7 est suffisamment chargée (c'est-à-dire tant que sa tension est supérieure à la tension basse d'alternateur), c'est la seconde batterie 7 qui fournit l'énergie électrique au réseau 2.

Les phases où l'on impose la tension haute d'alternateur en vue de recharger la seconde batterie 7, sont de préférence les phases de roulage à faible coût en carburant, par exemple les phases de décélération récupérative, c'est-à-dire si le véhicule est dans un mode de décélération permettant d'utiliser le frein moteur, et d'utiliser une partie de l'énergie mécanique de l'arbre moteur pour faire tourner l'alternateur. Il suffit par exemple pour cela que la consigne à la pédale du véhicule corresponde à une phase de décélération moteur.

Une partie de l'énergie cinétique de freinage du véhicule sert alors à recharger la seconde batterie 7. Cette énergie récupérée pendant les phases de freinage permet ensuite d'économiser du carburant, en limitant la tension d'alternateur imposée pendant les phases de roulage correspondant au premier mode de fonctionnement.

La figure 2 illustre un exemple de positionnement relatif des différentes valeurs de tensions mentionnées précédemment dans la description du système d'alimentation électrique 1. Les différents niveaux représentés sur la figure 2 illustrent la tension minimale à vide de la première batterie 4 soit VOmini_battl , la tension maximale à vide de la première batterie 4 soit VOmax_battl , la tension minimale à vide V0mini_batt2 de la seconde batterie 7, la tension maximale à vide V0max_batt2 de la seconde batterie, la

tension basse d'alternateur Valt_basse, la tension haute d'alternateur Valt_haute et la tension maximale Vmax_réseau que le réseau 2 est capable de supporter sans être endommagé.

De manière typique, si l'on fonctionne avec une batterie au plomb comme première batterie 4, et avec, comme seconde batterie, une batterie de type lithium-ion issue de la récupération de batteries lithium-ion ayant servi à propulser des véhicules électriques ou hybrides, la tension minimale à vide VOmini_batt1 de la première batterie au plomb est de l'ordre de 12 volts, et correspond sensiblement à la tension minimale à vide V0mini_batt2 de la seconde batterie au lithium, ou est un peu inférieure.

La tension maximale à vide VOmax_batt1 de la première batterie au plomb est de l'ordre de 12,8 volts, et la tension basse d'alternateur Valt_basse que l'on impose pour être juste au dessus de cette tension maximale à vide est de l'ordre de 13,2 volts.

La tension maximale à vide V0max_batt2 de la seconde batterie au lithium peut être de l'ordre de 16,8 volts, et la tension haute d'alternateur Valt_haute de l'ordre de 15 volts afin de rester en dessous de la valeur maximale acceptée par le réseau Vmax_réseau, qui elle, est de l'ordre de 16 volts.

Il est envisageable d'utiliser d'autres types de batterie pour la première et pour la seconde batterie, et la tension maximale de la seconde batterie n'est pas obligatoirement supérieure à la tension maximale du réseau. La tension basse d'alternateur doit de préférence être supérieure à la tension maximale à vide de la première batterie. On pourrait éventuellement envisager un mode de réalisation où la tension basse d'alternateur serait très légèrement inférieure à la tension maximale à vide de la première batterie, mais on imposerait alors inutilement des cycles de charge et de décharge à la première batterie en réduisant la durée de vie de celle-ci.

La tension maximale de la seconde batterie devra être obligatoirement supérieure à la tension maximale à vide de la première batterie, de manière à pouvoir définir une valeur de tension basse d'alternateur entre ces deux valeurs de tension maximale à vide des deux batteries.

La tension haute d'alternateur peut être égale, voire supérieure à la tension maximale à vide de la seconde batterie, par

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exemple si la tension maximale de la seconde batterie est inférieure à la tension maximale tolérée par le réseau.

La tension minimale à vide de la seconde batterie doit être inférieure à la tension haute d'alternateur afin de permettre une charge au moins partielle de la seconde batterie 7 pendant les phases de fonctionnement avec la tension haute d'alternateur.

La seconde batterie 7 peut être rechargée, outre pendant les phases où l'alternateur tourne à sa valeur de tension élevée, par des moycns de production électriques supplémentaires tels que les panneaux solaires 9. Dans le cas où la tension maximale à vide de la seconde batterie est inférieure à la tension maximale tolérée par le réseau, ou dans le cas où le système comprend un transformateur CC/CC apte à abaisser la tension délivrée par la seconde batterie à une tension inférieure à la tension maximale tolérée par le réseau, on peut également envisager de recharger la seconde batterie 7 sur un réseau extérieur au véhicule, par exemple sur une aire de stationnement.

La tension maximale à vidc de la seconde batterie 7, c'est-à-dire V0max_batt2, peut être inférieure ou supérieure à la tension maximale acceptée par lc réseau 2. Si la tension maximale à vide de la seconde batterie est supérieure à la tension maximale acceptée par le réseau Vmax_réseau, selon une première variante de réalisation, on exploite la seconde batterie 7 sur une partie seulement de son domaine de fonctionnement c'est-à-dire par exemple entre la tension basse d'alternateur et la tension haute d'alternateur.

Selon une seconde variante de fonctionnement, on peut exploiter la seconde batterie 7 sur un domaine plus large, par exemple entre la tension basse d'alternateur et la tension maximale à vide acceptée par la seconde batterie 7, si par exemple lc système est muni d'un transformateur CC/CC 8, apte à abaisser la tension délivrée par la seconde batterie 7 de manière à l'amener à une valeur inférieure ou égale à la tension maximale tolérée par le réseau.

Dans ce cas, on peut par exemple envisager de charge la seconde batterie 7 à sa tension maximale à vide à partir d'un réseau extérieur au véhicule, quand le véhicule est à l'arrêt. On utilise ensuite cette réserve d'énergie pendant le roulage du véhicule en la

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complétant par une recharge partielle de la batterie à une tension haute d'alternateur quand le véhicule est en décélération récupérative.

Si le transformateur CC/CC est bidirectionnel, on peut même envisager de charger la seconde batterie à sa tension maximale à vide en élevant la tension aux bornes de la seconde batterie 7 par rapport à la tension haute d'alternateur pendant les phases de décélération récupérative.

Par sécurité, afin d'éviter une décharge même partielle de la première batterie 4, la tension basse d'alternateur est choisie légèrement supérieure à la tension maximale à vide de la première batterie 4.

La tension minimale à vide de la seconde batterie 7 est de préférence inférieure à la tension basse d'alternateur de manière à ce que, lorsque le véhicule est dans un mode de roulage où la tension basse d'alternateur est imposée par l'unité de gestion électronique 10, l'énergie fournie par l'alternateur vienne automatiquement compléter l'énergie fournie par la seconde batterie 7 lorsque la tension de celle-ci vient à baisser. On évite ainsi que la tension de la seconde batterie 7 puisse descendre à la tension minimale tolérée V0mini_batt2.

On pourrait envisager des variantes de réalisation où la tension minimale à vide de la seconde batterie serait supérieure à la tension basse d'alternateur, mais il faut pour une telle variante que l'unité de gestion électronique 10 impose une tension haute d'alternateur avant que la tension de la seconde batterie 7 ne descende en dessous de sa valeur minimale. Il faut, dans tous les cas, que la tension minimale à vide de la seconde batterie 7 soit inférieure à la tension haute d'alternateur.

La tension basse d'alternateur est de préférence inférieure à la tension maximale à vide de la seconde batterie 7. Elle est aussi proche que possible, par valeur supérieure, de la tension maximale à vide de la première batterie, tout en gardant une marge d'écart afin d'être sûr que l'alternateur régulé en tension basse d'alternateur reste au dessus de cette valeur minimale VOmax_battl .

Il est avantageux d'utiliser une seconde batterie 7 dont la tension maximale à vide V0max_batt2 est supérieure à la tension

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maximale Vmax_réseau du réseau 2, ce qui permet, pour choisir les valeurs de la tension basse d'alternateur et de la tension haute d'alternateur, de disposer de tout l'intervalle de tension compris entre la tension maximale à vide de la première batterie VOmax_batt1 et la tension maximale acceptée par le réseau Vmax_réseau.

On se trouve en particulier dans cette configuration lorsque l'on a un réseau 2 du véhicule dont la tension maximale acceptable est de l'ordre de 15 à 16 volts, et que l'on utilise comme première batterie 4 une batterie au plomb, dont la tension maximale à vide est d'environ 12,8 volts, et une batterie lithium-ion pour la seconde batterie 7, par exemple une batterie lithium-ion reconditionnée suite à une utilisation pour la propulsion de véhicule électrique. Une telle batterie reconditionnée présente par exemple une tension maximale à vide de l'ordre de 16,8 volts et une tension minimale à vide acceptable voisine de 12 volts.

Outre le basculement à une tension d'alternateur haute pendant les phases de décélération du véhicule, des stratégies complémentaires implémentées dans l'unité de gestion électronique 10 peuvent être définies, afin d'éviter une décharge excessive de la seconde batterie 7 dans les cas de figure où les phases de décélération récupérative ne sont pas suffisamment fréquentes et/ou suffisamment prolongées.

On peut alors choisir d'imposer une tension d'alternateur intermédiaire entre la tension basse d'alternateur et la tension haute d'alternateur, c'est-à-dire strictement supérieure à la tension basse d'alternateur et inférieures ou égales à la tension haute d'alternateur. Une ou plusieurs tensions intermédiaires peuvent ainsi être imposées pendant certaines phases de roulage qui peuvent laisser supposer que les prochaines décélérations sont éloignées dans le temps. Ces phases de roulage peuvent comprendre des modes de roulage de type autoroutier. Une ou plusieurs tensions intermédiaires peuvent également être imposées pour des modes de roulage préprogrammés dans l'unité de gestion électronique parce que le point de fonctionnement du moteur, pour ces modes de roulage, correspond à une consommation en carburant moins élevée que pour d'autres modes de roulage.

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Le basculement vers une tension intermédiaire d'alternateur peut également être conditionné par la détection simultanée d'un mode de roulage donné, et d'un état de charge inférieur ou égal à un état de charge seuil de la seconde batterie 7.

La figure 3 illustre un algorithme 1 qui peut être implanté dans l'unité de gestion électronique 10 d'un système d'alimentation en énergie selon l'invention. A un instant initial 21, correspondant par exemple à la mise en service du véhicule ou à sa remise en service après un changement de batteries, l'unité de gestion électronique 10 teste, à une étape 22, si le véhicule est en mode parking.

Si c'est le cas, l'unité de gestion électronique 10 déconnecte, si ce n'est déjà fait, la seconde batterie 7 du réseau 2 à l'aide de l'interrupteur 11, à une étape 23.

Elle teste ensuite à une étape 24, si la tension aux bornes de la seconde batterie 7 est descendue en dessous d'une tension Vmin qui peut, par exemple, être égale à la tension minimale à vide V0mini_batt2 de la seconde batterie, ou être une valeur légèrement supérieure à cette tension minimale à vide.

Si la tension mesurée est inférieure à la tension seuil Vmin, l'unité de gestion électronique 10 affiche un message d'alerte avertissant le conducteur qu'il doit changer la seconde batterie 7, à une étape 25. Si la tension est supérieure à la tension seuil Vmin, l'unité de gestion électronique retourne à l'étape 22.

Quand le test 22 indique que le véhicule n'est plus en configuration de parking, l'unité de gestion électronique 10 teste à une étape 26 la santé de la seconde batterie 7. Ce test de santé peut par exemple consister à vérifier si le nombre de cycles de charges et de décharges déjà subies par la seconde batterie 7 est inférieur à un nombre seuil Nmax de charges et de décharges, si les différentes cellules de la batterie sont suffisamment équilibrées, et si la tension aux bornes de la batterie est supérieure ou égale à la tension seuil Vmin.

Si la réponse est négative, l'unité de gestion électronique 10 affiche le message d'alerte correspondant à l'étape 25. Si le résultat du test 26 est positif, l'unité de gestion électronique effectue un test 27 pour savoir si le moteur thermique du véhicule est actif. Si ce

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n'est pas le cas, l'unité de gestion électronique 10 met en place une stratégie 28 permettant d'alimenter le réseau 2 soit à partir de la première batterie, soit à partir de la seconde batterie, soit à partir des deux batteries conjointement, puis retourne à l'étape 22.

Lorsque le test 27 indique que le moteur thermique du véhicule est actif, l'unité de gestion électronique teste à une étape 29 si le véhicule est dans un mode de décélération récupérative, c'est-à-dire si le véhicule est dans un mode de décélération permettant d'utiliser le frein moteur, en puisant une partie de l'énergie mécanique de l'arbre moteur pour faire tourner l'alternateur. Il suffit par exemple pour cela que la consigne à la pédale du véhicule corresponde à une phase de décélération moteur.

Si le véhicule est en mode de décélération récupérative, l'unité de gestion électronique 10 impose à l'alternateur une tension haute d'alternateur, par exemple 15 volts, à une étape 31, et continue à boucler sur le test 29 puis sur le pilotage à la tension haute d'alternateur 31, tant que le véhicule est en décélération.

Si le véhicule n'est pas en décélération récupérative à la sortie de l'étape de test 29, l'unité de gestion électronique 10 impose à l'alternateur 3 de fonctionner à la tension basse d'alternateur, par exemple à 13 volts, à une étape 30.

Suite à l'étape 30, l'unité de gestion électronique 10 teste si le véhicule et la seconde batterie 7 sont dans une configuration « de charge forcée ». Une telle configuration de charge forcée peut par exemple correspondre au cas où la tension aux bornes de la seconde batterie 7 descend en dessous d'une valeur seuil Vi et où simultanément un compteur de temps Δi, qui comptabilise le temps écoulé depuis la dernière décélération, passe au dessus d'un seuil Δt_1.

Dans ce cas de figure, on peut considérer que la tension de la seconde batterie commence à devenir insuffisante, et que le mode de roulage détecté n'est pas un mode de roulage ponctué de décélérations suffisamment fréquentes.

Si ce test 32 révèle que l'on se trouve dans la configuration de marche forcée, l'unité de gestion électronique 10 impose, à une étape 33, une régulation de l'alternateur 3 à une tension Valt Mid par exemple égale à 14,5 volts, et continue à imposer ce mode de

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charge forcée tant que le niveau de recharge de la batterie testé à une étape 34 n'a pas atteint un niveau satisfaisant minimal SOC_{min}.

Ce niveau de charge minimal peut par exemple être détecté par une baisse du courant de recharge entrant dans la seconde batterie 7.

Quand le test de l'étape 34 indique que le niveau de recharge de la seconde batterie est suffisant, l'unité de gestion électronique 10 teste à une étape 35 la santé de la seconde batterie 7, par exemple en vérifiant que la température de la batterie ne dépasse pas une température T_{max} maximale, en vérifiant que le niveau d'équilibrage entre les différentes cellules est suffisant, ou à défaut que ce niveau permet encore de rééquilibrer les différentes cellules, et en vérifiant que la tension V aux bornes de la seconde batterie est supérieure à la tension seuil V_{min}.

Si le niveau de santé détecté à l'étape 35 est insuffisant, l'unité de gestion électronique 10 affiche le message d'alerte correspondant à l'étape 25. Dans le cas contraire, l'unité de gestion électronique 10 teste à une étape 36 si les différentes cellules de la seconde batterie 7 sont suffisamment équilibrées. Si c'est le cas, l'unité de gestion électronique revient à l'étape de test 22 permettant de vérifier si le véhicule, entre temps, se trouve en mode parking.

Dans le cas contraire, l'unité de gestion électronique déclenche un équilibrage des cellules à une étape 37 et retourne également à l'étape 22.

L'objet de l'invention ne se limite pas aux exemples de réalisation décrits et peut faire l'objet de nombreuses variantes, aussi bien en ce qui concerne l'agencement des différents éléments du système 1, les algorithmes de fonctionnement implantés dans l'unité de gestion électronique 10 et/ou le choix des types de batteries ou autres types d'accumulateurs.

La tension basse et la tension haute imposées aux bornes de la seconde batterie 7, peuvent être obtenues soit en régulant la tension délivrée par l'alternateur à deux niveaux différents, soit en élevant la tension aux bornes de la seconde batterie à l'aide d'un transformateur CC/CC. La tension haute peut également être obtenue en élevant à la fois la tension de consigne aux bornes de

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l'alternateur et en transformant cette tension, à l'aide du transformateur CC/CC, en une tension encore plus élevée aux bornes de la seconde batterie.

L'algorithme de fonctionnement, dont un exemple est donné en figure 3, admet de très nombreuses variantes, notamment en ce qui concerne la succession des différents tests pour déterminer quelle tension d'alternateur doit être imposée à un instant donné, ou dans la définition d'un ou de plusieurs modes de charge forcée. Ces modes de charge forcée peuvent être définis avec différentes tensions d'alternateur Valt Mid selon les modes. On peut par exemple définir différents modes de charge forcée suivant différentes conditions de niveau de charge de la seconde batterie et différentes conditions de type de roulage et/ou de point de fonctionnement du moteur détecté.

Les accumulateurs électriques désignés sous le terme de première et seconde batterie peuvent être des batteries d'accumulation de type électrochimique, par exemple une première batterie au plomb et une seconde batterie de type lithium-ion. On peut également envisager d'utiliser pour la seconde batterie d'autres types de batteries lithium que les batteries lithium-ion, d'autres batteries de type électrochimique ou encore un ou plusieurs supercondensateurs.

L'invention peut être utilisée pour un système d'alimentation d'un véhicule à propulsion par un moteur thermique. Elle peut également être utilisée pour un système d'alimentation électrique d'un véhicule à propulsion hybride thermique électrique. Dans ce dernier cas, on peut par exemple utiliser une batterie au lithium comme première batterie servant à la fois pour le démarrage du véhicule et pour la propulsion occasionnelle du véhicule, et une seconde batterie de type supercapacité pour accumuler de l'énergie pendant les phases de décélération. Il faut donc comprendre dans cette demande le terme « batterie d'accumulation électrique » au sens large puisqu'il englobe des systèmes de stockage de type supercapacité.

Le système selon l'invention permet de réduire la consommation globale en carburant du véhicule, de prolonger la durée de vie de la première batterie, et, dans le cas où on utilise

comme seconde batterie une batterie au lithium reconditionnée, de réduire le coût et l'empreinte écologique du système.

Il est à noter que le concept d'utilisation de deux batteries pour des usages différents peut être élargi à plus de deux batteries. En effet il est enviseageable d'utiliser également une troisième batterie connectée au réseau de bord par l'intermédiaire d'un convertisseur CC/CC et d'un commutateur, ce commutateur étant fermé en mode « parking » c'est-à-dire moteur arrêté, pour fournir l'énergie électrique nécessaire aux consommateurs du réseau de bord. Avantageusement cette troisième batterie est constituée de modules récupérés d'une batterie de traction de véhicule électrique, bénéficie des meilleurs points de rendement du moteur et de l'alternateur pour être rechargée (par exemple en décélération, de la même manière que la deuxième batterie au lithium), et bénéficie d'un système de recharge complémentaire tel qu'un panneau solaire.

De même la première batterie plomb utilisée pour le démarrage du véhicule, peut être connectée au réseau de bord par l'intermédiaire d'un commutateur, permettant de spécialiser encore plus son utilisation : ce commutateur est par exemple fermé seulement au démarrage, et sur les meilleurs points de rendement du moteur et de l'alternateur lorsque son état de charge est en dessous d'un certain seuil.

Il est à noter que l'utilisation d'un commutateur entre d'une part une première batterie et le réseau de bord et d'autre part une deuxième batterie et le réseau de bord permet d'utiliser pour ces deux batteries des batteries plomb identiques connectées en parallèle de l'alternateur sans CC/CC intermédiaire tout en leur attribuant un rôle spécifique (démarrage pour l'une, consommation du réseau de bord pour l'autre) et en les faisant recharger aux meilleurs points de rendement du moteur et de l'alternateur.

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REVENDICATIONS

1. Système (1) d'alimentation en énergie électrique d'un véhicule, comprenant :

-un réseau (2) à courant continu, d'au moins un organe (6) consommateur électrique, apte à être alimenté dans une gamme de tensions inférieure ou égale à une tension maximale de réseau (Vmax_réseau),

-une première batterie (4) d'accumulation électrique connectée au réseau (2), et présentant une première tension maximale à vide (VOmax_Batt1) inférieure à la tension maximale de réseau (Vmax_réseau),

-une seconde batterie (7) d'accumulation électrique connectée au réseau (2), présentant une seconde tension maximale à vide (V0max_Batt2), supérieure à la tension maximale à vide de la première batterie (VOmax_Batt1), et une tension minimale à vide acceptable (V0mini_Batt2) inférieure à la tension maximale de réseau (Vmax_réseau),

-un alternateur (3) pilotable connecté au réseau (2), et apte à délivrer à la seconde batterie (7) une énergie électrique sous une tension de consigne pilotable à différentes valeurs de consigne (Valt_basse, Valt_haute),

caractérisé en ce que le système comprend en outre une unité de gestion électronique (10), configurée pour imposer à l'alternateur (3) lors du roulage du véhicule, successivement au moins deux tensions de consigne différentes, à savoir une tension basse d'alternateur (Valt_basse) qui est strictement supérieure à la première tension maximale à vide de la première batterie (VOmax_Batt1), et une tension haute d'alternateur (Valt_haute) qui est strictement supérieure à la fois à la tension minimale à vide de la seconde batterie (V0mini_Batt2), et à la tension basse d'alternateur (Valt_basse).

2. Système selon la revendication 1, comportant en outre un transformateur de tension (8) de type CC/CC apte à abaisser la tension délivrée par la seconde batterie (7) au réseau, et dans lequel la seconde tension maximale à vide (V0max_Batt2) de la seconde

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batterie (7) est supérieure à la tension maximale de réseau (Vmax_réseau).

3. Système selon la revendication 2, dans lequel le transformateur de tension (8) est bidirectionnel, et est apte à alimenter la seconde batterie (7) à une tension supérieure à la tension maximale du réseau (Vmax_réseau) quand l'alternateur (3) débite un courant sous la tension haute d'alternateur (Valt_haute).

4. Système selon l'une des revendications précédentes, dans lequel la première batterie (4) est unc batterie au plomb, et la seconde batterie (7) est une batterie au lithium.

5. Système selon l'une des revendications précédentes, dans lequel l'unité de gestion électronique (10) est configurée pour ouvrir un interrupteur (11) de la seconde batterie (7) quand le moteur du véhicule est arrêté et, si la tension de la première batterie (4) passe sous un premier seuil et simultanément la tension de la seconde batterie est au dessus d'un second seuil, pour refermer cet interrupteur (11) pendant une période prédéterminée avant d'effectuer le prochain démarrage du véhicule.

6. Procédé de gestion d'un véhicule automobile équipé d'une première batterie (4) et d'une seconde batterie (7) d'alimentation en énergie électrique, les deux batteries présentant des tensions maximales à vides (V0max_Battl2, V0max_Batt2) différentes et étant connectées à un même alternateur (3) et à un même réseau électrique à courant continu du véhicule (2), caractérisé en ce que l'on impose une tension basse d'alternateur (Valt_basse) pendant des premières phases de roulage du véhicule, et l'on impose une tension haute d'alternateur (Valt_haute) plus élevée que la tension basse d'alternateur pendant des secondes phases de roulage du véhicule telles que des phases de freinage récupératif, moins consommatrices en carburant que les premières phases.

7. Procédé selon la revendication 6, dans lequel on impose la tension haute d'alternateur (Valt_haute) quand le véhicule est en phase de décélération récupérative, et on impose la tension basse d'alternateur (Valt_basse) quand le véhicule est dans une phase d'accélération du moteur.

8. Procédé selon les revendications 6 à 7, dans lequel on impose une tension intermédiaire d'alternateur (Valt Mid),

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strictement supérieure à la tension basse d'alternateur (Valt_basse) et inférieure ou égale à la tension haute d'alternateur (Valt_haute), quand un niveau de charge de la seconde batterie (7) devient inférieur à une charge seuil, et/ou quand un certain mode de roulage du véhicule autre que la décélération, est détecté, et/ou si le courant délivré par la seconde batterie (7) au réseau dépasse un certain seuil.

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FIG.1

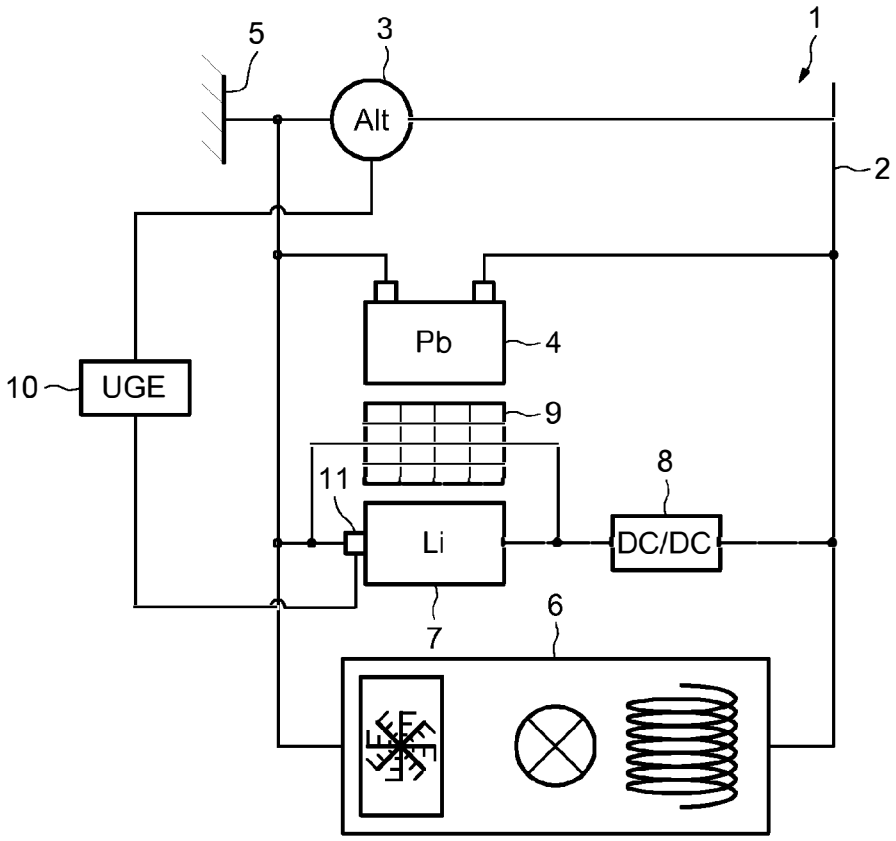


FIG.2

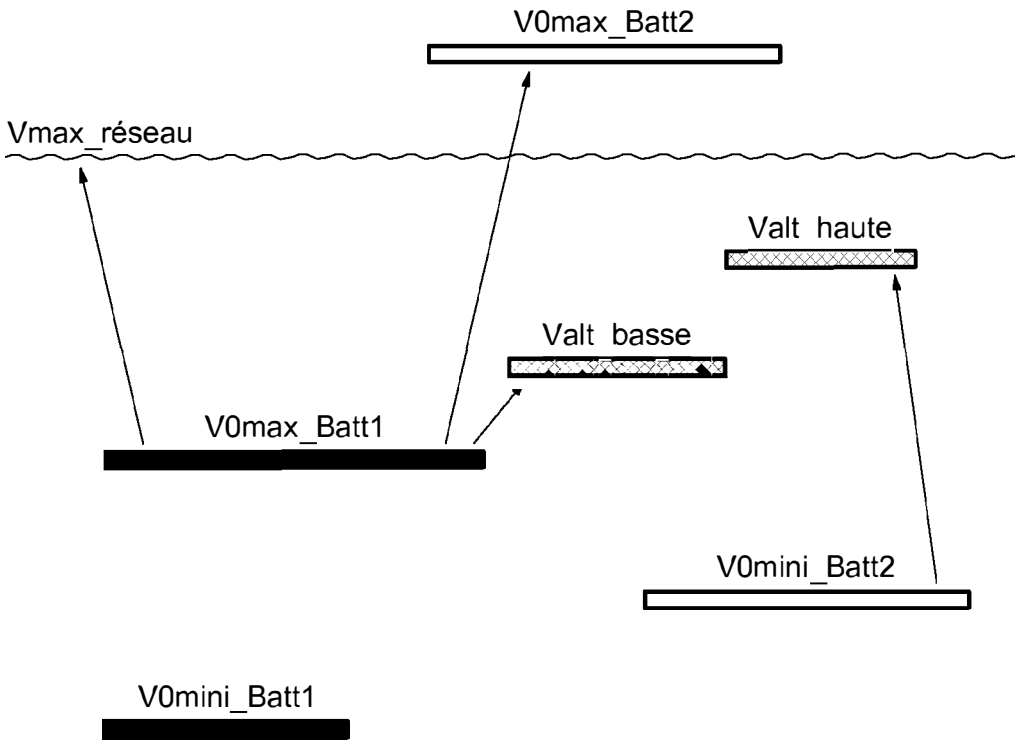


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FIG.3

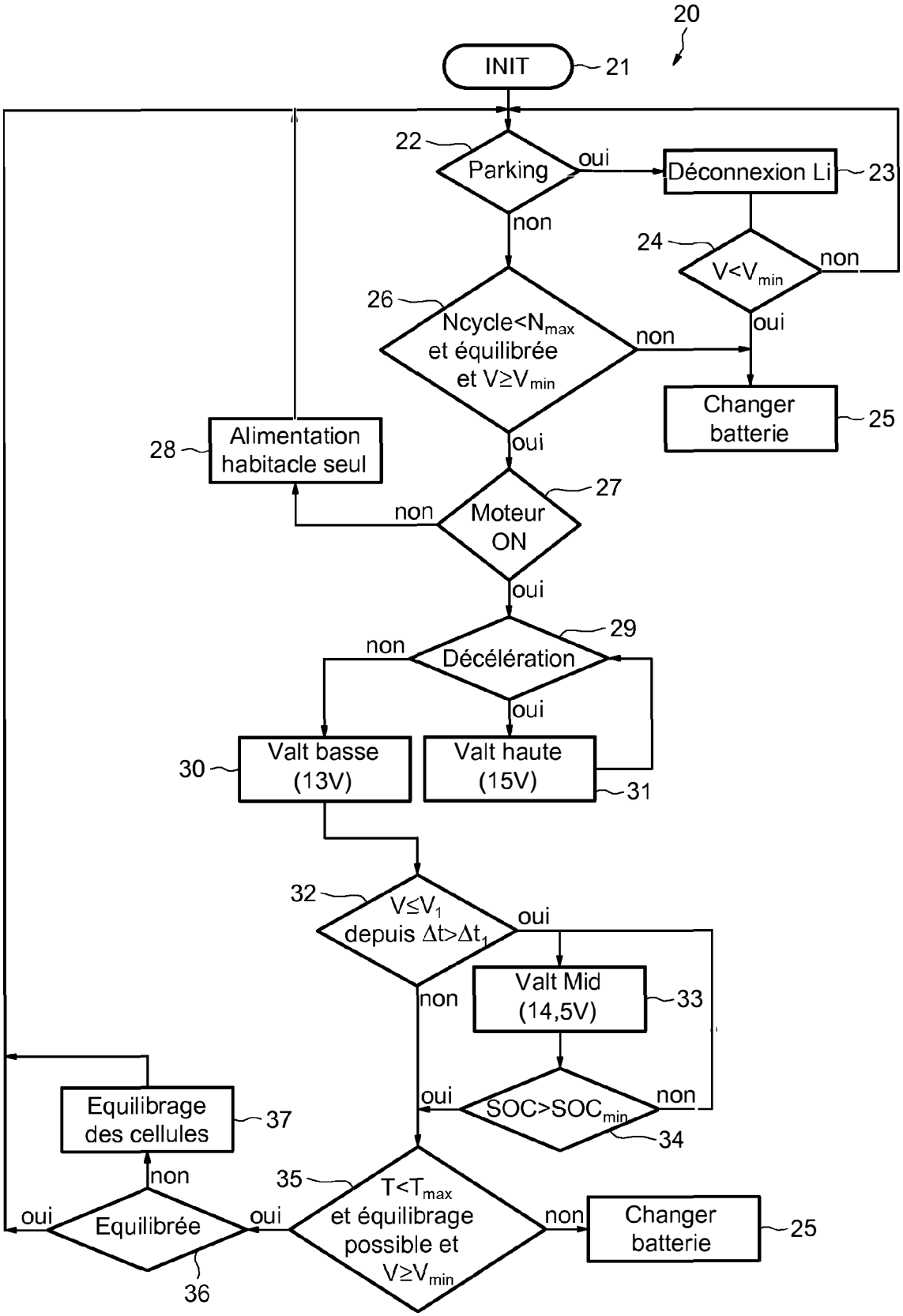


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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 054985.000055PCT	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2014/045434	International filing date *(day/month/year)* 03 July 2014	(Earliest) Priority Date *(day/month/year)*
Applicant THE NOCO COMPANY		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/045434

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H02J 7/00 (2014.01)
CPC - H02J7/0034 (2014.09)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B60R-016/03, B60R-016/04, F02N-11/08, H02J 7/00 (2014.01)
USPC -307/150, 320/105, 307/127, 340/636.1, 340/636.150, 361/82, 320/103

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - H02J7/0063, H02J7/0034, H02J 2001/006 (2014.09)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2005/0110467 A1 (THOMASON) 26 May 2005 (26.05.2005) entire document	1, 4-6,8-9, 12-18, 22, 25 --- 2, 3, 7, 10, 11, 19, 20, 21, 23, 24, 26
Y	WO 2013/137873 A1 (DAO) 19 September 2013 (19.09.2013) entire document	2-3, 10-11
Y	US 6362599 B1 (TURNER et al.) 26 March 2002 (26.03.2002) entire document	7, 19-20
Y	US 7148580 B2 (SODEMANN et al.) 12 December 2006 (12.12.2006) entire document	21,23,24,26
A	US 6803743 B2 (GEORGE et al.) 12 October 2004 (12.10.2004) entire document	1-26

☐ Further documents are listed in the continuation of Box C. ☐

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Date of the actual completion of the international search	Date of mailing of the international search report
07 October 2014	03 NOV 2014

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16450422
Filing Date	2019-06-24
First Named Inventor	NOOK
Art Unit	2859
Examiner Name	DIAO
Attorney Docket Number	054985-000055-US-05

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	3085187		1963-04-09	GODSHALK	
	2	3105183		1963-09-24	HYSLER et al.	
	3	3267452		1966-08-16	WOLF	
	4	4972135		1990-11-20	BATES et al.	
	5	4990723		1991-02-05	ZIBERNA et al.	
	6	5496658		1996-03-05	HEIN et al.	
	7	5707257		1998-01-13	KOTAJIMA et al.	
	8	6002235		1999-12-14	CLORE	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2019-06-24
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	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

	9	6215273		2001-04-10	SHY	
	10	6222342		2001-04-24	EGGERT et al.	
	11	6300742		2001-10-09	HUNG	
	12	6384573		2002-05-07	DUNN	
	13	6679708		2004-01-20	DEPP et al.	
	14	7095339		2006-08-22	PENG et al.	
	15	D597029		2009-07-28	LI	

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	1	20050213867		2005-09-29	RAJENDRAN et al.	
	2	20080131764		2008-06-05	SAIKI	

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	First Named Inventor	NOOK
	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

	3	20090174362		2009-07-09	RICHARDSON et al.	
	4	20100001682		2009-07-02	DICKSON et al.	
	5	20100129723		2010-05-27	NODA et al.	
	6	20100244766		2010-09-30	OLSBERG	
	7	20110117408		2011-05-19	LENNOX	
	8	20110140651		2011-06-16	DAI	
	9	20120126818		2012-05-24	ISHIHARA	
	10	20130084471		2013-04-04	HAN et al.	
	11	20130241498		2013-09-19	KOEBLER	
	12	20130104817		2013-05-02	MILLER	
	13	20140045001		2014-02-13	YANG	

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	Attorney Docket Number	054985-000055-US-05

	14	20140113463		2014-04-24	PETERSON et al.	
	15	20150087182		2015-03-26	ZHAO et al.	
	16	20160141728		2016-05-19	FAUTEUX et al.	
	17	20160181587		2016-06-23	KOEBLER et al.	
	18	20170084899		2017-03-23	DENG et al.	
	19	20070178777		2007-08-02	MIEKKA	
	20	20110250473		2011-10-13	KIM	

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	1	2006/057497	WO		2006-06-01	LG CHEM		
	2	2012/074548	WO		2012-06-07	KOEBLER MARTIN		

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	First Named Inventor	NOOK
	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

	3	2014/206323	WO		2014-12-31	FAUTEUX DENIS GASTON; TECHTRONIC POWER TOOLS...		
	4	2105980	EP		2009-09-30	SAMSUNG SDI CO LTD		
	5	2605313	EP		2013-06-19	OXIS ENERGY LTD		
	6	102010062708	DE		2012-06-14	BOSCH GMBH ROBERT	English Abstract attached	X
	7	3185027	JP	U	2013-07-25	SFJ Co., Ltd.; Asia Bright Industrial (Hong Kong)	English Abstract attached	☒
	8	2001069673	JP	A	2001-03-16	HITACHI LTD	English Abstract attached	☒
	9	2011023249	JP	A	2011-02-03	NISSAN MOTOR	English Abstract attached	☒
	10	2012169161	JP	A	2012-09-06	PANASONIC CORP	English Abstract attached	☒
	11	2014232666	JP	A	2014-12-11	KANEKA CORP	English Abstract attached	☒
	12	103035874	CN	A	2013-04-10	BOSCH GMBH ROBERT; SAMSUNG SDI CO LTD	English Abstract attached	☒
	13	104795527	CN	A	2015-07-22	MICROVAST POWER SYSTEMS CO LTD	English Abstract attached	☒

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	First Named Inventor	NOOK
	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

	14	202696190	CN	U	2013-01-23	GUANGWEI AMERICA LINE ELECTRICAL APPLIANCE CO...	English Machine Translation attached	☒
	15	204516832	CN	U	2015-07-29	CONTEMPORARY AMPEREX TECHNOLOGY LTD	English Abstract attached	☒
	16	204966731	CN	U	2016-01-13	PRIME ELECTRIC (SHENZHEN) CO LTD	English Abstract attached	☒

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	1	XP 55517268A 1, NOCO Product Brochure, Jump Starter, Lithium GB70 2000A 12V.	
	2	XP 55517270A 1, NOCO Product Brochure, Jump Starter, Lithium GB40 1000A 12V.	
	3	USB Battery Charging Specification Version 1.2 (EX1009)	
	4	GROUNDS OF INVALIDITY: Annex A to the Grounds of Invalidity; PROJECTA product manual for 2200A JUMPSTARTER, P/No.s HP 2012, HP 2200.; Carku E-Power 21 device.	
	5	GROUNDS OF INVALIDITY: Prior use of the Carku E-Power 21 device ("Carku E-Power 21").; User manual for Carku E-Power 21 (Ann 1).; Specification sheet for Carku E-Power 21 (Ann 2).; Claimant's E-catalogue dated 22 April 2014, which included Carku E-Power 21 (Ann 3).; Photograph of claimants' booth at 115th 2014 Canton Fair (Ann 4).; Photographs and quotation sheet rcvd by Edelbert Lenz GmbH & Co. KG (Ann 5).; User manuals and specification sheets rcvd by Kaz Corp. of Japan (Ann 6).; E-Catalogue rcvd by email by Krautli (Schweiz) AG (Ann 7).	
	6	DEFENDANT DELTONA TRANSFORMER CORPORATION'S INVALIDITY CONTENTIONS: USB Implementers Forum, Inc, Battery Charging Specification, Rev 1.1, 4/15/2009.; MICRO-START/PPS, offered for sale as late as 07/29/2013, by Antigravity Batteries.; E-Power, offered for sale as late as 04/15/2013 by Carku.; Battery Tender Power Pack, offered for sale prior to 07/03/2014 by Carku/Deltran USA LLC.; PowerAll, offered for sale as late as 03/26/2014 by Gryphon Mobile Electronics LLC.; Electromate 400, offered for sale as late as 2013 by Black & Decker.	

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	Filing Date	2019-06-24
	First Named Inventor	NOOK
	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

	7	DEFENDANT TII TRADING INC.'S INVALIDITY CONTENTIONS
	8	DEFENDANT'S INVALIDITY AND UNENFORCEABILITY CONTENTIONS: USB Battery Charging Spec Ver 1.2.; E-Flite EC Connector Assembly Instruct w 2008.; Datasheet for LM7805 Voltage Regulator from Fairchild Semiconductor.; Carku Product Brochure for Epower-20 jump starter product.; Carku Product Brochure for Epower-21 jump starter product.; MC78XX/LM78XX/MC78XXA 3-Terminal 1A Positive Voltage Regulator from Fairchild Semiconductor Corp. 2001.; Patent Owner The NOCO Company's Preliminary Response in Dongguan IPR.
	9	Memo Opin and Order of US Dist Ct Jud Barker construing disputed terms of claims 1, 9 and 19 of the '015 issued NOCO v. SmarTech Produts, Inc., 1:18-cv-2780 (N.D. Ohio April 2, 2020; NOCO Amend Compl NOCO v Shenzhen Lianfa Tong Tech Co., Ltd., et al., 1:19-cv-01855 (N.D. Ohio April 2, 2020; Dec Wan; Dec Hartup; Dec Kirtley; Special Master Report on Prop Claim Const For USPN 9,007,015 issued NOCO v. Shenzhen Dika Na'Er E-Commerce Co., 1:17CV2282 (N.D. Ohio June 28, 2018) acc/adopt by US Dist Ct Jud Boyko, 2019 WL 1723358
	10	DEFENDANTS' AMENDED FINAL INVALIDITY AND UNENFORCEABILITY CONTENTIONS: The Powerall PBJS12000RD Jump Starter, offered for sale by Gryphon Mobile Electronics at least as early as 11/05/2013.; The Lightning 12V Jump Starter, offered for sale by Pilot, Inc. at least as early as 03/2014.; The L3 Model Jump Starter, offered for sale by Shenzhen Tsevie Company at least as early as 05/19/2019.
	11	STATEMENT OF DEFENSE AND COUNTERCLAIM: Carku Epower-20 jump starter; Carku Epower-21 jump starter; Carku Product Brochure for the Epower-20 jump starter product; Carku Product Brochure for the Epower-21 jump starter product

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

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	Application Number	16450422
	Filing Date	2019-06-24
	First Named Inventor	NOOK
	Art Unit	2859
	Examiner Name	DIAO
	Attorney Docket Number	054985-000055-US-05

CERTIFICATION STATEMENT

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

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

OR

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See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/William L. Klima/	Date (YYYY-MM-DD)	2022-06-10
Name/Print	William L. Klima	Registration Number	32422

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

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(19) World Intellectual Property Organization
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(71) Applicant: **DELTRAN OPERATIONS USA, INC.** [US/US]; 801 U.S. Highway 92 East, Deland, FL 32724 (US).

(72) Inventors: **BRUMLEY, Edward, William, Jr.**; 801 E International Speedway Blvd, Deland, FL 32724 (US). **SHREAD, Peter, James**; 801 E International Speedway Blvd, Deland, FL 32724 (US).

(74) Agent: **DIXON, Michael, K.** et al.; Akerman LLP, 777 South Flagler Drive, Suite 1100 West Tower, West Palm Beach, FL 33401 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW,

(54) Title: BATTERY MANAGEMENT SYSTEM FOR BATTERIES IN ENGINE START AND DEEP CYCLE APPLICATIONS

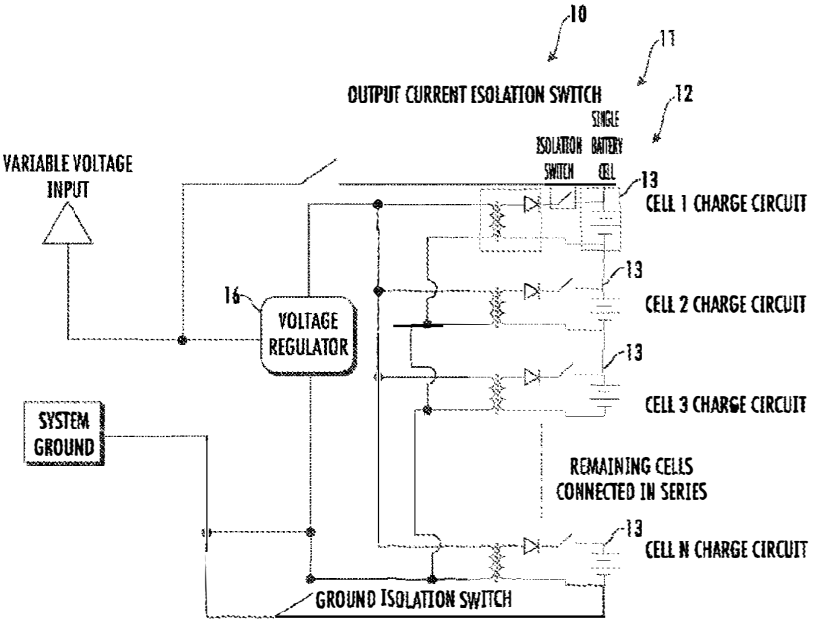


FIG. 1

(57) Abstract: A battery management system for batteries, such as, but not limited to, electric vehicle battery packs and cells, lithium iron phosphate batteries, lead acid batteries, gel batteries, and absorbed gel mat batteries, in engine start applications is disclosed. The battery management system is configured to control the charge and charging of each cell individually. The battery management system may be configured to control the charge of a battery which may consist of a plurality of cells, such as, but not limited to, lithium iron phosphate cells, and in at least one embodiment, the battery may consist of, but is not limited to being formed from, four lithium iron phosphate cells connected in series and a battery management system to ensure proper charge and safe operation.

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[Continued on next page]

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Published:

— *with international search report (Art. 21(3))*

EXHIBIT 1002
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BATTERY MANAGEMENT SYSTEM FOR BATTERIES IN ENGINE START AND DEEP CYCLE APPLICATIONS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to United States Patent Application No. 17/175014, filed February 12, 2021, and claims priority to and the benefit of United States Provisional Patent Application No. 63/032148, filed on May 29, 2020, both of which are incorporated herein in their entireties.

FIELD OF THE INVENTION

The invention relates to battery charging systems, and more particularly, to battery charging systems configured with engine start batteries and deep cycle batteries.

BACKGROUND

Lithium iron phosphate ($LiFePO_4$) batteries often include protection modes, such as Under Voltage Protection (UVP) mode and Over Voltage Protection (OVP) mode, to protect the batteries from being completely discharged and overcharged. During Under Voltage Protection mode, a control system of a lithium iron phosphate battery disconnects the cell pack from the battery posts to prevent further discharge. In the Under Voltage Protection mode, the control system disconnects the cell pack from the battery's posts, whereby the measured voltage across the posts is zero. In this mode, the battery may appear as if it is completely "dead". Automatic battery chargers do not detect such condition and are unable to charge the battery when in the Under Voltage Protection mode.

Similarly, when a lithium iron phosphate battery is in Over Voltage Protection (OVP) mode, the control system disconnects the cell pack from the battery posts to prevent overcharging. In this mode, there is no load on the charging system. When the battery is in such mode, an electrical system of a vehicle to which the battery is

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coupled often suffers improper operation, such as dash board lights flickering, check engine light, etc. Such problems do not typically occur with a conventional battery, such as lead acid, flooded, AGM, etc., which presents a constant load to a charging system regardless of the state of charge of the battery.

Additionally, a charging system can create excessive electrical potential and high current flow from the charging system. Charging systems can generate between about 12 Volts direct current to more than 20 Volts direct current at currents as high as 60 amps. Such high voltage and current can damage cells in lithium iron phosphate battery batteries.

Charging systems often do not produce clean direct current. Rather, charging systems may create a great deal of ripple, which may cause improper charging of the battery packs cells leading to shortened lifetimes and damage.

SUMMARY OF THE INVENTION

A battery management system for engine start applications, battery charging and deep cycle applications for batteries such as, but not limited to, electric vehicle battery packs and cells and battery chemistries, such as, but not limited to, lithium iron phosphate batteries, lead acid batteries, gel batteries, and absorbed gel mat batteries is disclosed. The battery management system is configured to control the charge and charging of each cell individually. The battery management system may be configured to control the charge of a battery which may consist of a plurality of cells, such as, but not limited to, lithium iron phosphate cells, and in at least one embodiment, the battery may consist of, but is not limited to being formed from, four lithium iron phosphate cells connected in series and a battery management system to ensure proper charge and safe operation. The battery management system may be configured to control the charge and charging of each cell individually and not control charging based only on the overall metrics of the battery as a whole, which is a sum total of each of the individual cells within the battery.

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The battery management system may be configured to address the problems previously set forth as follows. The battery management system may include an under voltage protection mode to protect one or more cells, or an entire battery formed from a plurality of cells from losing too much voltage. Unlike conventional technology, the battery management system can enable a voltage to be present across the poles of a battery when the battery is in undervoltage protection mode to enable the battery voltage to be monitored. As such, the battery management system may be configured to allow a battery's voltage to be read while in under voltage protection mode while limiting current flow. Under voltage protection mode may also automatically clear once the battery charge is sufficient or may be cleared via direction from a user through a wireless or other communications interface. Under voltage protection mode may also automatically clear, such as being temporarily suspended, upon detection of an engine start attempt.

The battery management system may also be configured to protect one or more cells of a battery or the entire battery via an over voltage protection mode. In particular, the battery management system may be configured to continuously monitor each cell of a battery and start to discharge the cell when the cell approaches over voltage protection value. The battery management system may be configured to regulate the input voltage and current.

The battery management system may be configured for engine starts applications. In particular, the battery management system may be configured to replace cell banks with super capacitors or may be configured to be compatible with a combination of cell banks and super capacitors allowing for high instantaneous current draw events, such as, but not limited to engine starts. The battery management system may be configured to collect cells into pack banks, which may allow one or more packs to be discharged while the other packs are being charged and thus always maintaining a load on the charging system. The battery management system may be configured to integrate learning/filtering into the software to customize the reserve charge set aside for engine starts. The battery management system may include a battery charging system including one or more

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power source connections. The battery charging system may include one or more voltage regulators per battery cell.

The battery management system may include a controller configured to control voltage via under and over voltage protection modes and to charge each cell individually in a multicell battery. The battery management system may include precision voltage references for use as a direct comparison for under voltage protection and over voltage protection. The controller may be configured to sense whether an individual cell voltage is equal to or greater than an over voltage protection reference voltage. If the individual cell voltage is equal to or greater than the over voltage protection reference voltage, then the controller may engage the over voltage protection mode via opening a charging field effect transistor. The controller may be configured such that when the controller senses that an individual cell voltage is equal to or less than an under voltage protection reference voltage, the microcontroller may engage the under voltage protection mode via opening a discharging field effect transistor. In at least one embodiment, the controller is a microcontroller or other appropriate device.

The battery management system may include a voltage regulator for regulating input for the cell charging circuit to filter out input voltage ripple before it reaches the plurality of cells. The voltage regulator may be set to a charge voltage level, thereby allowing maximum loading on the external charging system. The voltage regulator may have operating modes including a constant current mode and a constant voltage mode. The voltage regulator may be in constant current mode when the cell voltage is less than the current voltage level. The battery management system may include a feedback loop measuring cell voltage to properly control the state of the regulator.

The battery management system may include a system control module configured to maintain the integrity of an electrical system, such as a vehicle electrical system, to which the battery management system is attached when the battery management system is in an over voltage mode. In particular, the system control module simulates a battery so that the electrical system, such as a vehicle

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electrical system, to which the battery management system is attached does not develop odd, explained errors and operating conditions when the battery management system is in an over voltage mode. The system control module may emulate the battery's impedance when measuring the voltage of each cell. The system control module of the battery management system may include a discharge field effect transistor and a battery impedance emulator circuit, wherein the cell voltage is measured with the discharge field effect transistor open and the battery impedance emulator circuit engaged, thereby maintaining a quieting load on the external charging system, which models a lead acid battery and a absorbent glass mat battery. The controller may implement hysteresis to prevent an oscillation of states in the feedback loop. The controller may use a voltage regulator to maintain maximum applied voltage while in constant current mode. Once cell voltage reaches a charge level voltage, the controller fixes a regulated voltage adjust entering constant voltage mode and remains in this mode until cell voltage level drops below the charge voltage level. The voltage regulator may be configured to accept input voltage within a range between 12 Volts direct current and 20 Volts direct current.

The battery management system may include a cell balancing system configured to compare cell performance and adjust cells with voltages misaligned from target voltages. The cell balancing system may include one or more discharge resistors and one or more voltage monitors on each cell.

The battery management system may include a communication system, which may be wireless or another design, enabling the battery management system to communicate with remote devices to transmit data regarding cell and cell pack characteristics. The communication system may enable inter-battery management system communications to facilitate parallel and series battery configurations. The battery management system may include an alert system for indicating operational features of the battery management system. The battery management system may include an input system configured to receive input to control aspects of the battery management system.

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The controller may include an engine start mode in which the battery is discharged to the under voltage protection level and under voltage mode is engaged. The controller may disengage the under voltage protection mode for a specified window of time, referred to as an engine start window, thereby enabling an engine start to be attempted during the engine start window. The battery management system may include a battery impedance emulator to stabilize the battery management system when in over voltage protection mode.

An advantage of this system is that each cell of a battery, such as a lithium battery, may be individually analyzed and individually charged such that each cell may be fully charged thereby fully charging the battery as a whole.

Another advantage of this system is that when the battery management system is in over voltage protection mode, a filtering circuit is engaged which emulates a standard battery thereby eliminate electrical system malfunctions.

Yet another advantage of this system is that when the battery management system is in under voltage protection mode, the battery voltage is still detectable on the battery posts allowing smart chargers to automatically detect the battery and start charging the battery.

Another advantage of this system is that the battery management system is configured to regulate both voltage and current into a cell pack, thereby eliminating charging system instability which can damage cells.

Still another advantage of this system is that the battery management system is configured to detect smart battery chargers and provides a direct charging path for the cells for smart battery chargers, thereby allowing the smart battery charger to directly control charging.

These and other embodiments are described in more detail below.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a schematic diagram of the battery management system.

Figure 2 is a schematic diagram of a portion of the battery management system.

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Figure 3 is a schematic diagram of another embodiment of the battery management system.

Figure 4 is a schematic diagram of another embodiment of the battery management system.

Figure 5 is a schematic diagram of another embodiment of the battery management system.

Figure 6 is a schematic diagram of another embodiment of the battery management system.

Figure 7 is a perspective view of the battery management system including the battery charging system.

Figure 8 is a schematic diagram of the system enabling users to access data collected via the system from remote locations.

Figure 9 is a schematic diagram of a machine in the form of a computer system within which a set of instructions, when executed, may cause the machine to perform any one or more of the methodologies or operations of the system.

Figure 10 is a schematic diagram of a battery with a battery management system contained therein.

Figure 11 is a schematic diagram of a battery with a battery management system contained therein and coupled to a battery charger or other power source.

Figure 12 is a schematic diagram of a battery with a battery management system contained therein, positioned within a vehicle and coupled to a vehicle charging system therein.

Figure 13 is a schematic diagram of a battery management system self-contained within a battery management system housing and attached to positive and negative posts of a battery and also including connections so that the battery management system can be coupled to another system.

Figure 14 is a schematic diagram of a battery management system self-contained within a battery management system housing and positioned remotely from the battery. The battery management system may be in electrical communication, in series, with the positive and negative posts of the battery and

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may be in electrical communication with a vehicle charging system, a battery charger or a power source.

Figure 15 is a schematic diagram of a battery management system self-contained within a battery management system housing and positioned remotely from the battery. The battery management system may be in electrical communication with only the negative posts of the battery and may be in electrical communication with a vehicle charging system, a battery charger or a power source.

DETAILED DESCRIPTION OF THE FIGURES

As shown in Figures 1-15, a battery management system 10 for engine start applications, battery charging and deep cycle applications for batteries such as, but not limited to, electric vehicle battery packs and cells and battery chemistries, such as, but not limited to, lithium iron phosphate batteries, lead acid batteries, gel batteries, and absorbed gel mat batteries is disclosed. The battery management system 10 may be configured to control the charge and charging of each cell on an individual cell basis. The battery management system 10 may be configured to control the charge of a battery 12 which may consist of a plurality of cells 13, such as, but not limited to, lithium iron phosphate cells, and in at least one embodiment, the battery 12 may consist of, but is not limited to being formed from, four lithium iron phosphate cells connected in series and a battery management system 10 to ensure proper charge and safe operation. The battery 12 may be removably coupled to the battery management system 10.

In at least one embodiment, the battery management system 10 may include a battery charging system 11 including one or more power source connections 36, as shown in Figure 7, and one or more voltage monitors 18 per battery cell 13, as shown in Figures 1 and 3-5. The battery management system 10 may include one or more controllers 14 configured to control voltage and charging of each cell 13 individually in a multicell battery 12. The battery management system 10 may be formed from one or more printed circuit board assemblies (PCBA). The one or more printed circuit board assemblies may implement embodiments, such as, but not

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limited to, the configurations shown in Figures 1 and 3-6 and described herein. The one or more printed circuit board assemblies may enable a system integrator to customize a battery 12 and other components.

The battery management system 10 may be configured in a number of different ways. In particular, the battery management system 10 may be positioned within a battery housing 46, as shown in Figure 10. As such, the battery 12 and battery management system 10 may appear to be a single unit contained within the battery housing 46. In another embodiment, as shown in Figure 11, the battery management system 10 may be positioned within a battery housing 46 and coupled to a battery charger 11 or a power source 36. In an embodiment shown in Figure 12, the battery management system 10 may be positioned within a battery housing 46 and coupled to an electrical system and vehicle charging system 50 positioned within a vehicle 48. In another embodiment, as shown in Figure 13, the battery management system 10 may be self-contained within a battery management system housing 52 that mounts to the posts 15 of a battery 12. The battery management system housing 52 may include posts 54 for connection to an electrical system of a vehicle 48 and the like. In another embodiment, as shown in Figure 14, the battery management system 10 may be self-contained within a battery management system housing 52 that may be positioned remotely from a battery 12 and coupled to the battery posts 15 via electrical wires and the like and may be coupled to a vehicle charging system 50, battery charging system 11, power source 36 and the like. In such configuration, the battery management system 10 may be wired in series to both battery posts 15. In another embodiment, as shown in Figure 15, the battery management system 10 may be self-contained within a battery management system housing 52 that may be positioned remotely from a battery 12 and coupled to a negative battery post 15 via an electrical wire or the like and may be coupled to a vehicle charging system 50, battery charging system 11, power source 36 and the like.

The battery management system 10 may be configured to monitor a number of parameters. In particular, the battery management system 10 may be configured

to measure input voltage independent of cell pack voltage and independent of individual cell voltages. The battery management system 10 may be configured to measure input current to the battery 12. Similarly, the battery management system 10 may be configured to measure output current from the battery 12. The battery management system 10 may be configured to measure the state of charge of the battery cells 13 and the cell pack forming the battery 12. The battery management system 10 may be configured to measure resting voltage of the battery cells 13 while charging. In at least one embodiment, the battery management system 10 may accomplish this by removing the input charge momentarily and measuring the resting voltage during this momentary removal of the input charge. The battery management system 10 may compensate for temperature. If the battery 12 is above a temperature threshold, i.e. too hot, then the battery management system 10 will stop the discharge current. If the battery 12 is below a temperature threshold, i.e. too cold, then the battery management system 10 will stop the charge current.

In at least one embodiment, the battery management system 10 may be configured to control current or voltage, or both, to each cell to prevent overcharging and damage to the battery 12. The battery management system 10 may operate in one of a plurality of modes including, but not limited to, a normal mode, an under voltage protection mode and an over voltage protection mode, at any given time. The battery management system 10 may be configured such that the battery 12 has voltage present on the posts 15 of the battery 12. Such configuration enables chargers and charging systems to work properly to charge the battery 12.

The battery management system 10 may include an under voltage protection mode to protect one or more cells 13, or an entire battery 12 formed from a plurality of cells 13 from losing too much voltage. Unlike conventional technology, the battery management system 10 can enable a voltage to be present across the poles of a battery 12 when the battery 12 is in undervoltage protection mode to enable the battery voltage to be monitored. As such, the battery management system 10 may be configured to allow a battery's voltage to be read while in under voltage protection mode while limiting current flow. Additionally, the battery management

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system 10 may be configured to allow a minimum discharge current to operate critical systems, such as, but not limited to the security system described herein. The battery management system 10, a user or the like may adjust this minimal current flow available when one or more battery cells 13 are in under voltage protection mode, for example, during an emergency start in the engine start mode. As such, the battery management system 10 may function such that a voltage across the posts of a battery 12 may always be present, even in under voltage protection mode. Under voltage protection mode may also automatically clear once the battery charge is sufficient or may be cleared via direction from a user through a wireless or other communications interface. Under voltage protection mode may also automatically clear, such as being temporarily suspended, upon detection of an engine start attempt discussed below.

The battery management system 10 may be designed to require no calibration. The battery management system 10 may use one or more, or multiple, voltage references as a direct comparison for under voltage protection and over voltage protection. Under voltage protection mode occurs when the voltage of one or more of the cells 13 is less than a threshold. The battery management system 10 may then open the discharge path preventing further discharging of the cells 13. The threshold can be set at a point to prevent damage to the cells 13 or to allow sufficient charge in the cells 13 for critical operations such as an engine start. Over voltage protection mode occurs when the voltage of one or more of the cells 13 is greater than a threshold. The battery management system 10 may open the charging path preventing further charging of the cells 13. The threshold is set at a point to prevent damage to the cells.

The battery management system 10 may include a controller 14, which in at least one embodiment, may be, but it not limited to being, a microcontroller 14. The controller 14 may be configured to control voltage via under and over voltage protection modes and to charge each cell individually in a multicell battery 12. The battery management system 10 may include precision voltage references for use as a direct comparison for the under voltage protection mode and the over voltage

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protection mode. The controller 14 may be configured to sense whether an individual cell voltage is equal to or greater than an over voltage protection mode reference voltage. If the individual cell voltage is equal to or greater than the over voltage protection reference voltage, then the controller 14 may place the individual battery cell 13 or entire cell pack forming the battery 12 in over voltage protection mode. In at least one embodiment, the controller 14 may place the individual battery cell 13 or entire cell pack forming the battery 12 in over voltage protection mode via opening a charging field effect transistor 24. The controller 14 may be configured such that when the controller 14 senses that an individual cell voltage is equal to or less than an under voltage protection mode reference voltage, the controller 14 may place the individual battery cell 13 or entire cell pack forming the battery 12 in the under voltage protection mode. In at least one embodiment, the controller 14 may place the individual battery cell 13 or entire cell pack forming the battery 12 in the under voltage protection mode via opening a discharging field effect transistor 26. In at least one embodiment, the controller 14 is a microcontroller or other appropriate device.

A voltage regulator 16 may be used as the input for the cell charging circuit. The voltage regulator 16 may filter input voltage ripple before it reaches the cells. The voltage regulator 16 may be set to the charge voltage level. Setting the voltage regulator 16 to the charge voltage level will allow maximum loading on the external charging system. This loading models a lead acid or absorbent glass mat style battery 12. The battery management system 10 uses the voltage regulator 16 as a direct current voltage regulator to generate the power output power algorithm to charge and maintain the batter cells 13 individually. The algorithm may be broken into two main parts: constant current control mode and a constant voltage mode. The constant voltage mode may be set by feedback resistors in the voltage regulator circuit. Constant current may be set by measuring the resting voltage of the battery cells 13 and using variable feedback resistors to set a voltage higher than the resting cell voltage. The difference is that in the set voltage versus the resting cell voltage depends on the state of charge of the cells 13. A lower state of charge will

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require less difference between the set voltage and resting cell voltage. The constant current mode voltage set point will be increased until the voltage reaches the constant voltage limit of the charging algorithm. It is important to incrementally increase the set point voltage in smaller increments when the state of charge is low on the battery cells to prevent the battery management system 10 from going into an over current protection mode in the regulator 16. The DC regulator 16 has a current limit and increasing the set point voltage prematurely will cause the DC regulator 16 to go in an overload/shutdown mode or cause the regulator 16 to fail.

The voltage regulator 16 will have two operating modes: a constant current mode and a constant voltage mode. In order to properly control the state of the voltage regulator 16, there may be a feedback loop measuring the cell voltage and the voltage regulator 16 adjust. The cell voltage will be measured with the discharge field effect transistor open and the battery impedance emulator circuit engaged so the external charging system will maintain the quieting load on the system; thereby, maintaining the model of a lead acid or absorbent glass mat battery 12. The voltage regulator 16 may be in constant current mode when the cell voltage is less than the current voltage level. The microcontroller 14 may use an adjustable voltage regulator 16 to maintain the maximum output of the voltage regulator 16 while in constant current mode. Once the cell voltage reaches the charge level voltage, the microcontroller 14 will fix the regulated voltage adjust entering constant voltage mode and will remain in this mode until the cell voltage level drops below the charge voltage level. Hysteresis may be added to ensure there is not an oscillation of the states in the feedback loop. The voltage regulator 16 measures a cell voltage for a single battery cell 13 independently of other battery cells 13 within the same battery 12.

Typical charging systems in vehicles have a wide variance of input charge power. There often exists large fluctuations in current and voltage in these systems. Voltages can range from 12 Volts direct current to greater than 20 Volts direct current. The voltage regulator 16 may accept this wide range of input current and voltages and output a consistent state for the battery cells to charge. As such, the

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voltage regulator 16 may regulate the input voltage and input current. This may allow for longer cell life, longer battery life, longer battery pack life, and more consistent performance.

The battery management system 10 may include a cell balancing system 28. The cell balancing system 10 may be incorporated to maximize the life of the battery cells. This may consist of a discharge resistor and a voltage monitor 18 on each cell. The voltage monitor 18 may compare all four cells performance and activate the discharge resistor if a cell is significantly higher in voltage than its counterparts. The battery cells 13 may be discharged independently from each other within a single battery 12 or multiple batteries 12.

The battery management system 10 may include a wired or wireless communication system 30, as shown in Figures 3-5. In at least one embodiment, the communication system 30 may be, but is not limited to being, a wireless module 20. In at least one embodiment, the communication system 30 may be configured to communicate with an application to a user or others to monitor individual cell status, cell pack status and other data, such as, but not limited to, state of charge of one or more of the cells individually, state of charge of all of the cells forming a battery, voltage of the cells, voltage of all of the cells forming a battery, temperature of the all of the cells forming a battery, discharge current, charge current, number of charging cycles on each cell, input voltage, temperature, whether the battery is in under voltage protection mode, whether the battery is in over voltage protection mode, discharging current and charging current, number of charging cycles, status of cell balancing, determination of how close a voltage of each cell is to an average voltage of all the cells. The communication system 30 may be configured for inter-battery management system 10 communications to facilitate parallel and series battery configurations. The communication system 30 may be configured to transmit alerts to an application such as, but not limited to, under voltage protection mode, over voltage protection mode. The communication system 30 may be configured to receive commands from an application such as, but not limited to, enabling security

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features, disengaging under voltage protection. The communication system 30 may be configured to enable discharging given proximity to an authorized mobile device.

The battery management system 10 may include an alert system 31 configured to indicate to a user various information. In at least one embodiment, the alert system 31 may include one or more visual alerts, such as, but not limited to, three light emitting diodes to indicate the battery 12 is powered, the communication system 30 is operational, and an error light emitting diode indicating any abnormalities. The alerts system 31 may communicate alerts to a user via visual indicators physically attached to the system or via communications, such as through the wireless communication system 30 to a user device 102, 111 and the like.

The battery management system 10 may also include an input system 34 configured to enable a user to input information into the system 10. In at least one embodiment, the input system 34 may be formed from one or more input devices, such as, but not limited to buttons, one to reset the communication system 30 and one to reset the microcontroller 14. In at least one embodiment, the battery management system 10 may be configured such that the input system 34 is a device, such as, but not limited to a user device 102, 111, as shown in Figure 8, which may be a computer, a laptop, a tablet device, a phablet, a server, a mobile device, a smartphone, a smart watch, and/or any other type of computing device. A user may communicate with the battery management system 10 via any appropriate portal on the user device 102, 111, such as, but not limited to, a battery management system application (app), other software programs and the like. The battery management system 10 may communicate to a user in through a user account, which the user may choose to view on any device, with alerts and other notifications set forth herein. The user may communicate with the battery management system 10 via the user account via any device. The user account may be established on a system for use by the battery management system 10.

The battery management system 10 may include an engine start mode enabling an engine to which a battery of the battery management system 10 is attached, to be started. In at least one aspect of the engine start mode, the battery

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management system 10 may be configured to enable an emergency start function. If the battery 12 is discharged to the under voltage protection threshold and a user would like to reset the battery 12 to try and perform an engine start, the controller 14 will disengage the under voltage protection mode upon boot-up. This will allow the user to perform a boot with input to the controller 14 such as via a controller reset button, which may be, but is not limited to being, positioned inline on a charging cable, then immediately try an engine start before time expires on the engine start mode and under voltage protection mode is activated. During use, when the battery 12 is discharged to an under voltage protection level, the battery management system 10 engages the under voltage protection mode. In the under voltage protection mode, the batter management system 10 prevents the battery from discharging any voltage to protect the battery 12 from being completely discharged, thereby preventing further battery discharge and thus also prevents actions such as engine start. The controller 14 of the battery management system 10 may enable an emergency start function by temporarily disengaging the under voltage protection mode to create an engine start window in which the battery is permitted to discharge, thereby enabling an engine start to be attempted during the engine start window. The engine start window may be, but is not limited to being between two seconds of time and five minutes of time. In another embodiment, the engine start window may be, but is not limited to being between ten seconds of time and one minute of time. The controller 14 may automatically disengage the under voltage protection mode once the battery charge is sufficient.

A user may indicate the user's desire to try an emergency start on a vehicle, such as, but not limited to a motorcycle, to which the battery management system 10 is attached. As such, the user may disengage the under voltage protection mode via user input, such as, but not limited to, the user turning an ignition key on and off a predetermined number of times, pushing an engine start button on and off a predetermined number of times, via a user interface, such as, but not limited to, a wireless device, such as an application on a cellular phone communicating via a wireless interface, such as a radio frequency interface, or other such input. The

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under voltage protection mode may be disengaged through a wired, a wireless or other type communications interface. In another embodiment, the controller 14 may automatically disengage the under voltage protection mode upon detection of an engine start attempt via use of the ignition key or ignition system.

The battery management system 10 may include a system control module configured to maintain the integrity of an electrical system, such as a vehicle electrical system, to which the battery management system 10 is attached when the battery management system 10 is in an over voltage protection mode. In particular, the system control module simulates a battery 12 so that the electrical system, such as a vehicle electrical system, to which the battery management system 10 is attached does not develop odd, explained errors and operating conditions when the battery management system 10 is in an over voltage protection mode. The system control module may emulate the battery's impedance when measuring the voltage of each cell. The system control module of the battery management system 10 may include a battery impedance emulator 38 to stabilize the battery management system 10 when in over voltage protection mode. During use, when one or more of the battery cells 13 in a call pack forming a battery 12 reach or exceed an over voltage protection level, the battery management system 10 may engage the over voltage protection mode. Once engaged, the over voltage protection mode disconnects the battery cells 13 from the loading battery management system 10. This can cause the battery management system 10 to become unstable resulting in electrical system failures, however, the battery impedance block 32 emulates the load of a standard battery thereby maintaining the battery management system 10 stability and preventing system instability.

The battery management system 10 operates such that each impedance block 32 emulates the battery 12, as shown in Figure 2. When an impedance block 32 reaches capacity, the impedance block 32 is switched out and a discharged impedance block 32 switched in. The capacity of the impedance block 32 is determined by measurements of the voltage on the input. Each impedance block 32 may be self-discharging. The number of impedance blocks 32 necessary depends

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on the discharge time of each impedance block 32 versus the characteristics of the charging system to which the battery 12 is coupled.

The battery management system 10 may include a security system configured to secure the battery 12 to prevent theft of a vehicle by securing the battery 12. In at least one embodiment, the battery management system 10 may be configured to prevent outflow of current and thereby prevent an engine start after the security system has been activated. The security system may be activated automatically by the controller 14 after a predetermined threshold has been met. The security system may be activated by a user. The user may communicate with the controller 14 via the communication system 30.

The battery management system 10 may include a smart charger detection module configured to detect the presence of a smart charger attached to posts of a battery 12. A smart charger is configured to only apply a charge when it detects a voltage across the posts, also referred to as the battery terminals, of the battery 12. If a smart charger doesn't sense voltage across the posts, then the smart charger will not apply a charge. During use, the battery management system 10 may sense that it is receiving an input charge. The battery management system 10 may remove all battery cells 13 from supplying voltage to the battery posts. The battery management system 10 then determines whether a charge remains at the battery posts. If a charge remains, the battery management system 10 concludes that conventional charger is attached to the battery 12. If the battery management system 10 determines that no charge exists across the posts of the battery 12, the battery management system 10 concludes that a smart charger is attached to the battery 12.

The battery management system 10 may be configured such that at least two different charging paths exist. In particular, the battery management system 10 may have a charging path for a conventional charger in which a regulator exists. The battery management system 10 may also include a charging path whereby a smart charger is attached directly to posts of a battery 12. As such, the charging path for a

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smart charger is a direct path to the cell pack, battery 12, thereby allowing the smart charger to manage charging.

The battery management system 10 may be configured for engine starts applications. In particular, the battery management system 10 may be configured to replace cell banks 12 with super capacitors or may be configured to be compatible with a combination of cell banks and super capacitors allowing for high instantaneous current draw events, such as, but not limited to engine starts. The battery management system 10 may be configured to collect cells into pack banks, which may allow one or more packs 12 to be discharged while the other packs 12 are being charged and thus always maintaining a load on the charging system. The battery management system 10 may be configured to integrate learning/filtering into the software to customize the reserve charge set aside for engine starts. The battery management system 10 may include a battery charging system 11 including one or more power source connections. The battery charging system 11 may include one or more voltage regulators per battery cell.

The battery management system 10 may include a voice control module. The voice control module may enable input to be made by the battery management system 10 to be controlled via voice commands. The battery management system 10 may be configured to be an intelligent system to learn the language and dialect of the user. The battery management system 10 may be configured to be adjusted to operate in any language configurable by a user. An example of a voice command would be a user stating verbally "Security Enable", which would enable the security system described herein and limit the current flow out of the battery 12 to prevent an engine start but allow the electronics to be powered. The battery management system 10 may be configured such that the voice control module can be incorporated in an embodiment in which the battery management system 10 is embedded in the battery 12. The battery management system 10 could be included within a combo charger/jump-pack. A speaker 40, microphone 42 and amplifier 44, as shown in Figure 15, may be included to enable the voice control module. In at least one embodiment, the battery management system 10 includes a command set

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of words that a user could use verbally to control various aspects of the battery management system 10. In at least one embodiment, the battery management system 10 may be in communication with a remote server system, such as, but not limited to an Amazon Web Services and the like, via the wireless communication system 30 to enable the voice control module to operate on a greater range of commands. For instance, more CPU power would be available on Amazon Web Services servers which would allow for wider range of voice input.

As shown in Figures 8 and 9, the battery management system 10 may include a wireless communication system 30 enabling analysis and review of the data of the battery management system 10 to take place anywhere desired. The system 10 may be configured to be accessible via systems such as, but not limited to, machine learning services, data and content services, computing applications and services, cloud computing services, internet services, satellite services, telephone services, software as a service (SaaS) applications and services, mobile applications and services, platform as a service (PaaS) applications and services, web services, client servers, and any other computing applications and services. The system 10 may include a first user 101, who may utilize a first user device 102 to access data, content, and applications, or to perform a variety of other tasks and functions. As an example, the first user 101 may utilize first user device 102 to access an application (e.g. a browser or a mobile application) executing on the first user device 102 that may be utilized to access web pages, data, and content associated with the system 10. The system 10 may include any number of users.

The battery management system 10 may be configured to use the wireless communication system 30 to enable a user to communicate with the battery management system 10. The battery management system 10 may include one or more wireless modules 20, which may be fashioned as a hubs to communicate wirelessly to the wireless communication system 30. The hub 20 could be in a charger with a WiFi connection and, through the wireless communication system 30, connect to tire pressure monitors, battery monitors, OBD data ports, and the like. The hub 20 could connect through a user's WiFi network to a servers of a battery

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management system provider. The hub 20 could also be connected to servers of a battery management system provider via the wireless communication system 30 described herein. A user may monitor the status of connected sensors through any connection to the battery management system 10, such as, but not limited to, a mobile app, a web-based portal and other devices described herein. A user may also control the battery management system 10 and such features as stopping a battery charger, enabling a security feature and the like. The command of the battery management system 10 may be either for an individual consumer or for fleet management. The battery management system 10 may be monitored via the wireless communication system 30 to via home speakers such as Amazon's Alexa. The battery management system 10 may include an alert system to generate and send alerts to a user such as, but not limited to, "Low Battery Warning", "Low Tire Pressure Warning", "Vehicle Is Moving", "Temperature Warning", and the like. A user may also issue verbal commands such as "Charge My Battery" and the like that could be received via a microphone in close proximity to the user and transmitted via the wireless communication system 30 to the battery management system 10.

In at least one embodiment, the wireless communication system 30, as shown in Figures 8 and 9 may include a first user device 102 utilized by the first user 101 may include a memory 103 that includes instructions, and a processor 104 that executes the instructions from the memory 103 to perform the various operations that are performed by the first user device 102. In certain embodiments, the processor 104 may be hardware, software, or a combination thereof. The first user device 102 may also include an interface 105 (e.g. screen, monitor, graphical user interface, etc.) that may enable the first user 101 to interact with various applications executing on the first user device 102, to interact with various applications executing within the system 10, and to interact with the system 10 itself. In certain embodiments, the first user device 102 may include components that provide non-visual outputs. For example, the first user device 102 may include speakers, haptic components, tactile components, or other components, which may be utilized to generate non-visual outputs that may be perceived and/or experienced by the first

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user 101. In certain embodiments, the first user device 102 may be configured to not include interface 105. In certain embodiments, the first user device 102 may be a computer, a laptop, a tablet device, a phablet, a server, a mobile device, a smartphone, a smart watch, and/or any other type of computing device. Illustratively, the first user device 102 is shown as a mobile device in Figure 8.

In addition to the first user 101, the system 10 may include a second user 110, who may utilize a second user device 111 to access data, content, and applications, or to perform a variety of other tasks and functions. As with the first user 101, in certain embodiments, the second user 110 may be any type of user that may review data from the system 10. Much like the first user 101, the second user 110 may utilize second user device 111 to access an application (e.g. a browser or a mobile application) executing on the second user device 111 that may be utilized to access web pages, data, and content associated with the system 10. The second user device 111 may include a memory 112 that includes instructions, and a processor 113 that executes the instructions from the memory 112 to perform the various operations that are performed by the second user device 111. In certain embodiments, the processor 113 may be hardware, software, or a combination thereof. The second user device 111 may also include an interface 114 (e.g. a screen, a monitor, a graphical user interface, etc.) that may enable the second user 110 to interact with various applications executing on the second user device 111, to interact with various applications executing in the system 10, and to interact with the system 10. In certain embodiments, the second user device 111 may be a computer, a laptop, a tablet device, a phablet, a server, a mobile device, a smartphone, a smart watch, and/or any other type of computing device. Illustratively, the second user device 111 may be a computing device in Figure 1. The second user device 111 may also include any of the componentry described for first user device 102.

In certain embodiments, the first user device 102 and the second user device 111 may have any number of software applications and/or application services stored and/or accessible thereon. In certain embodiments, the software applications

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and services may include one or more graphical user interfaces so as to enable the first and second users 101, 110 to readily interact with the software applications. The software applications and services may also be utilized by the first and second users 101, 110 to interact with any device in the system 10, any network in the system 10, or any combination thereof.

The system 10 may also include a communications network 135. The communications network 135 of the system 10 may be configured to link each of the devices in the system 10 to one another. For example, the communications network 135 may be utilized by the first user device 102 to connect with other devices within or outside communications network 135. Additionally, the communications network 135 may be configured to transmit, generate, and receive any information and data traversing the system 10. In certain embodiments, the communications network 135 may include any number of servers, databases, or other componentry, and may be controlled by a service provider. The communications network 135 may also include and be connected to a cloud-computing network, a phone network, a wireless network, an Ethernet network, a satellite network, a broadband network, a cellular network, a private network, a cable network, the Internet, an internet protocol network, a content distribution network, a virtual private network, any network, or any combination thereof. Illustratively, server 140 and server 150 are shown as being included within communications network 135.

Notably, the functionality of the system 10 may be supported and executed by using any combination of the servers 140, 150, and 160. The servers 140, and 150 may reside in communications network 135, however, in certain embodiments, the servers 140, 150 may reside outside communications network 135. The servers 140 and 150 may be utilized to perform the various operations and functions provided by the system 10, such as those requested by applications executing on the first and second user devices 102, 111. In certain embodiments, the server 140 may include a memory 141 that includes instructions, and a processor 142 that executes the instructions from the memory 141 to perform various operations that are performed by the server 140. The processor 142 may be hardware, software, or a combination

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thereof. Similarly, the server 150 may include a memory 151 that includes instructions, and a processor 152 that executes the instructions from the memory 151 to perform the various operations that are performed by the server 150. In certain embodiments, the servers 140, 150, and 160 may be network servers, routers, gateways, switches, media distribution hubs, signal transfer points, service control points, service switching points, firewalls, routers, edge devices, nodes, computers, mobile devices, or any other suitable computing device, or any combination thereof. In certain embodiments, the servers 140, 150 may be communicatively linked to the communications network 135, any network, any device in the system 10, or any combination thereof.

The database 155 of the system 10 may be utilized to store and relay information that traverses the system 10, cache information and/or content that traverses the system 10, store data about each of the devices in the system 10, and perform any other typical functions of a database. In certain embodiments, the database 155 may store the output from any operation performed by the system 10, operations performed and output generated by the first and second user devices 102, 111, the servers 140, 150, 160, or any combination thereof. In certain embodiments, the database 155 may store a record of any and all information obtained from any data sources utilized by the system 10 to facilitate the operative functions of the system 10 and its components, store any information and data obtained from the internal and external data sources 201, 202, store the agglomerated models 208, store outputs generated by an application under evaluation 230, store feedback received from the first and second users 101, 110 and/or the first and second user devices 102, 111, store inputs entered into or utilized to interact with the application under evaluation 230, store software code 245 generated by the system 10, store reports 242 generated by the system 10, store analyses 243 generated by the system 10, store test results 246 generated by the system 10, store test data 247, store media training videos and media content, store any information generated and/or received by the system 10, any other data traversing the system 10, or any combination thereof. In certain embodiments, the

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database 155 may be connected to or reside within the communications network 135, any other network, or a combination thereof. In certain embodiments, the database 155 may serve as a central repository for any information associated with any of the devices and information associated with the system 10. Furthermore, the database 155 may include a processor and memory or be connected to a processor and memory to perform the various operations associated with the database 155. In certain embodiments, the database 155 may be connected to the servers 140, 150, 160, the first user device 102, the second user device 111, any devices in the system 10, any other device, any network, or any combination thereof.

The database 155 may also store information obtained from the system 10, store information associated with the first and second users 101, 110, store location information for the first and second user devices 102, 111 and/or first and second users 101, 110, store user profiles associated with the first and second users 101, 110, store device profiles associated with any device in the system 10, store communications traversing the system 10, store user preferences, store demographic information for the first and second users 101, 110, store information associated with any device or signal in the system 10, store information relating to usage of applications accessed by the first and second user devices 102, 111, store any information obtained from any of the networks in the system 10, store historical data associated with the first and second users 101, 110, store device characteristics, store information relating to any devices associated with the first and second users 101, 110, or any combination thereof. The user profiles may include any type of information associated with an individual (e.g. first user 101 and/or second user 110), such as, but not limited to a username, a password, contact information, demographic information, psychographic information, an identification of applications used or associated with the individual, any attributes of the individual, any other information, or a combination thereof. Device profiles may include any type of information associated with a device, such as, but not limited to, operating system information, hardware specifications, information about each component of

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the device (e.g. sensors, processors, memories, batteries, etc.), attributes of the device, any other information, or a combination thereof.

In certain embodiments, the database 155 may store algorithms facilitating the operation of the system 10 itself, any software application utilized by the system 10, or any combination thereof. In certain embodiments, the database 155 may be configured to store any information generated and/or processed by the system 10, store any of the information disclosed for any of the operations and functions disclosed for the system 10 herewith, store any information traversing the system 10, or any combination thereof. Furthermore, the database 155 may be configured to process queries sent to it by any device in the system 10.

In certain embodiments, the system 10 may communicate and/or interact with an external network 165. In certain embodiments, the external network 165 may include any number of servers, databases, or other componentry, and, in certain embodiments, may be controlled by a service provider. The external network 165 may also include and be connected to a cloud-computing network, a phone network, a wireless network, an Ethernet network, a satellite network, a broadband network, a cellular network, a private network, a cable network, the Internet, an internet protocol network, a content distribution network, a virtual private network, any network, or any combination thereof.

The system 10 may also include a software application or program, which may be configured to perform and support the operative functions of the system 10. In certain embodiments, the application may be a software program, a website, a mobile application, a software application, a software process, or a combination thereof, which may be made accessible to users utilizing one or more computing devices, such as first user device 102 and second user device 111. The application of the system 10 may be accessible via an internet connection established with a browser program executing on the first or second user devices 102, 111, a mobile application executing on the first or second user devices 102, 111, or through other suitable means. Additionally, the application may allow users and computing devices to create accounts with the application and sign-in to the created accounts

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with authenticating username and password log-in combinations. In certain embodiments, the software application may execute directly as an installed program on the first and/or second user devices 102, 111, such as a mobile application or a desktop application. In certain embodiments, the software application may execute directly on any combination of the servers 140, 150, 160.

The software application may include multiple programs and/or functions that execute within the software application and/or are accessible by the software application. For example, the software application may include an application that generates web content and pages that may be accessible to the first and/or second user devices 102, 111, any type of program, or any combination thereof.

Notably, in certain embodiments, various functions and features of the system 10 may operate without human intervention and may be conducted entirely by computing devices, robots, programs, and/or processes. For example, in certain embodiments, multiple computing devices may interact with devices of the system 10 to provide the functionality supported by the system 10.

Referring now also to Figure 18, at least a portion of the methodologies and techniques described with respect to the exemplary embodiments of the system 10 can incorporate a machine, such as, but not limited to, computer system 1000, or other computing device within which a set of instructions, when executed, may cause the machine to perform any one or more of the methodologies or functions discussed above. The machine may be configured to facilitate various operations conducted by the system 10. For example, the machine may be configured to, but is not limited to, assist the system 10 by providing processing power to assist with processing loads experienced in the system 10, by providing storage capacity for storing instructions or data traversing the system 10, or by assisting with any other operations conducted by or within the system 10.

In some embodiments, the machine may operate as a standalone device. In some embodiments, the machine may be connected (e.g., using communications network 135, another network, or a combination thereof) to and assist with operations performed by other machines and systems, such as, but not limited to,

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the first user device 102, the second user device 111, the server 140, the server 150, the database 155, the server 160, or any combination thereof. The machine may assist with operations performed by other component in the system, any programs in the system, or any combination thereof. The machine may be connected with any component in the system 10. In a networked deployment, the machine may operate in the capacity of a server or a client user machine in a server-client user network environment, or as a peer machine in a peer-to-peer (or distributed) network environment. The machine may comprise a server computer, a client user computer, a personal computer (PC), a tablet PC, a laptop computer, a desktop computer, a control system, a network router, switch or bridge, or any machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed herein.

The computer system 1000 may include a processor 62 (e.g., a central processing unit (CPU), a graphics processing unit (GPU, or both), a main memory 1004 and a static memory 1006, which communicate with each other via a bus 1008. The computer system 100 may further include a video display unit 1010, which may be, but is not limited to, a liquid crystal display (LCD), a flat panel, a solid state display, or a cathode ray tube (CRT). The computer system 100 may include an input device 1012, such as, but not limited to, a keyboard, a cursor control device 1014, such as, but not limited to, a mouse, a disk drive unit 1016, a signal generation device 1018, such as, but not limited to, a speaker or remote control, and a network interface device 1020.

The disk drive unit 1016 may include a machine-readable medium 1022 on which is stored one or more sets of instructions 1024, such as, but not limited to, software embodying any one or more of the methodologies or functions described herein, including those methods illustrated above. The instructions 1024 may also reside, completely or at least partially, within the main memory 1004, the static

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memory 1006, or within the processor 62, or a combination thereof, during execution thereof by the computer system 100. The main memory 1004 and the processor 62 also may constitute machine-readable media.

Dedicated hardware implementations including, but not limited to, application specific integrated circuits, programmable logic arrays and other hardware devices can likewise be constructed to implement the methods described herein. Applications that may include the apparatus and systems of various embodiments broadly include a variety of electronic and computer systems. Some embodiments implement functions in two or more specific interconnected hardware modules or devices with related control and data signals communicated between and through the modules, or as portions of an application-specific integrated circuit. Thus, the example system is applicable to software, firmware, and hardware implementations.

In accordance with various embodiments of the present disclosure, the methods described herein are intended for operation as software programs running on a computer processor. Furthermore, software implementations may include, but are not limited to, distributed processing or component/object distributed processing, parallel processing, or virtual machine processing can also be constructed to implement the methods described herein.

The present disclosure contemplates a machine-readable medium 1022 containing instructions 1024 so that a device connected to the communications network 135, another network, or a combination thereof, can send or receive voice, video or data, and communicate over the communications network 135, another network, or a combination thereof, using the instructions. The instructions 1024 may further be transmitted or received over the communications network 135, another network, or a combination thereof, via the network interface device 1020.

While the machine-readable medium 1022 is shown in an example embodiment to be a single medium, the term "machine-readable medium" should be taken to include a single medium or multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) that store the one or more sets of instructions. The term "machine-readable medium" shall also be taken to include

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any medium that is capable of storing, encoding or carrying a set of instructions for execution by the machine and that causes the machine to perform any one or more of the methodologies of the present disclosure.

The terms "machine-readable medium," "machine-readable device," or "computer-readable device" shall accordingly be taken to include, but not be limited to: memory devices, solid-state memories such as a memory card or other package that houses one or more read-only (non-volatile) memories, random access memories, or other re-writable (volatile) memories; magneto-optical or optical medium such as a disk or tape; or other self-contained information archive or set of archives is considered a distribution medium equivalent to a tangible storage medium. The "machine-readable medium," "machine-readable device," or "computer-readable device" may be non-transitory, and, in certain embodiments, may not include a wave or signal per se. Accordingly, the disclosure is considered to include any one or more of a machine-readable medium or a distribution medium, as listed herein and including art-recognized equivalents and successor media, in which the software implementations herein are stored.

The foregoing is provided for purposes of illustrating, explaining, and describing embodiments of this invention. Modifications and adaptations to these embodiments will be apparent to those skilled in the art and may be made without departing from the scope or spirit of this invention.

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CLAIMS

We claim:

1. A battery management system for a battery, comprising:

a controller configured to be coupled to a multicell battery;

wherein the controller is configured to control charging and discharge of each cell individually of the multicell battery.

2. The battery management system of claim 1, wherein the controller is a microcontroller.

3. The battery management system of claim 1, wherein the controller is configured to determine whether an individual cell voltage is equal to or greater than an over voltage protection reference voltage and, if the individual cell voltage is equal to or greater than the over voltage protection reference voltage, then the controller places that individual cell into an over voltage protection mode.

4. The battery management system of claim 1, wherein the controller is configured to determine whether an individual cell voltage is equal to or less than an under voltage protection reference voltage, and, if the individual cell voltage is equal to or less than the under voltage protection reference voltage, then the controller places that individual cell into an under voltage protection mode.

5. The battery management system of claim 1, wherein the controller includes a system control module configured to maintain the integrity of an electrical system to which the battery management system is attached when the battery management system is in an over voltage protection mode.

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6. The battery management system of claim 5, wherein the system control module comprises a discharge field effect transistor and a battery impedance emulator circuit, wherein cell voltage is measured with the discharge field effect transistor open and the battery impedance emulator circuit engaged, thereby maintaining a quieting load on the external charging system, which models a battery.

7. The battery management system of claim 1, wherein the controller includes a smart charger detection module configured to detect the presence of a smart charger attached directly to a battery and enable a smart charge to charge the multicell battery.

8. The battery management system of claim 1, wherein the controller includes an alert system configured to generate alerts.

9. The battery management system of claim 1, further comprising a battery charging system comprising at least one voltage regulator per battery cell.

10. The battery management system of claim 1, further comprising a voltage regulator for input for the cell charging circuit to filter out input voltage ripple from a charge before the charge reaches the cells of the multicell battery.

11. The battery management system of claim 10, wherein the voltage regulator is set to a charge voltage level, thereby allowing maximum loading on the external charging system.

12. The battery management system of claim 10, wherein the voltage regulator has operating modes include a constant current mode and a constant voltage mode.

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13. The battery management system of claim 10, wherein the voltage regulator is in constant current mode when the cell voltage is less than the current voltage level.

14. The battery management system of claim 10, further comprising a feedback loop measuring cell voltage to control a state of the regulator.

15. The battery management system of claim 14, wherein the controller implements hysteresis to prevent an oscillation of states in the feedback loop.

16. The battery management system of claim 10, wherein the controller includes an adjustable voltage regulator to maintain maximum output of applied voltage while in constant current mode.

17. The battery management system of claim 10, wherein once cell voltage reaches a charge level voltage, the controller fixes a regulated voltage adjust entering constant voltage mode and remains in this mode until cell voltage level drops below the charge voltage level.

18. The battery management system of claim 10, wherein the voltage regulator is configured to accept input voltage within a range between 12 Volts direct current and 20 Volts direct current.

19. The battery management system of claim 1, further comprising a cell balancing system configured to compare individual cell performance and adjust individual cells with voltages misaligned from target voltages.

20. The battery management system of claim 19, wherein the cell balancing system comprises at least one discharge resistor and at least one voltage monitor on cells individually.

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21. The battery management system of claim 1, further comprising a wireless communication system enabling the battery management system to communicate with remote devices to transmit data regarding at least one cell.

22. The battery management system of claim 1, further comprising an input system configured to receive input to control aspects of the battery management system.

23. The battery management system of claim 1, wherein the controller includes an engine start mode in which the controller enables a user to attempt an engine start of a vehicle to which the battery management system is attached even when one or more of the cells is in under voltage protection mode by temporarily suspending the under voltage protection mode to create an engine start window, thereby enabling an engine start to be attempted during the engine start window.

24. The battery management system of claim 1, further comprising a voice control module to enable input to the battery management system be made via voice commands.

25. The battery management system of claim 1, further comprising a security system configured to secure the battery to prevent theft of a vehicle to which the battery is attached by preventing outflow of current from the battery.

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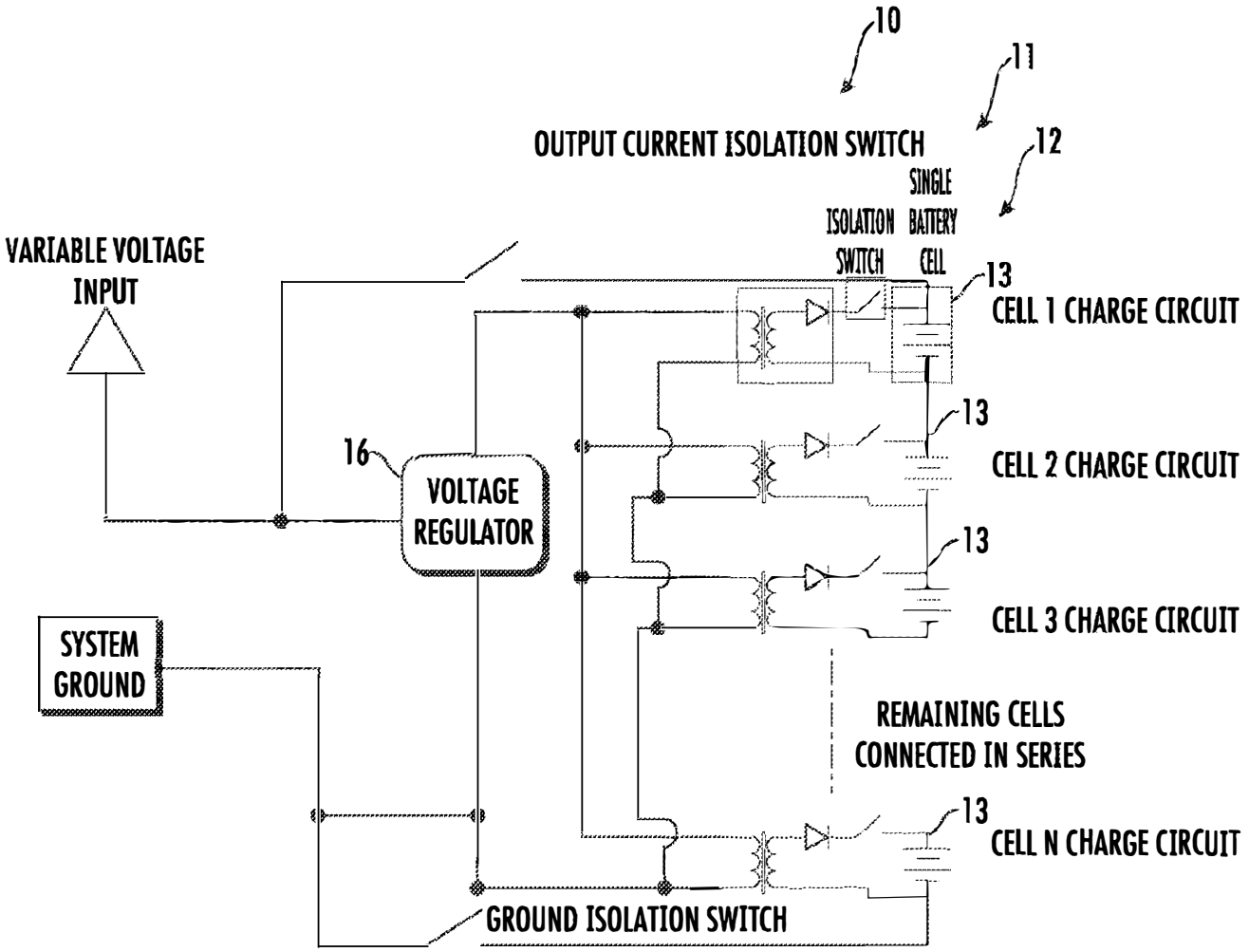


FIG. 1

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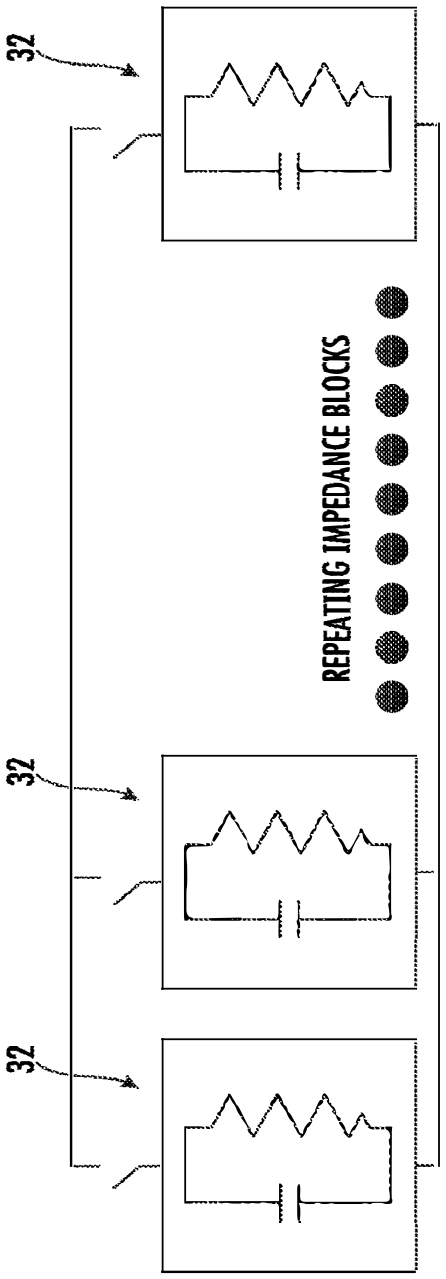


FIG. 2

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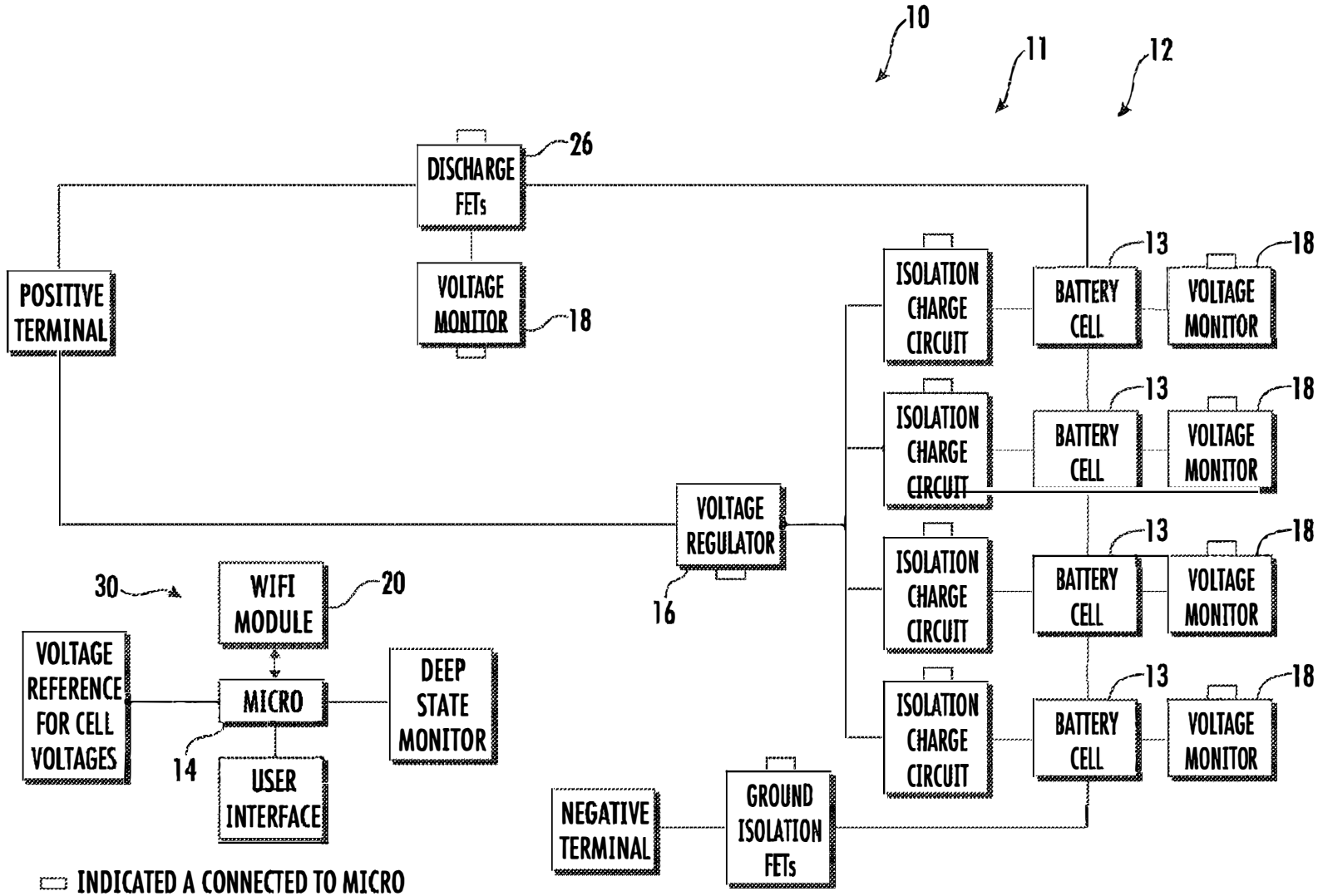


FIG. 3

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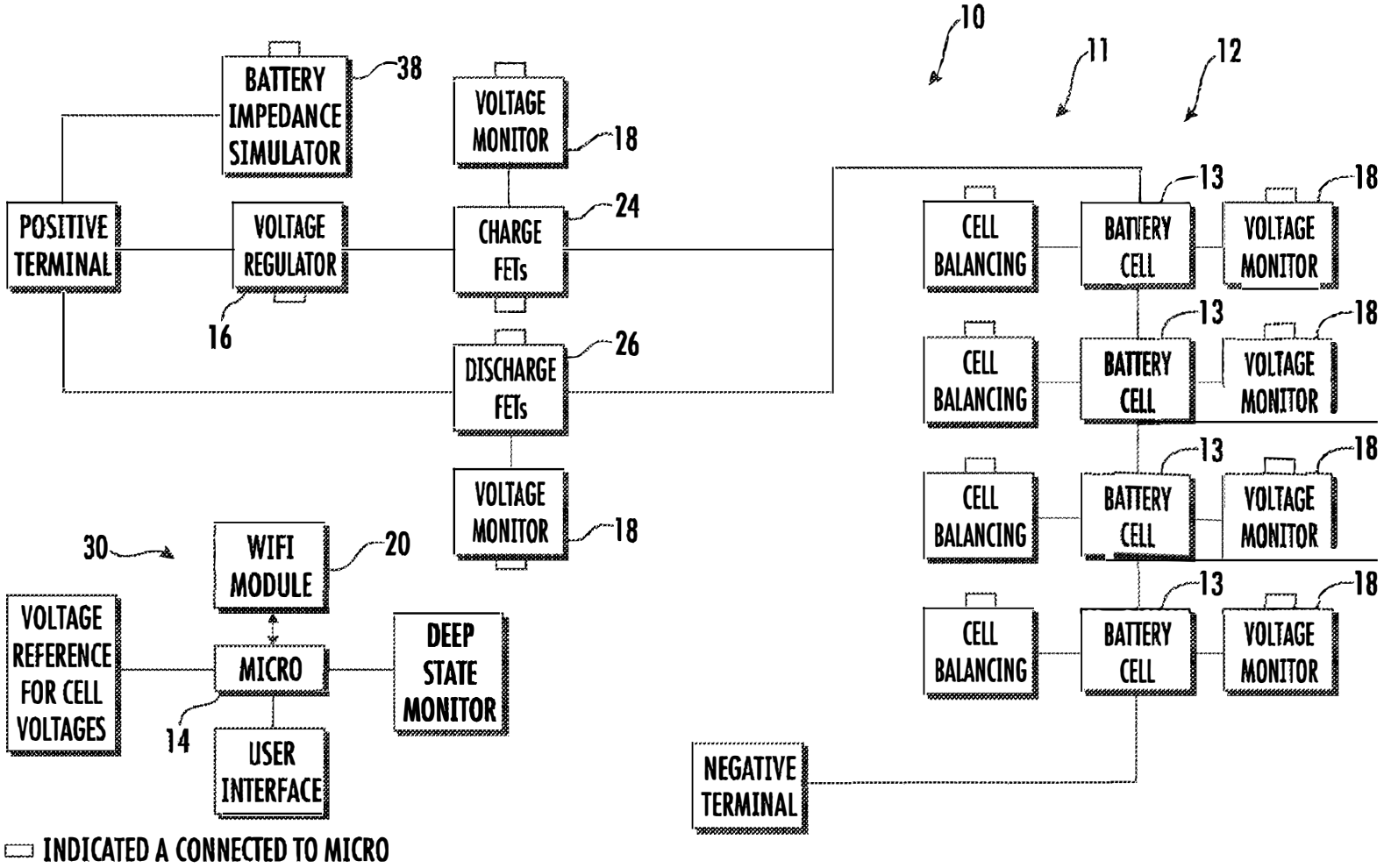


FIG. 4

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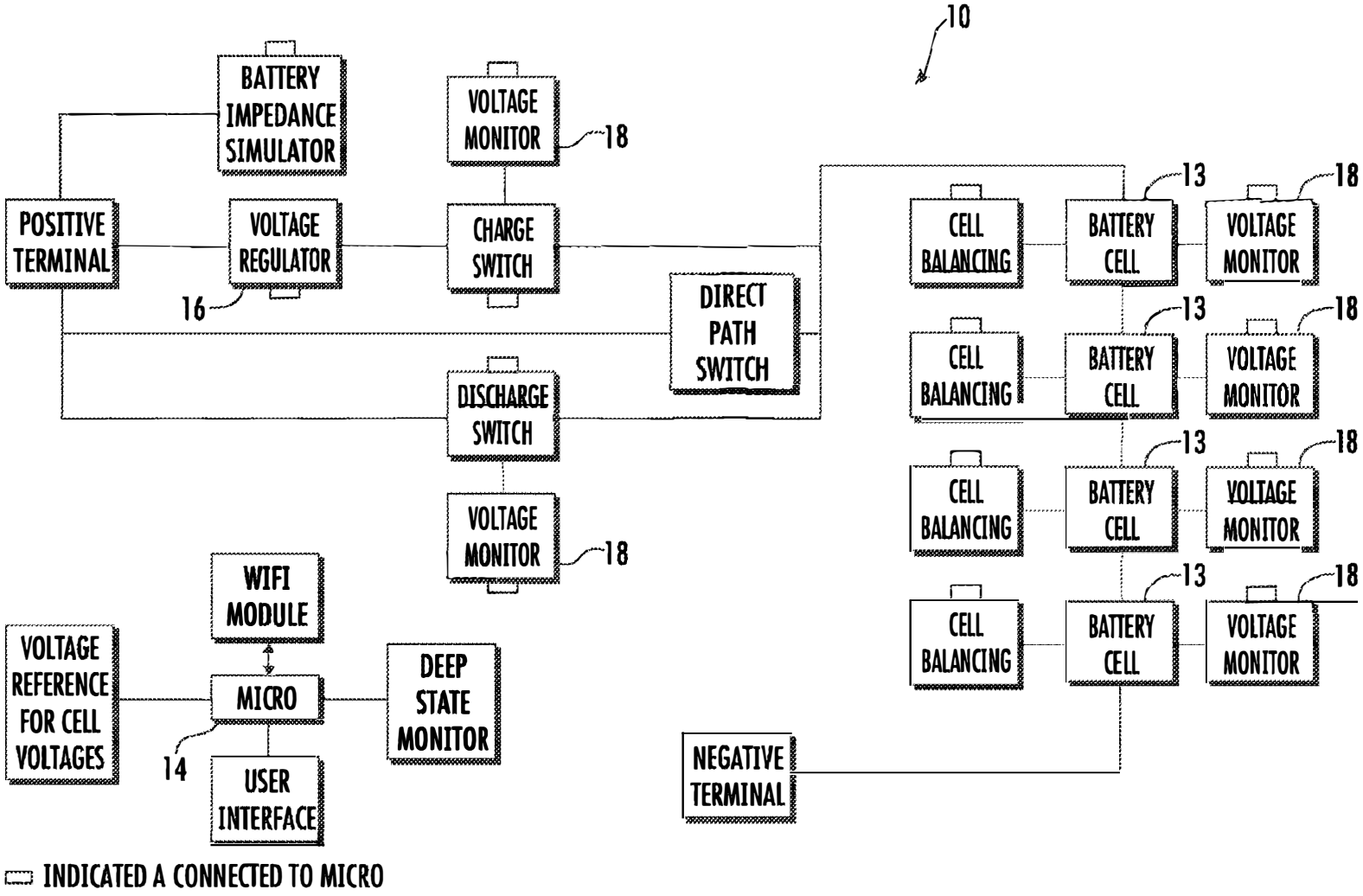

10
BATTERY IMPEDANCE SIMULATOR
VOLTAGE MONITOR
18
POSITIVE TERMINAL
VOLTAGE REGULATOR
16
CHARGE SWITCH
DIRECT PATH SWITCH
DISCHARGE SWITCH
VOLTAGE MONITOR
18
WIFI MODULE
VOLTAGE REFERENCE FOR CELL VOLTAGES
MICRO
14
USER INTERFACE
DEEP STATE MONITOR
CELL BALANCING
BATTERY CELL
13
VOLTAGE MONITOR
18
NEGATIVE TERMINAL
INDICATED A CONNECTED TO MICRO

FIG. 5

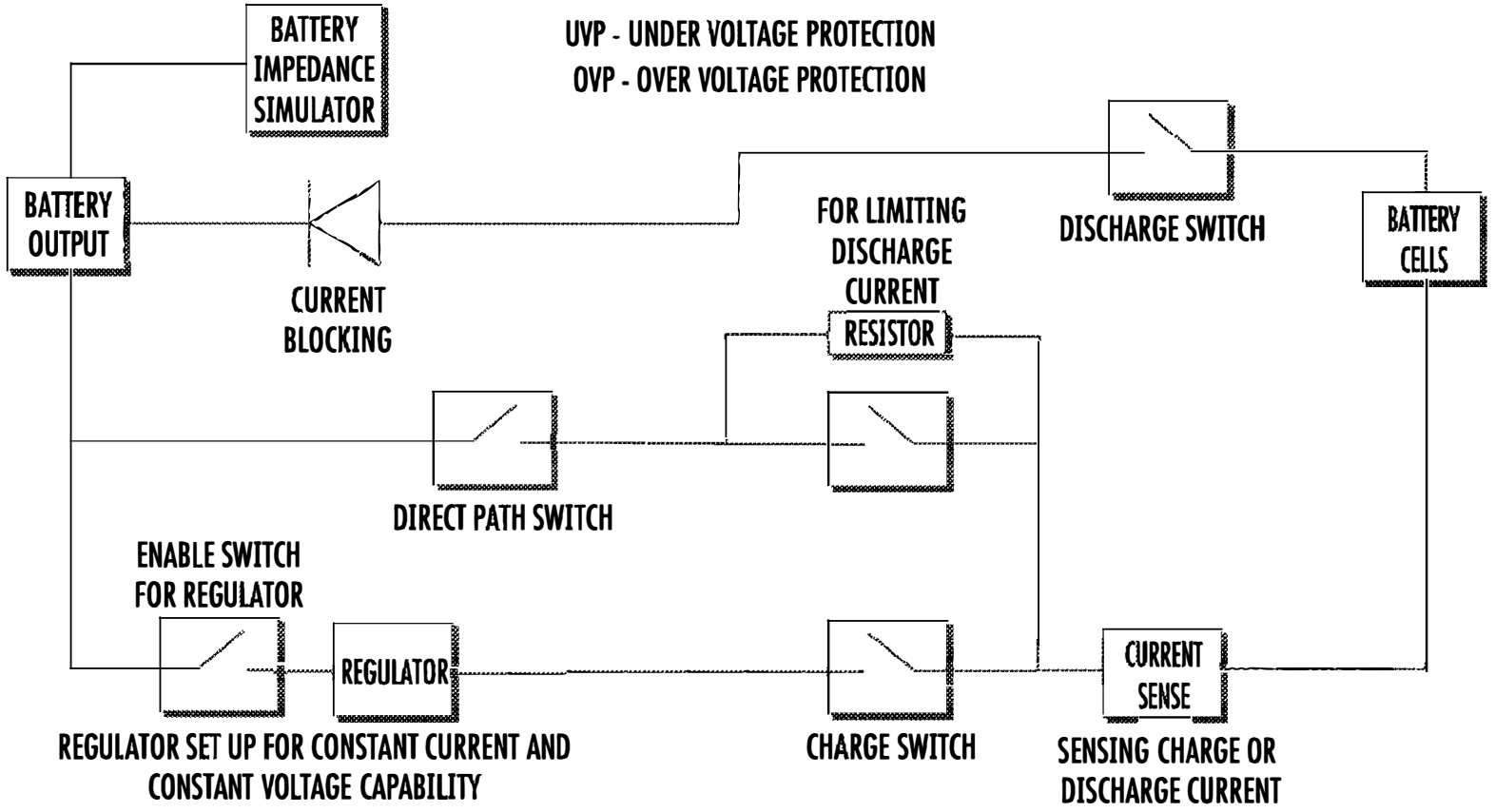


FIG. 6

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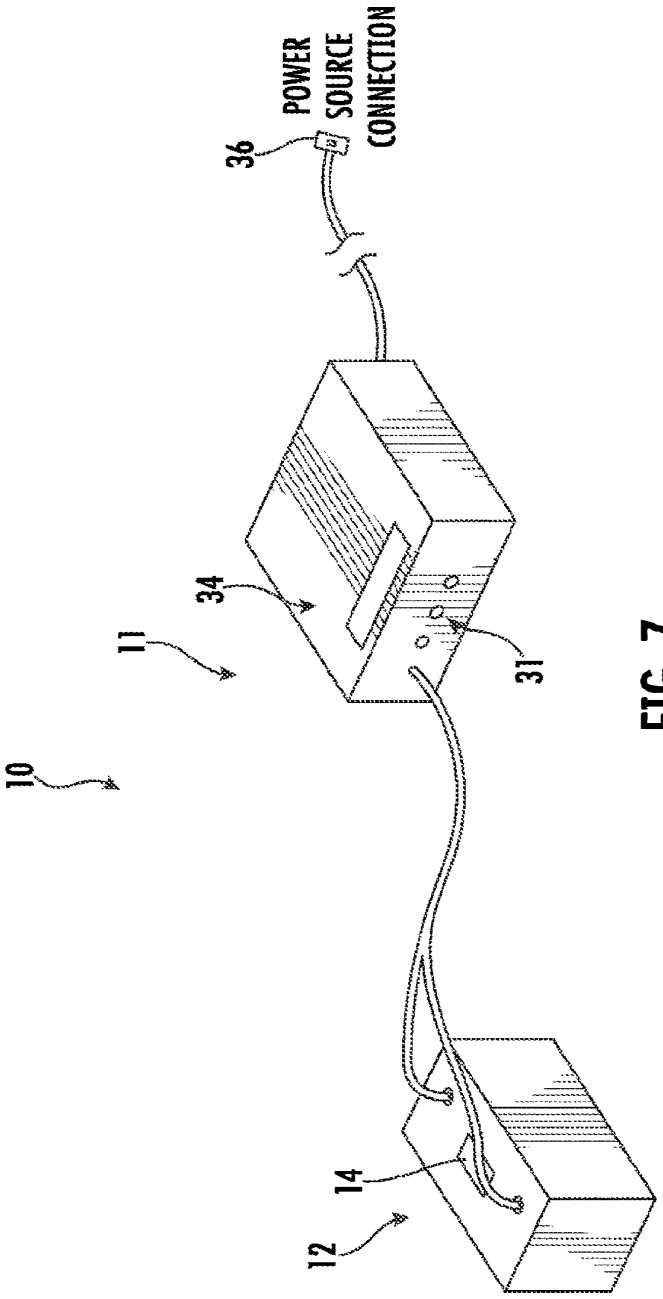


FIG. 7

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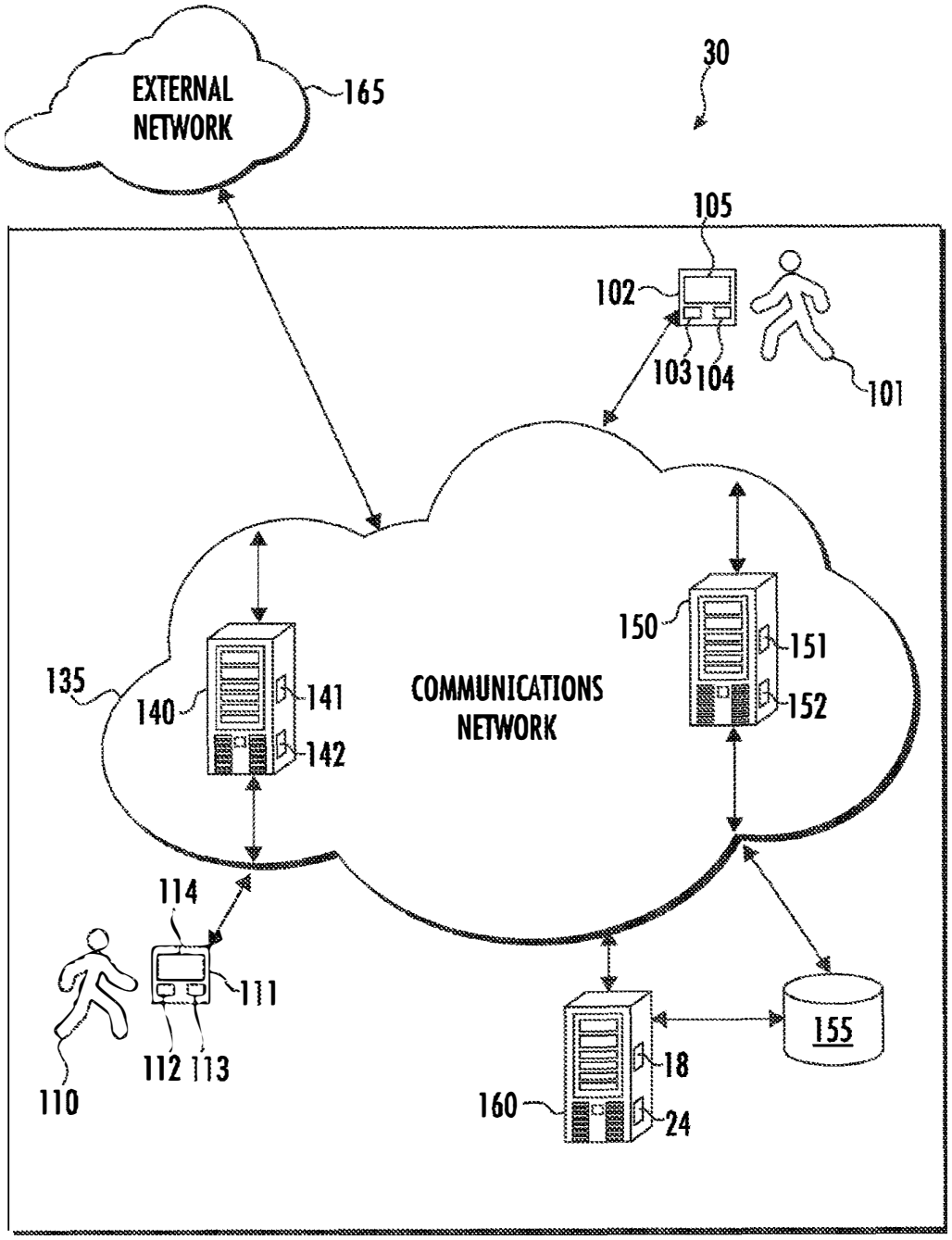


FIG. 8

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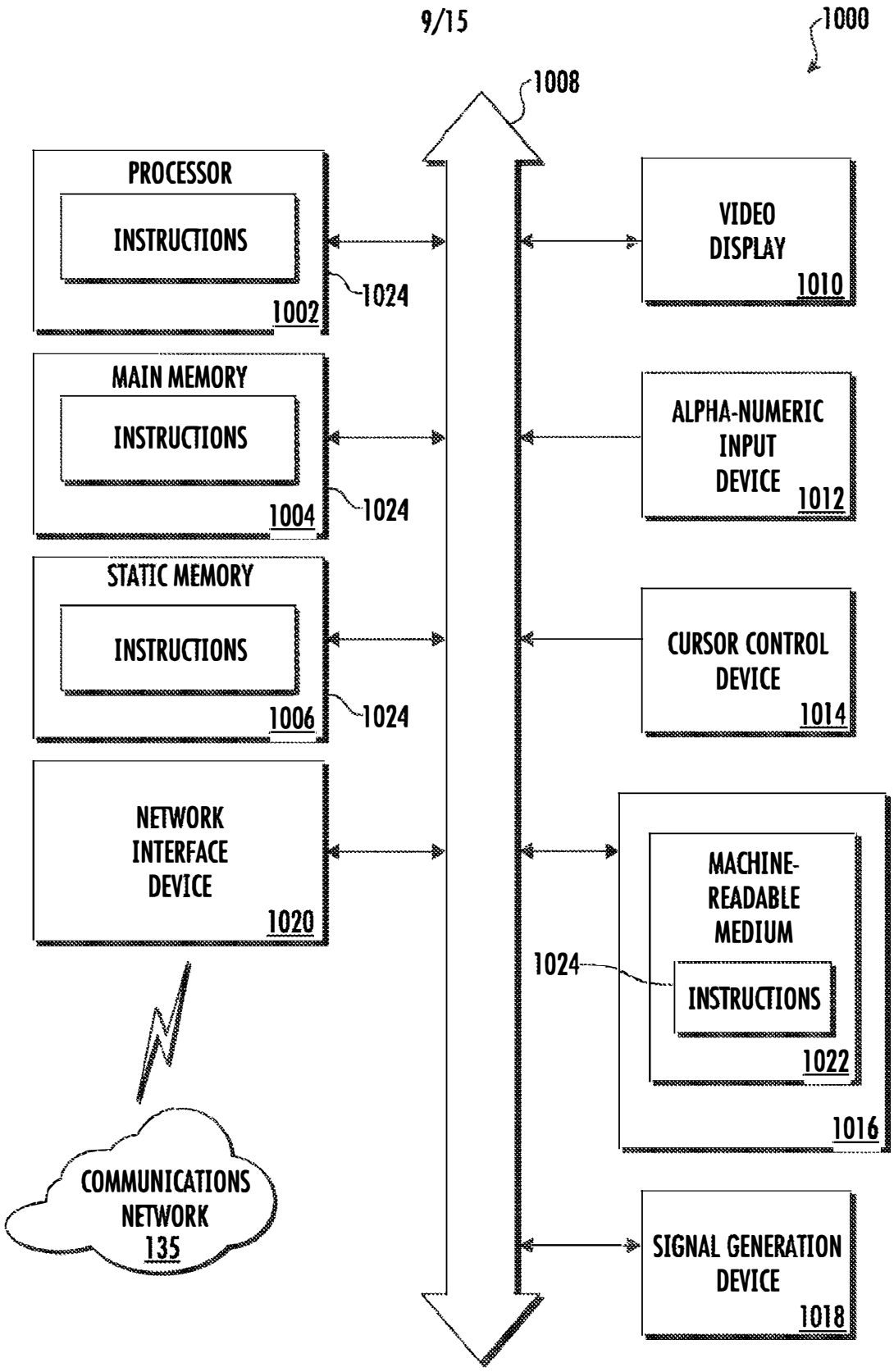

1000
1008
PROCESSOR
INSTRUCTIONS
1002
1024
MAIN MEMORY
INSTRUCTIONS
1004
1024
STATIC MEMORY
INSTRUCTIONS
1006
1024
NETWORK INTERFACE DEVICE
1020
COMMUNICATIONS NETWORK
135
VIDEO DISPLAY
1010
ALPHA-NUMERIC INPUT DEVICE
1012
CURSOR CONTROL DEVICE
1014
MACHINE-READABLE MEDIUM
1024
INSTRUCTIONS
1022
1016
SIGNAL GENERATION DEVICE
1018

FIG. 9

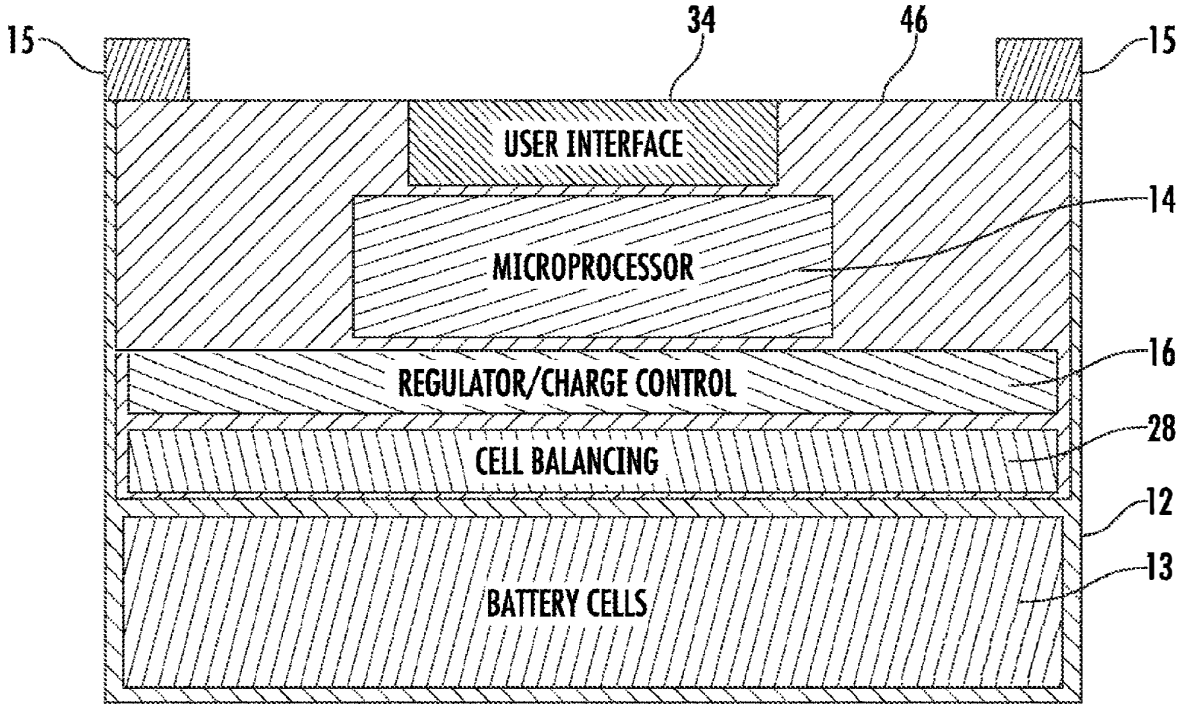


FIG. 10

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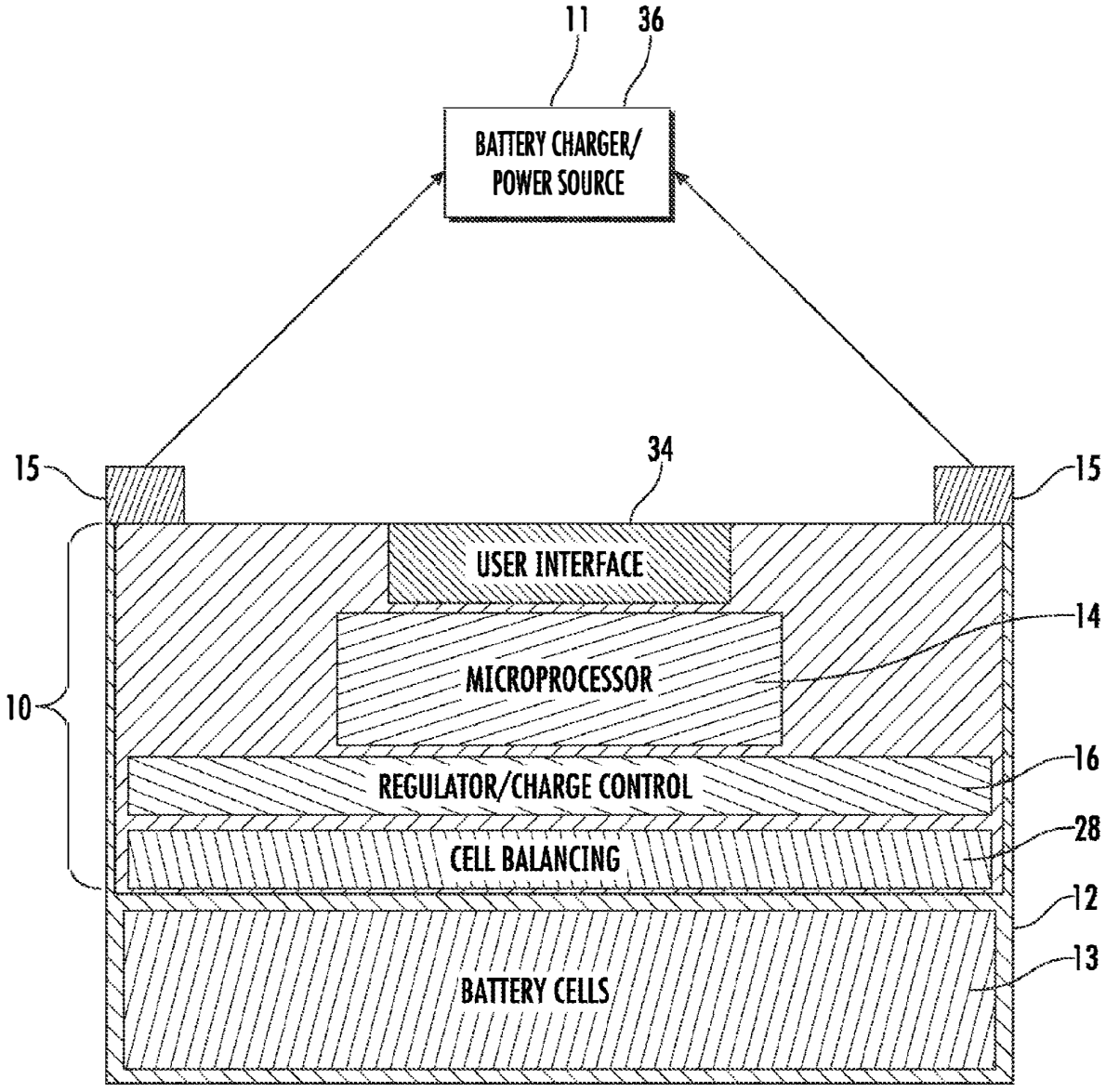


FIG. 11

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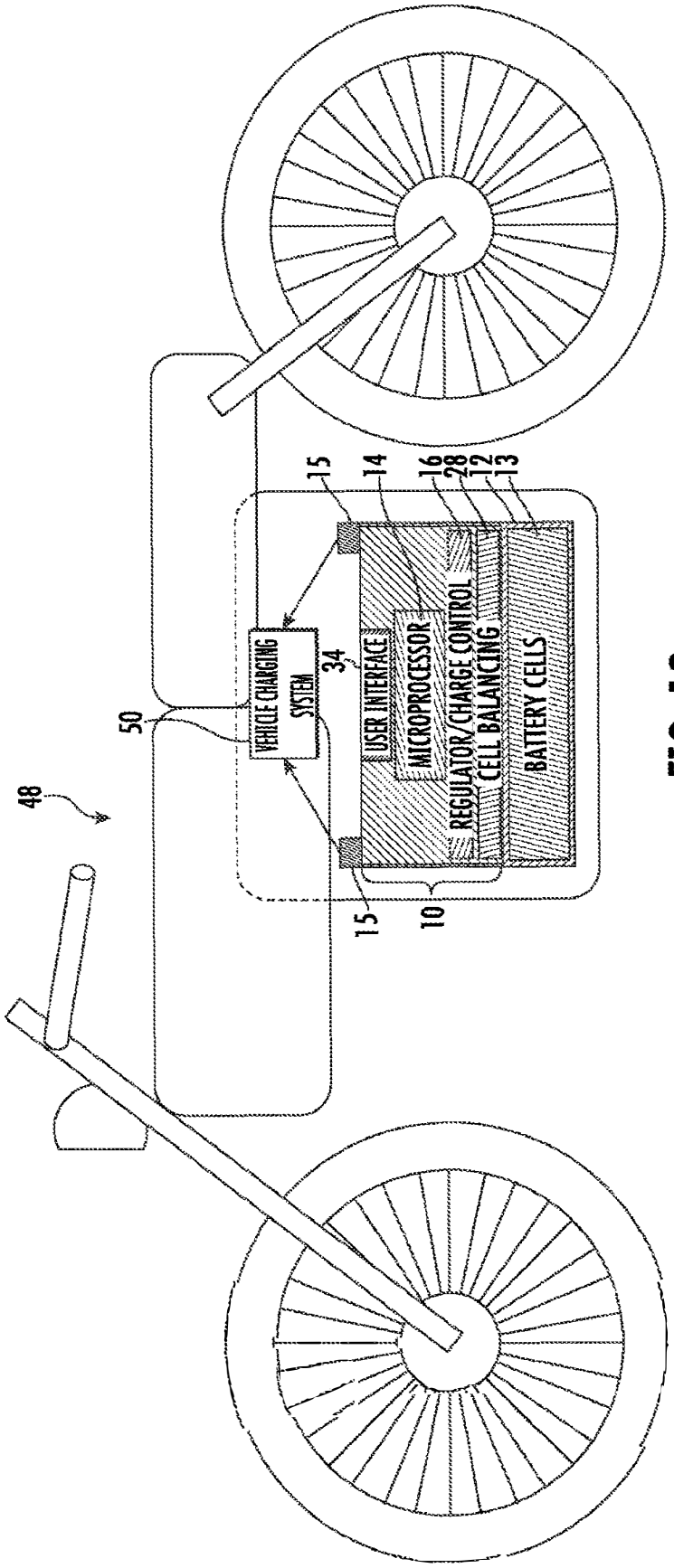


FIG. 12

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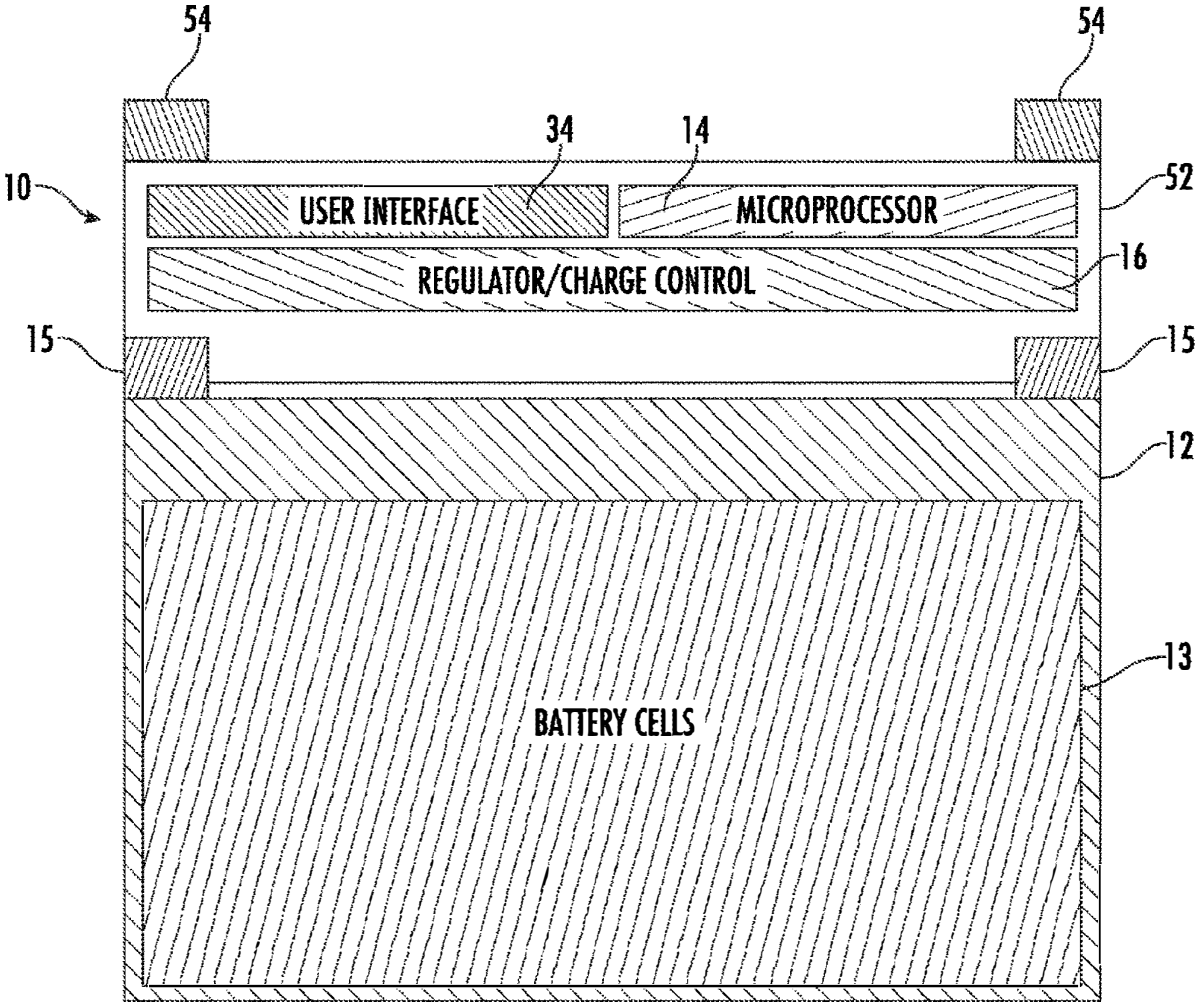


FIG. 13

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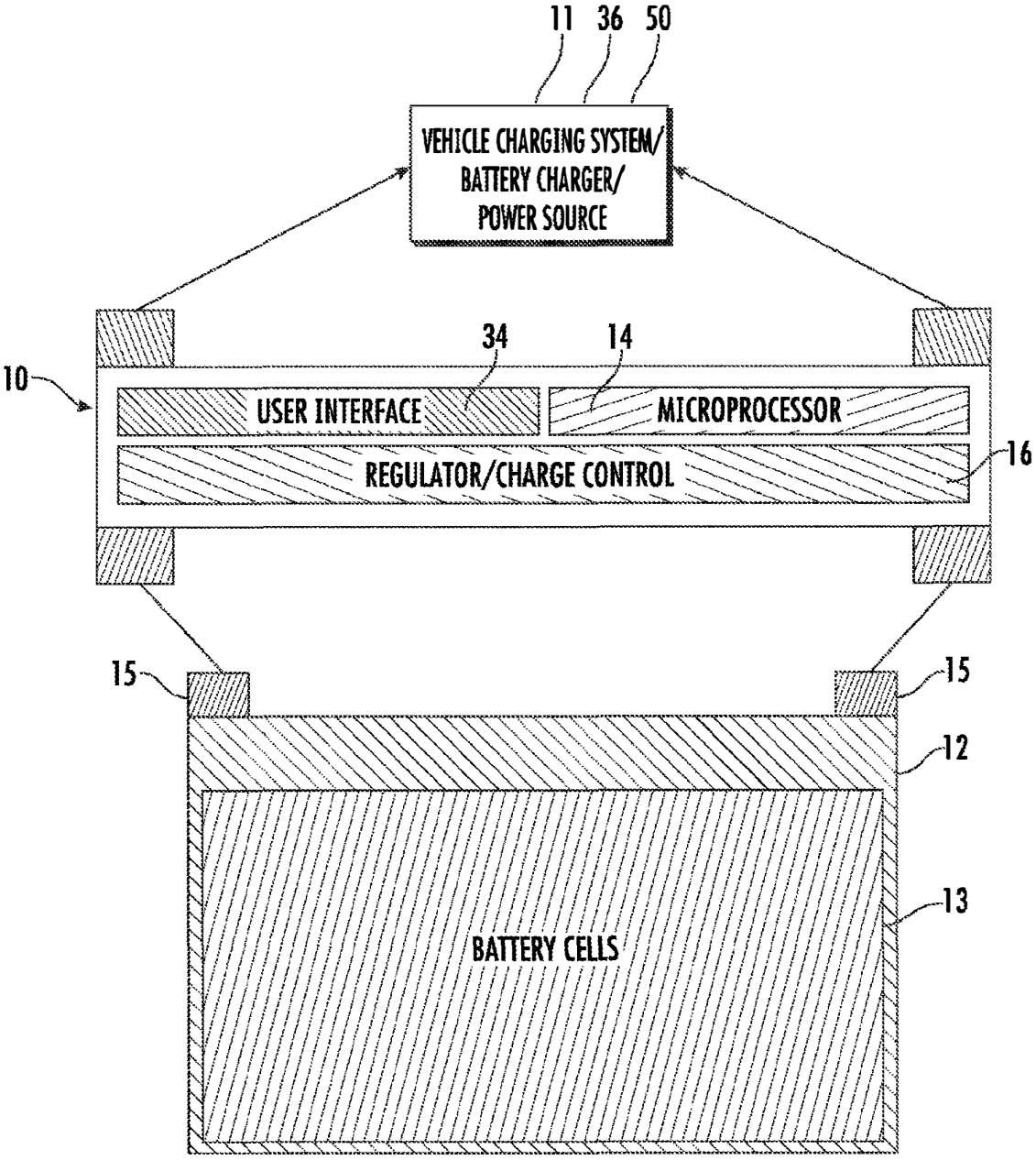


FIG. 14

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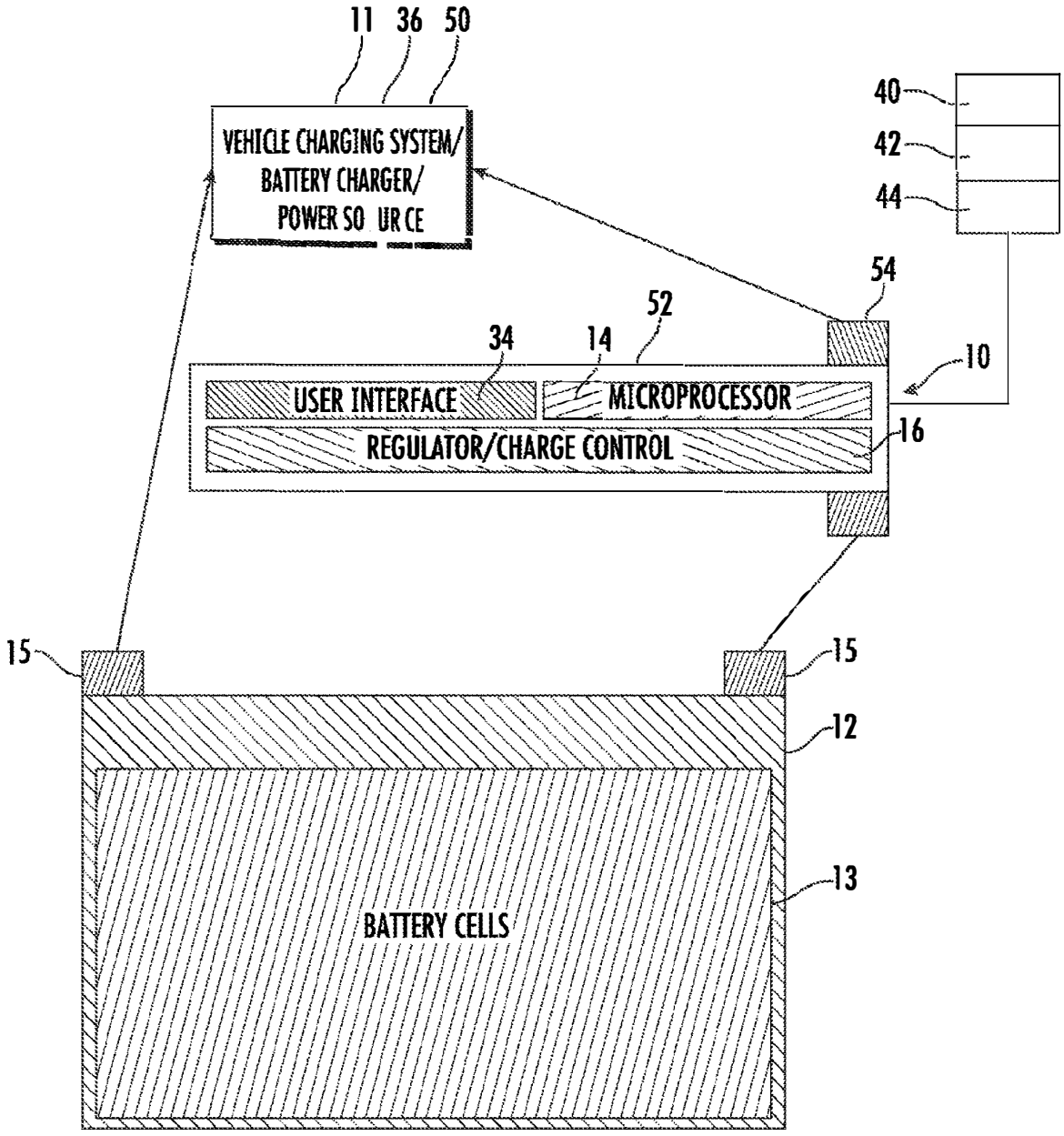


FIG. 15

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 21/34211

A. CLASSIFICATION OF SUBJECT MATTER
IPC - H01M 10/42; H01M 10/44 (2021.01)
CPC - B60L 58/18; B60L 58/20; B60L 58/22; H01M 10/4207; H01M 2010/4271; H01M 10/441

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0052614 A1 (NATHAN MARIELS) 04 March 2010 (04.03.2010) entire document.	1, 2, 5, 7-11, 14, 18, 19, 20, 22
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Y		3, 4, 6, 12, 13, 15-17, 21, 23-25
Y	US 2019/0229381 A1 (MYEONG-EUN HWANG) 25 July 2019 (25.07.2019) entire document.	3, 4, 23
Y	US 2011/0127831 A1 (SKARANI et al.) 02 January 2011 (02.01.2011) entire document, especially para[006].	6
Y	US 2008/0203974 A1 (MANAI et al.) 28 August 2008 (28.08.2008) Fig 2, Fig 7, para [0025], para [0075]	12, 13, 16, 17
Y	US 2005/0269992 A1 (LAI et al.) 08 December 2005 (08.12.2005) Fig 1, para [0015].	15
Y	US 2019/0378390 A1 (INCELL INTERNATIONAL AB) 12 December 2019 (12.12.2019) entire document.	21, 25
Y	US 2012/0324578 A1 (SEINFELD et al.) 20 December 2012 (20.12.2012) Fig 7, para [0023].	24
A	US 2010/0121511 A1 (PER ONNERUD et al.) 13 May 2010 (13.05.2010) entire document	1-25
A	US 2017/0144562 A1 (THOMAS GEORGE et al.) 25 May 2017 (25.05.2017) entire document	1-25

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 July 2021	SEP 10 2021
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Kari Rodriquez Telephone No. PCT Helpdesk: 571-272-4300

Form PCT/ISA/210 (second sheet) (July 2019)

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Espacenet

JP2012169161A CYLINDRICAL NONAQUEOUS ELECTROLYTE BATTERY AND METHOD FOR MANUFACTURING THE SAME

Applicants: PANASONIC CORP

Inventors: MINO TATSUJI,TAKEUCHI TAKASHI,YAMADA AKIHISA

Classifications:

IPC ***H01M10/052; H01M10/0566; H01M10/0587; H01M2/26;***

CPC Y02E60/10 (EP);

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Published as: JP2012169161A

CYLINDRICAL NONAQUEOUS ELECTROLYTE BATTERY AND METHOD FOR MANUFACTURING THE SAME

Abstract

PROBLEM TO BE SOLVED: To provide a method for manufacturing a cylindrical nonaqueous electrolyte battery, which can prevent weaving caused when winding an electrode group and can prevent cut of an electrode plate.SOLUTION: This manufacturing method includes winding a first electrode plate 21 to which a first electrode lead 210 is connected, a separator 27 and a second electrode plate 22 to which a second electrode lead 710 is connected. The first electrode lead 210 has a plate-like part and a round bar part. The plate-like part has a slip prevention structure formed therein for lowering sliding properties between the plate-like part and the separator 27. The manufacturing method also includes: protruding a peripheral part of the separator 27 from the first electrode plate 21 and the second electrode plate 22 in a width direction of the first electrode plate 21 and the second electrode plate 22 and positioning the round bar part to the outside of the peripheral part of the separator 27; and winding the first electrode plate 21, the separator 27 and the second electrode plate 22 while overlapping the peripheral part of the separator 27 on the slip prevention structure.

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H01M 2/26	(2006.01)	H01M	2/26	A	5H043
H01M 10/052	(2010.01)	H01M	10/00	102	
H01M 10/0566	(2010.01)	H01M	10/00	111	

審査請求 未請求　請求項の数 6　ＯＬ　（全 20 頁）

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最終頁に続く

(54)【発明の名称】円筒型非水電解液電池及びその製造方法

(57)【要約】　（修正有）
【課題】電極群を巻回する際の巻きずれ及び電極板の切れを防止できる円筒型非水電解液電池の製造方法を提供する。
【解決手段】第一電極リード２１０が接続された第一電極板２１、セパレータ２７及び第二電極リード７１０が接続された第二電極板２２を巻回する。第一電極リード２１０は、板状部と丸棒部とを有する。板状部には、当該板状部とセパレータ２７との間の摺動性を低下させるための滑り止め構造が形成されている。第一電極板２１及び第二電極板２２の幅方向に関して、セパレータ２７の周縁部を第一電極板２１及び第二電極板２２から突出させ、丸棒部をセパレータ２７の周縁部の外に位置させる。セパレータ２７の周縁部と滑り止め構造とを重ねつつ、第一電極板２１、セパレータ２７及び第二電極板２２を巻回する。
【選択図】図６

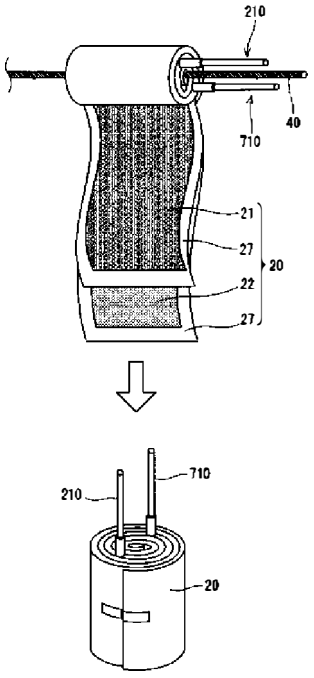


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【特許請求の範囲】
【請求項１】
リチウムイオンを吸蔵及び放出しうる第一活物質を含む第一電極板と、リチウムイオンを吸蔵及び放出しうる第二活物質を含み、前記第一電極板の極性と反対の極性を有する第二電極板と、前記第一電極板及び前記第二電極板よりも幅広のセパレータとを準備する工程と、
前記第一電極板及び前記第二電極板に第一電極リード及び第二電極リードをそれぞれ電気的に接続する工程と、
前記第一電極板及び前記第二電極板の幅方向に関して前記セパレータの周縁部が前記第一電極板及び前記第二電極板から突出し、前記第一電極板からの前記第一電極リードの突出方向が前記第二電極板からの前記第二電極リードの突出方向に一致するように、前記第一電極板、前記セパレータ及び前記第二電極板の相対的な位置関係を定める工程と、
巻かれた電極群を形成するように、前記第一電極板、前記セパレータ及び前記第二電極板を巻回する工程と、
前記第一電極リード及び前記第二電極リードが封口体を通じて円筒状の電池ケースの外部に延びるように、前記電極群を前記電池ケースに入れて前記電池ケースの開口部を前記封口体で閉じる工程と、を含み、
前記第一電極リードは、前記第一電極板に固定された板状部と、前記板状部と一体に形成された丸棒部とを有し、前記板状部の厚さ方向に関する前記第一電極リードの寸法が前記板状部と前記丸棒部との境界で不連続に変化しており、
前記板状部には、当該板状部と前記セパレータとの間の摺動性を低下させるための滑り止め構造が前記境界に隣接した位置に形成されており、
前記幅方向に関して前記丸棒部を前記セパレータの前記周縁部の外に位置させ、かつ、前記セパレータの前記周縁部を前記滑り止め構造に重ねつつ、前記巻回工程を実施する、円筒型非水電解液電池の製造方法。
【請求項２】
前記滑り止め構造が、前記板状部の表面及び裏面に形成されている、請求項１に記載の円筒型非水電解液電池の製造方法。
【請求項３】
前記滑り止め構造は、前記セパレータの外縁に平行な方向に沿って前記板状部の表面及び／又は裏面に形成された溝を含む、請求項１又は２に記載の円筒型非水電解液電池の製造方法。
【請求項４】
前記滑り止め構造は、前記板状部の表面及び／又は裏面に形成された凹凸を含む、請求項１又は２に記載の円筒型非水電解液電池の製造方法。
【請求項５】
前記第一電極板がその長手方向に関して一端及び他端を有し、
前記一端を前記長手方向に関する０％の位置、前記他端を前記長手方向に関する１００％の位置と定義したとき、
前記第一電極リードが前記長手方向に関して１０～３０％の範囲に位置するように、前記第一電極板に前記第一電極リードを接続する、請求項１～４のいずれか１項に記載の円筒型非水電解液電池の製造方法。
【請求項６】
リチウムイオンを吸蔵及び放出しうる第一活物質を含む第一電極板と、リチウムイオンを吸蔵及び放出しうる第二活物質を含み、前記第一電極板の極性と反対の極性を有する第二電極板と、前記第一電極板及び前記第二電極板よりも幅広のセパレータとを有する、巻かれた電極群と、
前記電極群を収容している円筒状の電池ケースと、
前記電池ケースの開口部を閉じている封口体と、
前記第一電極板に電気的に接続され、前記封口体を通じて円筒状の電池ケースの外部に

延びている第一電極リードと、
前記第二電極板に電気的に接続され、前記封口体を通じて円筒状の電池ケースの外部に延びている第二電極リードと、を備え、
前記第一電極リードは、前記第一電極板に固定された板状部と、前記板状部と一体に形成された丸棒部とを有し、前記板状部の厚さ方向に関する前記第一電極リードの寸法が前記板状部と前記丸棒部との境界で不連続に変化しており、
前記板状部には、当該板状部と前記セパレータとの間の摺動性を低下させるための滑り止め構造が前記境界に隣接した位置に形成されており、
前記第一電極板及び前記第二電極板の幅方向に関して前記セパレータの周縁部が前記第一電極板及び前記第二電極板から突出し、
前記幅方向に関して前記丸棒部が前記セパレータの前記周縁部の外に位置し、かつ、前記セパレータの前記周縁部が前記滑り止め構造に重なっている、円筒型非水電解液電池。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、円筒型非水電解液電池及びその製造方法に関する。
【背景技術】
【０００２】
二次電池は、ノート型パソコンを始めとした様々なポータブル機器に使用されている。携帯性の向上、駆動時間の延長及び駆動の安定化の観点から、ポータブル機器向けの二次電池には、軽量化、エネルギー密度の向上及び信頼性の向上が求められる。
【０００３】
ポータブル機器向けの二次電池として、リチウムイオン二次電池が挙げられる。電極群を収容するための容器として、アルミニウム箔製の容器、及び金属製の角型容器が広く使用されている。
【０００４】
一方、エネルギー分野向けの二次電池には、金属製の円筒状容器が広く使用されている。金属製の円筒状容器を用いた二次電池は、一般的には、容器内に電極群を収容し、容器の開口部を封口板により封口することにより製造される。電極群に接続された２つのリード端子は、容器及び封口板にそれぞれ溶接される。封口板の構造は、比較的複雑で値段も高い。また、リードの溶接工程も面倒である。そこで、特許文献１の構造の電池が提案されている。
【０００５】
特許文献１には、図９に示すような円筒型非水電解液電池８８０が開示されている。円筒型非水電解液電池８８０は、電極群８２０、正極リード８１０、負極リード９１０、電池ケース８６０及び封口体８７０を備えている。電極群８２０は電池ケース８６０に収容されている。正極リード８１０及び負極リード９１０は丸棒部８１２及び９１２をそれぞれ有する。封口体８７０はゴム製であり、丸棒部８１２及び９１２を支持しながら電池ケース８６０の開口部を封口している。
【先行技術文献】
【特許文献】
【０００６】
【特許文献１】特開平１０－３０８２０６号公報
【発明の概要】
【発明が解決しようとする課題】
【０００７】
本発明の発明者らが、特許文献１に記載された円筒型非水電解液電池を作製したところ、次の不具合が生じた。具体的には、電極群を巻回するときに巻きずれが生じたり、正極板及び負極板が切れたりした。このような不具合は、電極群とリードとの相互干渉によるものと考えられる。

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Petitioner ADC (IPR2024-00577)

【０００８】
本発明は上記従来の課題を鑑みてなされたもので、巻きずれ及び電極板の切れを防止できる円筒型非水電解液電池の製造方法と、当該製造方法によって製造された円筒型非水電解液電池を提供することを目的とする。
【課題を解決するための手段】
【０００９】
上記課題を解決するために、本発明は、
リチウムイオンを吸蔵及び放出しうる第一活物質を含む第一電極板と、リチウムイオンを吸蔵及び放出しうる第二活物質を含み、前記第一電極板の極性と反対の極性を有する第二電極板と、前記第一電極板及び前記第二電極板よりも幅広のセパレータとを準備する工程と、
前記第一電極板及び前記第二電極板に第一電極リード及び第二電極リードをそれぞれ電気的に接続する工程と、
前記第一電極板及び前記第二電極板の幅方向に関して前記セパレータの周縁部が前記第一電極板及び前記第二電極板から突出し、前記第一電極板からの前記第一電極リードの突出方向が前記第二電極板からの前記第二電極リードの突出方向に一致するように、前記第一電極板、前記セパレータ及び前記第二電極板の相対的な位置関係を定める工程と、
巻かれた電極群を形成するように、前記第一電極板、前記セパレータ及び前記第二電極板を巻回する工程と、
前記第一電極リード及び前記第二電極リードが封口体を通じて円筒状の電池ケースの外部に延びるように、前記電極群を前記電池ケースに入れて前記電池ケースの開口部を前記封口体で閉じる工程と、を含み、
前記第一電極リードは、前記第一電極板に固定された板状部と、前記板状部と一体に形成された丸棒部とを有し、前記板状部の厚さ方向に関する前記第一電極リードの寸法が前記板状部と前記丸棒部との境界で不連続に変化しており、
前記板状部には、当該板状部と前記セパレータとの間の摺動性を低下させるための滑り止め構造が前記境界に隣接した位置に形成されており、
前記幅方向に関して前記丸棒部を前記セパレータの前記周縁部の外に位置させ、かつ、前記セパレータの前記周縁部を前記滑り止め構造に重ねつつ、前記巻回工程を実施する、円筒型非水電解液電池の製造方法を提供する。
【００１０】
他の側面において、本発明は、
リチウムイオンを吸蔵及び放出しうる第一活物質を含む第一電極板と、リチウムイオンを吸蔵及び放出しうる第二活物質を含み、前記第一電極板の極性と反対の極性を有する第二電極板と、前記第一電極板及び前記第二電極板よりも幅広のセパレータとを有する、巻かれた電極群と、
前記電極群を収容している円筒状の電池ケースと、
前記電池ケースの開口部を閉じている封口体と、
前記第一電極板に電気的に接続され、前記封口体を通じて円筒状の電池ケースの外部に延びている第一電極リードと、
前記第二電極板に電気的に接続され、前記封口体を通じて円筒状の電池ケースの外部に延びている第二電極リードと、を備え、
前記第一電極リードは、前記第一電極板に固定された板状部と、前記板状部と一体に形成された丸棒部とを有し、前記板状部の厚さ方向に関する前記第一電極リードの寸法が前記板状部と前記丸棒部との境界で不連続に変化しており、
前記板状部には、当該板状部と前記セパレータとの間の摺動性を低下させるための滑り止め構造が前記境界に隣接した位置に形成されており、
前記第一電極板及び前記第二電極板の幅方向に関して前記セパレータの周縁部が前記第一電極板及び前記第二電極板から突出し、
前記幅方向に関して前記丸棒部が前記セパレータの前記周縁部の外に位置し、かつ、前

記セパレータの前記周縁部が前記滑り止め構造に重なっている、円筒型非水電解液電池を提供する。

【００１１】

第一電極板が正極板のとき、第一電極リードが正極リードに相当し、第一活物質が正極活物質に相当し、第二電極板が負極板に相当し、第二電極リードが負極リードに相当し、第二活物質が負極活物質に相当する。第一電極板が負極板のとき、第一電極リードが負極リードに相当し、第一活物質が負極活物質に相当し、第二電極板が正極板に相当し、第二電極リードが正極リードに相当し、第二活物質が正極活物質に相当する。

【発明の効果】

【００１２】

本発明によれば、第一電極リードの寸法が板状部と丸棒部との境界で不連続に変化している。第一電極リードの板状部には、当該板状部とセパレータとの間の摺動性を低下させるための滑り止め構造が形成されている。幅方向に関して丸棒部をセパレータの周縁部の外に位置させ、かつ、セパレータの周縁部を滑り止め構造に重ねつつ、巻回工程を実施する。このようにすれば、セパレータの周縁部が第一電極リードから過度な荷重を受けたり、第一電極リードの表面を滑ったりすることを防止できる。そのため、電極群に過度な応力が加わることも防止できる。本発明によれば、巻きずれ及び電極板の切れを防止できる。また、本発明によれば、外部の振動などによる巻きずれが生じ難い電極群を有する円筒型非水電解液電池を提供することができる。

【図面の簡単な説明】

【００１３】

【図１】本発明の実施形態に係る円筒型非水電解液電池の断面図
【図２】図１に示す電池の電極群の分解斜視図
【図３Ａ】電極リードの製造方法を説明するためのフロー図（斜視）
【図３Ｂ】電極リードの製造方法を説明するためのフロー図（断面）
【図３Ｃ】滑り止め構造として凹凸が形成された電極リードの平面図
【図３Ｄ】滑り止め構造としてローレットが形成された電極リードの平面図
【図４Ａ】正極側のリード取付工程を説明するための斜視図
【図４Ｂ】負極側のリード取付工程を説明するための斜視図
【図４Ｃ】リード取付工程を説明するための、正極リード周辺の拡大斜視図
【図４Ｄ】リード取付工程を説明するための、負極リード周辺の拡大斜視図
【図５Ａ】積層工程を説明するための斜視図
【図５Ｂ】積層工程を説明するための、正極リード周辺の拡大斜視図
【図５Ｃ】積層工程を説明するための、負極リード周辺の拡大斜視図
【図６】巻回工程を説明するためのフロー図
【図７】収容工程を説明するためのフロー図
【図８】封口工程を説明するためのフロー図
【図９】従来の円筒型非水電解液電池の断面図

【発明を実施するための形態】

【００１４】

以下、図面を参照しつつ本発明の実施形態を説明する。

【００１５】

図１に示すように、本実施形態の円筒型非水電解液電池８０（以下、単に「電池８０」とも記載する）は、円筒状の電池ケース６０、電池ケース６０に収容された電極群２０、及び電池ケース６０の開口部に固定された封口体７０を備えている。電池８０は、典型的には、リチウムイオン二次電池である。

【００１６】

図２に示すように、電極群２０は、正極板２１、負極板２２及び２つのセパレータ２７で構成されている。正極板２１は、正極集電体２３及び正極活物質層２４で構成されている。負極板２２は、負極集電体２５及び負極活物質層２６で構成されている。セパレータ

２７は、それぞれ、正極板２１と負極板２２との間に配置されている。正極板２１には、電力取り出し用の正極リード２１０が電気的に接続されている。負極板２２には、電力取り出し用の負極リード７１０が電気的に接続されている。電極群２０は、渦状に巻かれており、全体として円筒の形を有している。電極群２０の巻回軸に関して、正極リード２１０は、負極リード７１０と向かい合っている。

【００１７】

図１に示すように、封口体７０には、貫通孔７０ａ及び７０ｂが形成されている。正極リード２１０は、貫通孔７０ａの中で封口体７０に保持されるように封口体７０の貫通孔７０ａに挿し込まれている。同様に、負極リード７１０は、貫通孔７０ｂの中で封口体７０に保持されるように封口体７０の貫通孔７０ｂに挿し込まれている。つまり、正極リード２１０及び負極リード７１０は、それぞれ、貫通孔７０ａ及び７０ｂを通って電池ケース６０の外部まで延びている。本実施形態では、電池ケース６０の高さ方向に関して、正極リード２１０の長さが、負極リード７１０の長さに一致している。

【００１８】

電池ケース６０の側部には、電池ケース６０の高さ方向に関して封口体７０の上面７０ｐと封口体７０の下面７０ｑとの間において、電極群２０の中心軸に向かう方向に突出しているかしめ部６０ａが設けられている。かしめ部６０ａは、円環の形状を有するように電池ケース６０の周方向に沿って形成されている。この構成によれば、封口体７０に対して、周方向に均一な圧縮荷重を付与できる。電池ケース６０の開口部には、Ｕ字状に曲げられたかしめ部６０ｂが設けられている。かしめ部６０ｂは、封口体７０の上面に接しており、これにより、電池ケース６０の中に押し込む方向の荷重を封口体７０に付与している。

【００１９】

なお、電池ケース６０の底部の空間、すなわち、電池ケース６０の底部と電極群２０との間に絶縁シートなどの他の部材が設けられていてもよい。同様に、封口体７０の下面７０ｑと電極群２０との間に絶縁シートなどの他の部材が設けられていてもよい。

【００２０】

次に、図１に示す電池８０の製造方法を説明する。

【００２１】

［部材準備工程］

まず、電池８０を構成する各部材を準備する。

【００２２】

（電極リード）

本実施形態では、図３Ａに示すように、ワークピース１０を加工することにより正極リード２１０を作製する。ワークピース１０として、既存の電極リードを使用できる。ワークピース１０は、板状部１１と、丸棒部１２と、先端部１３と、隆起部１４とを有する。

【００２３】

板状部１１は、帯状の形状を有する。図３Ａにおいて、板状部１１の長手方向は、ｘ方向に平行である。丸棒部１２は、円柱の形状を有する。丸棒部１２は、板状部１１に一体に形成されている。先端部１３は、線状の形状を有する。先端部１３は、板状部１１の反対側で丸棒部１２に溶接されている。

【００２４】

図３Ｂに示すように、隆起部１４は、板状部１１の厚さ方向（図３Ｂに示すｙ方向）に関するワークピース１０の寸法を、板状部１１と丸棒部１２との境界近傍領域において連続に変化させるように設けられている。

【００２５】

まず、ワークピース１０の隆起部１４を除去する。隆起部１４を除去する方法は限定されない。例えば、ヤスリで隆起部１４を削り取ればよい。隆起部１４を除去した後、板状部１１の厚さ方向に関するワークピース１１０の寸法は、板状部１１と丸棒部１２との境界で不連続に変化している。つまり、板状部１１の厚さd_1及び丸棒部１２の直径d_2は、

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それぞれ、一定であり、丸棒部１２の直径d_2は、板状部の厚さd_1よりも大きい。丸棒部１２は、例えば、板状部１１の厚さの２～１０倍の直径を有している。板状部１１の厚さd_1は、例えば、０．２～０．５ｍｍである。丸棒部１２の直径d_2は、例えば、０．４～５ｍｍである。ワークピース１１０の板状部１１及び丸棒部１２の各構造は、正極リード２１０に反映される。

【００２６】

次に、板状部１１に溝１１ａを形成する。溝１１ａは、板状部１１の幅方向（図３Ａに示すｚ方向）に延びている。幅方向とは、板状部１１の長手方向及び厚さ方向に直交する方向である。溝１１ａは、板状部１１の長手方向の摺動性を低下させる、すなわち、摩擦係数を高めるように作用する滑り止め構造を構成する。本実施形態では、溝１１ａを、板状部１１における、板状部１１と丸棒部１２との境界に隣接した位置に形成する。また、本実施形態では、溝１１ａを、板状部１１の表面及び裏面に形成する。このようにして、正極リード２１０を作製する。

【００２７】

なお、本実施形態では、複数の溝１１ａを形成している。しかし、溝１１ａは、１つの溝であってもよい。また、溝１１ａの具体的な寸法は限定されない。例えば、溝１１ａの深さは０．０５～０．１ｍｍとすればよい。また、溝１１ａは、幅方向全体に形成することが好ましい。つまり、溝１１ａの一端が板状部１１の一方の側面に位置し、溝１１ａの他端が板状部１１の他方の側面に位置していてもよい。このようにすれば、板状部１１の側面によってもセパレータ２７を捕らえることができる。

【００２８】

また、単一の工程で、隆起部１４の除去と、溝１１ａの形成とを実施してもよい。例えば、隆起部１４にヤスリを接触させ、ヤスリを幅方向に動かすことにより、隆起部１４の除去と、溝１１ａの形成の双方を実施できる。このようにすれば、単一の工程でワークピース１０から正極リード２１０が得られる。したがって、加工コストを抑制できる。

【００２９】

また、ワークピース１０としては、市販の電極リードを用いればよい。また、本実施形態では、ワークピース１０を加工して正極リード２１０を作製しているが、本発明はこれに限定されない。例えば、原材料から直接正極リード２１０を作製してもよい。具体的には、まず、丸棒部１２の直径と同じ直径を有する線材を準備する。次に、線材を適切な長さに切断する。次に、板状部１１が形成されるように、切断された線材をプレス加工する。次に、プレス加工によってできた隆起部１４を研削、研磨などの加工方法で除去する。最後に、先端部１３を丸棒部１２に溶接すればよい。

【００３０】

また、本実施形態では、溝１１ａにより滑り止め構造を構成している。溝１１ａによる滑り止め構造は、板状部１１の長手方向の摺動性を低下させる点で優れている。しかし、他の態様で滑り止め構造を構成してもよい。例えば、凹凸、ローレット、突起又はノッチにより滑り止め構造を構成してもよい。図３Ｃに示すような、凹凸１１ｂにより構成された滑り止め構造は、板状部１１の厚さ方向に垂直な全ての方向の摺動性を低下させる点で優れている。凹凸１１ｂは、例えば、板状部１１の表面を粗すことで形成できる。なお、図３Ｃでは、凹凸１１ｂは目視可能な大きさの凹凸であるが、凹凸１１ｂは、目視できない粗面であってもよい。また、図３Ｄに示すような、ローレット１１ｃにより構成された滑り止め構造も、凹凸１１ｂにより構成された滑り止め構造と同様の点で優れている。ローレット１１ｃは、例えば、板状部１１における滑り止め構造を形成すべき部分に対してダイスを強く押し当てることにより、当該部分を塑性変形させることで形成できる。また、突起により構成された滑り止め構造も、板状部１１の摺動性を低下させる点で優れている。また、ノッチにより滑り止め構造は、セパレータ２７の破損を抑制しつつ板状部１１の摺動性を低下させる点で優れている。

【００３１】

本実施形態において、負極リード７１０は、正極リード２１０と同じ構造を有している

。そのため、負極リード７１０も正極リード２１０と同じ方法で作製できる。図３Ａ及び図３Ｂに示すように、リード作製工程では、ワークピース５１０から隆起部５１４を除去する。隆起部５１４が除去されたワークピース６１０に溝５１１ａを形成することにより負極リード７１０が得られる。負極リード５１０は、板状部５１１、丸棒部５１２及び先端部５１３を有する。板状部５１１の表面及び／又は裏面には、滑り止め構造としての溝５１１ａが形成されている。

【００３２】

正極リード２１０及び負極リード７１０の材料としては、例えば、アルミニウム、アルミニウム合金、ニッケル、ニッケル合金、銅、銅合金、ステンレスが挙げられる。負極リード７１０は、正極リード２１０と同じ材料でできていてもよいし、異なる材料でできていてもよい。正極リード２１０において、板状部１１及び丸棒部１２は、基本的には、同じ材料でできている。先端部１３は、板状部１１及び丸棒部１２と同じ材料でできていてもよいし、異なる材料でできていてもよい。このことは、負極リード７１０についても同じである。

【００３３】

（正極板）

まず、正極活物質及び任意の材料を混練することにより正極合剤を作製する。任意の材料には、溶媒、導電助剤、結着剤などが含まれる。次に、正極合剤を正極集電体２３に塗布する。塗布された正極合剤を乾燥させることにより、正極集電体２３の上に正極活物質層２４が形成される。次に、所定の厚さの正極板２１が形成されるように、正極集電体２３及び正極活物質層２４を圧延する。その後、正極板２１を所定の寸法に切断する。これにより、帯状の正極板２１が得られる。なお、正極集電体２３の両面に正極合剤を塗布してもよいし、正極集電体２３の片面に正極合剤を塗布してもよい。

【００３４】

正極集電体２３は、導電性を有するシート状の部材であり、典型的には金属箔で構成されている。金属箔に代えて、多数の孔を有する部材（金属メッシュ、パンチングメタル、エキスパンドメタル）も使用できる。正極集電体２３の材料としては、アルミニウム、アルミニウム合金などの金属が挙げられる。

【００３５】

正極活物質としては、リチウムイオンを吸蔵及び放出しうる材料を使用できる。このような正極活物質としては、二酸化マンガン（MnO_2）、リチウムマンガン複合酸化物（例えば$Li_xMn_2O_4$又はLi_xMnO_2）、リチウムニッケル複合酸化物（例えばLi_xNiO_2）、リチウムコバルト複合酸化物（例えばLi_xCoO_2）、リチウムニッケルコバルト複合酸化物（例えば$LiNi_{1-y}Co_yO_2$）、リチウムマンガンコバルト複合酸化物（例えば$Li_xMn_yCo_{1-y}O_2$）、スピネル型リチウムマンガンニッケル複合酸化物（$Li_xMn_{2-y}Ni_yO_4$）、オリビン構造を有するリチウムリン酸化物（Li_xFePO_4）などの酸化物が挙げられる。上記化学式の「ｘ」及び「ｙ」は、それぞれ、０～１の範囲の値をとりうる。好ましい正極活物質としては、リチウムマンガン複合酸化物、リチウムニッケル複合酸化物、リチウムコバルト複合酸化物、リチウムニッケルコバルト複合酸化物、スピネル型リチウムマンガンニッケル複合酸化物、リチウムマンガンコバルト複合酸化物、リチウムリン酸鉄が挙げられる。これらは、金属リチウムの電位に対して例えば３．０Ｖ以上５．０Ｖ以下の充放電電位を有する。

【００３６】

導電助剤としては、アセチレンブラック、カーボンブラック、黒鉛などの炭素材料を使用できる。結着剤としては、ポリテトラフルオロエチレン（ＰＴＦＥ）、ポリフッ化ビニリデン（ＰＶｄＦ）、カルボキシメチルセルロース（ＣＭＣ）、フッ素ゴム、スチレンブタジエンゴム（ＳＢＲ）などの樹脂材料を使用できる。

【００３７】

（負極板）

まず、負極活物質及び任意の材料を混練することにより負極合剤を作製する。任意の材

料には、溶媒、導電助剤、結着剤などが含まれる。次に、負極合剤を負極集電体２５に塗布する。塗布された負極合剤を乾燥させることにより、負極集電体２５の上に負極活物質層２６が形成される。次に、所定の厚さの負極板２２が形成されるように、負極集電体２５及び負極活物質層２６をプレスする。その後、負極板２２を所定の寸法に切断する。これにより、帯状の負極板２２が得られる。なお、負極集電体２５の両面に負極合剤を塗布してもよいし、負極集電体２５の片面に負極合剤を塗布してもよい。

【００３８】

負極集電体２５も、導電性を有するシート状の部材であり、典型的には金属箔で構成されている。金属箔に代えて、多数の孔を有する部材（金属メッシュ、パンチングメタル、エキスパンドメタル）も使用できる。負極集電体２５の材料としては、ニッケル、ニッケル合金、銅、銅合金、アルミニウム、アルミニウム合金などの金属が挙げられる。

【００３９】

負極活物質としては、リチウムイオンを吸蔵及び放出しうる材料を使用できる。好ましい負極活物質としては、例えば、金属リチウム、リチウム合金、リチウムチタン複合酸化物（例えば$Li_4Ti_5O_{12}$）、リチウムイオンを吸蔵及び放出しうる炭素材料、リチウムと合金を形成しうる材料（いわゆる合金系活物質）などが挙げられる。炭素材料としては、グラファイトが挙げられる。合金系活物質としては、スズ、スズ合金、シリコン及びシリコン合金が挙げられる。充放電効率及びサイクル寿命の観点から、炭素材料又はリチウムチタン複合酸化物を好適に使用できる。

【００４０】

なお、負極板２２が有する負極活物質の電位が金属リチウムの電位よりも１．０Ｖ以上高い場合は、負極集電体２５の材料としてアルミニウム又はアルミニウム合金を用いることが好ましい。これにより、電池ケース６０の材料として、後述の理由で好適なアルミニウム又はアルミニウム合金を用いることができる。すなわち、アルミニウム又はアルミニウム合金で構成された電池ケース６０に負極板が触れると、電池ケース６０の溶出することがあるが、このような負極板２２によれば、電池ケース６０の溶出を防ぐことができる。

【００４１】

金属リチウムの電位に対して１．０Ｖ以上高い電位を有する負極活物質として、リチウムとチタンとを含む複合酸化物が挙げられる。具体的には、化学式$Li_{4+x}Ti_5O_{12}$（$0 \leqq x \leqq 3$）で表され、スピネル型構造を有するチタン酸リチウムが挙げられる。チタン酸リチウムを負極板２２に使用すると、負極板２２の柔軟性は損なわれることがある。柔軟性に乏しい電極板は、巻回時に切れやすい。したがって、チタン酸リチウムを負極活物質として使用する場合、本実施形態の方法が特に推奨される。

【００４２】

負極板２２の結着剤及び導電助剤としては、正極板２１と同じものを使用できる。

【００４３】

（セパレータ）

本実施形態では、正極板２１及び負極板２２よりも幅広である帯状の２つのセパレータ２７を準備する。すなわち、セパレータ２７の短辺は、正極板２１の短辺及び負極板２２の短辺よりも長い。また、本実施形態では、セパレータ２７の長辺は、正極板２１の長辺及び負極板２２の長辺よりも長い。

【００４４】

セパレータ２７としては、例えば、多孔質フィルム、不織布などが挙げられる。多孔質フィルムとしては、ポリエチレン又はポリプロピレンでできたものなどが挙げられる。不織布としては、セルロース又はポリビニルアルコール（ＰＶＡ）でできたものなどが挙げられる。

【００４５】

（非水電解質）

本実施形態では、電解質と有機溶媒とを含む液状の非水電解質を準備する。有機溶媒と

しては、エチレンカーボネート（ＥＣ）、プロピレンカーボネート（ＰＣ）、ビニレンカーボネート（ＶＣ）などの環状カーボネートが挙げられる。また、ジメチルカーボネート（ＤＭＣ）、メチルエチルカーボネート（ＭＥＣ）、ジエチルカーボネート（ＤＥＣ）などの鎖状カーボネート、テトラヒドロフラン（ＴＨＦ）、２メチルテトラヒドロフラン（２ＭｅＴＨＦ）などの環状エーテル、ジメトキシエタン（ＤＭＥ）などの鎖状エーテル、アセトニトリル（ＡＮ）、スルホラン（ＳＬ）などを使用してもよい。これらの有機溶媒は、単独又は２種以上の混合物の形態で使用できる。

【００４６】

電解質としては、過塩素酸リチウム（$LiClO_4$）、六フッ化リン酸リチウム（$LiPF_6$）、四フッ化ホウ酸リチウム（$LiBF_4$）などのリチウム塩が挙げられる。化学的安定性と高誘電率化の観点から、六フッ化リン酸リチウム（$LiPF_6$）を主たる電解質として用いることが好ましい。「主たる電解質」とは、モル比にて最も多く含まれた電解質を意味する。電解質は、有機溶媒に対して、例えば０．５～２．０ｍｏｌ／Ｌの濃度で溶解している。

【００４７】

（電池ケース）

本実施形態では、底部と開口部とを有する円筒形の電池ケース６０を準備する。電池ケース６０の材料としては、軽量で、加工性に優れる金属材料が好ましい。また、後述のように封口体７０をかしめるために、かしめ強度を高め易い金属材料の中から選択することが好ましい。軽量で加工性に優れた金属材料としては、アルミニウム及びアルミニウム合金などが挙げられる。かしめ強度を高め易い金属材料としては、Ｃｕ、Ｍｎ、Ｓｉなどの元素を微量添加したアルミニウム合金が挙げられる。もちろん、ステンレスなどの他の金属材料も使用できる。

【００４８】

（封口体）

本実施形態では、弾性材料（エラストマー）により構成された円柱状の封口体７０を準備する。封口体７０には貫通孔７０ａ及び７０ｂが設けられている。封口体７０の材料としては、例えば、エチレンプロピレンジエンゴム（ＥＰＤＭ）、イソブチレンイソプレンゴム（ＩＩＲ）、ブタジエンスチレンゴム（ＳＢＲ）が挙げられる。貫通孔７０ａ及び７０ｂの内径は、例えば、０．２～４．９ｍｍである。

【００４９】

以上の部材を準備した後に、下記の工程により電池８０を組み立てる。

【００５０】

［リード取付工程］

まず、図４Ａに示すように、正極板２１に正極リード２１０を電気的に接続する。具体的には、正極集電体２３に正極リード２１０の板状部１１を溶接によって固定する。溶接の方法としては、抵抗溶接、超音波溶接などが挙げられる。正極板２１と同様の方法で、図４Ｂに示すように、負極板２２に負極リード７１０を電気的に接続する。

【００５１】

本実施形態では、正極リード２１０の溝１１ａが、正極板２１に重なり合わないように、正極リード２１０と正極板２１とを接続する（図４Ｃ参照）。すなわち、正極板２１の幅方向に関して板状部１１の一部が正極板２１から突出するように正極リード２１０を正極板２１に接続する。板状部１１には、正極板２１から突出した部分にのみ溝１１ａ（滑り止め構造）が形成されている。同様に、負極リード７１０の溝５１１ａが、負極板２２に重なり合わないように、負極リード７１０と負極板２２とを接続する（図４Ｄ参照）。負極板２２及び負極リード７１０にも正極板２１及び正極リード２１０と同じ位置関係が採用されている。

【００５２】

また、本実施形態では、正極板２１の長手方向（図４Ｃに示すｚ方向）の一端を０％の位置、他端を１００％の位置と定義したとき、正極リード２１０が正極板２１の長手方向

に関して１０～３０％の範囲に位置するように、正極リード２１０を正極板２１に接続する。同様に、負極板２２の長手方向（図４Ｄに示すｚ方向）の一端を０％の位置、他端を１００％の位置と定義したとき、負極リード７１０が負極板２２の長手方向に関して１０～３０％の範囲に位置するように、負極リード７１０を負極板２２に接続する。これにより、後述の巻回工程後に、正極リード２１０及び負極リード７１０が適切な位置に配置される。

【００５３】

［積層工程］

次に、図５Ａに示すように、正極板２１、１対のセパレータ２７及び負極板２２の相対的な位置関係を定める。具体的には、セパレータ２７、負極板２２、セパレータ２７、正極板２１の順にこれらを配置する。このようにして、電極群２０、正極リード２１０及び負極リード７１０を有する積層体３０を形成する。

【００５４】

積層工程では、以下の関係を満たすように各部材の相対的な位置を調節する。すなわち、図５Ｂ及び図５Ｃに示すように、正極板２１及び負極板２２の幅方向（図５Ｂ及び図５Ｃに示すｘ方向）に関して、セパレータ２７の周縁部２７ａが、正極板２１及び負極板２２から突出している。正極板２１からの正極リード２１０の突出方向（図５Ｂ及び図５Ｃに示すｘ方向）は、負極板２２からの負極リード７１０の突出方向に一致している。正極板２１及び負極板２２の幅方向に関して、丸棒部１２の全部及び丸棒部５１２の全部が、周縁部２７ａの外に位置している。正極リード２１０の溝１１ａは、セパレータ２７の周縁部２７ａに重なっている。負極リード７１０の溝５１１ａも、セパレータ２７の周縁部２７ａに重なっている。厳密には、溝１１ａは周縁部２７ａのみと重なり合っている。同様に、溝５１１ａは周縁部２７ａのみと重なり合っている。

【００５５】

なお、本実施形態では、溝１１ａが板状部１１と丸棒部１２との境界に隣接した位置に形成されている。板状部１１と丸棒部１２との境界に隣接した位置とは、詳細には、板状部１１と丸棒部１２との境界からその境界に最も近い正極板２１の外縁までの領域に含まれた位置、又は、板状部１１と丸棒部１２との境界からその境界に最も近い負極板２２の外縁までの領域に含まれた位置を意味する。より詳細には、板状部１１と丸棒部１２との境界に隣接した位置とは、板状部１１と丸棒部１２との境界からその境界に最も近い正極板２１の外縁までの領域に含まれ、かつ、板状部１１と丸棒部１２との境界からその境界に最も近い負極板２２の外縁までの領域に含まれた位置を意味する。

【００５６】

［巻回工程］

次に、図６に示すように、積層体３０を巻回する。具体的には、まず、巻芯４０の軸方向が積層体３０の短手方向に沿うように、積層体３０の端部に巻芯４０を接続する。次に、セパレータ２７の周縁部２７ａを溝１１ａ及び５１１ａに重ねつつ、巻芯４０を軸にして積層体３０を巻回する。これにより、巻かれた電極群２０が得られる。

【００５７】

比較の形態として、正極リード及び負極リードとして、図３Ａのワークピース１０のような、隆起部を有する電極リードを用い、隆起部がセパレータに接触するように積層体を作製した場合を想定する。このような積層体を巻回すると、隆起部の外周側に巻回されたセパレータが巻回軸に平行な方向にずれ易い。したがって、巻きずれが生じたり、正極板及び負極板がねじれたり、正極板及び負極板の強度が弱い箇所が切れたりする。

【００５８】

これに対し、本実施形態によれば、板状部１１の厚さ方向に関する正極リード２１０の寸法は、板状部１１と丸棒部１２との境界で不連続に変化している。さらに、本実施形態では、正極板２１の幅方向に関して、丸棒部１２が、セパレータ２７の周縁部２７ａの外に位置する。したがって、積層体３０を巻回するときに丸棒部１２がセパレータ２７に接しない。すなわち、本実施形態では、セパレータ２７が巻回軸に平行な方向にずれる要因

が取り除かれている。正極板２１、負極板２２及びセパレータ２７は、巻回軸に平行に保たれる。これにより、積層体３０を巻回するときに巻きずれ並びに正極板２１及び負極板２２の切れを防止できる。

【００５９】

さらに、本実施形態では、正極リード２１０の溝１１ａがセパレータ２７の周縁部２７ａに重なっている。溝１１ａは、セパレータ２７の外縁に平行な方向に延びている。これにより、セパレータ２７と正極リード２１０との間の摺動性を低下させることができる。特に、巻回軸に平行な方向に関して、セパレータ２７を滑りにくくすることができる。したがって、積層体３０を巻回するときに巻きずれ並びに正極板２１及び負極板２２の切れをより効果的に防止できる。

【００６０】

また、溝１１ａは、セパレータ２７の周縁部２７ａのみと重なっている。したがって、セパレータ２７が、正極リード２１０の溝１１ａと正極板２１との間に挟まれることがない。これにより、積層体３０を巻回するときに、溝１１ａからセパレータ２７に過剰な圧力が加わることを防止できる。したがって、積層体３０を巻回するときに、セパレータ２７が破れ難い。これにより、セパレータ２７が破れることによって生じる電気的短絡を防ぐことができる。

【００６１】

なお、本実施形態では、溝１１ａが板状部１１の表面及び裏面に形成されているので、セパレータ２７の滑りをより確実に防止できる。ただし、板状部１１の片面にのみ溝１１ａを形成しても、巻きずれ並びに正極板２１及び負極板２２の切れの防止効果を得ることができる。

【００６２】

本実施形態において、負極リード７１０は正極リード２１０と同じ構造を有しており、負極リード７１０とセパレータ２７との位置関係も正極リード２１０とセパレータ２７との位置関係と同じように設定されている。したがって、上述した効果は、負極リード７１０についても得られる。

【００６３】

本実施形態では、正極リード２１０及び負極リード７１０の両方がセパレータ２７の滑りを防止するための構成を有している。しかし、正極リード２１０と負極リード７１０のいずれか一方のみを上記のように構成しても、巻きずれ並びに正極板２１及び負極板２２の切れを防止できる。

【００６４】

一般的な円筒型二次電池では、リードの厚みは１００μｍ程度なので、リードに起因した巻きずれ及び電極板の切れは起こり難い。

【００６５】

これに対し、図９を参照して説明した電池８８０では、正極板の中間部に正極リードが固定されている。同様に、負極板の中間部に負極リードが固定されている。すなわち、電極群を巻回したとき、正極リード及び負極リードが電極群に巻き込まれる。そのため、巻きずれ並びに正極板及び負極板の切れが本質的に発生し易い。本実施形態では、上記したような構成を採用しているので、正極リード２１０及び負極リード７１０が電極群２０に巻き込まれたとしても、巻きずれ並びに正極板２１及び負極板２２の切れを防止できる。

【００６６】

［収容工程］

次に、図７に示すように、電極群２０を電池ケース６０に収容する。電極群２０を電池ケース６０に収容したら、非水電解液（図示せず）を電池ケース６０に注入する。

【００６７】

［封口工程］

次に、図８に示すように、電池ケース６０の開口部を封口体７０により封口する。具体的には、正極リード２１０及び負極リード７１０が封口体７０に設けられた貫通孔７０ａ

及び７０ｂからそれぞれ電池ケース６０の外部に延びるように封口する。本実施形態では、丸棒部１２及び丸棒部５１２が、貫通孔７０ａ及び７０ｂの中で封口体７０から押圧力を受けて支持される。

【００６８】

次に、電池ケース６０をかしめて、封口体７０を固定する。具体的には、電池ケース６０に、かしめ部６０ａと、かしめ部６０ｂとを形成する。かしめ部６０ａは、電池ケース６０の側面を中心方向に向かって凹ませて形成する。また、かしめ部６０ｂは、電池ケース６０の開口側の端部を、中心方向に向かうＵ字状に折り曲げて形成する。

【００６９】

封口体７０の具体的な寸法は限定されないが、封口体７０の直径は、封口体７０が電池ケース６０の開口部を密閉するように、電池ケース６０の内径よりもある程度大きいことが好ましい。また、封口体７０が有する貫通孔７０ａ及び７０ｂの内径は、封口体７０と丸棒部１２及び丸棒部５１２とが密着するように、丸棒部１２及び丸棒部５１２の直径よりもある程度小さいことが好ましい。

【００７０】

このようにして作製された電池８０は、外部の振動などによる電極群２０における巻きずれが発生し難い。したがって、電池８０の信頼性は高い。また、電池８０は、電極群２０に接触すると巻きずれを引き起こす隆起部を省略できる。また、隆起部を省略すると、正極リード２１０の板状部１１と丸棒部１２との境界がセパレータ２７の長辺に一致するように、正極リード２１０とセパレータ２７との位置関係を設定することもできる。負極リード７１０とセパレータ２７との位置関係も同様に設定することができる。したがって、本実施形態によれば、電池８０を、小型化できる（すなわち、高エネルギー密度化できる）。

【実施例】

【００７１】

（実施例）

まず、正極リード、負極リード、正極板、負極板、及びセパレータを準備した。

【００７２】

正極リードを図３Ａを参照して説明した方法で作製した。まず、ワークピースとして、コンデンサ用リード（ニューセントラル社製Ｌ３Ｗ２０３２８ＦＷＰＳ）を準備した。次に、このワークピースの隆起部をやすりで削り取った。次に、ワークピースの板状部における丸棒部側の端部２ｍｍの領域の表面及び裏面をやすりで削った。これにより、幅方向（図３Ａに示すｚ方向）に延びる溝を形成した。このようにして正極リードを作製した。また、同様にして負極リードを作製した。

【００７３】

正極板は、下記のように作製した。まず、正極活物質と、導電助剤と、結着剤と、溶媒とを、双腕式練合機で撹拌、混練して、正極合剤を作製した。正極活物質としては、コバルト酸リチウムを用いた。導電助剤としては、正極活物質１００重量部に対して２重量部のアセチレンブラックを用いた。結着剤としては、正極活物質１００重量部に対して２重量部のポリフッ化ビニリデンを用いた。溶媒としては、正極合剤の固形分濃度を５０％程度にするのに適量のＮ－メチル－２－ピロリドンを用いた。

【００７４】

次に、厚さ１５μｍのアルミニウム箔でできた正極集電体の表面及び裏面に上記の正極合剤を塗布した。塗布した正極合剤を乾燥させ、正極集電体の上に正極活物質層を形成した。その後、正極集電体及び正極活物質層を圧延し、得られた正極板を所定の寸法に切断した。このようにして、幅４２ｍｍ、長さ５８０ｍｍ、片面側の正極活物質層の厚さが５０μｍの正極板を作製した。なお、この幅は、円筒型電池の正極板の幅の規定値である。

【００７５】

負極板は、下記のように作製した。まず、負極活物質と、導電助剤と、結着剤と、溶媒とを、双腕式練合機で撹拌、混練して、負極合剤を作製した。負極活物質としては、リチ

ウムチタン複合酸化物（$Li_4Ti_5O_{12}$）を用いた。導電助剤としては、負極活物質１００重量部に対して４重量部の気相成長法炭素繊維（ＶＧＣＦ：Vapor Grown Carbon Fiber）を用いた。結着剤としては、負極活物質１００重量部に対して５重量部のポリフッ化ビニリデンを用いた。溶媒としては、負極合剤の固形分濃度を５０％程度にするのに適量のＮ－メチル－２－ピロリドンを用いた。

【００７６】

次に、厚さ１５μｍのアルミニウム箔でできた負極集電体の表面及び裏面に上記の負極合剤を塗布した。塗布した負極合剤を乾燥させ、負極集電体の上に負極活物質層を形成した。その後、負極集電体及び負極活物質層を圧延し、得られた負極板を所定の寸法に切断した。このようにして、幅４０ｍｍ、長さ５４０ｍｍ、片面側の負極合剤層の厚さが１００μｍの負極板を作製した。なお、この幅は、円筒型電池の負極板の幅の規定値である。

【００７７】

セパレータとしては、厚さ２５μｍ、幅４４ｍｍ、長さ６００ｍｍの寸法を有するセルロースフィルム（ニッポン高度紙工業社製）を用いた。

【００７８】

次に、正極リードを正極集電体に溶接した。具体的には、正極板の長手方向（図４Ａのｚ方向）の一端から他端に向かって１１０ｍｍの位置に正極リードを溶接した。丸棒部と板状部との境界が正極板の長辺の外に（すなわち図４Ｃのｘの正方向に）１ｍｍ突出するように正極リードと正極板との位置関係を設定した。

【００７９】

次に、負極リードを負極集電体に溶接した。具体的には、負極板の長手方向（図４Ｂのｚ方向）の一端から他端に向かって９５ｍｍの位置に負極リードを溶接した。丸棒部と板状部との境界が負極板の長辺の外に（すなわち図４Ｄのｘの正方向に）２ｍｍ突出するように負極リードと負極板との位置関係を設定した。

【００８０】

溶接には、超音波溶着機（日本エマソン社製メタルウェルダ２０００ｅａ型）を用いた。また、ウェルドタイムは０．１秒に、振幅は８０％に、それぞれ設定した。

【００８１】

次に、セパレータ、負極板、セパレータ及び正極板の順にこれらを配置し、電極群、正極リード及び負極リードを有する積層体を形成した。セパレータの幅方向（図５Ａに示すｘ方向）に関して、２つのセパレータが負極板の外に２ｍｍ突出するように２つのセパレータと負極板との位置関係を設定した。同様に、セパレータの幅方向に関して、２つのセパレータが正極板の外に１ｍｍ突出するように２つのセパレータと正極板との位置関係を設定した。すなわち、本実施例では、正極リードにおける丸棒部と板状部との境界、負極リードにおける丸棒部と板状部との境界、および２つのセパレータの長辺が一致するように、正極板、負極板、および２つのセパレータの位置関係を設定した。

【００８２】

次に、積層体の長手方向の一端に巻芯を取り付けた。そして、巻回機を用いて１０Ｎ程度の張力をかけながら積層体を巻回し、巻かれた電極群を得た。最後に、電極群の最外周を粘着テープで固定した。

【００８３】

（比較例）

正極リード及び負極リードとして図３Ａの電極リードが有するような隆起部を有するコンデンサ用リード（ニューセントラル社製Ｌ３Ｗ２０３２８ＦＷＰＳ）を用いた。また、隆起部とセパレータとが重なるように積層体を作製した。それ以外は実施例と同様にして電極群を作製した。

【００８４】

［評価］

実施例の電極群と比較例の電極群とを目視により比較した。実施例の電極群には、巻きずれ並びに正極板及び負極板の切れが発生していなかった。一方、比較例の電極群には、

巻きずれ並びに正極板及び負極板の切れが発生していた。

【産業上の利用可能性】

【００８５】

本発明は、エネルギー分野向けの二次電池、例えば、一般家庭用の二次電池に適用できる。

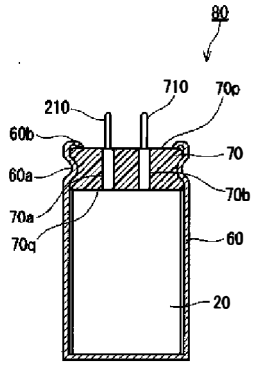
【符号の説明】

【００８６】

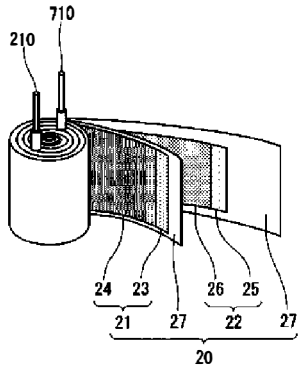
１０，５１０，１１０，６１０　ワークピース
１１，５１１　板状部
１１ａ，５１１ａ　溝（滑り止め構造）
１１ｂ　凹凸（滑り止め構造）
１１ｃ　ローレット（滑り止め構造）
１２，５１２　丸棒部
１３，５１３　先端部
１４，５１４　隆起部
２０　電極群
２１　正極板
２２　負極板
２３　正極集電体
２４　正極活物質層
２５　負極集電体
２６　負極活物質層
２７　セパレータ
２７ａ　周縁部
３０　積層体
４０　巻芯
６０　電池ケース
６０ａ，６０ｂ　かしめ部
７０　封口体
７０ａ，７０ｂ　貫通孔
７０ｐ　上面
７０ｑ　下面
８０　円筒型非水電解液電池
２１０　正極リード
７１０　負極リード

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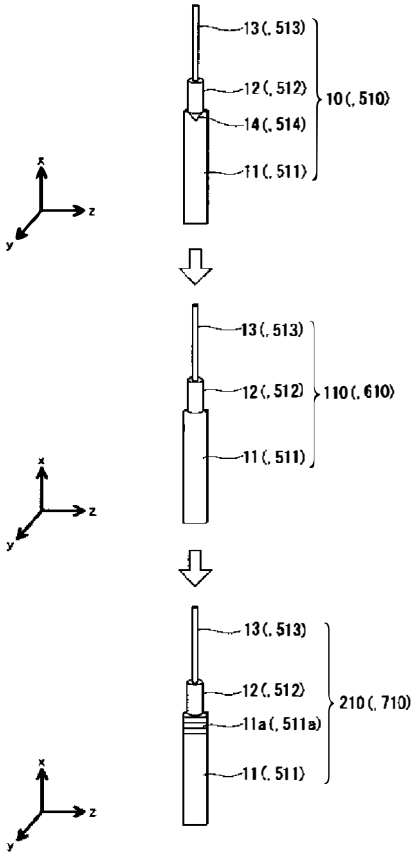
【図１】



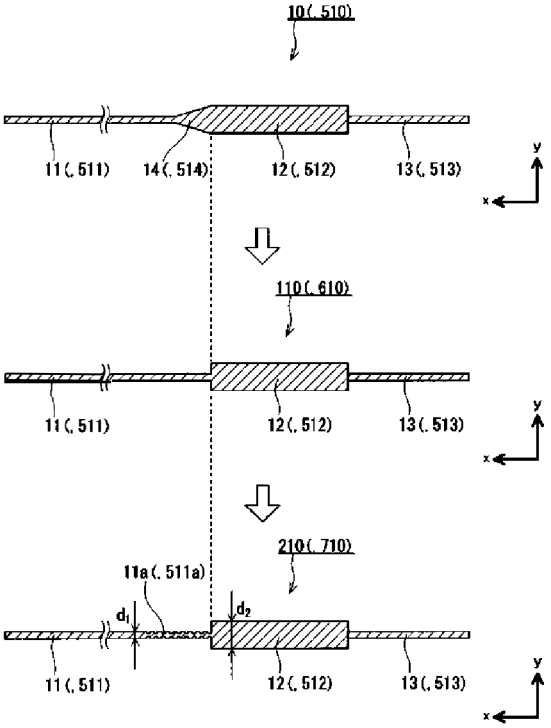
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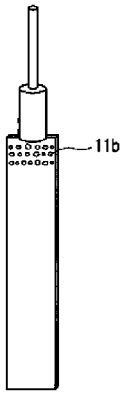
【図３Ａ】



【図３Ｂ】



【図３Ｃ】



【図３Ｄ】

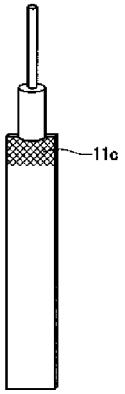
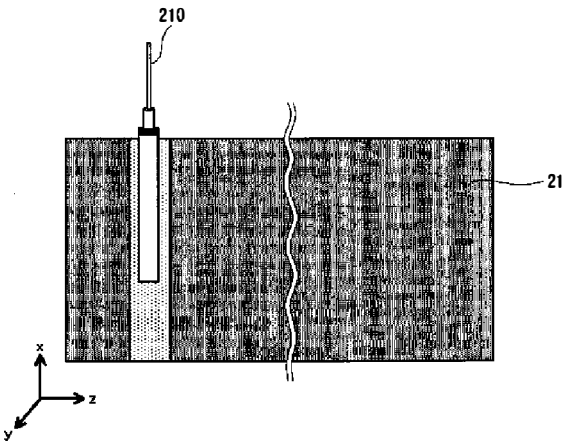
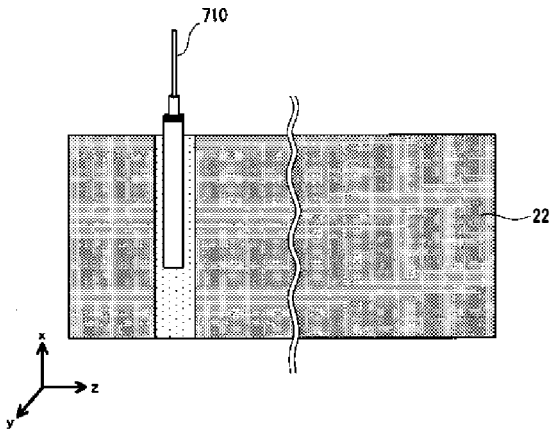


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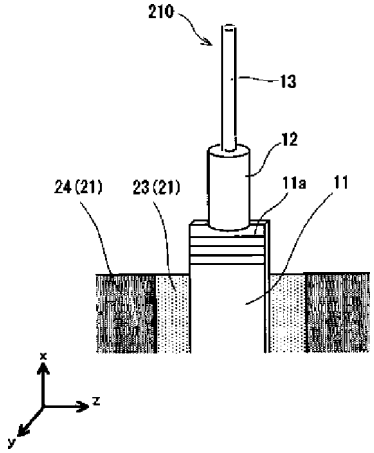
【図４Ａ】



【図４Ｂ】



【図４Ｃ】



【図４Ｄ】

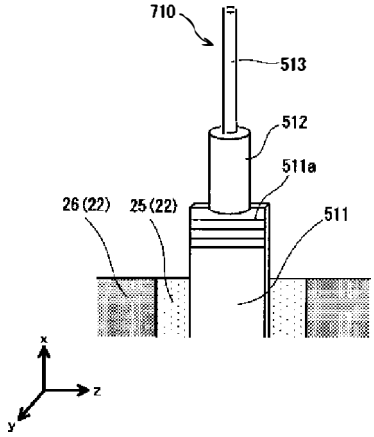
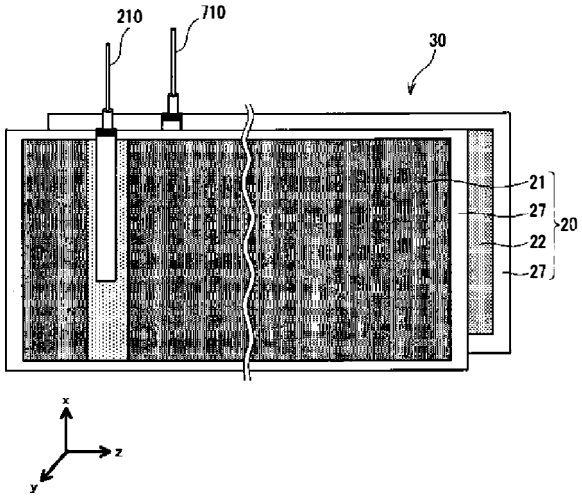
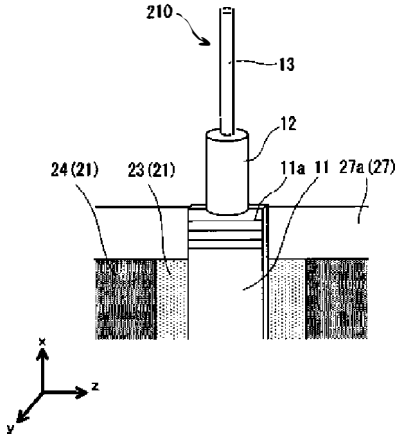


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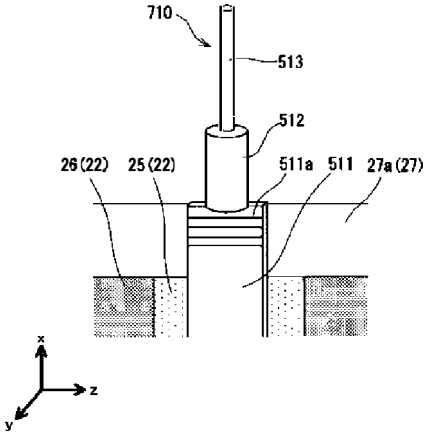
【図５Ａ】



【図５Ｂ】



【図５Ｃ】



【図６】

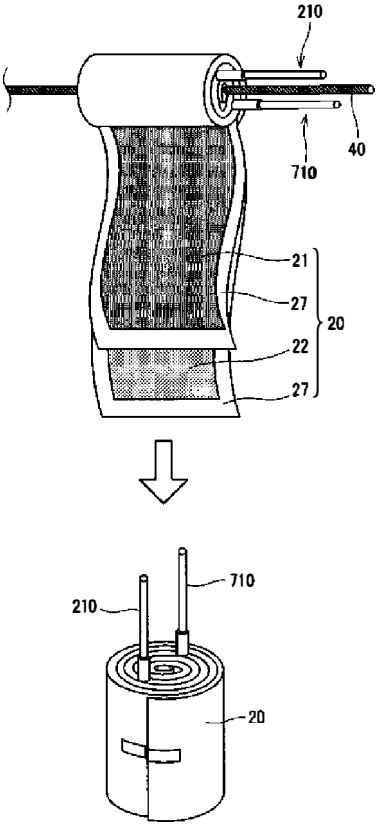
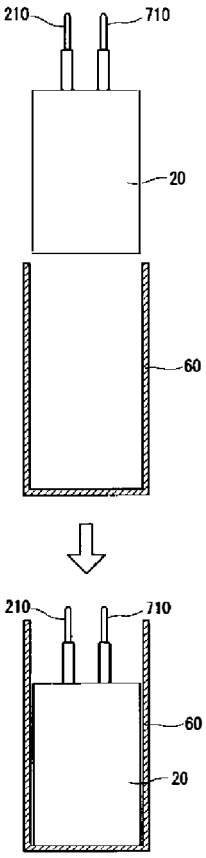
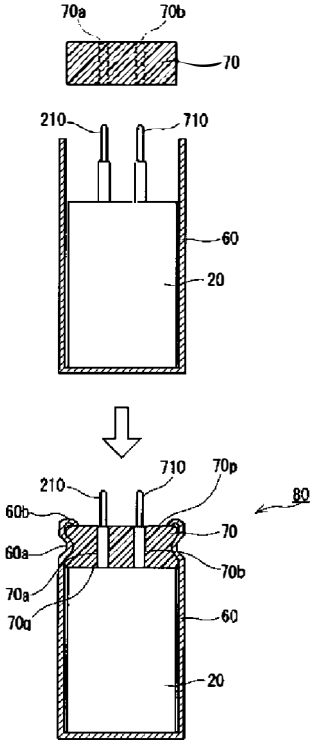


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【図７】



【図８】



【図９】

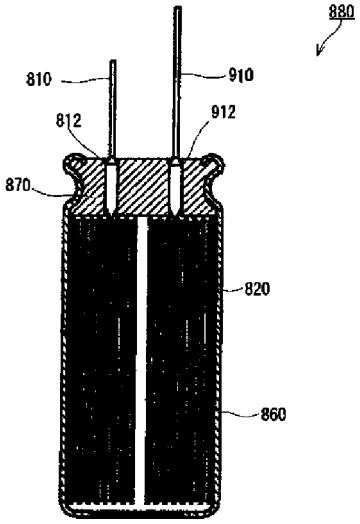


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AM04 BJ02 BJ14 CJ07 DJ04 DJ05 DJ14 HJ04 HJ12
5H043 AA20 BA19 CA03 CA12 CB04 CB09 EA02 EA22 EA60 HA33E
JA01E JA03E JA11E JA13E LA02E

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Espacenet

JP2011023249A SECONDARY BATTERY, BATTERY PACK

Applicants: NISSAN MOTOR

Inventors: MATOBA MASASHI,SUZUKI NAOTO

Classifications:

IPC ***H01M10/04; H01M10/0585; H01M2/10; H01M2/26; H01M2/30; H01M4/02; H01M4/13; H01M4/66; H01M4/70;***

CPC Y02E60/10 (EP);

Priorities: JP2009168203A 2009-07-16

Application: JP20110 23249A·2009-07-16

Publication: JP2011023249A·2011-02-03

Published as: JP2011023249A

SECONDARY BATTERY, BATTERY PACK

Abstract

<P>PROBLEM TO BE SOLVED: To provide a secondary battery capable of suppressing unevenness of heat generation of a current collector in an in-plane direction. <P>SOLUTION: A cathode current collector 11 is formed of cathode conductive layers 111 (conductive material) on both surfaces of a reinforcing layer 140. The cathode conductive layer 111 is formed to become thicker in thickness from a first end part 112 side toward a second end part 113 side opposite to the first end part 112. Then, a cathode terminal lead 20 connecting electrically a cathode current collector tab 18 is connected with the second end part 113 side. <P>COPYRIGHT: (C)2011,JPO&INPIT

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Petitioner ADC (IPR2024-00577)

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(54)【発明の名称】二次電池、組電池

(57)【要約】
【課題】集電体の面内方向における発熱の偏りを抑えた二次電池を提供する。
【解決手段】正極集電体１１が補強層１４０の両面に正極導電性層１１１（導電材）を形成したものを使用している。正極導電性層１１１は第１端部１１２側からそれとは反対側の第２端部１１３側にかけて厚みが厚くなるように形成している。そして第２端部１１３側に、正極集電タブ１８を電気的に接続する正極端子リード２０が接続される。
【選択図】図２

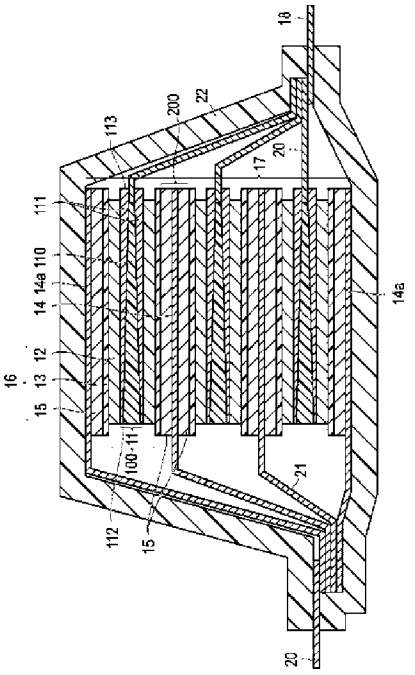


EXHIBIT 1002
Petitioner ADC (IPR2024-00577)

【特許請求の範囲】
【請求項１】
正極活物質層が形成された第１集電体と、
前記正極活物質層に対して電解質層を介在させて対向する位置に配置された負極活物質層が形成された第２集電体と、
前記第１集電体および前記第２集電体のうち少なくとも一方の集電体に含まれ、第１端部からそれに対向する第２端部の方向に単位面積当たりの質量が重くなるように質量勾配をつけた導電材と、
前記第２端部側に電気的に接続された集電タブと、
を有することを特徴とする二次電池。
【請求項２】
正極活物質層が形成された第１集電体と、
前記正極活物質層に対して電解質層を介在させて対向する位置に配置された負極活物質層が形成された第２集電体と、
前記第１集電体および前記第２集電体のうち少なくとも一方の集電体に含まれ、第１端部からそれに対向する第２端部の方向にシート抵抗が低くなっている導電材と、
前記第２端部側に電気的に接続された集電タブと、
を有することを特徴とする二次電池。
【請求項３】
前記導電材は、厚みが前記第１端部から前記第２端部方向に厚くなっていることを特徴とする請求項１または２記載の二次電池。
【請求項４】
前記集電体は、前記導電材に沿って配置された補強層を含み、
前記補強層の厚みが前記導電材の厚みと逆に変化していることを特徴とする請求項３記載の二次電池。
【請求項５】
前記導電材は、導電部と非導電部とからなり、前記導電材内における単位面積あたりの前記非導電部の割合（前記非導電部の体積／前記導電材全体の体積）が前記第１端部から前記第２端部の方向へ小さくなることを特徴とする請求項１または２記載の二次電池。
【請求項６】
前記導電材は、前記第１端部から前記第２端部の方向に対して直交する方向には単位面積当たりの質量が同一であることを特徴とする請求項１～５のいずれか一つに記載の二次電池。
【請求項７】
前記導電材は、前記集電タブが電気的に接続された部分を中心とする同心円の円弧方向には単位面積当たりの質量が同一であることを特徴とする請求項１～５のいずれか一つに記載の二次電池。
【請求項８】
前記導電材を含む集電体を前記第１集電体および前記第２集電体の両方に用いて、当該第１集電体における第１端部と当該第２集電体における第２端部が互いに向かい合う位置となるように、前記第１集電体における前記正極活物質層、前記電解質層、および前記第２集電体における前記負極活物質層が積層されて、前記集電タブが互いに対向する位置に配置されていることを特徴とする請求項１～７のいずれか一つに記載の二次電池。
【請求項９】
前記正極活物質層はリチウムを含み、リチウムイオン二次電池になることを特徴とする請求項１～８のいずれか一つに記載の二次電池。
【請求項１０】
請求項１～９のいずれか１項に記載の電池が複数電気的に接続されてなることを特徴とする組電池。
【発明の詳細な説明】

【技術分野】
【０００１】
本発明は、二次電池、およびこれを用いた組電池に関する。
【背景技術】
【０００２】
二次電池は、活物質を形成して保持し、かつ電流を集めるための集電体を有する。従来、この集電体として、多数のメッシュ孔を備えた電解箔に補強部を一体に形成してなるものがある（特許文献１）。
【先行技術文献】
【特許文献】
【０００３】
【特許文献１】特開２０００－２８５９２６号公報
【発明の概要】
【発明が解決しようとする課題】
【０００４】
ところで集電体には、そこから電流を外部へ取り出すための集電タブが接続される。従来の集電体に用いられる電解箔は、その厚みが面内方向に均一である。したがって、集電タブが接続された端部から、それとは反対の端側まで抵抗値が略同一となる。このため集電体全面から集められた電流が集電タブ接続部周囲に集中することになる。そうすると集電タブ接続端周辺では電流が集中することから、それとは反対の端側より相対的に発熱が多くなる。一方で電流集中のない集電タブ接続端の反対側では発熱が少ない。このような集電体の面内での発熱の偏りは、電池性能の低下や耐久性の低下につながる虞がある。
【０００５】
そこで、本発明の目的は、集電体の面内方向における発熱の偏りを抑えた二次電池を提供することである。
【課題を解決するための手段】
【０００６】
上記目的を達成するための本発明は以下のように構成される。
【０００７】
本発明の二次電池は、正極活物質層が形成された第１集電体と、この正極活物質層に対して電解質層を介在させて対向する位置に配置された負極活物質層が形成された第２集電体とを有する。そして第１集電体および第２集電体のうち少なくとも一方の集電体には、その第１端部からそれに対向する第２端部の方向に単位面積当たりの質量が重くなるように質量勾配をつけた導電材が含まれていて、第２端部側に集電タブが電気的に接続されている。
【０００８】
また、本発明の二次電池は、正極活物質層が形成された第１集電体と、この正極活物質層に対して電解質層を介在させて対向する位置に配置された負極活物質層が形成された第２集電体とを有する。そして第１集電体および第２集電体のうち少なくとも一方の集電体には、その第１端部からそれに対向する第２端部の方向にシート抵抗が低くなるようにした導電材が含まれていて、第２端部側に集電タブが電気的に接続されている。
【発明の効果】
【０００９】
本発明によれば、正極集電体または負極集電体のうち少なくとも一方の集電体において、第１端部側からそれとは反対側の第２端部方向に質量が重くなるようにして、第２端部側に集電タブが電気的に接続されようにしている。したがって、電流集中が起きる第２端部側で電流が流れやすくなり、その部分での発熱が抑えられて集電体の面内方向における発熱の偏りを抑えることができる。
【００１０】
また、本発明によれば、正極集電体または負極集電体のうち少なくとも一方の集電体に

おいて、第１端部側からそれとは反対側の第２端部方向にシート抵抗が低くなるようにして第２端部側に集電タブが電気的に接続されようにしている。したがって、電流集中が起きる第２端部側での電流が流れやすくなり、その部分での発熱が抑えられて、集電体の面内方向における発熱の偏りを抑えることができる。

【図面の簡単な説明】

【００１１】

【図１】実施形態の二次電池の外観を示す外観図である。

【図２】実施形態１の二次電池を説明するための断面図である。

【図３】実施形態１の正極集電体を説明するための説明図であり、図３Ａは平面図、図３Ｂは図３ＡにおけるＡ－Ａ線に沿う断面図である。

【図４】二次電池から構成される組電池の代表的な実施形態の外観図であって、図４Ａは組電池の平面図、図４Ｂは組電池の正面図であり、図４Ｃは組電池の側面図である。

【図５】二次電池を搭載した車両の例を説明するための図である。

【図６】実施形態２の二次電池を説明するための要部断面図である。

【図７】実施形態２の二次電池に外部から導電体が貫通した場合を説明するための説明図である。

【図８】実施形態３の二次電池を説明するための要部断面図である。

【図９】実施形態４の二次電池を説明するための要部断面図である。

【図１０】実施形態４の正極集電体を説明するための説明図であり、図１０Ａは平面図、図１０Ｂは図１０ＡにおけるＡ－Ａ線に沿う断面図である。断面図である。

【図１１】実施形態５の正極集電体を説明するための説明図であり、図１１Ａは平面図、図１１Ｂは断面図である。

【発明を実施するための形態】

【００１２】

以下、図面を参照して本発明の実施形態について説明する。なお、図面において同一の機能を有する要素には同一の符号を付し、重複する説明を省略する。また、図面はあくまでも本発明の実施形態を説明するためのものであるので、各部材の寸法や比率は説明の都合上誇張または簡略化しており、実際の寸法や比率とは異なる。

【００１３】

［実施形態１］

以下では、本発明を適用した実施形態１として、リチウムイオン二次電池を例に挙げて説明するが、本発明の技術的範囲は下記の形態のみに制限されない。

【００１４】

（二次電池）

図１は、本実施形態の二次電池の外観を示す外観図であり、図２は、本実施形態の二次電池を説明するための断面図である。

【００１５】

図１および図２に示すように、本実施形態の二次電池１（リチウムイオン二次電池）は、発電要素１７（詳細後述）を収納した電池外装材２２によって密封されている。電池外装材２２は高分子－金属を複合したラミネートフィルムを用いて、その周辺部の全部を熱融着にて接合する。

【００１６】

発電要素１７の具体的な構成要素は以下の通りである。

【００１７】

発電要素１７は、正極活物質層１２、電解質層１３および負極活物質層１５からなる単電池層１６が複数積層された構成を有する。正極活物質層１２は、導電性材料を含む（例えば第１集電体）一枚の正極集電体１１の両面に形成されている。この正極集電体１１の両面に正極活物質層１２が形成されてなるものを正極１００（例えば第１電極）と称する。負極活物質層１５は導電性材料を含む負極集電体１４（例えば第２集電体）の両面に形成されている。この負極集電体１４の両面に負極活物質層１５が形成されてなるものを負

極２００（例えば第２電極）と称する。

【００１８】

ここでは、正極集電体１１の片面の正極活物質層１２と隣接する負極集電体１４の片面の負極活物質層１５とが、電解質層１３を介して向き合うように、正極１００、電解質層１３、負極２００がこの順に積層されることで、単電池層１６が複数積層され、かつ単電池層１６が電気的に並列接続される形態となっている。

【００１９】

発電要素１７の両最外層には最外層負極集電体１４ａが位置する。最外層負極集電体１４ａは正極と対峙せず電池反応に関与しないため、発電要素の内側の面のみに負極活物質層１５が形成されている。なお、単電池層１６の積層数によっては、最外層には正極集電体の片面に正極活物質層１２が形成されてなるものを用いてもよい。

【００２０】

正極集電体１１および負極集電体１４は、それぞれの一端が正極端子リード２０および負極端子リード２１を介して正極集電タブ１８および負極集電タブ１９に電気的に接合されている。正極集電体１１および負極集電体１４は、その一部がラミネートフィルムとの熱融着を介して電池外装材２２の外部に露出されていて、発電要素１７からの電力を外部へ取り出したり、発電要素１７へ充電したりするための端子となる。この端子は、後述するように複数の二次電池１とバスバーやリード線など（連結端子２５と云う）により接続して組電池３００にする際にも使用される。

【００２１】

なお、正極集電体１１および負極集電体１４における正極端子リード２０および負極端子リード２１の接続には、半田付けや溶接、また超音波接合などが用いられる。同様に、正極端子リード２０および負極端子リード２１と正極集電タブ１８および負極集電タブ１９との接続には、半田付けや溶接、また超音波接合などが用いられる。

【００２２】

図３は、正極集電体１１を説明するための説明図であり、図３Ａは平面図、図３Ｂは図３ＡにおけるＡ－Ａ線に沿う断面図である。

【００２３】

正極集電体１１は、非導電性材料で構成される補強層１１０（樹脂層）の両面に正極導電性層１１１（導電材）が形成された構造としている。つまり、正極集電体１１に沿って補強層１１０が配置されているのである。なお、本実施形態１では、負極集電体１４は、その厚みに変化はなく、均等な厚みの一枚板（たとえばアルミニウムや銅などの金属箔膜）としている。

【００２４】

正極導電性層１１１（図３に示した補強層１１０を挟んで２枚あるうちの一方を云う。以下、正極導電性層１１１という場合は同じ意味である）だけでは正極集電体１１としての機械的強度が弱くなる場合がある。補強層１１０を用いることで正極集電体１１全体としての機械的強度を高めることができる。これにより、例えば、発電要素１７の組付けの際の機械的負荷に対しての耐性が高くなり製造が容易になる。また、電池運転時の熱負荷に伴う電池構成部材の膨張収縮に伴う機械的応力に対する耐性も強くなり、二次電池としての耐久性も高くすることができる。

【００２５】

正極導電性層１１１の形状は、その面内において第１端部１１２から、それとは反対側の第２端部１１３にかけて正極導電性層１１１の厚みを厚くするように直線的な勾配をつけて形成している。そして、第２端部１１２には正極端子リード２０を接続することで正極導電性層１１１と正極集電タブ１８と電気的に接続している。

【００２６】

一方、本実施形態１では、負極集電体１４は、その厚みに変化はなく、均等な厚みの一枚板（たとえばアルミニウムや銅などの金属箔膜）としている。

【００２７】

このように正極導電性層１１１の厚みを変えることで正極導電性層１１１の活物質形成面における単位面積あたりの質量に勾配をつけて、単位面積あたりの正極活物質層１２と同等の電気抵抗となるようにしているのである。このようにすることで、導電性層１１１の活物質形成面では、シート抵抗が、第１端部１１２から第２端部１１３方向に低くなる。すなわち、第１端部１１２から第２端部１１３方向に電流がより流れやすく構成されているのである。

【００２８】

したがって、仮に図３Ａに示した点線ａ～ｆの位置で、一定の面積となるように切り出せば、その質量はａ＞ｂ＞ｃ＞ｄ＞ｅ＞ｆとなる。同じく点線ａ～ｆの位置で一定の面積部分のシート抵抗を測定すればａ＜ｂ＜ｃ＜ｄ＜ｅ＜ｆとなる。なお本実施形態においては、点線ａ～ｆのそれぞれの線上、すなわち、第１端部１１２から第２端部１１３への方向に直交する方向（点線ａ～ｆの方向）では同じ質量および同じシート抵抗となっている。

【００２９】

ちなみに、シート抵抗と部材の厚さとの関係は下記（１）および（２）式の通りである。

【００３０】

$$R=(\rho L)/(tW)=Rs\cdot(\rho L)/W \quad \cdots(1)$$

したがって、$Rs=\rho/t$ …（２）

各式中、Ｒは抵抗値、Ｒｓはシート抵抗、ｔは厚さ、Ｗは幅、Ｌは長さである。

【００３１】

（２）式から、部材の厚さｔが変わればシート抵抗が変化し、電流の流れやすさが違ってくることがわかる。

【００３２】

この正極導電性層１１１はできるだけ薄い方が好ましい。その理由は下記のとおりである。二次電池は様々な理由から内部短絡が発生するおそれある。内部短絡が起きる理由はたとえば導電性異物の混入や正極集電体または負極集電体でのデンドライトの成長などである。このような電池内部において内部短絡が発生した場合に、正極導電性層１１１をごく薄くしておけば内部短絡による電流集中でその部分が発熱して焼切れ、その部分での電流を止めてしまうことができる。このような作用を持たせるためには、例えばアルミニウムでは、１０μｍ以下とすることが好ましい。なお、下限値（最も薄くなる第１端部１１２部分）については特に限定されず、電流を流すことができる最小限の厚さでよい。特に本実施形態１の場合、補強層１１０が設けられているため、金属薄膜単独でその形状が維持できないほど薄くても電流を流すことができれば問題ない。

【００３３】

そして、このようなごく薄い金属膜を用いた場合でも集電体として必要な機能、つまり充放電レートを確保することができるようにするために既に説明した通り導電性層１１１に質量勾配およびシート抵抗の勾配を付けたのである。

【００３４】

正極集電体１１は、構成する材料に特に制限はなく、上記した金属以外にも導電性樹脂が採用されうる。金属を用いる場合には、例えば、上記アルミニウムのほか、銅やステンレス鋼などを用いることができる。なかでも電子伝導性、電池作動電位という観点からはアルミニウムが好ましい。

【００３５】

一方、導電性樹脂の場合は、樹脂全体が導電性を示す導電性高分子と非導電性の中に導電性フィラーを配合したもののいずれであってもよい。より具体的には下記のとおりである。

【００３６】

（高分子材料が導電性高分子である形態）

まず、簡単に樹脂を構成する高分子材料が導電性高分子である形態を説明する。この場

合、正極導電性層１１１全体が導電性高分子材料からなることになる。

【００３７】

導電性高分子は導電性を有し、電荷移動媒体として用いられるイオンに関して伝導性を有さない材料から選択される。これらの導電性高分子は、共役したポリエン系がエネルギー帯を形成し伝導性を示すと考えられている。代表的な例としては電解コンデンサなどで実用化が進んでいるポリエン系導電性高分子を用いることができる。具体的には、ポリアニリン、ポリピロール、ポリチオフェン、ポリアセチレン、ポリパラフェニレン、ポリフェニレンビニレン、ポリアクリロニトリル、ポリオキサジアゾール、またはこれらの混合物などが好ましい。電子伝導性および電池内で安定に使用できるという観点から、ポリアニリン、ポリピロール、ポリチオフェン、ポリアセチレン、がより好ましい。

【００３８】

（非導電性樹脂および導電材（導電性フィラー）を含む形態）

次に、非導電性樹脂に導電性フィラーを含む形態について説明する。この場合、正極導電性層１１１全体が、非導電性樹脂に均一に導電性フィラーを配合して、全体として導電性樹脂となったものが用いられる。

【００３９】

導電性フィラーは、導電性を有する材料から選択される。好ましくは、導電性を有する樹脂層内のイオン透過を抑制する観点から、電荷移動媒体として用いられるイオンに関して伝導性を有さない材料を用いるのが望ましい。

【００４０】

導電性フィラーの具体例としては、アルミニウム材、ステンレス（ＳＵＳ）材、グラファイトやカーボンブラックなどのカーボン材、銀材、金材、銅材、チタン材などが挙げられるが、これらに限定されるわけではない。これらの導電性フィラーは１種単独で用いられてもよいし、２種以上併用してもよい。また、これらの合金材が用いられてもよい。好ましくは銀材、金材、アルミニウム材、ステンレス材、カーボン材、さらに好ましくはカーボン材である。またこれらの導電性フィラーは、粒子系セラミック材料や樹脂材料の周りに導電性材料（上記導電性フィラー）をめっき等でコーティングしたものでもよい。

【００４１】

また、導電性フィラーの形状（形態）は、粒子形態で用いればよいが、粒子形態に限られず、カーボンナノチューブなど、いわゆるフィラー系導電性樹脂組成物として実用化されている粒子形態以外の形態であってもよい。

【００４２】

導電性フィラーの平均粒子径は、特に限定されるものではないが、正極導電性層１１１に形成する際の厚さを考慮すれば、０．０１～１０μｍ程度であることが望ましい。つまり正極導電性層１１１の厚さを最大値１０μｍとする場合、これより大きな導電性フィラーを用いると、導電性フィラーが正極導電性層１１１の厚さを越えてしまうことになり、局所的な厚さばらつきが発生する原因になって好ましくないのである。もちろん正極導電性層１１１の厚さを厚くすれば、導電性フィラーを１０μｍ以上にしても差し支えない。

【００４３】

また、樹脂層が導電性フィラーを含む形態の場合、樹脂層を形成する樹脂は、導電性フィラーに加えて、導電性フィラーを結着させる導電性のない高分子材料を含んでいてもよい。樹脂層の構成材料として高分子材料を用いることで、導電性フィラーの結着性を高め、双極型二次電池の信頼性を高めることができる。高分子材料は、印加される正極電位および負極電位に耐えうる材料から選択される。

【００４４】

非導電性の樹脂である高分子材料の例としては、好ましくは、ポリエチレン（ＰＥ）、ポリプロピレン（ＰＰ）、ポリエチレンテレフタレート（ＰＥＴ）、ポリエーテルニトリル（ＰＥＮ）、ポリイミド（ＰＩ）、ポリアミド（ＰＡ）、ポリテトラフルオロエチレン（ＰＴＦＥ）、スチレンブタジエンゴム（ＳＢＲ）、ポリアクリロニトリル（ＰＡＮ）、ポリメチルアクリレート（ＰＭＡ）、ポリメチルメタクリレート（ＰＭＭＡ）、ポリ塩化

ビニル（ＰＶＣ）、ポリフッ化ビニリデン（ＰＶｄＦ）、エポキシ樹脂、またはこれらの混合物が挙げられる。これらの材料は電位窓が非常に広く正極電位、負極電位のいずれに対しても安定である。また軽量であるため、二次電池の高出力密度化が可能となる。

【００４５】

非導電性樹脂に対する導電性フィラーの比率は、特に限定されず、十分な導電性が確保されていればよい。たとえば、高分子材料（非導電性の樹脂とその他の添加剤などを含む）および導電性フィラーの合計に対して、５～９０ｗｔ％、好ましくは５～４０ｗｔ％の導電性フィラーを均等に配合する。５～９０ｗｔ％程度であれば導電性を確保することができる。

【００４６】

また、樹脂成分内に結着剤を入れた場合には、好ましくは５～４０ｗｔ％程度とすることで結着性を高めることができ、形態（形状）が安定する。

【００４７】

結着剤として用いられる結着高分子は特に限定されるものではないが、たとえば下記のような高分子材料が使用されうる。エポキシ樹脂；スチレン－エチレン－ブチレン－スチレンブロック共重合体（ＳＥＢＳ）；アクリロニトリル－ブタジエン－スチレン共重合体（ＡＢＳ）；スチレンブタジエンゴム（ＳＢＲ）などの合成ゴム材料のほか、ポリエチレン（ＰＥ）、ポリプロピレン（ＰＰ）等のポリオレフィン；ポリエチレンテレフタレート（ＰＥＴ）、ポリエチレンナフタレート（ＰＥＮ）等のポリエステル；シリコーン、ポリイミド（ＰＩ）；ポリアミド（ＰＡ）；ポリフッ化ビニリデン（ＰＶｄＦ）；ポリテトラフルオロエチレン（ＰＴＦＥ）；ポリアクリロニトリル（ＰＡＮ）；ポリメチルアクリレート（ＰＭＡ）；ポリメチルメタクリレート（ＰＭＭＡ）；ポリ塩化ビニル（ＰＶＣ）などが挙げられる。これらの高分子材料は、１種単独で用いてもよいし、２種併用してもよい。

【００４８】

なお、導電性フィラーおよび非導電性の樹脂の他、他の添加剤を含んでいてもよい。

【００４９】

これら導電性樹脂による正極導電性層１１１は（高分子材料が導電性高分子である形態と非導電性樹脂に導電性フィラーを含む形態のどちらも）従来公知の手法により製造できる。たとえば、導電性高分子材料または導電性フィラーを含む非導電性高分子のスラリーを調製し、これを塗布し硬化させる手法が挙げられる。具体的にはたとえば、スプレー法やコーティング法により調整したスラリーを、塗り回数を変えたり、開口径の異なるノズルを使用するなどして、滑らかにあるいは段階的に厚さを変えて塗布する。またインクジェット方式により作製することも可能である。

【００５０】

次に、補強層１１０は、用いる材料の機械的強度に応じて必要最小限の厚み以上とする。しかし、厚すぎても発電要素１７の体積が必要以上に大きくなるため、例えば樹脂を用いる場合は補強層１１０の厚さとして１０～３０μｍにて構成することが好ましい。

【００５１】

この補強層１１０の厚みは、正極導電性層１１１の厚さの勾配とは逆勾配になるよう形成する。これにより正極集電体１１としての厚みを一定に保つことができ、ひいては単電池層１６としての厚みも一定に保たれて、発電要素１７を組付ける際に単電池層１６が斜めに積層されることを回避することができる。

【００５２】

補強層１１０を構成する材料としては、例えば、樹脂のほかに、セラミック、セラミックと樹脂の複合体などの絶縁性材料が挙げられる。なかでも補強層の軽量化という観点からは、補強層の構成材料は樹脂であることが好ましい。この樹脂も、特に制限はないが、たとえば、ポリイミド（ＰＩ）、ポリエチレンテレフタレート（ＰＥＴ）、ポリアクリロニトリル（ＰＡＮ）、ポリプロピレン（ＰＰ）、ポリエチレン（ＰＥ）などが用いられうる。なかでも、耐熱性という観点からは、ポリイミドまたはポリエチレンテレフタレート

が好ましく、ポリイミドが特に好ましい。なお、ポリイミドの具体的な名称としては、カプトン（登録商標）が挙げられる。

【００５３】

なお、本実施形態の二次電池に使用される正極活物質、負極活物質および電解質については、通常リチウムイオン二次電池に使用される物質を使用すればよく特に限定されないため説明を省略する。また、本実施形態の二次電池としてリチウムイオン二次電池以外の二次電池とする場合には、それらに合わせた素材を使用すればよいことは云うまでもない。

【００５４】

（組電池）

次に、上述した二次電池の利用形態の一つである組電池について説明する。

【００５５】

図４は、上述した二次電池から構成される組電池の代表的な実施形態の外観図であって、図４Ａは組電池の平面図、図４Ｂは組電池の正面図であり、図４Ｃは組電池の側面図である。

【００５６】

図４に示すように、組電池３００は、まず、上述した二次電池を複数、直列および並列に接続して組電池２５０を構成し、さらにこの組電池２５０を複数、直列および並列に接続している。これにより、高体積エネルギー密度、高体積出力密度が求められる車両駆動用電源や補助電源に適した組電池３００となる。

【００５７】

組電池２５０は、バスバーのような電気的な接続手段を用いて相互に接続し、接続治具３１０を用いて複数段積層される。組電池２５０は、接続治具３１０によってくみつけられるため組電池３００に対して装脱着可能となっている。なお、組電池３００に組み込む組電池２５０の数およびその接続形態（直列か並列か）は、それを搭載する車両（電気自動車など）が必要とする電池容量や出力に応じて決めればよい。

【００５８】

なお、組電池２５０を構成する際の個々の二次電池１の接続形態（直列か並列か）についても同様であり、所望する出力電圧や電池容量に応じて決めればよい。

【００５９】

（車両）

次に、上述した二次電池の利用形態の一つである車両への搭載について説明する。

【００６０】

図５は、上述した二次電池を搭載した車両の例を説明するための図である。

【００６１】

本実施形態の二次電池電池は、例えば上述した組電池３００の形態に組み上げて、図５に示すように、たとえば電気自動車４００のような車両に搭載されうる。電気自動車４００に搭載された二次電池電池は、例えば、車両のモータを駆動する電源として用いられうる。

【００６２】

図示した電気自動車４００の例では、電気自動車４００の車体中央部の座席下に組電池３００を搭載している。座席下に搭載すれば、車内空間およびトランクルームを広く取ることができるからである。なお、組電池３００を搭載する場所は、座席下に限らず、後部トランクルームの下部でもよいし、車両前方のエンジンルームでも良い。

【００６３】

以上説明した本実施形態１によれば、以下のような効果を奏する。

【００６４】

本実施形態の正極集電体１１は、補強層１１０の片面または両面に正極導電性層１１１を接合させてなる構造とした。そして正極導電性層１１１は、第１端部１１２からそれとは反対側の第２端部１１３方向に質量が重くなるように質量勾配を持たせた。具体的には

厚さが第１端部１１２から第２端部１１３方向に厚くなるようにしている。したがって、正極導電性層１１１は第１端部１１２から第２端部１１３方向にシート抵抗が低くなって電流が流れやすくなっている。

【００６５】

これにより、第１端部１１２側から第２端部１１３側に行くほど電気抵抗値が相対的に小さくなり、かつ熱容量も大きく保つことができる。したがって、二次電池１から電力を取り出すとき、および充電するときには、電流が集中する正極集電タブ１８を接続する側において余裕を持って電流を流すことが可能となる。その結果、正極集電タブ１８が接続されて電流が集中する側だけが相対的に発熱するようなことがなくなり、電池全体としても温度上昇を招くことが少ない。したがって発熱による充放電時のロスも少ない二次電池となる。

【００６６】

またこの構成により、十分な充放電レートを確保することができるため充放電特性がよくなる。

【００６７】

また、正極導電性層１１１の厚さを、二次電池内部で短絡が生じた際に、その温度上昇意より焼き切れる厚さとすることで、耐異常時の耐久性を向上することができる。そして、上記のような正極導電性層１１１の構成とすることで、そのように薄くした場合でも十分な充放電レートを確保することができる。

【００６８】

また、補強層１１０を設け、この補強層１１０に沿って正極導電性層１１１を配置したことで、正極導電性層１１１単独では十分な強度を得ることができない場合でも、正極集電体１１全体としては、十分な強度を確保することができる。しかも、補強層１１０は、その厚みの勾配を正極導電性層１１１の厚みの勾配と逆勾配としたことで、正極集電体１１としては平坦な構造とすることができる。そのため、二次電池を構成する際に斜めに積層されることがなく、組付け性がよい。

【００６９】

また、質量勾配は、第１端部１１２から第２端部１１３方向に直交する方向には単位面積あたり同一質量となるようにしたので、正極導電性層１１１の厚さを違える加工も容易である。

【００７０】

また、本実施形態の二次電池を複数接続した組電池２５０および３００とすることで、さまざまな出力電圧や電池容量とすることができる。しかも、一つひとつの電池は本実施形態の二次電池であるので、充放電特性がよいので高速充電に適したものとなる。このため高速充電時においても温度上昇が少なく、高い耐久性を有する。

【００７１】

さらに、上記組電池３００を用いた電気自動車４００は、組電池３００が高速充電時においても温度上昇が少なく、高い耐久性を有するので、長期間使用しても十分な出力を提供しうる。したがって、これを車両に搭載したことで、二次電池の交換回数も少なくでき、さらに、発熱による充放電時のロスも少ないので、燃費に優れた電気自動車、ハイブリッド自動車を提供できる。

【００７２】

［実施形態２］

図６は、実施形態２の二次電池を説明するための要部断面図である。

【００７３】

本実施形態２の二次電池２は、負極集電体１４を非導電性材料で構成される補強層１４０の両面に負極導電性層１４１を形成したものを使用している。負極導電性層１４１以外の他の構成は、実施形態１と同様であるので説明は省略する。なお、負極導電性層１４１は、図６に示した補強層１４０を挟んで２枚あるうちの一方を云う。以下、負極導電性層１４１という場合は同じ意味である。

【００７４】
ここで用いている負極導電性層１４１（導電材）は、第１端部１４２側からそれとは反対側の第２端部１４３側にかけて厚みが薄くなるように形成している。負極集電タブ１９（図２参照）を電気的に接続する負極端子リード２１が接続される
これにより、負極導電性層１４１は、第１端部１４２から第２端部１４３方向に単位面積あたりの質量が重くなっている。これに伴いそのシート抵抗も第１端部１４２から第２端部１４３方向に低くなっている。すなわち、第１端部１４２から第２端部１４３方向に電流が流れやすくなっているのである。
【００７５】
なお、最外層の負極集電体１４ａは、補強層１４０に対して正極活物質層１２に対向する負極導電性層１４１が形成される方にのみ負極導電性層１４１が形成されてなる。
【００７６】
この負極導電性層１４１は、用いる材料に特に制限はなく、たとえば、金属や導電性高分子が採用されうる。具体的には、金属の場合は、例えば、ニッケル、銅、ステンレスなどの金属材料が挙げられる。なかでも、電子伝導性、電池作動電位という観点からは、銅が好ましい。
【００７７】
一方、本実施形態２では、正極集電体１１は、その厚みに変化はなく、均等な厚みの一枚板（たとえばアルミニウムや銅などの金属箔膜）としている。
【００７８】
正極集電体１１をたとえば、厚さについて特別な考慮をしないアルミニウムで構成し、負極導電性層１４１を銅の薄膜で上記のように厚さに勾配を持たせた構成とすることができる。この場合、アルミニウムの融点（６６０℃）よりも銅の融点（１０８３℃）が高いために、内部短絡が発生した際は、アルミニウムが特別厚さについて考慮しなくても先に焼き切れる。
【００７９】
また、仮に、図７に示すように、本実施形態２の二次電池２な複数の電池に外部から導電体９００が貫通した場合、正極集電体１１が焼ききれても、導電体９００が正極活物質１５に接触しているため正極集電体として作用する。このため隣接する単電池１６の間では負極導電性層１４１および負極集電タブ１９を通して短絡回路が形成されて短絡電流Ｉが流れ続ける。なお、負極導電性層１４１は、図２において負極集電体１４となるものであるから、その第２端部１４３側が負極集電タブ１９により互いに電気的に接続されている。
【００８０】
そこで、負極導電性層１４１の厚みを薄く、たとえば最大厚さを３μｍ以下に形成すれば、銅であっても瞬時に発熱より溶解し焼き切れる。このため内部短絡が発生した場合には、内部短絡部位の発熱による温度上昇が、その周囲に及ぶ前に電流を遮断することができる。
【００８１】
なお、銅を用いた場合の厚さの下限値（特に第１端部側）については特に限定されず、電流を流すことができる最小限の厚さでよい。特に本実施形態においても、補強層１４０が設けられているため、金属薄膜単独で、その形状が維持できないほど薄くても電流を流すことができれば問題ない。
【００８２】
一方、補強層１４０は負極導電性層１４１の厚みの勾配と逆勾配の厚みで形成されている。この補強層１４０については、実施形態１で説明したものと同じでよいので、詳細な説明は省略する。
【００８３】
また、負極集電体の材料として導電性樹脂を用いる場合も、実施形態１と同様の導電性樹脂を用いることができる。さらに、本実施形態２においても実施形態１同様にリチウム

イオン電池以外の電池でも適用可能である。

【００８４】

以上説明した本実施形態２によれば、以下のような効果を奏する。

【００８５】

本実施形態の負極集電体１４として、補強層１４０の片面または両面に負極導電性層１４１を接合させてなる構造とした。そして、負極導電性層１４１は、第１端部１４２からそれとは反対側の第２端部１４３方向に質量が重くなるように勾配を持たせ、第２端部１４３側に負極集電タブ１９を電気的に接続している。具体的にはその厚さが、第１端部１４２から第２端部１４３方向に厚くなるようにしている。したがって、負極導電性層１４１は第１端部１４２から第２端部１４３方向にシート抵抗が低くなっている。

【００８６】

これにより、第１端部１４２側から第２端部１４３側に行くほど電気抵抗値が相対的に小さくなり、かつ熱容量も大きく保つことができる。したがって、二次電池２から電力を取り出すとき、および充電するときには、電流が集中する負極集電タブ１９を接続する側において余裕を持って電流を流すことが可能となる。その結果、電流が集中する負極集電タブ１９を接続する側だけが相対的に発熱するようなことがなくなり、電池全体としても温度上昇を招くことが少ない。したがって発熱による充放電時のロスも少ない二次電池となる。

【００８７】

またこの構成により、十分な充放電レートを確保することができるため充放電特性がよくなる。

【００８８】

また、負極導電性層１４１の厚さを、二次電池内部で短絡が生じた際に、その温度上昇意より焼き切れる厚さとすることで、耐異常時の耐久性を向上することができる。そして、上記のような負極導電性層１４１の構成とすることで、そのように薄くした場合でも十分な充放電レートを確保することができる。

【００８９】

また、補強層１４０を設け、この補強層１４０に沿って負極導電性層１４１を配置したことで、負極導電性層１４１単独では十分な強度を得ることができない場合でも、正極集電体１１全体としては、十分な強度を確保することができる。しかも、補強層１４０は、その厚みの勾配を負極導電性層１４１の厚みの勾配と逆勾配としたことで、負極集電体１４としては平坦な構造とすることができる。そのため、二次電池を構成する際に斜めに積層されることがなく、組付け性の悪化を抑制することができる。

【００９０】

また、質量勾配は、第１端部１４２から第２端部１４３方向に直交する方向には単位面積あたり同一質量となるようにしたので、負極導電性層１４１の厚さを違える加工も容易である。

【００９１】

さらに、本実施形態２の二次電池２についても、実施形態１同様に、組電池として構成することができる。また、この組電池を車両に搭載することもできる。この場合、組電池および車両としての作用効果なども実施形態１と同様に得ることができる。

【００９２】

［実施形態３］

図８は、実施形態３の二次電池を説明するための要部断面図である。

【００９３】

本実施形態３の二次電池３は、前述した実施形態１と実施形態２を統合した形態である。すなわち、正極集電体１１は非導電性材料で構成される補強層１４０の両面に正極導電性層１１１（導電材）を形成したものを使用している。正極導電性層１１１は第１端部１１２側からそれとは反対側の第２端部１１３側にかけて厚みが厚くなるように形成している。そして第２端部１１３側に、正極集電タブ１８（図２参照）を電気的に接続する正極

端子リード２０が接続される。なお、正極導電性層１１１は、図８に示した補強層１１０を挟んで２枚あるうちの一方を云う。以下、正極導電性層１１１という場合は同じ意味である。

【００９４】

一方、負極集電体１４は、非導電性材料で構成される補強層１４０の両面に負極導電性層１４１（導電材）を形成したものを使用している。負極導電性層１４１は第１端部１４２側からそれとは反対側の第２端部１４３側にかけて厚みが厚くなるように形成している。そして、第２端部１４３側に負極集電タブ１９（図２参照）を電気的に接続する負極端子リード２１が接続される。なお、負極導電性層１４１は、図６に示した補強層１４０を挟んで２枚あるうちの一方を云う。以下、負極導電性層１４１という場合は同じ意味である。

【００９５】

したがって、正極導電性層１１１の構成は実施形態１と同様であり、負極導電性層１４１の構成は実施形態２と同様であるので、それらの詳細な説明は省略する。また、これら以外の構成についても実施形態１または実施形態２と同様であるので説明は省略する。

【００９６】

この本実施形態３によれば、以下のような効果を奏する。

【００９７】

正極集電体１１および負極集電体１４の両方を、それぞれ質量勾配を持たせた正極導電性層１１１および負極導電性層１４１を用いたことで、いっそう熱の偏りを抑えることができる。そして充放電レートもいっそう保たれるようになって高い電池性能を引き出すことができる。また、正極導電性層１１１および負極導電性層１４１の両方の溶解・焼切れ性を高めるために両方の厚さを極限まで薄くすることができる。したがって、電池の内部への異物混入やデンドライト成長に伴う内部短絡時および複数の電池に外部から導電体が貫通するような短絡時の場合に、面内のどの位置で短絡しても即刻、短絡電流の流れを遮断することができる。しかも充放電レートは十分に保って電池性能を向上させることができる。

【００９８】

また、本実施形態３では、正負極の集電タブ１８および１９を、二次電池の対向する位置に配置した。これにより正極導電性層１１１が厚い方向から薄い方向に対して負極導電性層１４１が薄い方向から厚い方向となるように積層されることになる。したがって、正極集電体１１と負極集電体１４で、その電気抵抗値の勾配の向きを逆になる。

【００９９】

このようにしたことで、仮に電池外部から導電性部材が貫通して電池内部で短絡が発生した場合、導電性部材が面内のどこで貫通しても正負極のいずれか薄い方が先に焼き切れるようになり、短絡電流の遮断性を向上することができる。したがって、電池の内部短絡に起因する安全性をさらに向上することができる。

【０１００】

そのほか、質量勾配をつけるための厚さや補強層については本実施形態３でも実施形態１および２と同様の効果を有する。

【０１０１】

もちろん本実施形態３においても、組電池とすることもできるし、車両に搭載することも可能であり、上述した実施形態１で説明した組電池および車両と同様の効果を得ることができる。

【０１０２】

［実施形態４］

図９は実施形態４の二次電池を説明するための要部断面図であり、図１０は実施形態４の正極集電体を説明するための説明図であり、図１０Ａは平面図、図１０Ｂは図１０ＡにおけるＡ－Ａ線に沿う断面図である。断面図である。

【０１０３】

本実施形態４は、正極集電体１１として、補強層１１０の片面または両面に多孔体構造の正極導電性層１６１を設けた構造としたものである。そして、正極導電性層１６１は、第１端部１６２からそれとは反対側の第２端部１６３方向に単位面積あたりの多孔体の空隙率が段階的または滑らかに小さくするよう構成されている。そして、第２端部１６３側に正極集電タブ１８を電気的に接続する正極リード２０を接続している。

【０１０４】

すなわち、正極導電性層１６１は、図１０に示すように、たとえば、空隙部分１６８の数が第１端部１６２から第２端部１６３方向に少なくなっている。これにより導電要素部分１６７の面積が第１端部１６２から第２端部１６３方向に多くなって、導電材としては単位面積あたりの質量が重くなる。これによりシート抵抗も第１端部１６２から第２端部１６３方向に低くなって、第１端部１６２から第２端部１６３方向に電流が流れやすくなるようにしている。

【０１０５】

空隙部分１６８の大きさは、特に限定されるものではないが、正極活物質からの電流を受けて、第１端部１６２から第２端部１６３方向に確実に電流が流れるようにしておく必要がある。この観点からは、たとえば０．１～数百μｍ程度の大きさが好ましい。これは、空隙部分１６８の大きさがあまり大きいと導電要素部分１６７が途切れたり、隙間が大きくなりすぎて集電作用が低下するおそれがあるためである。

【０１０６】

その他の構成は実施形態１と同様であるので説明は省略する。

【０１０７】

この本実施形態４によれば、以下のような効果を奏する。

【０１０８】

本実施形態４では、空隙率を違えて質量勾配をつけシート抵抗に変化をつけることとしたので、正極導電性層１６１の厚みに勾配をつける必要がない。したがって、補強層１１０の厚みにも勾配をつける必要がないため、正極導電性層１６１および補強層１１０の加工性がよくなる。もちろん、電池の充放電レートを保って電池性能を確保しつつ正極導電性層１６１の溶解・焼切れ性を向上させることもできる。

【０１０９】

そのほか補強層については本実施形態４でも実施形態１および２と同様の効果を有する。

【０１１０】

なお、本実施形態４の構成は、負極導電性層１４についても適用することができる。また、正極集電体１１と負極集電体１４の双方に適用することも可能である。さらに、これら形態の二次電池を組電池とし、また車両に搭載できることは実施形態１で説明したものと同様であり、それらの作用効果も同様に得ることができる。

【０１１１】

また、多孔体構造は、その空隙部分１６８としてハニカム構造に似た６角形の場合を図示したが、このような形状以外にも、円形（楕円形を含む）やその他の多角形や不定形形状などであってもよい。また、空隙率を違えるためには空隙部分１６８の単位面積あたりの数を違えるのではなく、空隙部分１６８の単位面積あたりの大きさを違えることでもよい。さらに多孔体構造の空隙部分１６８は、空間とするのではなく非導電性素材（例えば樹脂）によって埋め込まれた構造であってもよい。つまり、導電材である正極導電性層１６１は、空隙または非導電性素材からなる非導電部の割合（非導電部の体積／導電材全体の体積）が第１端部から第２端部の方向へ小さくなるように構成されていればよいのである。

【０１１２】

また、図では平面的に空隙部分１６８が存在するように示したが、これは、厚さ方向に存在するようにしてもよいし、ボーラス構造のようにしてもよい。もちろんこれらの場合も、非導電部の割合（非導電部の体積／導電材全体の体積）が第１端部１６２から第２端

部１６３の方向へ小さくなるように構成されていればよいのである。

【０１１３】

さらに本実施形態４の応用として、正極導電性層１６１として非導電性樹脂に導電性フィラーを配合した導電性樹脂を用いて、導電性フィラーの配合比率を単位面積あたりで違えることでもシート抵抗に差をつけることができる。

【０１１４】

つまり、第１端部１６２から第２端部１６３方向に、段階的にまたは滑らかに非導電性樹脂に対する導電性フィラーの配合量を多くするのである。これにより正極導電性層１６１の導電材としてのシート抵抗は第１端部１６２から第２端部１６３方向に低くなって、この方向に電流が流れやすくなる。この場合も正極導電性層１６１の厚さに変化をつけることなくシート抵抗を変化させることができる。

【０１１５】

［実施形態５］

図１１は実施形態５の正極集電体を説明するための説明図であり、図１１Ａは平面図、図１１Ｂは断面図である。

【０１１６】

本実施形態５は、前述した実施形態１における正極導電性層１１１の厚さを下記のようにしたものである。正極端子リード２０が接続された部分を略中心とした同心円の円弧（図示点線）上では同じ厚さにし、円弧に対し直交する方向（図示矢印）でかつ第１端部１１２から第２端部１１３方向には厚くなるようにしている。なお正極端子リード２０は第２端部１１３側に接続されている。これにより各矢印方向の断面を見れば、図１１Ｂのように正極導電性層１１１の厚さに勾配ができる。したがって、第１端部１１２から第２端部１１３方向を含む、正極集電タブ１８との電気的接続点となる略中心から円弧に対し直交する方向に質量勾配が生まれて、シート抵抗もこの方向に低くなる。ここで「略中心」としたのは、機械的な取り付け誤差の範囲があるためである。

【０１１７】

この際、補強層１１０は、正極導電性層１１１の勾配と逆勾配で形成されることは第１実施形態１と同様である。また、そのほかの構成も実施形態１と同様であるので説明を省略する。

【０１１８】

この本実施形態５によれば、以下のような効果を奏する。

【０１１９】

正極端子リード２０の幅Ｗ１に対して、正極導電性層１１１の幅Ｗ２が大きい場合などには、電流が正極端子リード２０の全周囲方向から流れ込む。このため第１端部１１２から第２端部１１３に向けて一方向に勾配をつける場合と比較して、特に第１端部１１２の辺に直交する辺１１４や１１５近傍の厚みを薄くすることができる。これにより、第１端部１１２の辺に直交する辺１１４や１１５から第２端部１１３方向である正極集電タブ１８との電気的接続点への電流の流れもよくなる。このため電池の充放電レートを保って電池性能を確保しつつ正極導電性層１１１の溶解・焼切れ性をさらに向上させることができる。

【０１２０】

なお、本実施形態５は、負極導電性層１４にも適用可能であるし、正極集電体１１と負極集電体１４の双方に適用することもでき、それらの場合に同様の効果を得ることができる。

【０１２１】

また、図においては、正極端子リード２０が接続された部分（集電タブとの電気的接続点）を正極集電体の一つの辺（第２端部１１３の辺）の中ほどに設けているが、この電気的接続点は正極集電体の一つの辺の端であってもよい。その場合も正極端子リード２０が接続された部分を略中心をして同心円の円弧上では正極導電性層１１１の厚さを同じ厚さにし、円弧に対し直交する方向でかつ第１端部１１２から第２端部１１３方向には厚くす

る。これにより上記効果と同じ効果を得ることができる。そのほか本実施形態は正極端子リード２０が接続された部分が正極集電体のどこであっても同じように実施可能である。もちろん負極集電体においても同様に実施できる。

【０１２２】

以上、本発明を適用した実施形態を説明したが、本発明はこれら実施形態に限定されるものではない。

【０１２３】

たとえば、上述した実施形態は、厚さの勾配（実施形態１～３および５）においては、図示上滑らかな勾配をつけて説明したが、段差的な勾配であってもよい。

【０１２４】

また、上述した実施形態は、積層型の扁平な形状の二次電池により説明したが、そのほかにも巻回型の二次電池である、円筒型形状（楕円形状を含む）、角型形状のものであってもよい。円筒型や角型の形状のものでは、その外装材にラミネートフィルムを用いてもよいし、従来の円筒缶（金属缶）を用いてもよいなど特に制限されるものではない。

【０１２５】

また上述した実施形態は、リチウムイオン二次電池を例に説明した。これは、リチウムイオン二次電池が単電池（１セル）当たりの電圧が大きく、高エネルギー密度、高出力密度が達成でき、車両の駆動電源用や補助電源用として優れているためである。しかし本発明は、これに限らず、その他にもたとえばニッケル水素二次電池などにも適用可能である。

【０１２６】

また、本実施形態の二次電池や組電池は、車両に搭載する以外にも、たとえば無停電電源装置などの載置用電源（固定型電源）として利用することも可能である。

【０１２７】

そのほか、本発明は、本発明の技術思想の範囲内においてさまざまな実施形態が可能であることはいうまでもない。

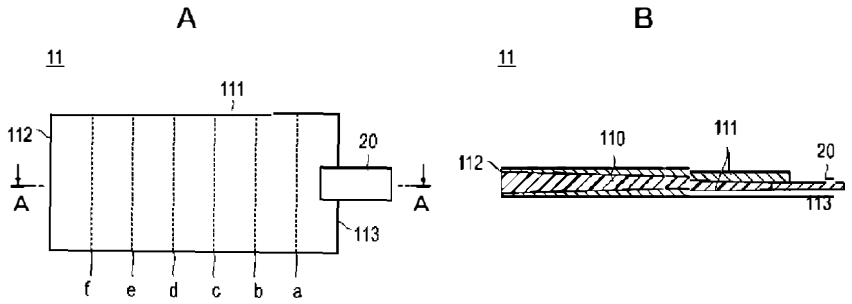
【符号の説明】

【０１２８】

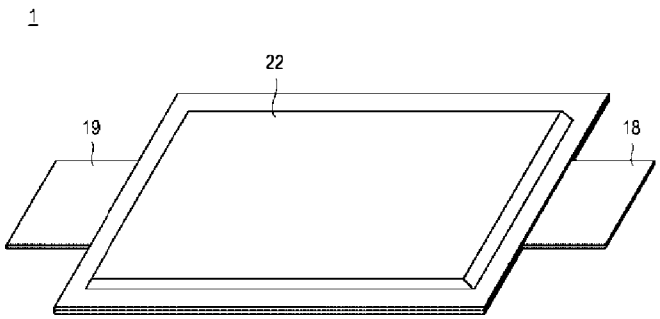
１、２、３、４　二次電池、
１１　正極集電体、
１４　負極集電体、
１８　正極集電タブ、
１９　負極集電タブ、
２０　正極端子リード、
２１　負極端子リード、
１１０、１４０　補強層、
１１１、１６１　正極導電性層
１１２、１４２、１６２　第１端部、
１１３、１４３、１６３　第２端部、
１４１　負極導電性層、
１６７　導電要素部分、
１６８　空隙部分。

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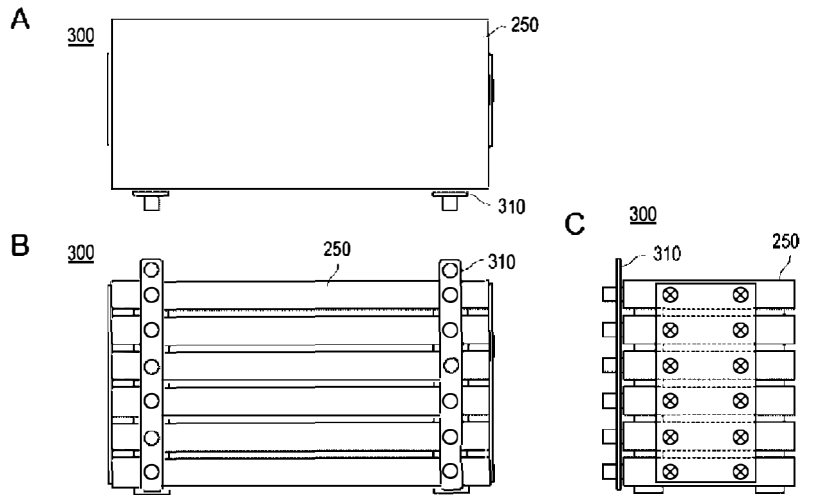
【図３】



【図１】



【図４】



【図２】

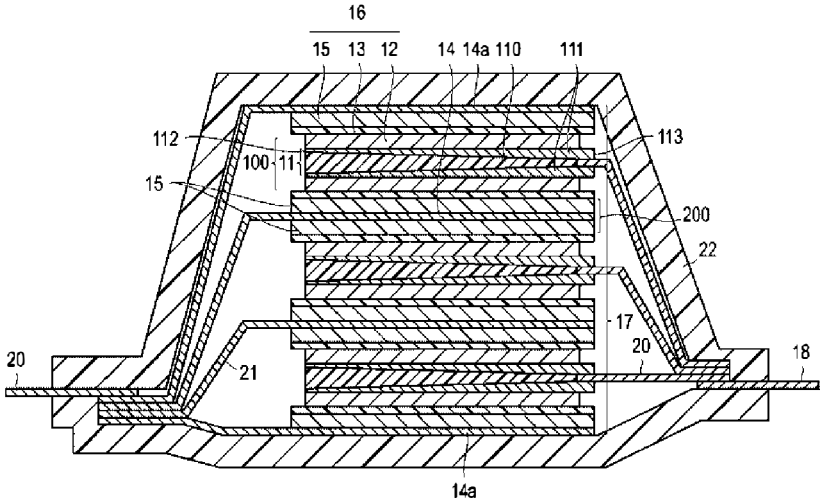
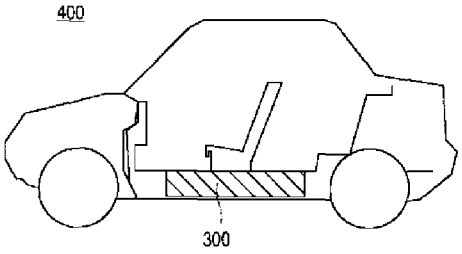
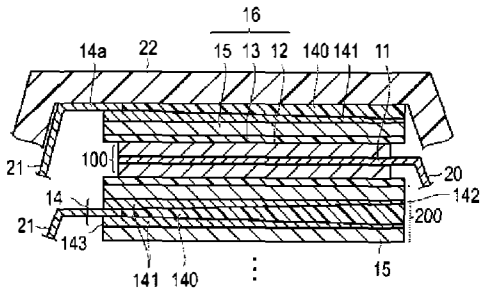


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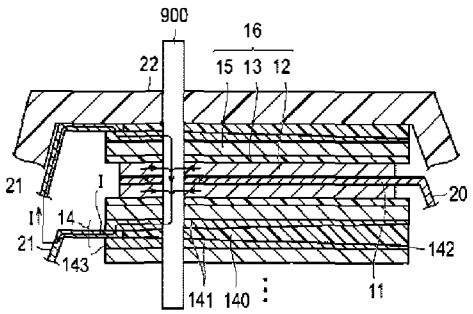
【図５】



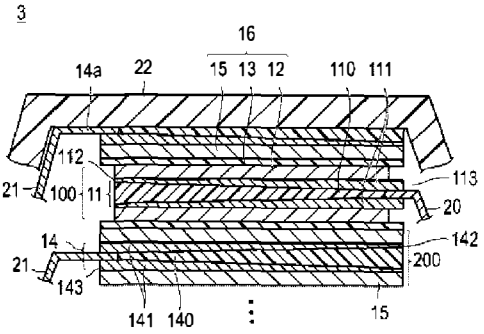
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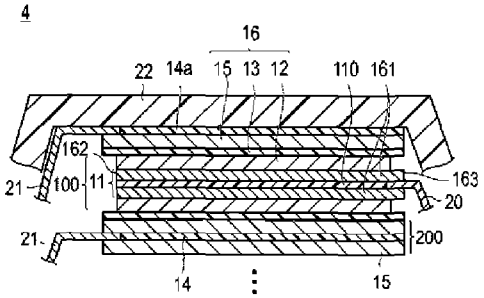
【図７】



【図８】



【図９】



【図１０】

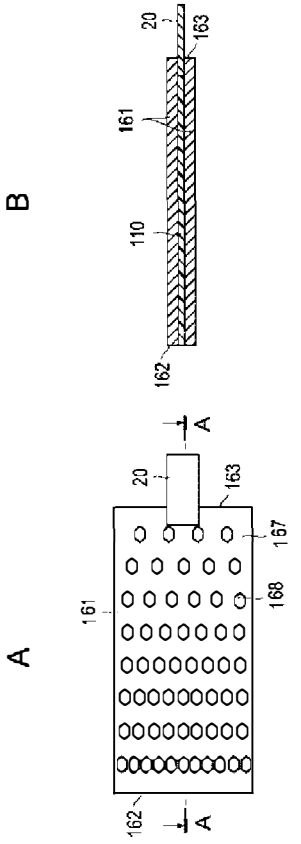


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【図１１】

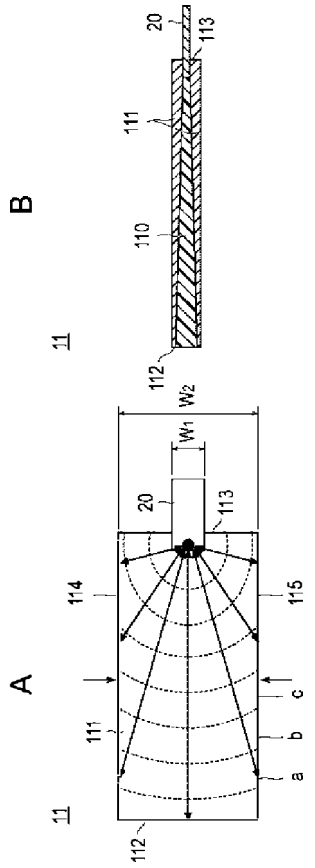


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(54) **Title**: BATTERY PACK,TOOL BATTERY AND BATTERY OPERATED TOOL

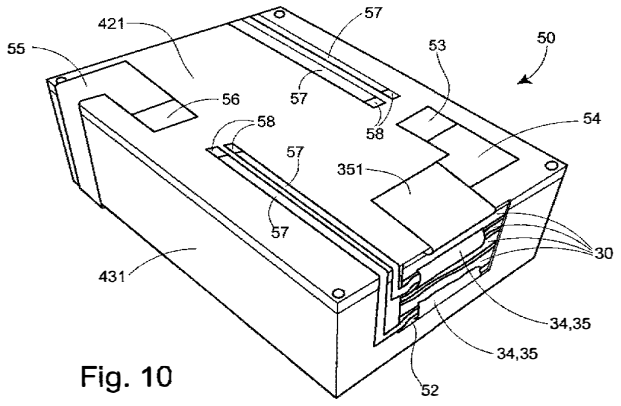


Fig. 10

(57) **Abstract**: A lithium-polymer based battery pack for power a hand held power tool or a garden tool,the battery pack has a plurality of battery cells located within housing that is selectively connectable to and supportable by a hand held power tool or a garden tool. The battery cells have a lithium- polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 5 milliohms.In one embodiment the cells are think cells are stacked within the housing such that each sell is layered over or under an adjacent cell and a resiliently deformable substrate located between adjacent battery cells.In another embodiment the cells may be interconnected to have a combined output voltage of at least 9 volts and to produce a combined average discharge current of greater than 20 amps.A lithium-polymer tool battery and a battery powered tool are also part of the invention.

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BATTERY PACK, TOOL BATTERY AND BATTERY OPERATED TOOL

Field of the Invention

The present invention relates to battery packs, and to tool batteries and battery operated tools. In particular, the invention relates to a battery pack suitable for powering a hand held cordless power tool.

Background to the invention

Power tools and in particular hand held power tools are increasingly relying on cordless rechargeable battery packs as a powering energy source. Such battery packs are preferably compact and lightweight, but must still deliver relatively high current and voltage for powering the tool motor.

Summary of the Invention

The present invention provides a lithium-polymer based battery pack, a lithium-polymer based tool battery and a lithium-polymer based battery operated tool as set forth in any one of the appended claims.

In particular, in a first aspect of the invention there is provided a lithium-polymer based battery pack for powering a hand held power tool or garden tool, the battery pack comprises a housing selectively connectable to and supportable by a hand held power tool or a garden tool, at least one battery cell located within the housing, the cell having an output voltage of at least 4 volts and producing an average discharge current of greater than 10 amps, wherein the battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms. Preferably there is a plurality of battery cells located within the housing, the plurality of cells being interconnected to have a combined output voltage of at least 4 volts and a combined average discharge current of greater than 10 amps, wherein each cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

In a second particular aspect of the invention there is provided a lithium-polymer based tool battery comprising a battery housing selectively connectable to and supportable by a hand held

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power tool or a garden tool, a plurality of substantially flat battery cells stacked within the housing such that each sell is layered with an adjacent cell, and a resiliently deformable substrate located between the adjacent battery cells, wherein each battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

In a third particular aspect of the invention there is provided a lithium-polymer battery powered tool comprising a tool housing, an electrical motor in the tool housing, a motor controller for controlling power supplied to the motor from an electrical energy source, a battery housing selectively connectable to and supportable by the tool housing, and a battery within the battery housing for supplying power to the motor controller and motor when the battery housing is connected with the power tool housing, the battery comprising one or more battery cells, the cell or cells being having a combined output voltage of at least 4 volts and producing a combined average motor supply current of at least 10 amps, wherein each battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

Further aspects of the invention will become apparent from the following description which is given by way of example only to illustrate the invention.

Description of the Drawings

Various embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 illustrates a power tool battery,

Figure 2 illustrates a cordless power tool,

Figure 3 illustrates a lithium-polymer based battery cell according to the invention,

Figure 4 illustrates a cell pouch for a lithium-polymer based battery,

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Figure 5 illustrates a string of the five battery cells having terminals welded in series prior to forming into a stack of Figure 4,

Figure 6 illustrates a stack of five interconnected lithium-polymer based battery cells forming a tool battery according to the invention,

Figure 7 illustrates a battery cell according to the invention and a resiliently deformable cradle for the battery cell,

Figure 8 illustrates a second view of the battery cell and cradle,

Figure 9 illustrates an explored view of a battery comprising a polarity of lithium-polymer battery cells,

Figure 10 illustrates a first perspective view of a battery case for a lithium-polymer based battery according to the invention,

Figure 11 illustrates a second perspective view of the battery case for a lithium-polymer based battery according to the invention, and

Figure 12 illustrates different connection arrangements for a stack of lithium-polymer battery cells.

Detailed Description of Preferred Embodiments of the Invention

The following description is given by way of example only to illustrate embodiments of the invention. The terminology used is for illustrative purpose only and is not intended to limit the scope or use of the invention, unless the text clearly and explicitly requires otherwise.

Figures 1 and 2 illustrate a typical tool battery 10 and a cordless (battery power) tool 20. The illustrated tool 20 is a drill or driver having a tool housing 21 and a pistol type handle 24. A

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motor 23 (indicated by broken lines) is located within the housing for driving a tool output 22. A battery 10 is connectable to a supported by the tool handle 24. A tool controller such as a trigger 25 is located adjacent the junction between the housing 21 and handle 24 for coupling energy from the battery 10 to the motor 23. This is, however, not intended to limit the scope of use of a battery according to the invention. Such a battery could be used in other types of cordless tools and in particular in hand-held cordless tools or in cordless lawn and garden equipment such as lawn mowers, hedge trimmers and the like. Such a battery could also be used in floor care products such as vacuum cleaners, hand-vacs and cordless sweepers.

A preferred embodiment of a battery for such types of cordless tools has a battery pack housing 11 have a mating face 12 for connecting to the tool. The battery housing 11 is selectively receivable with and supportable by the tool housing via battery connection features, and may be selectively separated from the tool for charging in a separate charger (not shown). One typical embodiment of battery mating features is illustrated in Figures 1. In the illustrated embodiment the battery connection features are a terminal post 13 and battery terminals 14, 15 on the post 13 for connecting the battery energy sources with the tool controller or trigger 25. In alternative embodiments the battery connection features may be slide-type connection features or any other type of battery connection features known in the art. The type of battery connection features in not an essential feature of the invention.

Figures 3 to 11 show details of a battery 40 for location within the battery pack housing 11. The battery 40 comprises a plurality of substantially flat lithium-polymer battery cells 30. Each lithium-polymer cell 30 comprises a first electrode sheet 31 and a second electrode sheet 32 laminated to respective sides of a polymer based separator substrate 33. Connection tabs/tapes 34 and 35 are connected to the respective first and second electrodes sheets 31, 32. The first and second electrode sheets 31, 32 may be any of the lithium-polymer cell anode and cathode combinations known in the art. The polymer separator 33 may be a dry solid polymer electrolyte or porous or micro-porous polymer substrate holding a lithium based electrolyte. The particular anode, cathode and lithium-polymer separator chemistry of the cell is chosen to provide a nominal charged internal cell impedance of less than or equal to approximately 10 milliohms. Each cell 30 may have a typical nominal cell voltage of between 2 volts and 4.2 volt and a

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nominal amp-hour capacity of greater than 1.5 amp-hours. Each cell is preferably, although not exclusively enclosed in a flexible and lightweight pouch 301. The pouch 301 is formed from, for example, an Aluminum laminate film that is folded around the cell 30 and sealed along the three adjoining sides 302, 303, 304. The connection tabs/tapes 34 and 35 protrude from the pouch between the sealed edges of the film.

A substantially flat cell 30 according the invention has a cell length L, cell width W and cell height or thickness H. In the preferred embodiment the cell thickness H is less than 10% of the cell width W. This provides a substantially flat lithium-polymer cell which can be stacked in interconnected groups, as illustrated in Figures 5 to 11 for example, to form a tool battery. For use a tool battery a plurality of the stacked battery cells 30 should have a combined output voltage of at least 4 volts and as high as 40 volts or more. Tool batteries are typically available in stepped voltages of, for example, 4, 9, 12, 18, and as high as 40 volts for some lawn and garden type tools such as lawn mowers. In order to provide sufficient torque in the tool motor the combine average discharge current provide by the plurality of battery cells 30 should be greater than 10 amps, but more preferably 20 amps, although different tools and tool motors will produce different average battery discharge currents.

The tabs 34, 35 from respective ones of the stacked plurality of battery cells 30 are connect together in series and/or parallel in order to provide the required average discharge current and combine output voltage of the battery 40. The connection between the respectively terminal tabs 34, 35 of adjacent cells 30 must be of a lower resistance than the internal resistance of the cells 30 and preferably of a very low resistance so as to prevent heating in the interconnection joint between the cells 30. It is typical in battery manufacturing to interconnect adjacent battery cells by welding respective cell tabs at a weld joint 38. In the preferred embodiment of the invention each battery cell 30 has its respectively pair of tabs 34, 35 on different edges of the cell 30 and preferably on symmetrically opposite edges of the cell 30. This arrangement allows the plurality of cells to be easily interconnected in a string of cells 30 by jointing respective tabs 34, 35 of adjacent cells 30 with a weld joint 38. As the terminal tabs 34, 35 of the cells extend from opposite ends of the cell 30 the weld joint can be quickly and easily formed by a weld between

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adjacent cells 30 without potential for bridging or shorting adjacent terminal tabs of the same cell which in prior art battery designs may be along a same edge of the cell.

After electrical interconnection of the cell tabs 34, 35 the interconnected cells 30 are formed into a vertical stack of cells 30 as shown in Figure 6, for example. In a vertical stack of cells each cell 30 is lying over or under an adjacent one of the cells 30. Although in the illustrated embodiment the cells are stacked vertically with reference to the horizontal plane this is for illustrative and descriptive purposes only and the stack of individual cell 30 may be stacked with each cell lying in a vertical, or any other, plane where each cell 30 is layered with an adjacent one of the cells 30. For the purpose of describing the invention, stacked means each cell lying in adjacent parallel planes. During charge and discharges cycles of the battery the thickness H of each cell 30 may very normally by up to 5% of the cell thickness H. In order to accommodate this variation in cell thickness during charge and discharges cycles the cell stack includes a resiliently deformable substrate 37 interposed between each adjacent battery cell 30. The thickness of the resiliently deformable substrates 37, and thus the distance between adjacent cells, is preferably between 5% and 10% of the normal cell thickness H in order to accommodate for variation in individual cell thickness up to 5%. In some embodiments the resiliently deformable substrate 37 between cells 30 may be provided with a thermally conductive characteristic for conducting heat away from the cells during charge and discharge cycles. For example, the substrate may be resiliently deformable and thermally conductive, or the substrate may be porous, such as a spongy material, and impregnated with a thermally conductive substance.

The cell interconnection tabs 34, 35 extended between adjacent stacked cells 30. To support and protect the interconnection tabs 34, 35 from mechanical damage in some embodiments of the invention a guide member 36 is provided at respective locations adjacent the edge of the stacked cells 30 to abut the interconnected tabs 34, 35 between adjacent cells 30. The guide member 36 has a convex guiding surface that abuts the joined tabs 34, 35 extending between the adjacent cells and supports the joined tabs about a smooth radius between the adjacent cells 30.

The interconnected stack of cells 30 forming battery 40 is located within a battery pack housing such as housing 11 of the battery of Figure 1. It will be appreciated by a skilled person that the

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battery 40 constructed of pouch cells must be physically and mechanically supported within the battery housing 11 against mechanical vibrations and shocks that might be experienced during use of the tool to which a battery pack 10 is connected. Figures 6 to 10 show a cradle and shell arrangement for mechanically supporting a stack of battery cells 30 within the battery housing 11 in some embodiments. Figure 7 shows an individual battery cradle 39 for supporting a substantially flat lithium-polymer battery cell 30. The cradle 39 is a flat substrate of resiliently deformable material such as EVA foam or the like and has a wide cell-channel extending through one face of the substrate. An individual battery cell 30 locates within the cell-channel for support by the cradle. The cradle 39 has side edges 40 to provide mechanical protection for the sides of the battery cell 30 and integrally combines the resiliently deformable cell spacer substrate 37, below the cell-channel, and cell tab guide 36 into a single protective cradle for an individual battery cell 30. Figure 9 shows a stack of battery cells 30 each held within its own individual resiliently deformable cradle 39. The cradled stack of battery cell 30 locates within a cradle frame 43 and is fitted with a cover 42 in order to mechanically hold the stack of battery cells 30 together. A printed circuit board assembly (PCBA) 44 can optionally be attached to or incorporated with the cover 42. The PCBA can contain battery pack electronics and protection circuits. The cradle frame 43 supporting the battery 40 is located within a battery housing 11. The cradles 39 and cradle frame 42, 43 are preferably a “friction fit” within the battery housing 11 such that the battery 40 is mechanically supported against and variations and shocks experienced during use of the battery on a power tool.

In some embodiments further mechanical protection of the pouch cell battery is provided by enclosing the stack of battery cells 30 within a shell or case 50 as shown in Figures 10 and 11. The case 50 comprises a case enclosure 431 having a base and four surrounding side walls defining a cavity into which the stacked battery cells 30 are located. A cover 421 is fixed to the tops of the four surrounding side walls to enclose the cavity and stacked battery cells 30. An opening 51, 52 is provided in each of the opposed end side walls of the case enclosure 431 to allow space for and accommodate connection access to the interconnected terminal tabs 34, 35 of adjacent cells 30. The free end terminal tabs 341 and 251 of the stack of cells 30 pass though respective end openings 51, 52 and are folded through substantially 180-degrees to lie substantially flat with respective upper and lower surfaces of the case 50. The first free terminal

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tab 351 of the stacked cells 30 is folded back against a first surface of the case 50 and electrically connected with one end of a conductive lead strap 54. The second end of the first conductive lead strap 54 has a first exposed connection terminal 53 of copper or other electrically conductive terminal material. The conductive lead strap 54 is preferably a copper strap having an insulated coating such as a polyurethane insulating varnish. The terminal end 53 of the strap is free of the insulating varnish to allow for electrical connection to the strap. The second free terminal tab 341 of the stacked cells 30 is folded back against the second opposite surface of the case 50 and electrically connected with one end of a second conductive lead strap 55. The second conductive lead strap 55 extends flat with the case surface around the side of the case to the first surface of the case 50 where it is provided with a second exposed connection terminal 56 of copper of other electrically conductive terminal material. The second conductive lead strap 55 is preferably a copper strap having an insulated coating such as a polyurethane insulating varnish. The terminal end 56 of the strap is free of the insulating varnish to allow for electrical connection to the strap. In some embodiments auxiliary conductive straps 57 of a type the same or similar to first and second conductive straps 54, 55 are provided for providing addition signal connections to the stack of cells 30. For example, auxiliary conductive straps 57 are preferably provided for each of the interconnected terminal tabs 34, 35 between stacked cells for providing means for measuring individual cell voltages. Each auxiliary conductive strap 57 has a connection terminal 58 at its distal end. Auxiliary conductive straps 57 may also be provided to temperature and other sensors associated with the stack of cells 30. A printed circuit board assembly (PCBA) can optionally be attached to or incorporated with the enclosure cover 421 or within the case 50. The PCBA can contain battery pack electronics and protection circuits.

Within some embodiment a small PCBA is attached to the tabs 34, 35 of the battery cells. Such a PCBA can comprises a sensor for transmitting a voltage dependent sensor signal to the battery controller 44, or a battery charger controller for determining cell voltages for using in, for example, cell balancing operations. In a further embodiment of the invention one or more sensor elements can be located between adjacent cells for measuring temperature and other cell characteristics. In one embodiment a pressure sensor is provided between adjacent cells for detecting expansion in cell thickness during charge and discharge cycles. If pressure or deformation of the substrate between adjacent cells exceeds a threshold this may indicate an

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abnormal and possibly dangerous cell condition. Signals from such sensors are transmitted to the battery controller 44, or a battery charger controller.

Traditional lithium ion cells used in tool batteries are mechanically contained in a strong cylindrical metal can. These cans are grouped together to form a battery and located in a battery pack housing. The interior of the housing has a first housing volume and the grouped cell cans defines a combined battery volume. The fill-factor of a cylindrical body in a substantially square or rectangular housing is at best Pi divided by 4 (II/4) or 78%. The stacked flat cells of the present invention provides a ratio of the combined battery volume to housing volume (fill ration) of greater than 80%, allowing for a smaller more light weight battery.

In the various embodiments described above the battery comprises a plurality of interconnected cells. In at least one alternative embodiment the battery may comprises just one lithium polymer based chemistry cell. In other alternative embodiment the battery may comprises between 2 and 20 interconnected cells, or more preferably between 2 and 10 interconnected cells. In yet another embodiment the battery may comprises between 3 and 5 cells interconnected in series. In the various embodiments the cells may be interconnected in series, in parallel, or groups of series cells may be interconnected in parallel in order to obtain a desired output voltage and combined average discharge current.

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CLAIMS

1. A lithium-polymer based battery pack for powering a hand held power tool or a garden tool, the battery pack comprising:

a housing selectively connectable to and supportable by a hand held power tool or a garden tool,

a battery cell located within the housing, the cell having an output voltage of at least 4 volts and producing an average discharge current of greater than 10 amps, wherein the battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

2. The lithium-polymer based battery pack of claim 1 further comprising a plurality of the battery cells located within the housing, the plurality of cells being interconnected to have a combined output voltage of at least 4 volts and a combined average discharge current of greater than 10 amps, wherein each cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

3. The lithium-polymer based battery pack of claim 2 wherein the plurality of the battery cells comprises between 2 and 20 cells interconnected in series.

4. The lithium-polymer based battery pack of claim 2 wherein the plurality of the battery cells comprises between 2 and 10 cells interconnected in series.

5. The lithium-polymer based battery pack of claim 2 wherein the plurality of the battery cells comprises between 3 and 5 cells interconnected in series.

6. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells has a nominal amp-hour capacity of greater than 1.5 amp-hours.

7. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells has a nominal cell voltage of between 2 volts and 4.2 volts.

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8. The lithium-polymer based battery pack of any preceding claim wherein the battery cells have a combined output voltage of between 4 volts and 40 volts.

9. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells comprises an anode electrode sheet, a cathode electrode sheet and a lithium-polymer based substrate lamented between the anode and cathode electrode sheets.

10. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells is generally flat and has a cell width and a cell thickness, the cell thickness being less than 15% of the cell width.

11. The lithium-polymer based battery pack of any one of claims 2 to 10 wherein the plurality of battery cells are layered within the housing such that each cell is lying adjacent another one of the cells, and further including a resiliently deformable substrate between the adjacent cells.

12. The lithium-polymer based battery pack of claim 11 wherein a distance between the adjacent cells in greater than 5% of the cell width.

13. The lithium-polymer based battery pack of claim 11 wherein the resiliently deformable substrate is thermally conductive or contains a thermally conductive component.

14. The lithium-polymer based battery pack of claim 11 including at least one sensor element located between at least two adjacent ones of the cells, said sensor element providing a sensor signal to a battery controller.

15. The lithium-polymer based battery pack of claim 14 wherein the sensor element comprises a temperature sensor.

16. The lithium-polymer based battery pack of claim 14 wherein the sensor element comprises a temperature sensor, and wherein a second pressure sensing element is located

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between at least two adjacent ones of the cells and provides a pressure sensor signal to a battery controller

17. The lithium-polymer based battery pack of any one of claims 2 to 16 wherein the housing defines a housing volume and the plurality of cells provides a combined battery volume, and wherein a ratio of the combined battery volume to the housing volume is greater than 80%.

18. The lithium-polymer based battery pack of any preceding claim wherein each of the battery cells comprises a first connection lead connected with an anode sheet of the cell and a second connection lead connected with a cathode sheet of the cell, the first connection lead extending from a first edge of the cell and the second connection lead extending from a second edge of the cell, the second edge being a different edge to the first edge of the cell.

19. The lithium-polymer based battery pack of claim 18 wherein the second edge is symmetrically opposite the first edge.

20. The lithium-polymer based battery pack of claim 18 or 19 wherein the plurality of battery cells is stacked within the housing such that each cell is lying adjacent another one of the cells, at least one of the connection leads joined with a connection lead of an adjacent cell.

21 The lithium-polymer based battery pack of claim 20 further including a guide member having a convex guiding surface abutting the joined connection leads extending between adjusted cells.

22. The lithium-polymer based battery pack of claim 21 wherein the guide member supports the joined connection leads about a smooth radius between the adjusted cells.

23. The lithium-polymer based battery pack of claim 21 or 22 further including a resiliently deformable substrate between adjacent cells.

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24. The lithium-polymer based battery pack of claim 23 wherein the guide member and resiliently deformable substrate between adjacent cells is a single integral member.

25. The lithium-polymer based battery pack of any preceding claim wherein the plurality of battery cells is supported within the housing in a resiliently deformable cradle surrounding at least a part of each cell.

26. The lithium-polymer based battery pack of claim 25 wherein the resiliently deformable cradle comprises two or more resiliently deformable members each abutting at least one battery cell.

27. A lithium-polymer tool battery comprising:

a housing selectively connectable to and supportable by a hand held power tool or a garden tool,

a plurality of substantially flat battery cells stacked within the housing such that each sell is layered over or under an adjacent cell and a resiliently deformable substrate located between adjacent battery cells, wherein each battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

28. The lithium-polymer tool battery of claim 27 further including the lithium-polymer battery based pack features of any one of claims 3 to 26.

29. A lithium-polymer battery powered tool comprising:

a power tool housing

an electrical motor in the housing,

a motor control circuit for controlling power supplied to the motor from an electrical energy source,

a battery housing selectively connectable to and supportable by the power tool housing,

a battery within the battery housing for supplying power to the motor control circuit and motor when the battery housing is connected with the power tool housing,

the battery comprising at least one battery cell having an output voltage of at least 4 volts

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and producing a combined average motor supply current of at least 10 amps, wherein each battery cell has a lithium-polymer based chemistry and a nominal charged internal impedance of less than or equal to approximately 10 milliohms.

30. The lithium-polymer tool of claim 29, further including the lithium-polymer battery based pack features of any one of claims 2 to 26.

31. The lithium-polymer tool of claim 29 or 30, wherein the tool is one of a hand held power tool such as a drill or saw, a lawn or garden care tool such as a lawn mower or edge trimmer, or a floor cleaner such as a vacuum cleaner.

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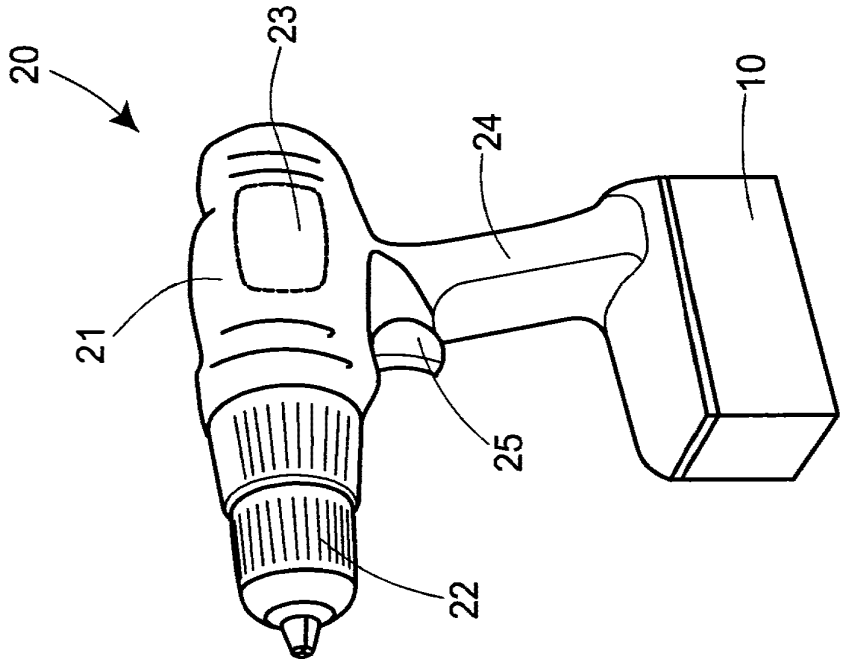


Fig. 2

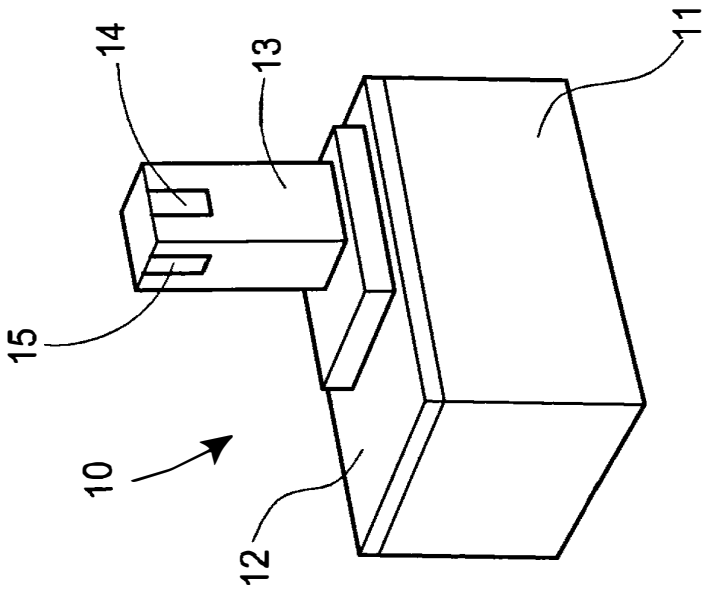


Fig. 1

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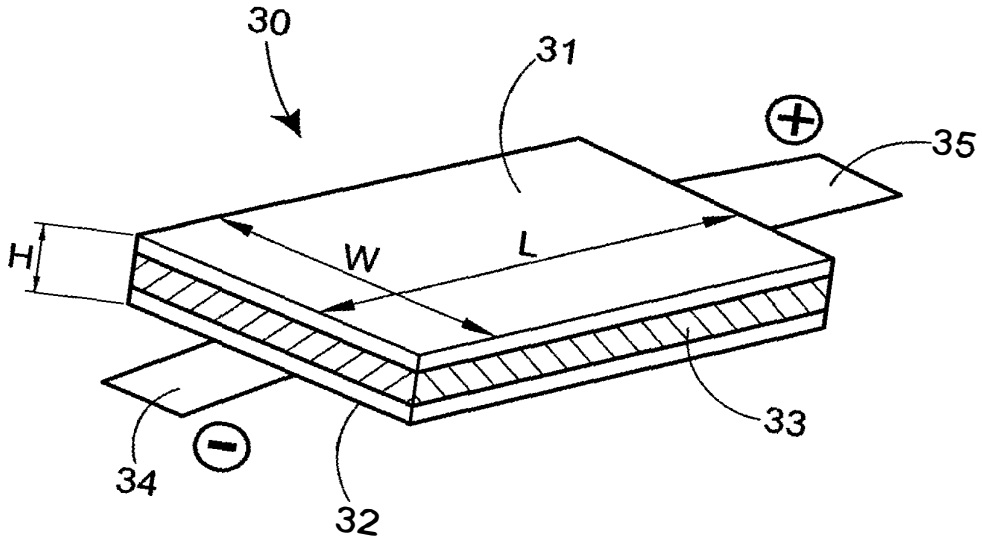


Fig. 3

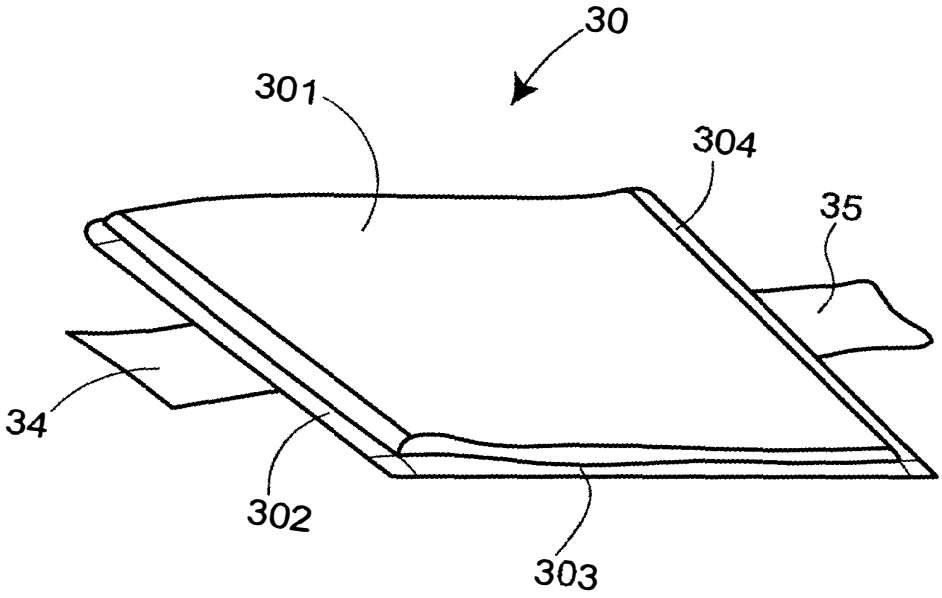


Fig. 4

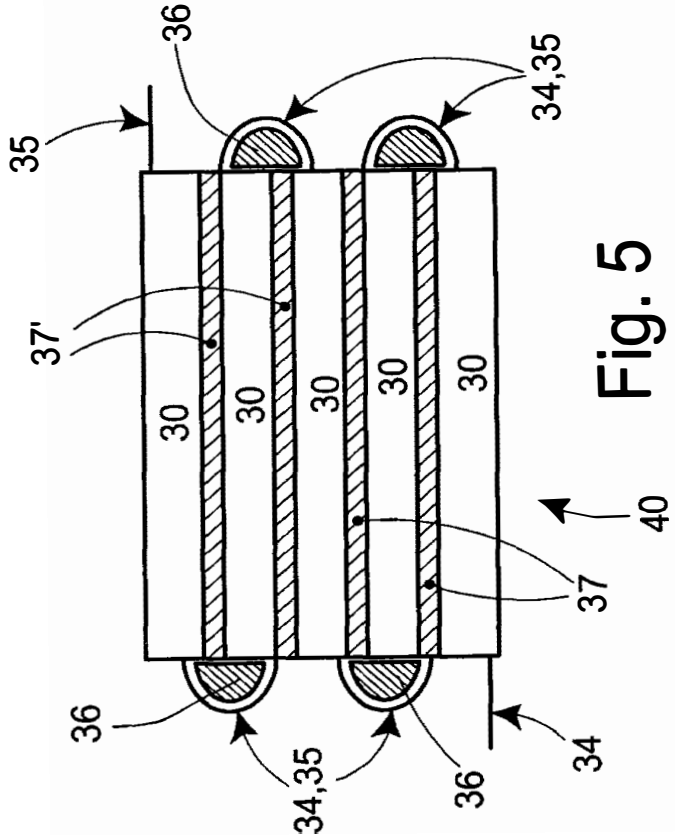


Fig. 5

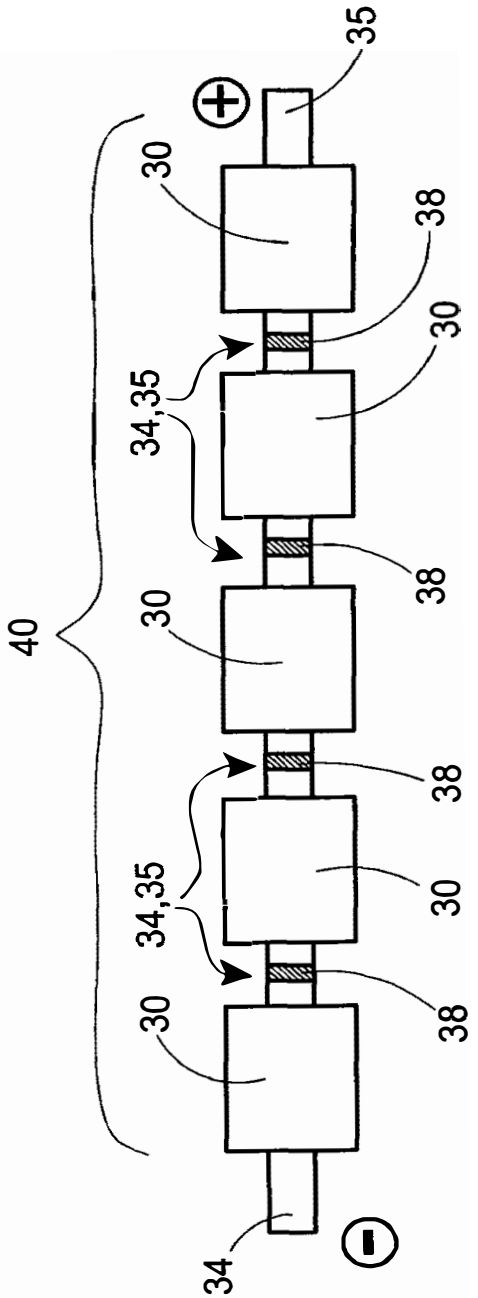


Fig. 6

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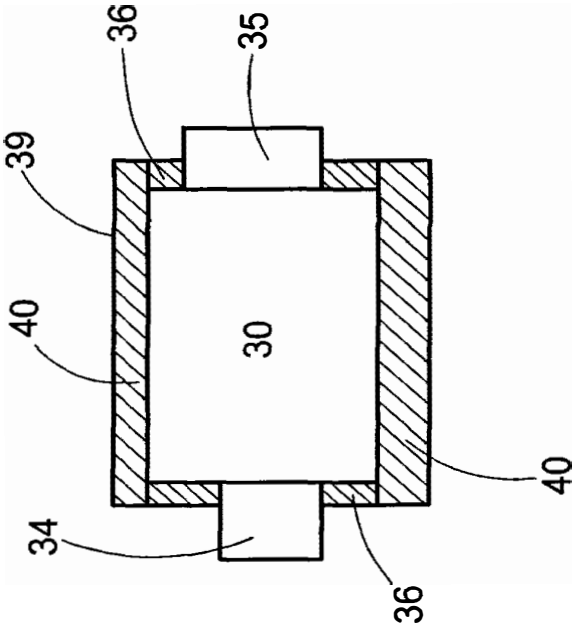


Fig. 8

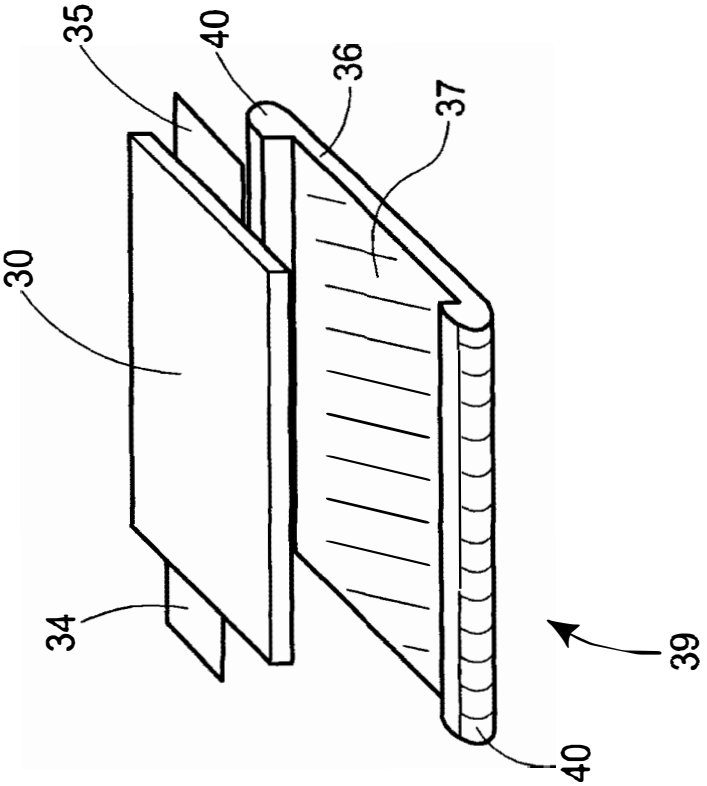


Fig. 7

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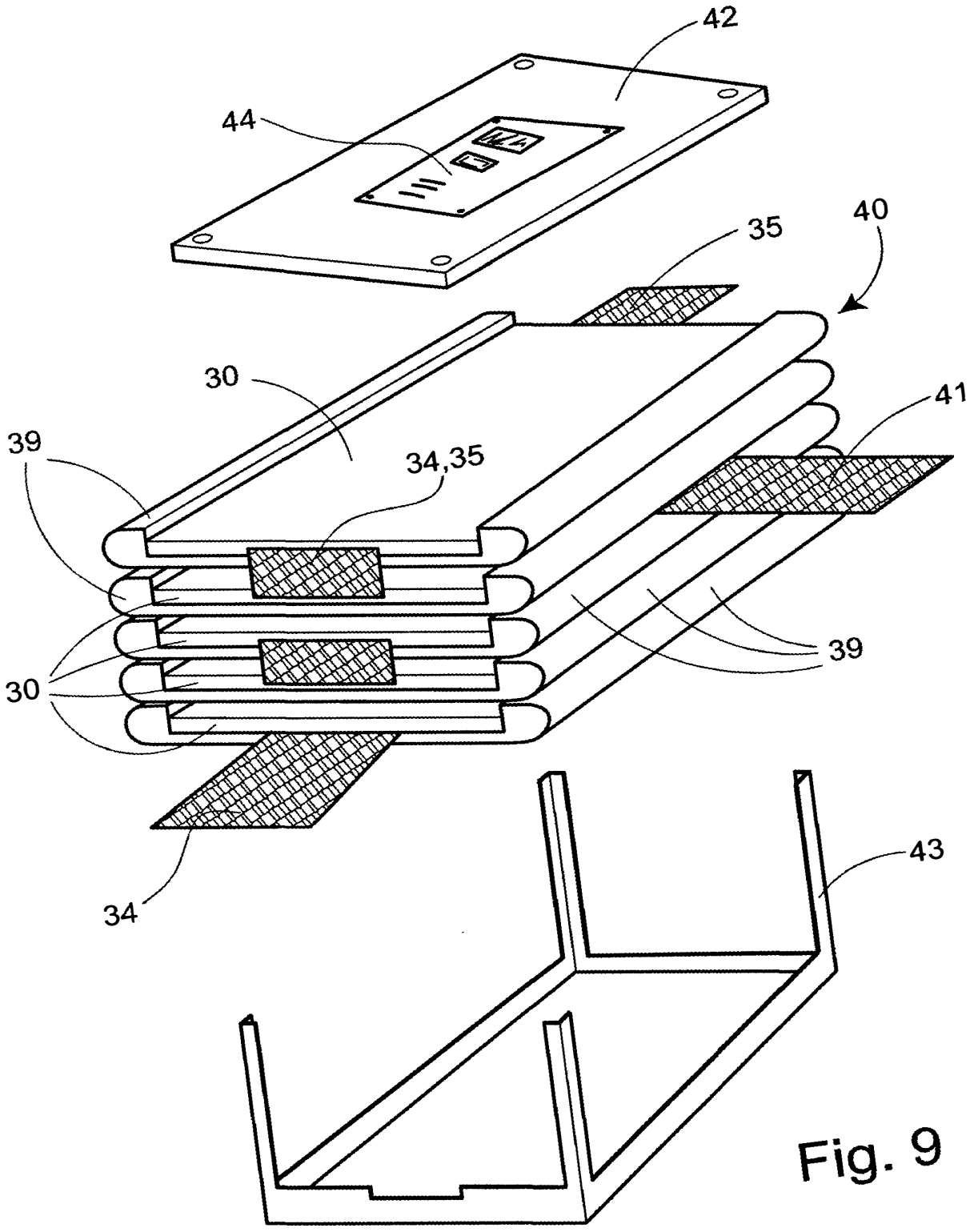


Fig. 9

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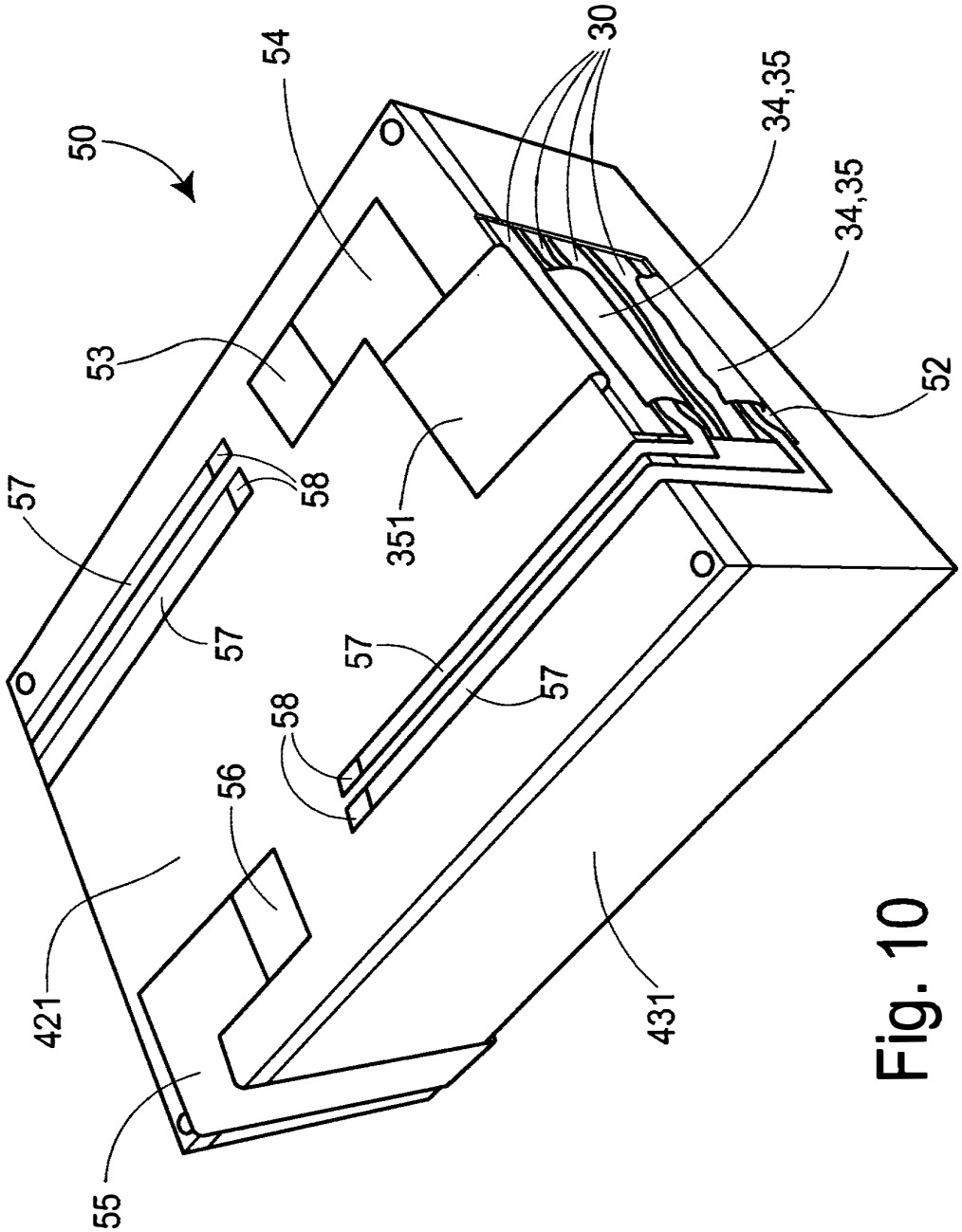


Fig. 10

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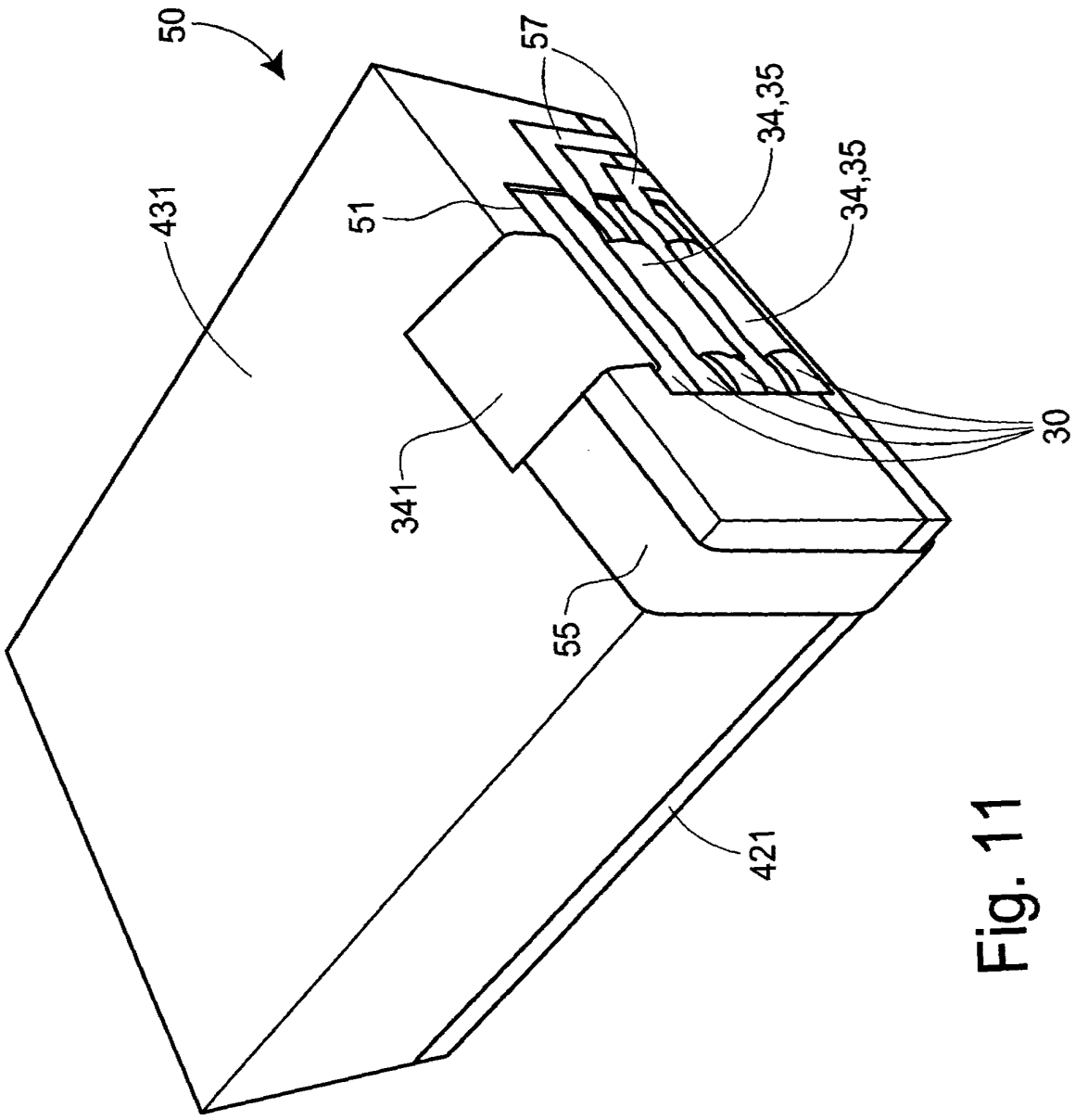


Fig. 11

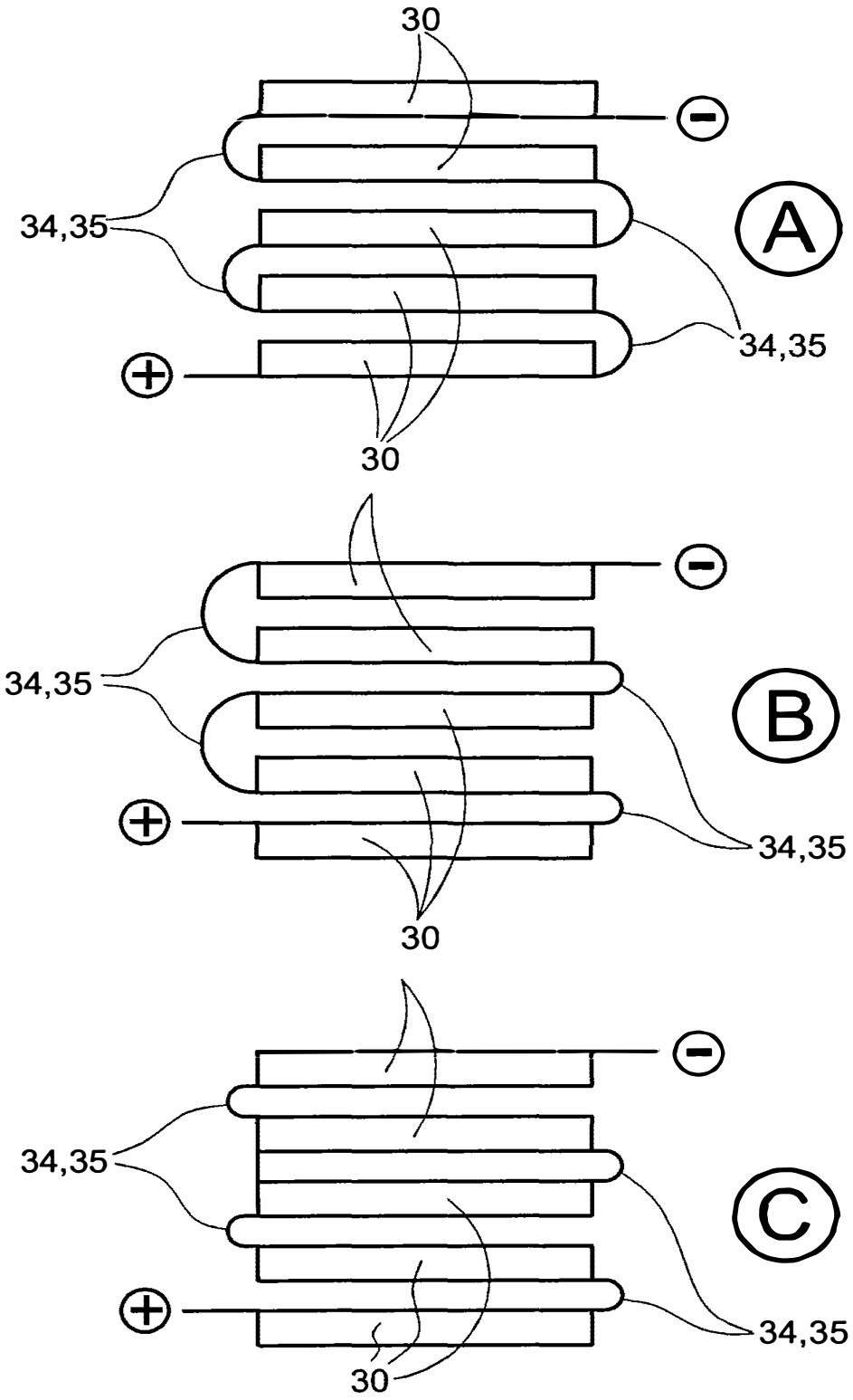


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/080868

A. CLASSIFICATION OF SUBJECT MATTER

H01M 10/36(2010.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01M H02K B25F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI,EPODOC,CNABS,CNTXT,CNKI:battery,cell,motor,tool,selective+,detachable,elastic+,spacer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008211327 A1 (SCHLEGEL, ANDREAS ET AL.) 04 September 2008 (2008-09-04) abstract, description,paragraphs [0022]-[0027] and figure 1	1-10,17,25-26,29-31
Y	US 2008211327 A1 (SCHLEGEL, ANDREAS ET AL.) 04 September 2008 (2008-09-04) abstract, description,paragraphs [0022]-[0027] and figure 1	11-16,18-24,27-28
Y	US 2009297936 A1 (NEMOTO, SEIJI ET AL.) 03 December 2009 (2009-12-03) description,paragraphs [0089]-[0097] and figures 6-7	11-16,18-24,27-28
X	CN 202952236 U (NINGBO YOUNGSUN ENTERPRISE CO., LTD.) 29 May 2013 (2013-05-29) description,paragraphs [0010]-[0012] and figure1	1-10,17,25-26,29-31
Y	CN 202952236 U (NINGBO YOUNGSUN ENTERPRISE CO., LTD.) 29 May 2013 (2013-05-29) description,paragraphs [0010]-[0012] and figure1	11-16,18-24,27-28
A	US 2008003505 A1 (WUENSCH, STEFFEN ET AL.) 03 January 2008 (2008-01-03) the whole document	1-31

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 August 2014	**28 September 2014**
Name and mailing address of the ISA/ **STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN) 6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China** Facsimile No. **(86-10)62019451**	Authorized officer **XIONG,Yue** Telephone No. **(86-10)82245487**

Form PCT/ISA/210 (second sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/080868

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2008211327	A1	04 September 2008	DE	102004036588	A1	23 March 2006
				EP	1774607	A2	18 April 2007
				WO	2006010676	A3	12 October 2006
				WO	2006010676	A2	02 February 2006
				CN	1989635	A	27 June 2007
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				CN	101490870	B	26 October 2011
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				CN	101115587	B	05 October 2011
				EP	1848570	A1	31 October 2007
				WO	2006081894	A1	10 August 2006
				DE	102005005553	A1	10 August 2006

Espacenet

CN204516832U The multi-functional sampling end minor structure of group battery

Applicants: CONTEMPORARY AMPEREX TECHNOLOGY LTD

Inventors: CHEN YONG,GE JINBO,WANG DERONG,ZHAO BIN

Classifications:
IPC ***H01M2/30;***

CPC Y02E60/10 (EP);

Priorities: CN201520093747U 2015-02-10

Application: CN204516832U·2015-02-10

Publication: CN204516832U·2015-07-29

Published as: CN204516832U

The multi-functional sampling end minor structure of group battery

Abstract

The utility model belongs to the technical field of the battery pack, in particular to the multi-functional sampling end minor structure of battery pack, including the insert in the electrode manner piece insert soon linkage segment, parcel temperature sensor probe the temperature sampling section and with the voltage sample section of voltage sample conductor compression jointing, the voltage sample section through the temperature sampling section with insert the linkage segment soon and be connected. It is integrated structural to the one terminal with battery pack temperature sampling and voltage sample through above-mentioned structure, can only realize temperature sampling or voltage sample as required, also can realize sampling simultaneously. The utility model discloses when realizing battery voltage and temperature sampling, both simplified technology, reduced manufacturing cost again, be suitable for batch production.

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(19)中华人民共和国国家知识产权局

(12)实用新型专利

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(45)授权公告日 2015.07.29

(21)申请号 201520093747.6

(22)申请日 2015.02.10

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代理人 罗伟平

(51)Int.Cl.
H01M 2/30(2006.01)

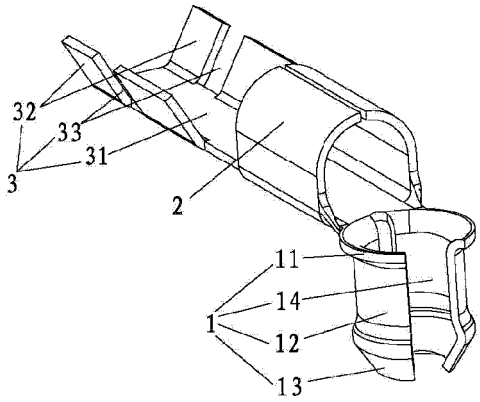
权利要求书1页 说明书3页 附图2页

(54)实用新型名称

电池组的多功能采样端子结构

(57)摘要

本实用新型属于电池组技术领域，特别涉及电池组的多功能采样端子结构，包括插设于电极连接片的快插连接段、包裹温度传感器探头的温度采样段及与电压采样导线压接的电压采样段，电压采样段通过温度采样段与快插连接段连接。通过上述结构将电池组温度采样和电压采样集成到一个端子结构上，可以根据需要只实现温度采样或者电压采样，也可以实现同时采样。本实用新型在实现电池组电压和温度采样的同时，既简化了工艺，又降低了生产成本，适合于批量生产。



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1. 电池组的多功能采样端子结构，其特征在于：包括插设于电极连接片的快插连接段、包裹温度传感器探头的温度采样段及与电压采样导线压接的电压采样段，所述电压采样段通过所述温度采样段与所述快插连接段连接。

2. 根据权利要求 1 所述的电池组的多功能采样端子结构，其特征在于：所述快插连接段包括连接头部、连接中部和连接尾部，所述连接头部通过所述连接中部与所述连接尾部连接为一体。

3. 根据权利要求 2 所述的电池组的多功能采样端子结构，其特征在于：所述快插连接段还包括开槽，所述连接头部、所述连接中部和所述连接尾部通过所述开槽形成“C”形或“U”形结构的弹簧体。

4. 根据权利要求 3 所述的电池组的多功能采样端子结构，其特征在于：当所述连接头部、所述连接中部和所述连接尾部为圆形结构时，所述连接头部和所述连接尾部的最大直径均大于所述连接中部的直径。

5. 根据权利要求 1 所述的电池组的多功能采样端子结构，其特征在于：所述温度采样段设置为“U”形、“C”形或“O”形结构。

6. 根据权利要求 1 所述的电池组的多功能采样端子结构，其特征在于：所述电压采样段包括搁置板及设置于所述搁置板两侧的侧板，所述侧板与所述搁置板形成为“V”形、“U”形或“C”形结构。

7. 根据权利要求 6 所述的电池组的多功能采样端子结构，其特征在于：所述侧板设置为两组，每组的数量为两个，且每组的两个所述侧板均沿所述搁置板对称设置。

8. 根据权利要求 7 所述的电池组的多功能采样端子结构，其特征在于：两组所述侧板之间设置有间隙。

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电池组的多功能采样端子结构

技术领域

[0001] 本实用新型属于电池组技术领域，特别涉及电池组的多功能采样端子结构。

技术背景

[0002] 在当前全球能源日益紧张及环境日益恶化的巨大挑战下，发展电动汽车、实现汽车能源动力系统的零排放和推动电动汽车的普及在国际上已经形成了广泛共识，在这样的背景下，动力电池有了越来越广泛的应用。在将动力电池用作电动汽车的供能元件时，整车控制系统必须监控电池的电压，温度等参数，所以电池组采样的设计是电池包结构设计中基础且重要的一环，其电池组采样设计和工艺的可靠性将会对电动汽车的安全性产生重要影响。

[0003] 现有技术中，电池组的电压采样结构和温度采样结构是各自分开实现的。如图 1 所示，导线 1’剥皮后，通过超声波将导线 1’的裸铜线芯 2’焊接到电极连接片 3’上，从而形成电压采样结构；将温度传感器探头 4’通过涂胶固定在一种金属端子 5’里面，然后金属端子 5’通过超声波焊接到电极连接片 3’，从而形成温度采样结构。上述结构的实现需要经过多道工序，不利于简化工艺（在现有技术中，实现电压采样需运用导线裁剪工艺、导线整形工艺和导线超声波焊接工艺；实现温度采样需运用胶水粘接工艺和超声波焊接工艺。），而且生产成本较高、不利于批量生产。

实用新型内容

[0004] 本实用新型的目的在于：针对现有技术的不足，而提供电池组的多功能采样端子结构，该结构将电池组温度采样和电压采样集成到一起，在实现电池组电压和温度采样的同时，既简化了工艺，又降低了生产成本，适合于批量生产。

[0005] 为实现上述目的，本实用新型采用如下技术方案：电池组的多功能采样端子结构，包括插设于电极连接片的快插连接段、包裹温度传感器探头的温度采样段及与电压采样导线压接的电压采样段，所述电压采样段通过所述温度采样段与所述快插连接段连接。

[0006] 作为本实用新型电池组多功能采样端子结构的一种改进，所述快插连接段包括连接头部、连接中部和连接尾部，所述连接头部通过所述连接中部与所述连接尾部连接为一体。

[0007] 作为本实用新型电池组多功能采样端子结构的一种改进，所述快插连接段还包括开槽，所述连接头部、所述连接中部和所述连接尾部通过所述开槽形成一“C”形或“U”形结构的弹簧体。

[0008] 作为本实用新型电池组多功能采样端子结构的一种改进，当所述连接头部、所述连接中部和所述连接尾部为圆形结构时，所述连接头部和所述连接尾部的最大直径均大于所述连接中部的直径。

[0009] 作为本实用新型电池组多功能采样端子结构的一种改进，所述温度采样段设置为“U”形、“C”形或“O”形结构。

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