(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 665 759 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
06.10.2021 Bulletin 2021/40

(21) Application number: **18769889.9**

(22) Date of filing: **17.08.2018**

(51) Int Cl.:
H02J 7/00 *(2006.01)* ***B60L 3/00*** *(2019.01)*
B60L 58/18 *(2019.01)* ***B60L 58/19*** *(2019.01)*

(86) International application number:
PCT/US2018/046880

(87) International publication number:
WO 2019/036595 (21.02.2019 Gazette 2019/08)

(54) CASCADING CONTACTOR DRIVE SYSTEM

KASKADIERENDES SCHÜTZANTRIEBSSYSTEM

SYSTÈME DE COMMANDE DE CONTACTEURS EN CASCADE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **17.08.2017 US 201762546805 P**

(43) Date of publication of application:
17.06.2020 Bulletin 2020/25

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Description

Background

[0001] In order to make large battery pack systems safer, they can be physically broken up into modules which may each have a maximum voltage of 60 V or less. Working on such isolated modules does not pose a significant electrocution risk to an operator compared to a large pack, such as a 576 volt DC vehicle charger. In order to connect the modules in series for operation, some kind of mechanical switch is required between each module. While physical switches may be used, this is not very practical since it requires going to each module and manually operating the switch; further, this reduces the safety factor somewhat because the user is in proximity to the switch.

[0002] A safer and more convenient method is to put an electromechanical switch, such as a contactor, between each module, and turning them all on remotely using a low- power control signal from the control module. However, simultaneously driving several contactors requires significant initial current - a Tyco EV200, for example, only needs about 200 mA to stay closed, but it might take 2.5 A initial drive current to turn on. So for a 17-contactor system, initial current could be as much as 42.5 A. This may be more than a simple control system is designed to drive. An example of such a system is shown in Polish patent application PL401580, which describes a modular battery bank consisting of a battery monitoring system (BMS), contactors, additional battery and shock sensor. The protected battery bank is divided into modules which are connected in series with the contactors normally open. The windings controlling the contactors are connected in series with the shock sensor and are supplied, via BMS, with an additional battery. The control windings of the contactors are connected in series or in parallel. The connection terminals of the shock sensor are attached to the modular battery housing.

[0003] One solution may be to separate each drive line, such that only 2.5A is needed by each line. However this may require sixteen additional control lines, which may result in a significantly more complex controller and wiring harness to all of the isolation contactors.

Summary

[0004] In accordance with one aspect of the present invention, a single control line may be used to drive a first contactor, and then the first contactor, after it has closed, may be used to drive the next contactor, and so on, until the entire battery system is engaged.

[0005] These and other objectives and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings wherein are set forth, by way of illustration and example, certain embodiments of the invention.

Description Of the Figures

[0006]

Figure 1 is a block diagram of a high voltage battery system incorporating a cascading contactor drive system in accordance with the invention;

Figure 2 is a schematic representation of one embodiment of an interconnect circuit which may be utilized in the cascading contactor drive system of Figure 1; and.

Figure 3 is a schematic representation of another embodiment of an interconnect circuit, incorporating a driver circuit, which may be utilized in the cascading contactor drive system of Figure 1;

Figure 4a is a schematic representation of another embodiment of an interconnect circuit, adding one embodiment of a delay circuit to the driver circuit of Figure 3;

Figure 4b is a schematic representation of another embodiment of an interconnect circuit, adding another embodiment of a delay circuit to the driver circuit of Figure 3;

Figure 5 is a schematic representation of an interconnect circuit including a contactor driver, delay and power out;

Figure 6 is a schematic representation of an interconnect circuit including a contactor driver, delay, power out and LED; and

Figure 7 is a block diagram of a high voltage battery system incorporating a dual interconnect cascading contactor drive system in accordance with the invention

Description of the Preferred Embodiments

[0007] While this invention is susceptible of embodiment in many different forms, there will be described herein in detail, specific embodiments thereof with the understanding that the present disclosure is to be considered exemplifications of the principles of the invention and is not intended to limit the invention to the specific embodiments illustrated.

[0008] Various methods of creating this cascading effect are contemplated.

[0009] A high voltage battery system, generally designated 10, is illustrated in Figure 1. The battery system 10 includes a plurality of battery modules, such as a first battery module 12a, a second battery module 12b, a third battery module 12c, through to an n^{th} battery module 12n (collectively, the battery modules 12). The battery modules 12 may each have a nominal voltage of thirty-two (32) volts DC, and the battery modules 12 may be coupled in series. Each of the battery modules may have conventional positive and negative power terminals B+ and B-, respectively.

[0010] The battery control system 10 includes a control module 14. The battery system 10 further includes a plurality of interconnect controllers (collectively the interconnect controllers 16), such as a first interconnect controller 16a, a second interconnect controller 16b, through to an n-1th interconnect controller 16(n-1), respectively disposed between the "n" battery modules 12. The control module 14 includes power output terminals (P+, P-) which provide system output DC power in a conventional manner, such as to a load (not shown). If the battery modules 12 each have a power output of thirty-two (32) volts DC, the power provided at the power output terminals P+, P-, would be thirty-two (32) times "n," where "n" equals the number of battery modules 12 coupled thereto in series.

[0011] A first embodiment of an interconnect controller 16^1 is illustrated in Figure 2. The interconnect controller 16^1 is disposed between two of the battery modules 12.

[0012] As illustrated in Figure 2, the interconnect controller 16^1 includes an electromagnetic switch, or contactor, 18 having an actuating coil 20, a main contact 22 and an auxiliary contact 24. The main contact 22 is electrically coupled between the power output of one of the battery modules 12 and the power input of another, serially coupled, one of the battery modules 12.

[0013] In the case of the first interconnect controller 16a of Figure 1, the auxiliary contact 24 has an input coupled to a control output of the control module 14, and an output coupled to a control input of the serially, downstream interconnect controller 16b. In the case of the second interconnect controller 16b of Figure 1, and other ones of the serially subsequent interconnect controllers 16, the auxiliary contact 24 has a control input coupled to a control output of a preceding interconnect controller 16, and a control output coupled to a control input of a serially downstream interconnect controller 16.

[0014] As discussed below, the control signal generated by the control module 14 is serially passed through the serially connected interconnect controllers 16, as the respective ones of the auxiliary contacts 24 sequentially close.

[0015] Specifically, the control module 14 (Fig.1) provides, upon command, an initial drive, or control, signal from its control out (Ctl Out) output. The voltage/current magnitude of the drive signal may be dependent upon requirements of the particular contactor utilized.

[0016] Still referring to Figure 2, the first interconnect controller 16^1 responds to the initial drive signal to energize the coil 20 of the contactor 18. As is known, energization of the coil 20 by the initial drive signal closes both the main contact 22 and the auxiliary contact 24. Closure of the main contact 22 couples the power output of the preceding battery module 12 to the serially subsequent battery module 12. Then after the interconnect controller 16^1 senses that the contactor 18 is closed, via closure of the auxiliary contactor 24, the interconnect controller 16^1 sends the control signal to the next one of the interconnect controllers 16^1, and so on. In this way the energy necessary to close a first one of the contactors 18 is already expended before the next one of the contactors 18 is driven, so the current demand to close subsequent ones of the contactors 18 remains an amount relatively equivalent to the amount required to drive a single contactor.

[0017] A second embodiment of an interconnect controller 16^2 is illustrated in Figure 3. The second embodiment of the interconnect controller 16^2 may include a driver circuit, generally designated 25, including first and second, conventionally biased MOSFET transistors 26, 28. The driver circuit 25 may provide a relatively inexpensive way to simplify a battery module isolation system on a high voltage battery. According to the second embodiment of the interconnect controller 16^2, the Control In signal closes the main contactor 22 and the auxiliary contactor 24. The Control In signal passes through the auxiliary contactor 24 to the driver circuit 25, which then passes out to the Control Out lines, to the serially next one of the interconnect controllers 16. A third embodiment of an interconnect controller 16^3 is illustrated in Figure 4a. According to the third embodiment of an interconnect controller 16^3, a capacitor 32 may be added to the driver circuit 25, to add a delay to the driver circuit 25 passing the Control In signal to the serially next interconnect controller 16.

[0018] A fourth embodiment of an interconnect controller 16^4 is illustrated in Figure 4b. According to the fourth embodiment of the interconnect controller 16^4, a microprocessor 34 may be added to the driver circuit 25 to add a programmable delay to the driver circuit 25 passing the Control In signal to the serially next interconnect controller 16.

[0019] A fifth embodiment of an interconnect controller 16^5 is illustrated in Figure 5. According to the fifth embodiment of the interconnect controller 16^5, Power Out lines may be provided, such as coupled to an output of the driver circuit 25, such as to run a cell monitor for that stage.

[0020] A sixth embodiment of an interconnect controller 16^6 is illustrated in Figure 6. According to the sixth embodiment of the interconnect controller 16^6, an LED 44 may be provided at the output of the driver circuit 25 to visually indicate engagement of the contactor 18.

[0021] Referring to Figure 7, a contactor 18 may be provided on both the positive and negative power terminals of each of the interconnect controllers 16, further isolating each of the battery modules 12 where such isolation may be desired or otherwise required, such as for human safety. As illustrated in Figure 7, the auxiliary outputs of associated contactors 18 may first be input to an AND gate 40, prior to input to the associated driver circuit 25.

[0022] It is to be understood that this disclosure is not intended to limit the invention to any particular form described, but to the contrary, the invention is intended to include all modifications, alternatives and equivalents falling within the scope of the inventior, which is defined

in the appended claims.

Claims

1. A system for providing DC power to a load, the system comprising:

first, second and third battery modules (12a, 12b, 12c), wherein each of the first, second and third battery modules includes a first power output terminal (B+) and a second power output terminal (B-), each of the first power output terminals being of a first polarity and the each of the second power output terminals being of a second, opposite polarity;
a control module (14) having a control module output for providing a control signal; a first interconnect controller (16a) electrically disposed between the first (12a) and second (12b) battery modules, the first interconnect controller including a first control input and a first control output, a first actuating coil (20) having a first coil input and a first coil output, a first main contact (22) having a first main contact input and a first main contact output, and a first auxiliary contact (24) having a first auxiliary contact input and a first auxiliary contact output, wherein the first control input is coupled to the control module output to operably receive the control signal, the first coil input is coupled to the first control input, the first main contact input is coupled to the first power output terminal of the first battery module (12a) and the first main contact output is coupled to the second power output terminal of the second battery module (12b), and the first auxiliary contact input is coupled to the first control input, and the first auxiliary contact output is coupled to first control output;
a second interconnect controller (16b) electrically disposed between the second (12b) and third (12c) battery modules, the second interconnect controller including a second control input, a second actuating coil (20) having a second coil input, and a second main contact (22) having a second main contact input and a second main contact output, wherein the second control input is coupled to the first control output, the second main contact input is coupled to the first power output terminal of the second battery module (12b) and the second main contact output is coupled to the second power output terminal of the third battery module (12c);
wherein actuation of the control signal by the control module (14) is adapted to energize the first actuating coil (20) of the first interconnect controller (16a), which is adapted to close the first main contact (22) of the first interconnect controller (16a) to couple the first battery module (12a) to the second battery module (12b), and to close the first auxiliary contact (24) of the first interconnect controller (16a) to pass the control signal to the second control input of the second interconnect controller (16b) when the first auxiliary contact (24) of the first interconnect controller (16a) closes, wherein the control signal passed by the first auxiliary contact (24) of the first interconnect controller (16a) is adapted to energize the second actuating coil (20) of the second interconnect controller (16b), which is adapted to close the second main contact (22) of the second interconnect controller (16b) and to couple the third battery module (12c) to the first (12a) and second (12b) battery modules.

2. The system of claim 1, wherein the first polarity is positive.

3. The system of claim 1, including a driver circuit (25) coupled between the first auxiliary contact output and the first control output for isolating the battery modules (12a, 12b, 12c) from the control signal.

4. The system of claim 3, wherein the driver circuit includes means for delaying the control signal passing to the first control output.

5. The system of claim 3, wherein the driver circuit comprises MOSFET transistors.

6. The system of claim 5, wherein the driver circuit includes a capacitor (32) for delaying the control signal passing to the first control output.

7. The system of claim 5, wherein the driver circuit includes a microprocessor (34) for delaying the control signal passing to the first control output.

8. The system of claim 4, including an output from the driver circuit for monitoring a cell stage.

9. The system of claim 4, including an LED (44) coupled to the driver circuit for indicating engagement of the main (22) and auxiliary (24) contacts.

10. The system of claim 1, including a third interconnect controller (16), and wherein the actuating coil (24) of the second interconnect controller (16b) responds to the passed control signal to close the respective auxiliary contact (24) of the second interconnect controller (16b) to pass the control signal to the third interconnect controller.

Patentansprüche

1. System zum Bereitstellen von DC-Leistung an eine Last, wobei das System umfasst:

erste, zweite und dritte Batteriemodule (12a, 12b, 12c), wobei jedes von dem ersten, zweiten und dritten Batteriemodul eine erste Leistungsausgangsklemme (B+) und eine zweite Leistungsausgangsklemme (B-) einschließt, wobei jede der ersten Leistungsausgangsklemmen eine erste Polarität hat und jedes der zweiten Leistungsausgangsklemmen eine zweite, entgegengesetzte Polarität hat;
ein Steuermodul (14) mit einem Steuermodulausgang zum Bereitstellen eines Steuersignals;
eine erste Verschaltungssteuerung (16a), die elektrisch zwischen dem ersten (12a) und dem zweiten (12b) Batteriemodul angeordnet ist, wobei die erste Verschaltungssteuerung einen ersten Steuereingang und einen ersten Steuerausgang, eine erste Aktorspule (20) mit einem ersten Spuleneingang und einem ersten Spulenausgang, einen ersten Hauptkontakt (22) mit einem ersten Hauptkontakteingang und einem ersten Hauptkontaktausgang und einen ersten Hilfskontakt (24) mit einem ersten Hilfskontakteingang und einem ersten Hilfskontaktausgang einschließt, wobei der erste Steuereingang an den Steuermodulausgang gekoppelt ist, um das Steuersignal funktional zu empfangen, der erste Spuleneingang an den ersten Steuereingang gekoppelt ist, der erste Hauptkontakteingang an die erste Leistungsausgangsklemme des ersten Batteriemoduls (12a) gekoppelt ist und der erste Hauptkontaktausgang an die zweite Leistungsausgangsklemme des zweiten Batteriemoduls (12b) gekoppelt ist, und der erste Hilfskontakteingang an den ersten Steuereingang gekoppelt ist und der erste Hilfskontaktausgang an den ersten Steuerausgang gekoppelt ist;
eine zweite Verschaltungssteuerung (16b), die elektrisch zwischen dem zweiten (12b) und dem dritten (12c) Batteriemodul angeordnet ist, wobei die zweite Verschaltungssteuerung einen zweiten Steuereingang, eine zweite Aktorspule (20) mit einem zweiten Spuleneingang und einen zweiten Hauptkontakt (22) mit einem zweiten Hauptkontakteingang und einem zweiten Hauptkontaktausgang einschließt, wobei der zweite Steuereingang an den ersten Steuerausgang gekoppelt ist, der zweite Hauptkontakteingang an die erste Leistungsausgangsklemme des zweiten Batteriemoduls (12b) gekoppelt ist, und der zweite Hauptkontaktausgang an die zweite Leistungsausgangsklemme des dritten Batteriemoduls (12c) gekoppelt ist;
wobei Auslösung des Steuersignals durch das Steuermodul (14) vorgesehen ist, um die erste Aktorspule (20) der ersten Verschaltungssteuerung (16a) zu erregen, die vorgesehen ist, um den ersten Hauptkontakt (22) der ersten Verschaltungssteuerung (16a) zu schließen, um das erste Batteriemodul (12a) an das zweite Batteriemodul (12b) zu koppeln, und um den ersten Hilfskontakt (24) der ersten Verschaltungssteuerung (16a) zu schließen, um das Steuersigal an den zweiten Steuereingang der zweiten Verschaltungssteuerung (16b) hindurch zu leiten, wenn der erste Hilfskontakt (24) der ersten Verschaltungssteuerung (16a) schließt, wobei das durch den ersten Hilfskontakt (24) der ersten Verschaltungssteuerung (16a) hindurch geleitete Steuersignal vorgesehen ist, um die zweite Aktorspule (20) der zweiten Verschaltungssteuerung (16b) zu erregen, die vorgesehen ist, um den zweiten Hauptkontakt (22) der zweiten Verschaltungssteuerung (16b) zu schließen und das dritte Batteriemodul (12c) an das erste (12a) und das zweite (12b) Batteriemodul zu koppeln.

2. System nach Anspruch 1, wobei die erste Polarität positiv ist.

3. System nach Anspruch 1, das eine Treiberschaltung (25) einschließt, die zwischen den ersten Hilfskontaktausgang und den ersten Steuerausgang gekoppelt ist, um die Batteriemodule (12a, 12b, 12c) von dem Steuersignal zu isolieren.

4. System nach Anspruch 3, wobei die Treiberschaltung Mittel zum Verzögern des Hindurchleitens des Steuersignals zu dem ersten Steuerausgang einschließt.

5. System nach Anspruch 3, wobei die Treiberschaltung MOSFET-Transistoren umfasst.

6. System nach Anspruch 5, wobei die Treiberschaltung einen Kondensator (32) zum Verzögern des Hindurchleitens des Steuersignals zu dem ersten Steuerausgang einschließt.

7. System nach Anspruch 5, wobei die Treiberschaltung einen Mikroprozessor (34) zum Verzögern des Hindurchleitens des Steuersignals zu dem ersten Steuerausgang einschließt.

8. System nach Anspruch 4, das einen Ausgang von der Treiberschaltung zur Überwachung einer Zellphase einschließt.

9. System nach Anspruch 4, das eine LED (44) einschließt, die an die Treiberschaltung gekoppelt ist, um Einkupplung des Hauptkontakts (22) und des

Hilfskontakts (24) anzugeben.

10. System nach Anspruch 1, das eine dritte Verschaltungssteuerung (16) einschließt, und wobei die Aktorspule (24) der zweiten Verschaltungssteuerung (16b) auf das hindurch geleitete Steuersignal reagiert, um den jeweiligen Hilfskontakt (24) der zweiten Verschaltungssteuerung (16b) zu schließen, um das Steuersignal an die dritte Verschaltungssteuerung hindurch zu leiten.

Revendications

1. Système destiné à assurer l'alimentation CC d'une charge, le système comprenant :

des premier, deuxième et troisième modules de batterie (12a, 12b, 12c), chacun des premier, deuxième et troisième modules de batterie comportant une première borne de sortie d'alimentation (B+) et une deuxième borne de sortie d'alimentation (B-), chacune des premières bornes de sortie d'alimentation étant d'une première polarité et chacune des deuxièmes bornes de sortie d'alimentation étant d'une deuxième polarité, opposée ;
un module de commande (14) ayant une sortie de module de commande pour délivrer un signal de commande ;
un premier contrôleur d'interconnexion (16a) disposé électriquement entre les premier (12a) et deuxième (12b) modules de batterie, le premier contrôleur d'interconnexion comportant une première entrée de commande et une première sortie de commande, une première bobine d'actionnement (20) ayant une première entrée de bobine et une première sortie de bobine, un premier contact principal (22) ayant une première entrée de contact principal et une première sortie de contact principal, et un premier contact auxiliaire (24) ayant une première entrée de contact auxiliaire et une première sortie de contact auxiliaire, la première entrée de commande étant couplée à la sortie de module de commande pour recevoir en fonctionnement le signal de commande, la première entrée de bobine étant couplée à la première entrée de commande, la première entrée de contact principal étant couplée à la première borne de sortie d'alimentation du premier module de batterie (12a) et la première sortie de contact principal étant couplée à la deuxième borne de sortie d'alimentation du deuxième module de batterie (12b), et la première entrée de contact auxiliaire étant couplée à la première entrée de commande, et la première sortie de contact auxiliaire étant couplée à la première sortie de commande ;
un deuxième contrôleur d'interconnexion (16b) disposé électriquement entre les deuxième (12b) et troisième (12c) modules de batterie, le deuxième contrôleur d'interconnexion comportant une deuxième entrée de commande, une deuxième bobine d'actionnement (20) ayant une deuxième entrée de bobine, et un deuxième contact principal (22) ayant une deuxième entrée de contact principal et une deuxième sortie de contact principal, la deuxième entrée de commande étant couplée à la première sortie de commande, la deuxième entrée de contact principal étant couplée à la première borne de sortie d'alimentation du deuxième module de batterie (12b) et la deuxième sortie de contact principal étant couplée à la deuxième borne de sortie d'alimentation du troisième module de batterie (12c) ;
dans lequel le déclenchement du signal de commande par le module de commande (14) est adapté pour alimenter la première bobine d'actionnement (20) du premier contrôleur d'interconnexion (16a), qui est adaptée pour fermer le premier contact principal (22) du premier contrôleur d'interconnexion (16a) pour coupler le premier module de batterie (12a) au deuxième module de batterie (12b), et pour fermer le premier contact auxiliaire (24) du premier contrôleur d'interconnexion (16a) pour faire passer le signal de commande à la deuxième entrée de commande du deuxième contrôleur d'interconnexion (16b) quand le premier contact auxiliaire (24) du premier contrôleur d'interconnexion (16a) se ferme, dans lequel le signal de commande passé par le premier contact auxiliaire (24) du premier contrôleur d'interconnexion (16a) est adapté pour alimenter la deuxième bobine d'actionnement (20) du deuxième contrôleur d'interconnexion (16b), qui est adaptée pour fermer le deuxième contact principal (22) du deuxième contrôleur d'interconnexion (16b) et pour coupler le troisième module de batterie (12c) aux premier (12a) et deuxième (12b) modules de batterie.

2. Système de la revendication 1, dans lequel la première polarité est positive.

3. Système de la revendication 1, comportant un circuit de pilotage (25) couplé entre la première sortie de contact auxiliaire et la première sortie de commande pour isoler les modules de batterie (12a, 12b, 12c) du signal de commande.

4. Système de la revendication 3, dans lequel le circuit de pilotage comporte des moyens pour retarder le passage du signal de commande à la première sortie de commande.

5. Système de la revendication 3, dans lequel le circuit de pilotage comprend des transistors MOSFET.

6. Système de la revendication 5, dans lequel le circuit de pilotage comporte un condensateur (32) pour retarder le passage du signal de commande à la première sortie de commande.

7. Système de la revendication 5, dans lequel le circuit de pilotage comporte un microprocesseur (34) pour retarder le passage du signal de commande à la première sortie de commande.

8. Système de la revendication 4, comportant une sortie partant du circuit de pilotage pour surveiller un étage de cellules.

9. Système de la revendication 4, comportant une DEL (44) couplée au circuit de pilotage pour indiquer un enclenchement des contacts principaux (22) et auxiliaires (24) .

10. Système de la revendication 1, comportant un troisième contrôleur d'interconnexion (16), et dans lequel la bobine d'actionnement (24) du deuxième contrôleur d'interconnexion (16b) répond au signal de commande passé pour fermer le contact auxiliaire respectif (24) du deuxième contrôleur d'interconnexion (16b) pour faire passer le signal de commande au troisième contrôleur d'interconnexion.

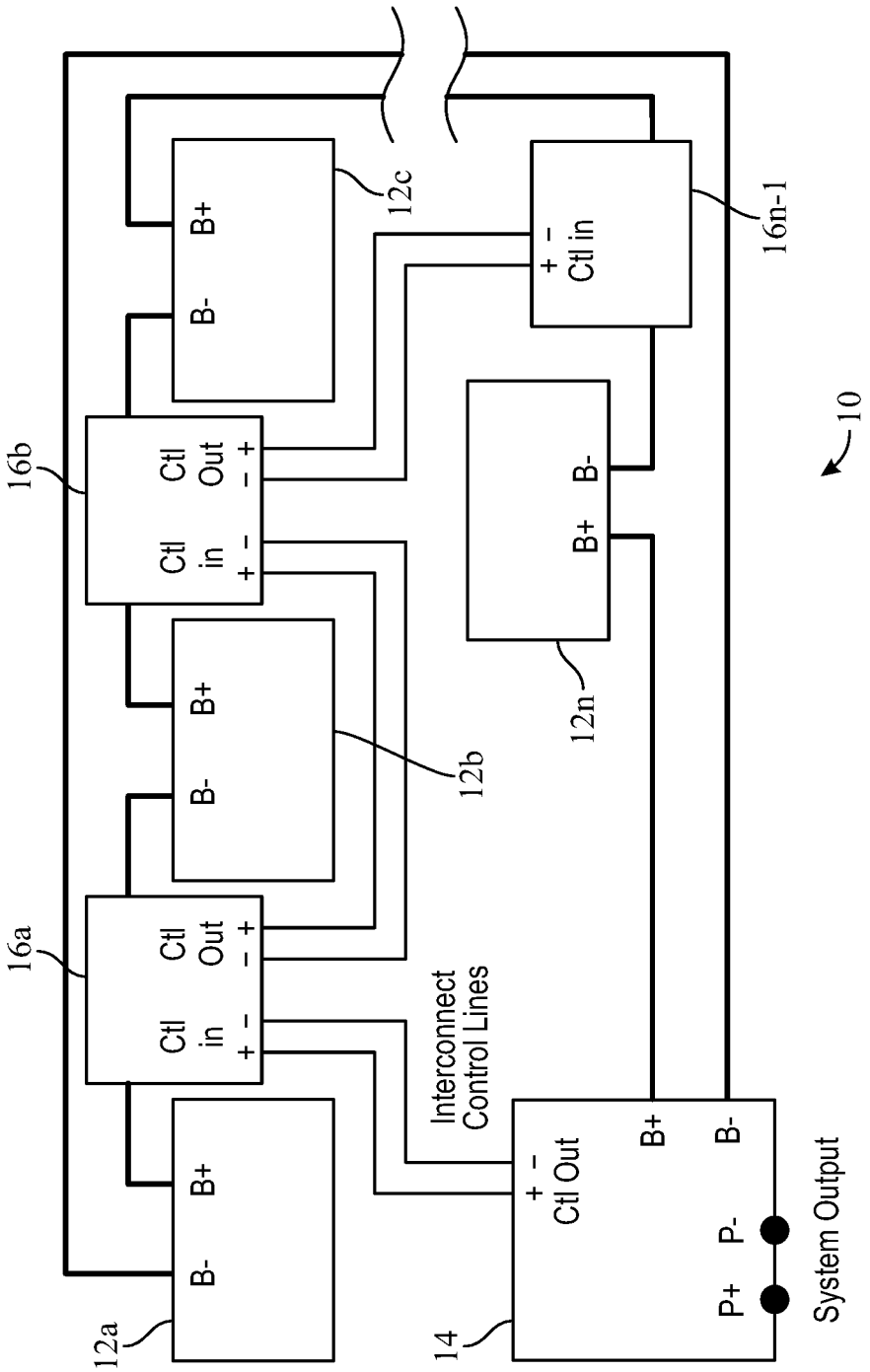
B+
B-
12c
16n-1
+ -
Ctl in
16b
Ctl
Out
Ctl
in
12n
12b
16a
Interconnect
Control Lines
12a
14
Ctl Out
P-
P+
System Output
10

FIG. 1

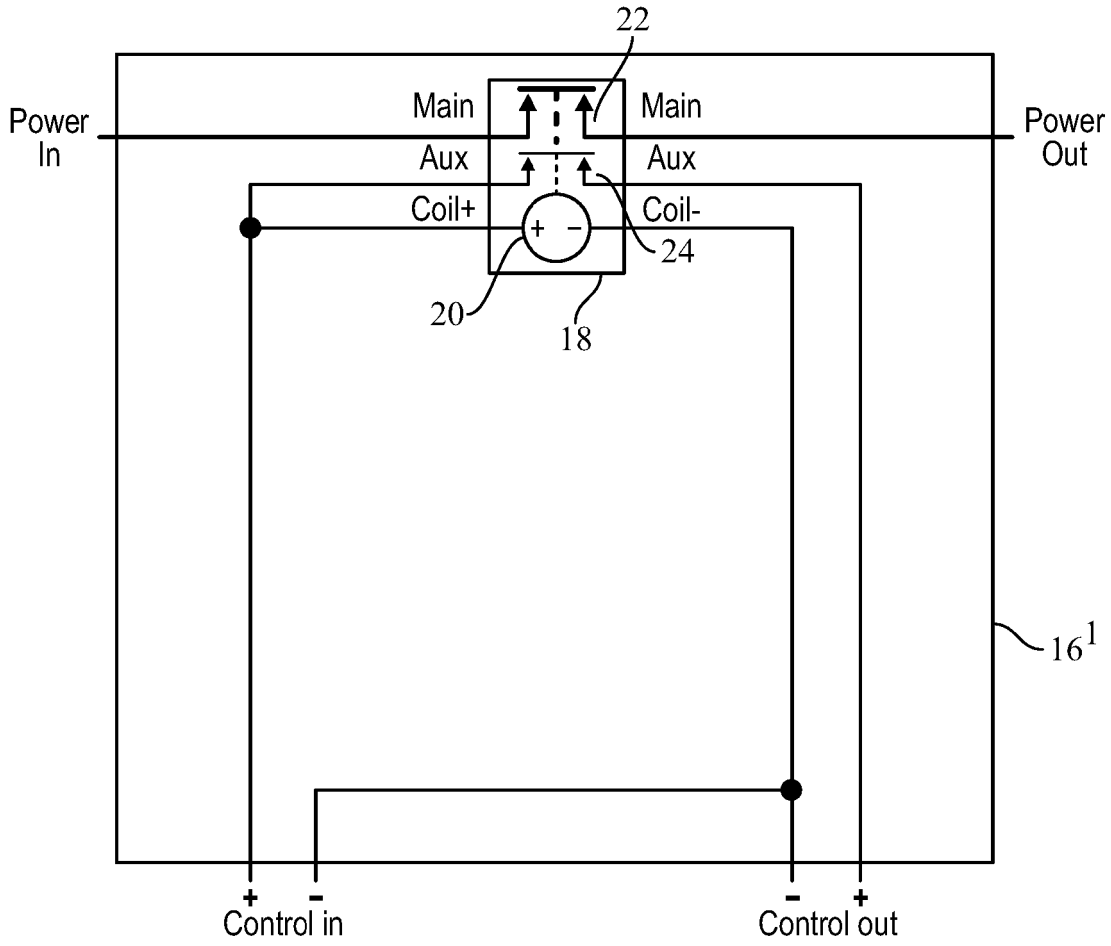
22
Power In
Main
Main
Power Out
Aux
Aux
Coil+
Coil-
24
20
18
16 1
+
-
Control in
-
+
Control out

FIG. 2

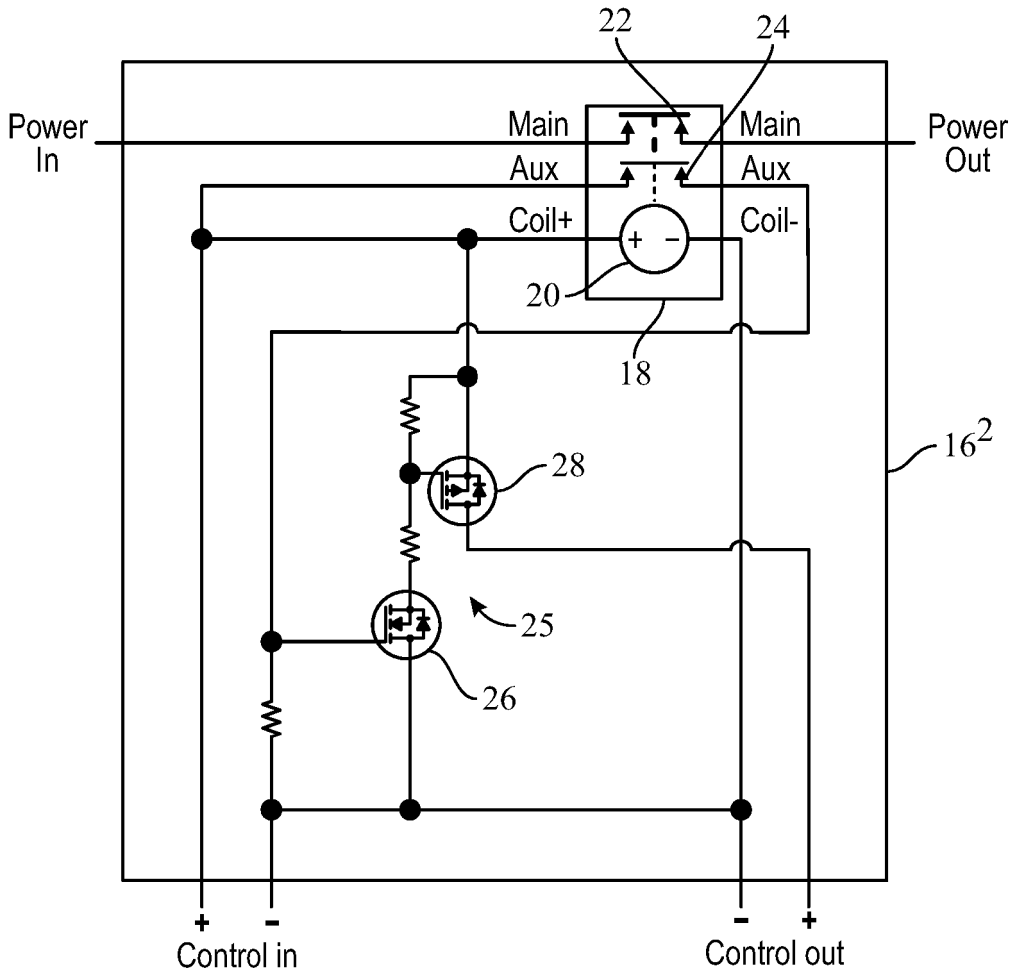
22
24
Power In
Main
Aux
Coil+
Main
Aux
Coil-
Power Out
20
18
28
25
26
16 2
+
-
Control in
-
+
Control out

FIG. 3

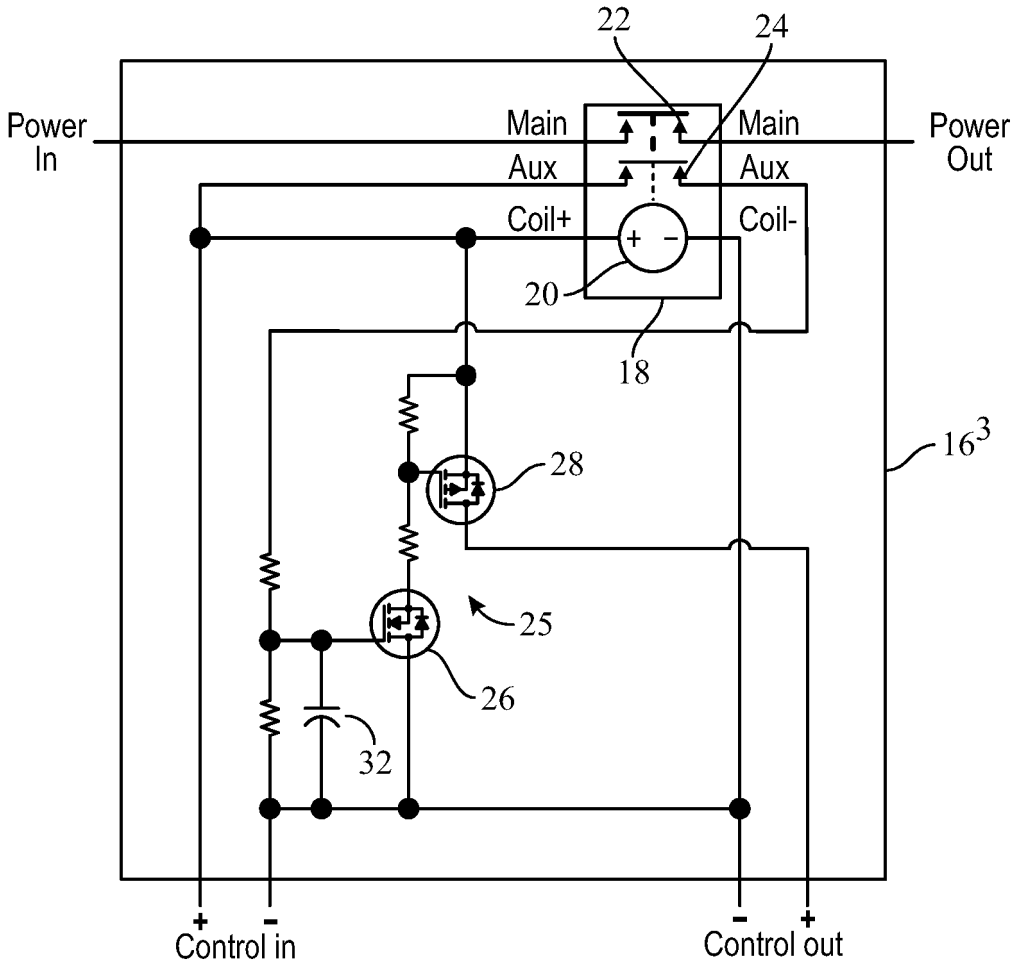
22
24
Power In
Main
Aux
Coil+
Main
Aux
Coil-
Power Out
20
18
163
28
25
26
32
+
-
Control in
-
+
Control out

FIG. 4A

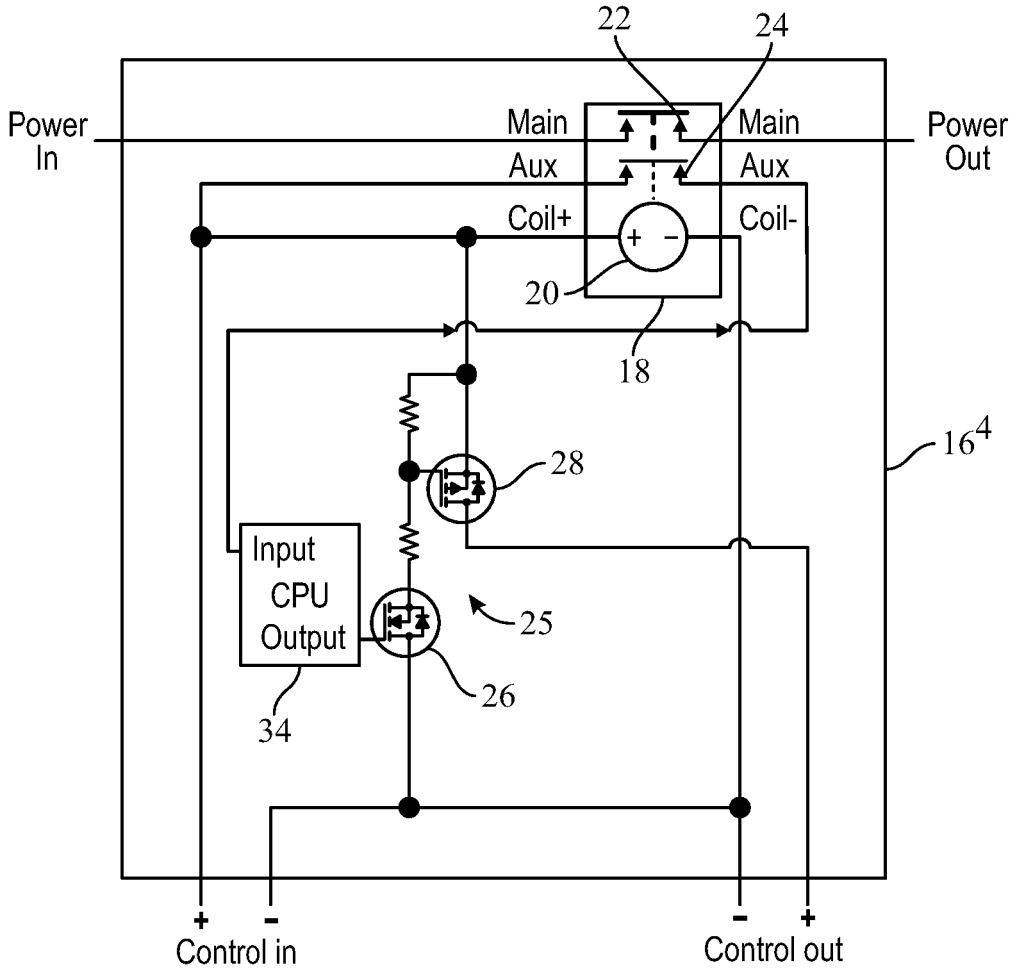
22
24
Power In
Main
Aux
Coil+
Main
Aux
Coil-
Power Out
20
18
16 4
28
Input CPU Output
25
26
34
+
-
Control in
-
+
Control out

FIG. 4B

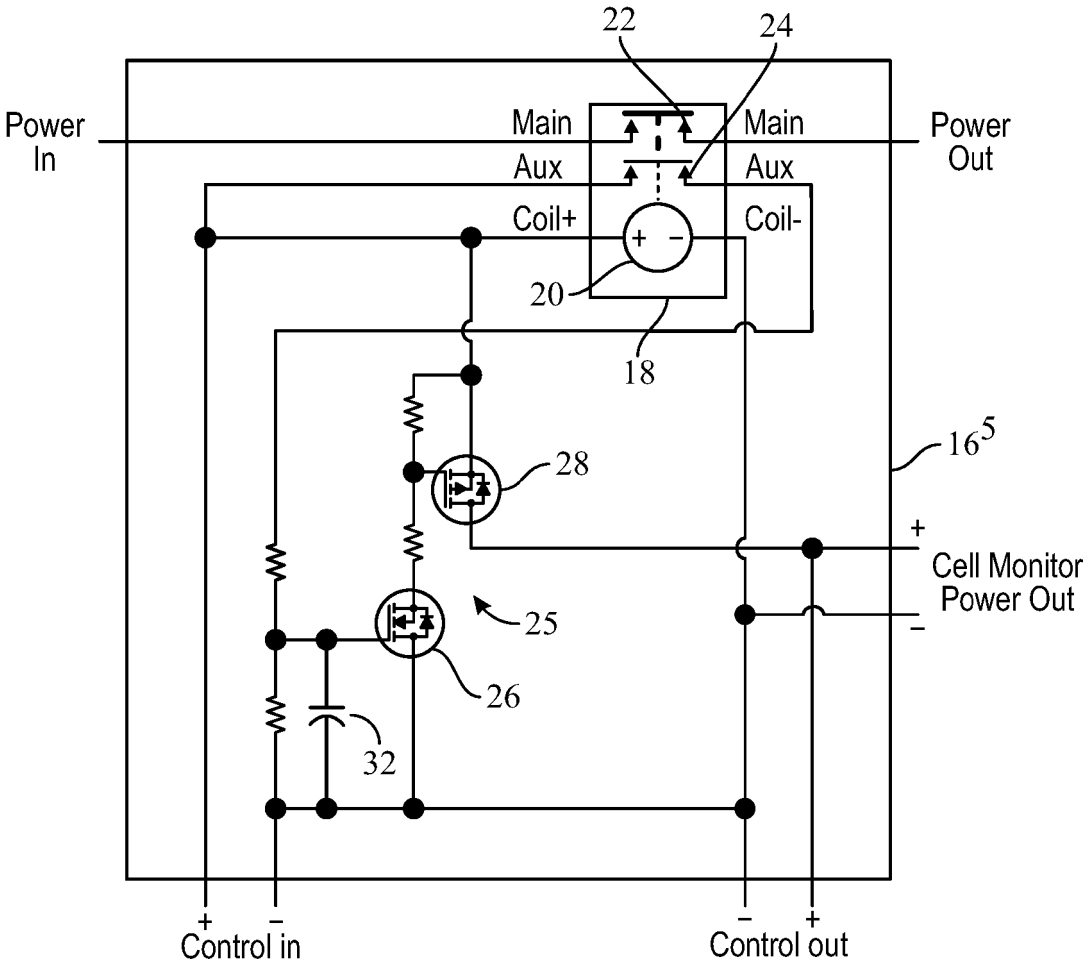
22
24
Power In
Main
Aux
Coil+
Main
Aux
Coil-
Power Out
20
18
165
28
25
26
32
+
Cell Monitor Power Out
−
+ −
Control in
− +
Control out

FIG. 5

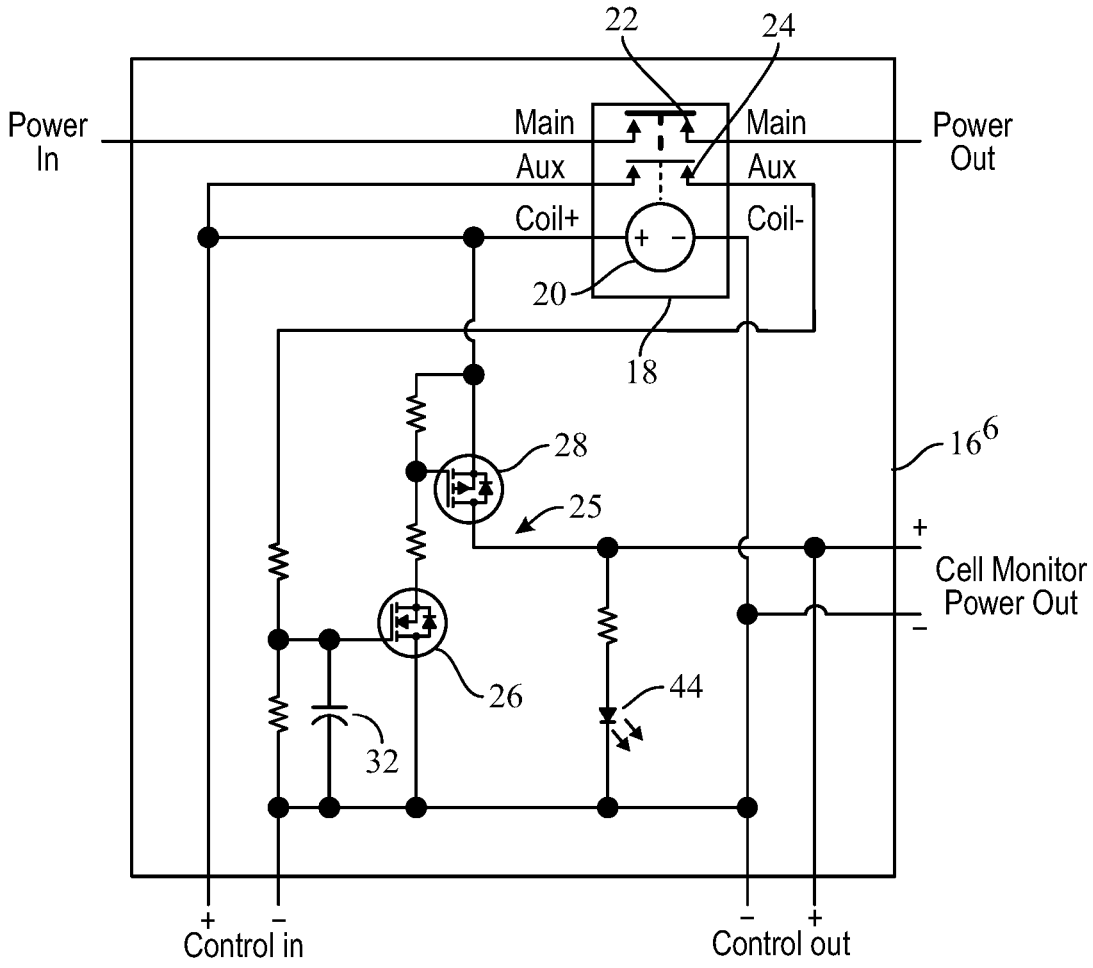
22
24
Power In
Main
Aux
Coil+
Main
Aux
Coil-
Power Out
20
18
28
25
166
Cell Monitor Power Out
26
44
32
Control in
Control out

FIG. 6

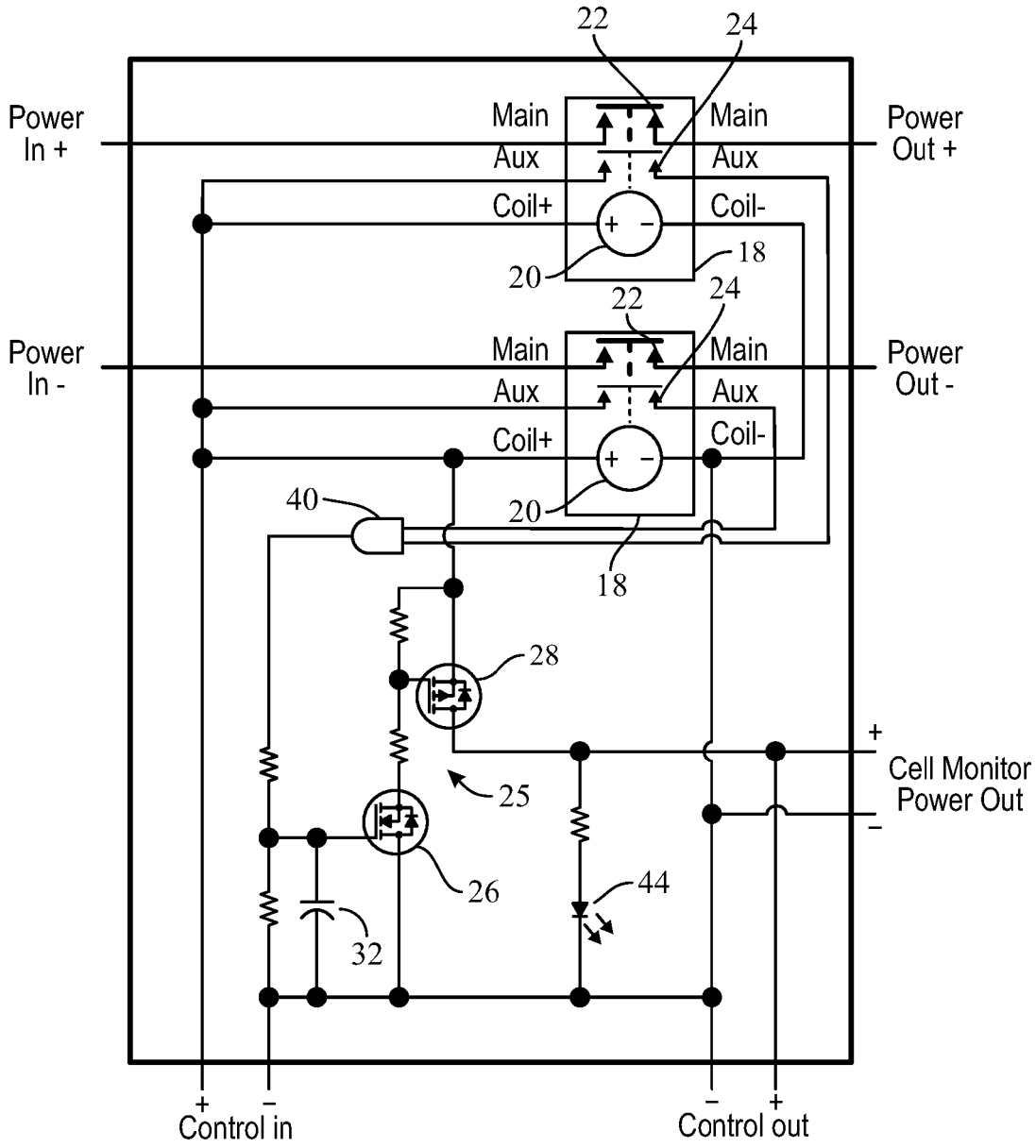
22
24
Power
In +
Main
Aux
Coil+
Coil-
Main
Aux
Power
Out +
20
18
22
24
Power
In -
Main
Aux
Coil+
Coil-
Main
Aux
Power
Out -
40
20
18
28
25
26
44
32
+
Cell Monitor
Power Out
–
+
–
Control in
–
+
Control out

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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