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(54) **SMART TRAILER POWER SUPPLY**

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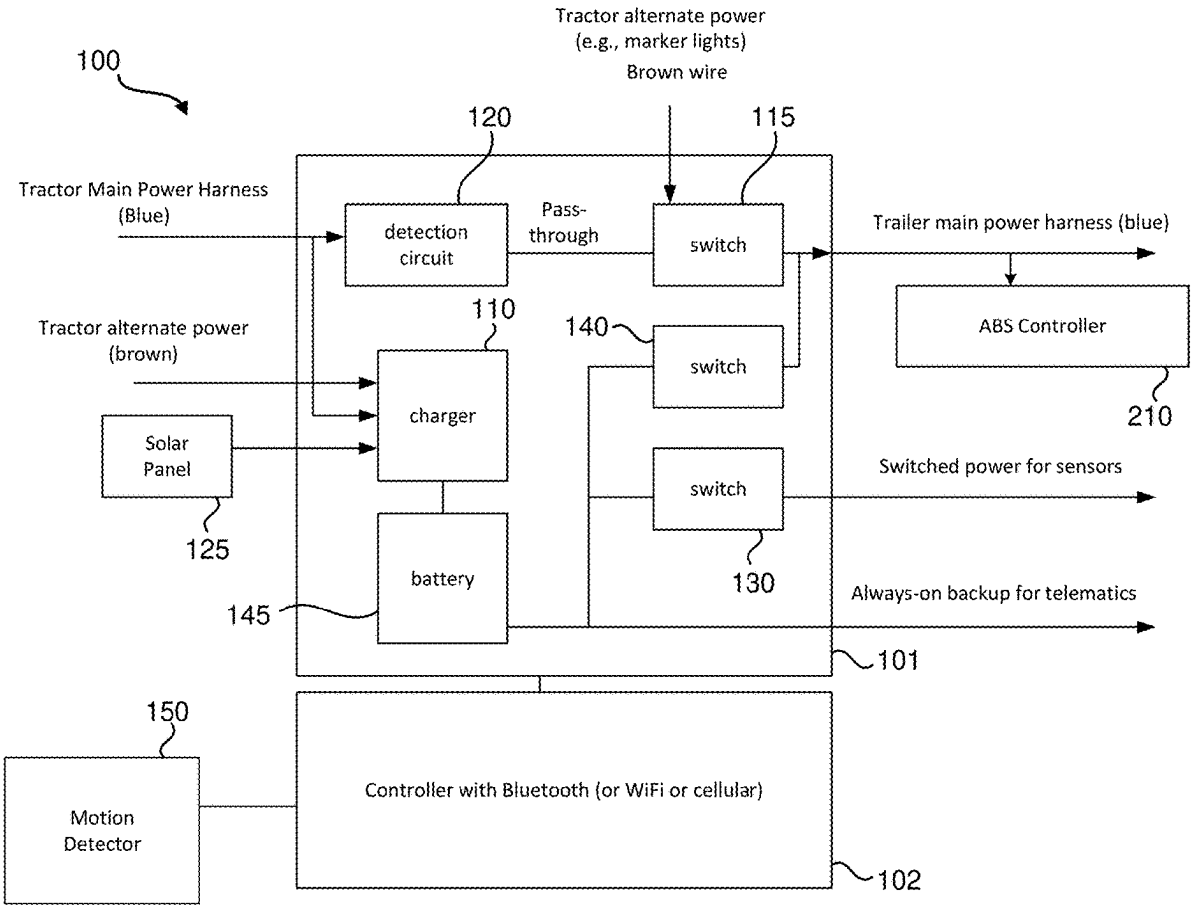
(57) **ABSTRACT**

A smart battery box is provided that includes a battery for selectively powering a trailer main harness coupled to an ABS controller. The smart battery box includes a controller configured to respond to a command to control a switch to close to power the ABS controller through the battery. In this fashion, the ABS controller may be tested through the smart battery box while the trailer is disconnected from a tractor.



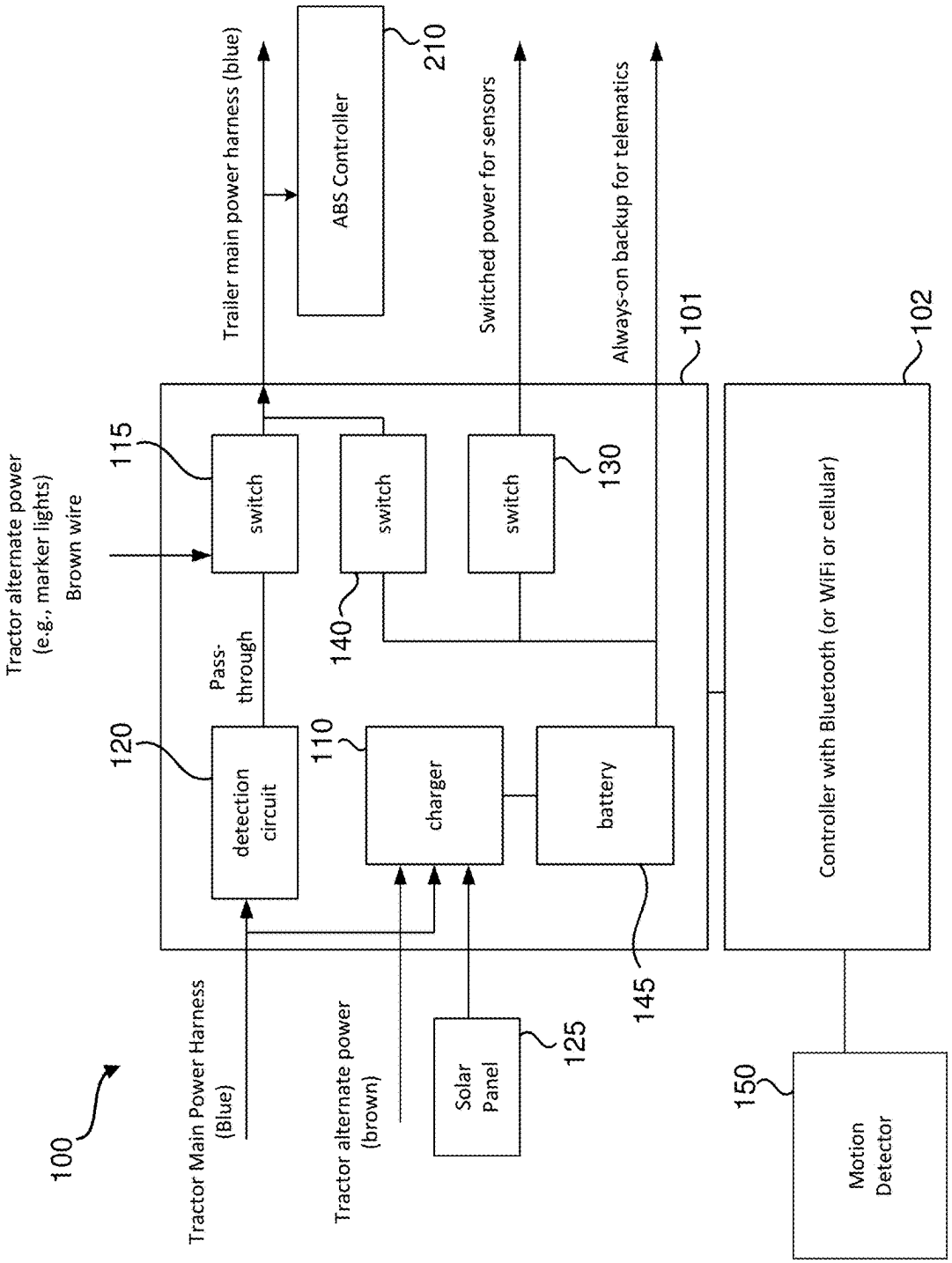

100
Tractor Main Power Harness (Blue)
Tractor alternate power (brown)
Solar Panel
125
145
150
Motion Detector
Tractor alternate power (e.g., marker lights) Brown wire
120
detection circuit
Pass-through
115
switch
110
charger
battery
140
switch
130
switch
Trailer main power harness (blue)
ABS Controller
210
Switched power for sensors
Always-on backup for telematics
101
102
Controller with Bluetooth (or WiFi or cellular)

FIG. 1

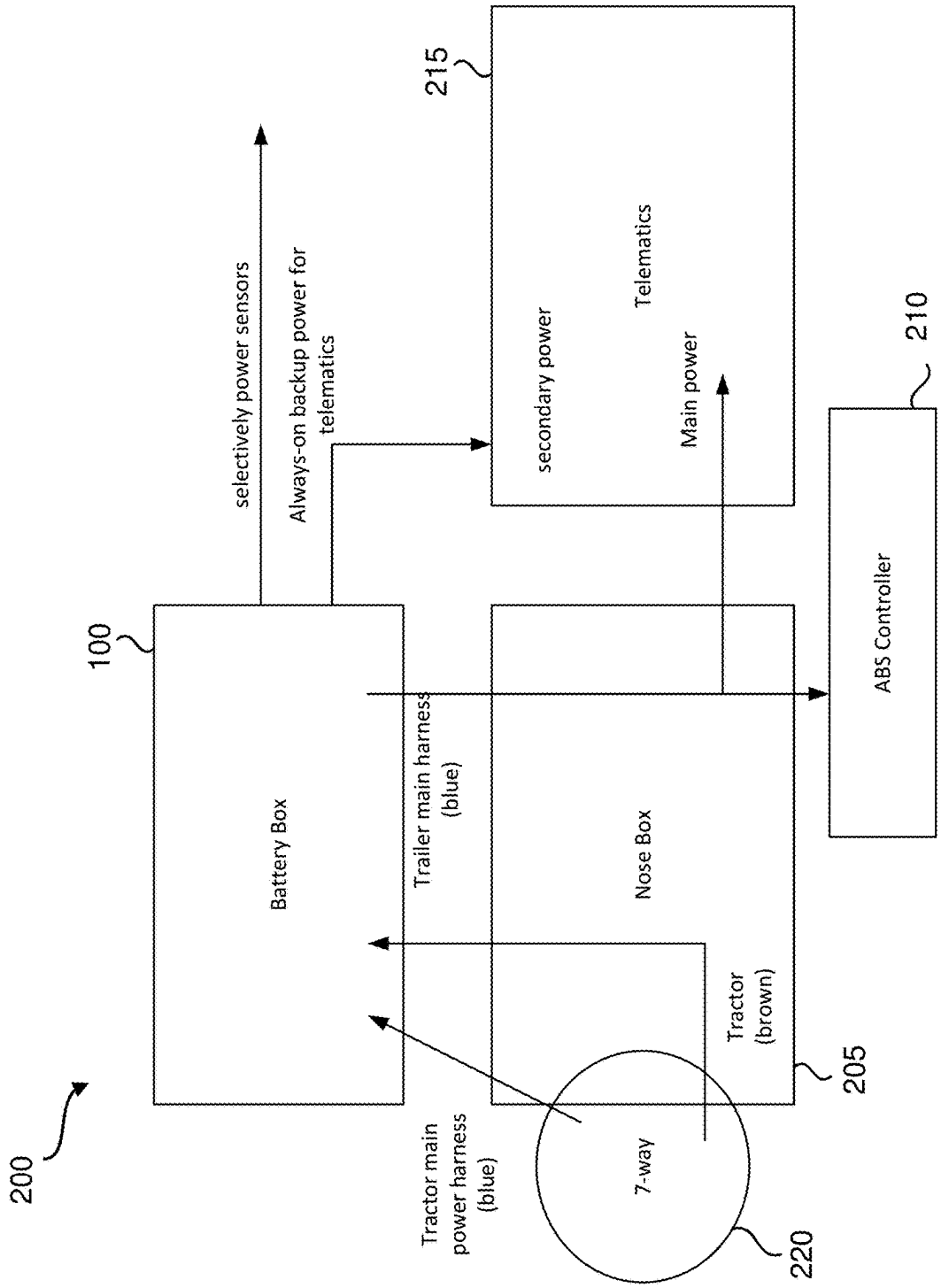

200
100
Battery Box
selectively power sensors
Always-on backup power for telematics
Trailer main harness (blue)
Tractor main power harness (blue)
215
secondary power
Telematics
Main power
Nose Box
Tractor (brown)
205
7-way
220
210
ABS Controller

FIG. 2

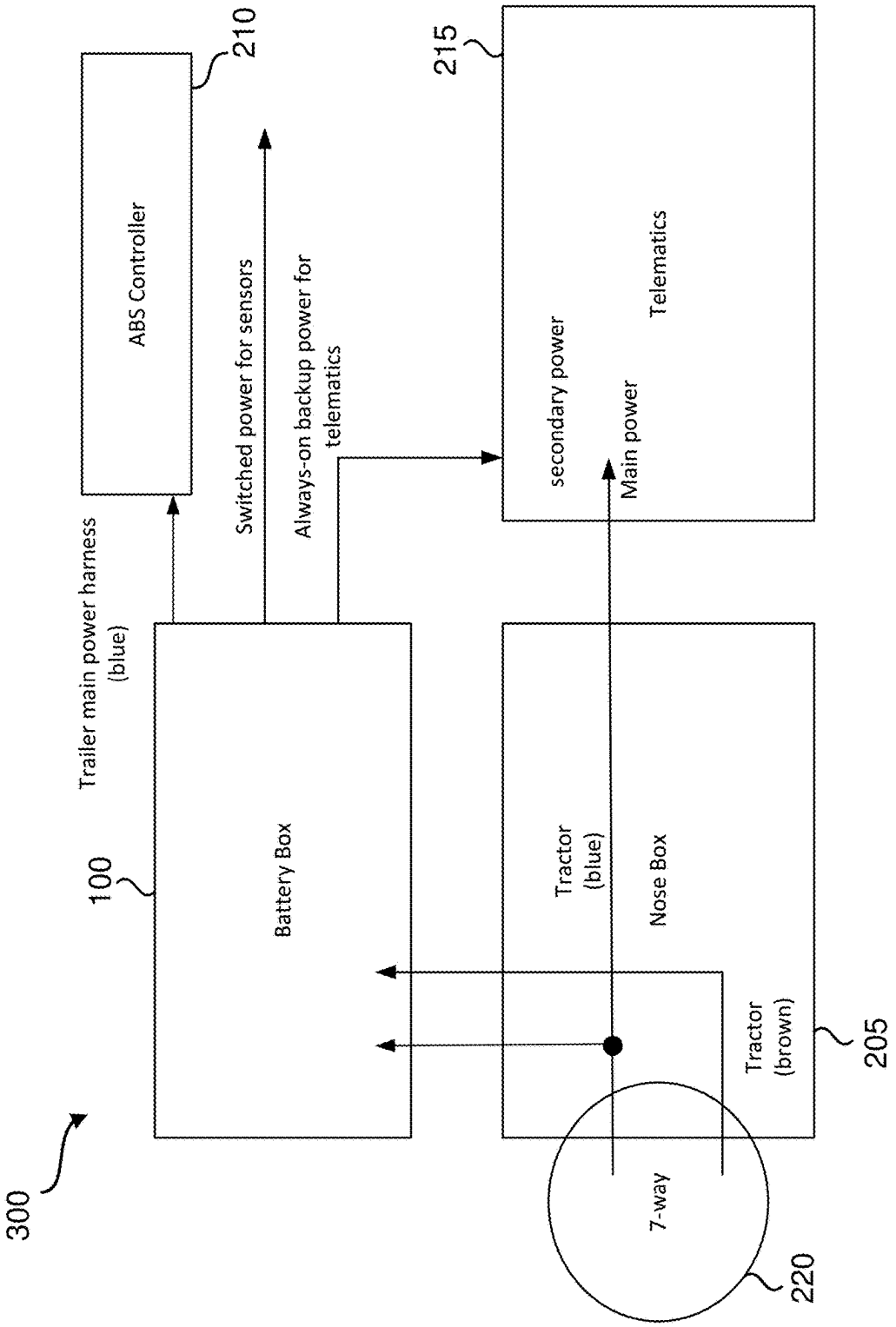

300
100
Battery Box
Trailer main power harness (blue)
ABS Controller
210
Switched power for sensors
Always-on backup power for telematics
215
secondary power
Telematics
Main power
Tractor (blue)
Nose Box
Tractor (brown)
205
7-way
220

FIG. 3

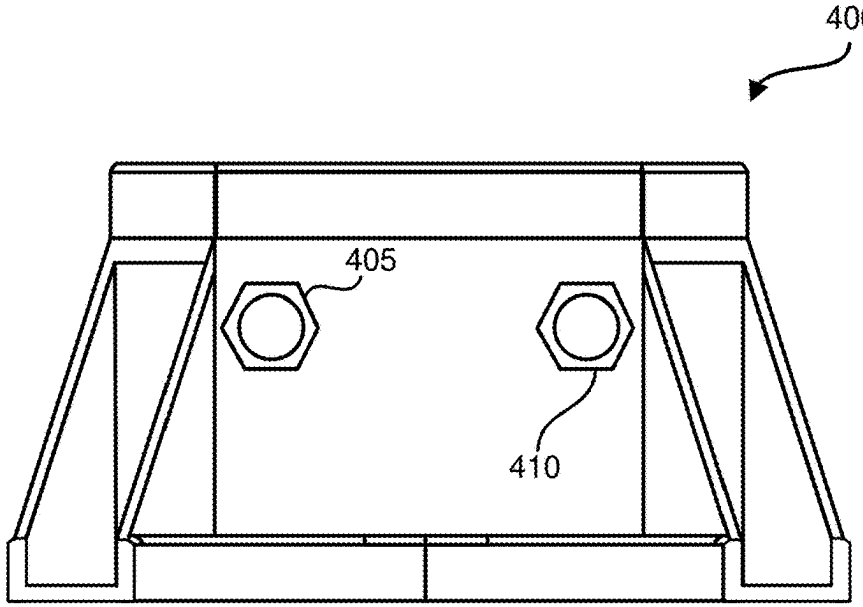


FIG. 4A

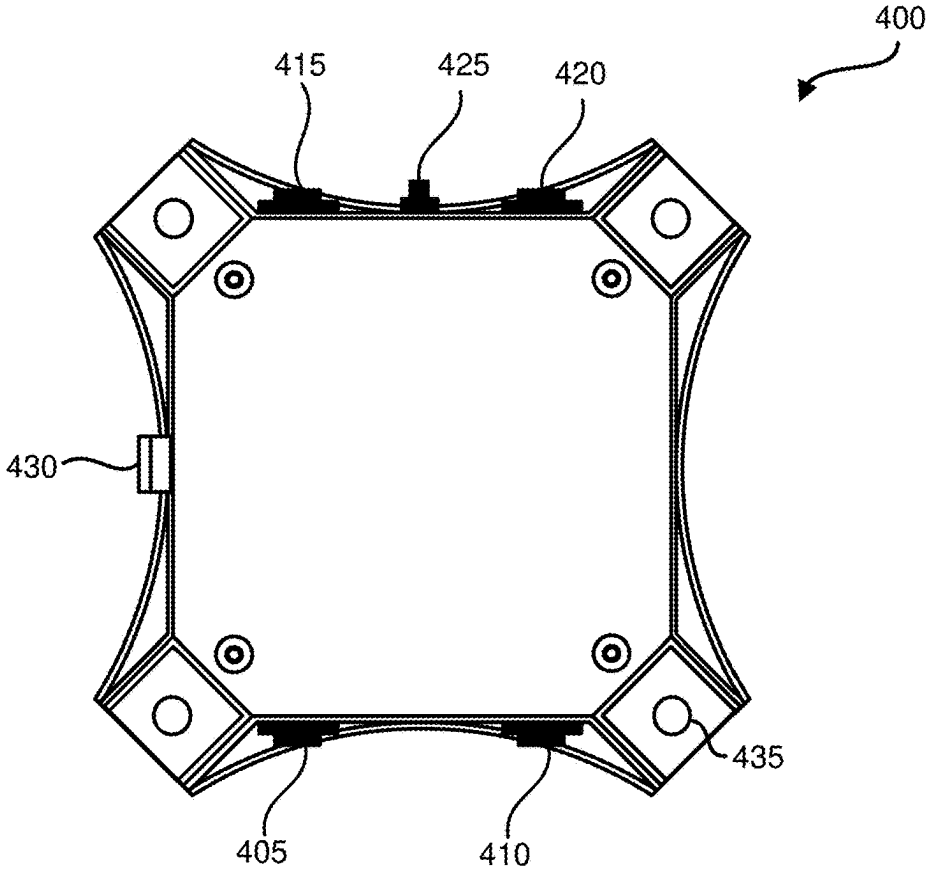


FIG. 4B

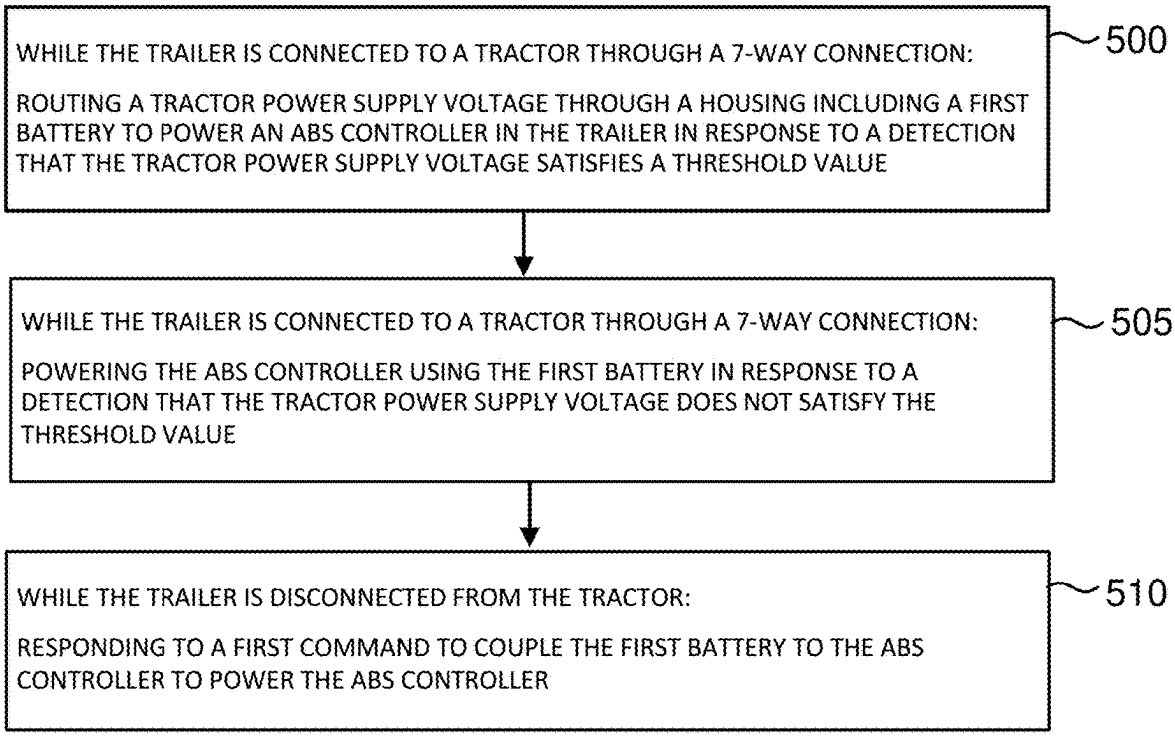

WHILE THE TRAILER IS CONNECTED TO A TRACTOR THROUGH A 7-WAY CONNECTION:
ROUTING A TRACTOR POWER SUPPLY VOLTAGE THROUGH A HOUSING INCLUDING A FIRST BATTERY TO POWER AN ABS CONTROLLER IN THE TRAILER IN RESPONSE TO A DETECTION THAT THE TRACTOR POWER SUPPLY VOLTAGE SATISFIES A THRESHOLD VALUE
500
WHILE THE TRAILER IS CONNECTED TO A TRACTOR THROUGH A 7-WAY CONNECTION:
POWERING THE ABS CONTROLLER USING THE FIRST BATTERY IN RESPONSE TO A DETECTION THAT THE TRACTOR POWER SUPPLY VOLTAGE DOES NOT SATISFY THE THRESHOLD VALUE
505
WHILE THE TRAILER IS DISCONNECTED FROM THE TRACTOR:
RESPONDING TO A FIRST COMMAND TO COUPLE THE FIRST BATTERY TO THE ABS CONTROLLER TO POWER THE ABS CONTROLLER
510

FIG. 5

SMART TRAILER POWER SUPPLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation of International Patent Application No. PCT/US2023/078729, filed Nov. 3, 2023, which claims priority to and the benefit of U.S. Provisional Application No. 63/382,183, filed Nov. 3, 2022, each of which are hereby incorporated by reference herein in their entirety.

TECHNICAL FIELD

[0002] The present invention relates to a trailer power supply, and more particularly, to trailer power supply that may selectively power at least one of a sensor a main trailer harness, and a telematics gateway.

BACKGROUND

[0003] The design of a trailer in a tractor-trailer varies depending upon the region but regardless of the design, it is conventional to use a J-560 interface (commonly referred to as a 7-way coupler) on the trailer or other type of towable asset to ease the connection and disconnection of the trailer from the tractor. As implied by the name, a 7-way coupler includes 7 pins or terminals. One pin is for ground. The remaining six pins are conventionally used to drive the tail lights, marker lights, an auxiliary circuit such as an anti-lock brake (ABS) unit, the left turn signal, the right turn signal, and the stop lights, respectively.

[0004] The proper functioning of these various lights and circuits is vital for public safety. Various monitors have thus been developed that may wirelessly report the operating status of the lights and circuits in the trailer. But the ease of integration of such monitors is an issue. Similarly, various telematic reporting systems have been developed for the trucking industry. Customers may have thousands of rigs so the costs of retrofitting them to include monitors and telematics must be minimized.

SUMMARY

[0005] In accordance with an aspect of the disclosure, a trailer power system is provided that includes: a battery; a charger configured to charge the battery using a tractor power supply voltage; a detection circuit configured to detect whether the tractor power supply voltage is greater than a threshold value; a first switch coupled between a lead carrying the tractor power supply voltage and a trailer main power lead for powering an ABS controller in the trailer; a second switch coupled between the battery and the trailer main power lead; and a controller configured to control the first switch to couple the tractor power supply voltage to the trailer main power lead in response to a detection by the detection circuit that the tractor power supply voltage is greater than the threshold value, and wherein the controller is configured to respond to a first command to control the second switch to couple the battery to the trailer main power lead while the trailer is disconnected from a tractor.

[0006] In accordance with another aspect of the disclosure, a method of powering a trailer is provided that includes the acts of: while the trailer is connected to a tractor through a 7-way connection: routing a tractor power supply voltage through a housing including a first battery to power an ABS controller in the trailer in response to a detection that the tractor power supply voltage satisfies a threshold value; powering the ABS controller using the first battery in response to a detection that the tractor power supply voltage does not satisfy the threshold value; and while the trailer is disconnected from tractor and the 7-way connection: responding to a wireless command to couple the first battery to the ABS controller to power the ABS controller.

[0007] These and additional advantageous features of the disclosed embodiments may be better appreciated through a consideration of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a block diagram of a smart battery box in accordance with an aspect of the disclosure.

[0009] FIG. **2** is a block diagram of a trailer system including a smart battery box in which the trailer main harness routes from the smart battery box to the nose box before routing to the trailer in accordance with an aspect of the disclosure.

[0010] FIG. **3** is a block diagram of a trailer system including a smart battery box in which the trailer main harness routes directly from the smart battery box to the trailer in accordance with an aspect of the disclosure.

[0011] FIG. **4**A is a side view of a housing for a smart battery box in accordance with an aspect of the disclosure.

[0012] FIG. **4**B is a plan view of the housing of FIG. **4**A.

[0013] FIG. **5** is a flowchart of an example method of operation of a smart battery box in accordance with an aspect of the disclosure.

[0014] Embodiments of the present disclosure and their advantages are best understood by referring to the detailed description that follows. It should be appreciated that like reference numerals are used to identify like elements illustrated in one or more of the figures.

DETAILED DESCRIPTION

[0015] To provide improved monitoring and telematics, a smart battery box is provided that provides always-on power for telematics and may selectively power the trailer main power harness to selectively power an anti-lock braking system (ABS) controller and also to selectively power sensors such as tire pressure monitoring system (TPMS) sensors, cameras, cargo sensors, and so on. The smart battery box may advantageously be used in conjunction with a smart nose box such as disclosed in U.S. patent application Ser. No. 17/890,895, (the '895 application) filed Aug. 8, 2022, the contents of which are incorporated by reference herein in their entirety. In such a smart nose box, a nose box housing encloses the telematics for tracking and monitoring the trailer and may also enclose a gateway or cellular transceiver. The nose box housing also encloses a battery for powering the telematics and the gateway through a power management system. However, it will be appreciated that the smart battery box disclosed herein may also be advantageously used in trailers having a nose box that lacks the advantageous features of the smart nose box disclosed in the '895 application.

[0016] The following discussion will use the term "trailer" generically to refer to a semi-trailer, a chassis, a flat bed, or any other suitable towable asset that may be towed by the tractor and receive the tractor's 7-way coupler. The smart nose box disclosed in the '895 application may also selectively power sensors while the trailer is detached from the

tractor so that a user may continue to monitor the trailer status. Although the smart nose box disclosed in the '895 application advantageously solves many issues with regard to monitoring and managing a trailer, note that a user may be retrofitting an existing trailer with a smart nose box. To enable the selective powering of sensors by the smart nose box may then require a user to route an electrical connection from the smart nose box to the sensor that is to be selectively powered. It may be difficult or burdensome to install such an electrical connection.

[0017] Although a smart nose box may include a battery for powering the telematics and gateway, note that the current draw of the trailer harness for powering the ABS controller may well exceed the power rating of such a battery. In that regard, there is a distinction between circuits in the trailer that are powered by the trailer harness from other circuits such as the brake lights, turn signals, and marker lights of the trailer that are powered by corresponding dedicated leads in the 7-way connection to the tractor. For example, a trucker may perform a safety check before driving during which the trucker verifies that the brake lights, turn signals, and marker lights of the trailer are working as powered by the 7-way connection attached to the trailer from the tractor. But such a safety check does not verify that the trailer harness main power wire or lead (typically coloured as a blue wire) is operative. But the trailer harness provides power to the anti-lock brake controller and other circuits such as the automatic tire inflation system (ATIS). It is a common safety backup for the anti-lock brake controller to also be wired to the 7-way lead for the brake lights so that, should the main harness power be faulty or insufficient, the anti-lock brake system can still have power. But such a backup leaves other main-harness-powered circuits such as the ATIS without power. The battery box disclosed herein encloses a battery of sufficient power for powering the trailer main power harness should the tractor main power from the 7-way coupler from the tractor be faulty. In this fashion, the danger from the usual inability of a driver safety check to check the trailer main harness power is eliminated as the battery box will power the trailer main power harness in lieu of the tractor-provided power being insufficient or faulty.

[0018] A block diagram of an example battery box **100** is shown in FIG. **1**. A battery system **101** receives the tractor main power harness from the 7-way connection to the tractor (should the tractor be coupled to the trailer including battery box **100**). The trailer main power harness is also denoted herein as a lead for carrying the tractor power supply voltage. As noted earlier, the tractor main power harness is typically a blue wire. A charger **110** in the battery system **101** couples to the tractor main power harness so that a battery **105** may be charged by the charger **110** while the tractor power is available. Battery system **101** includes a detection circuit **120** (e.g., a voltage divider and a comparator) that measures a voltage (and optionally also a current) for the tractor main power harness. Should the detection circuit **120** verify that the tractor main power harness voltage satisfies a threshold value (e.g., 12 V), battery system **101** controls a first switch **115** so that the tractor main power harness is coupled to the trailer main power harness (the trailer main power harness is also denoted herein as a trailer main power lead and is also typically a blue wire). In this fashion, the ATIS and ABS controller in the trailer are powered by the tractor power as coupled through the tractor main power harness, switch **115**, and the trailer main power harness.

[0019] As noted earlier, the visual safety check performed by a driver can typically only confirm the safe operation of the various lights on the trailer such as the brake lights, the marker lights, and the turn signals. The voltage on the tractor main harness may thus be faulty but not detected by the driver safety check. Detection circuit **120** detects such a faulty voltage such as by comparing the tractor main power harness voltage to a threshold value. To detect whether the trailer is in motion, battery box **100** may include a motion detector **150** such as an accelerometer or a vibration detector. Should the tractor main power harness voltage be less than the threshold as detected by the detection circuit **120** and the trailer be in motion as detected by the motion detector **150**, battery system **101** controls a second switch **140** to couple the battery **105** to the trailer main power harness. In this fashion, safe operation of the trailer is maintained by battery box **100** despite the faulty tractor main power harness voltage (which may also be denoted as the tractor+power supply voltage). In some implementations, switches such as the first switch **115** and the second switch **140** may be combined into a single switch. For example, a single switch replacing switches **115** and **140** would select between the tractor main power harness and battery **105** to drive the trailer main harness. Should the tractor main power harness voltage satisfy the threshold, the tractor main power harness may be deemed to pass through the battery system **101** to couple to the trailer main power harness.

[0020] Battery system **101** may function to automatically control the first switch **115** to couple the tractor main power harness to the trailer main power harness whenever the trailer is coupled through the 7-way connector to the tractor and the tractor main power harness voltage satisfies the threshold. To provide additional control flexibility, battery system **101** may be controlled such as through a wirelessly commanded controller **102**. For example, controller **102** may be configured to respond to Bluetooth commands, WiFi commands, cellular telephone commands, or any other suitable wireless protocol. Despite the trailer being disconnected from the tractor and thus not connected to the tractor's 7-way coupler, a user may then issue a Bluetooth command to force the second switch **140** to couple the trailer main power harness to the battery **105**. Systems coupled to the trailer main power harness such as an ABS controller **210** or the ATIS may then be operated and tested despite the trailer being disconnected. Alternatively, controller **102** may have a cellular or WiFi connection to the user (or to the user's server). Regardless of how controller **102** is wirelessly coupled to the user, the user may then command the second switch **140** to couple the trailer main power harness to the battery **105**. In this fashion, tests may be performed to verify proper operation of circuits connected to the tractor main power harness such as a test of the ABS controller **210** or a test of the ATIS.

[0021] In addition to powering the trailer main power harness, battery **105** may provide an always-on backup power to the trailer's telematics. As noted earlier, the telematics may be powered by its own battery such as contained within a smart nosebox. But battery box **100** provides a backup power to ensure uninterrupted operation of the telematics unit.

[0022] In addition to selectively powering the trailer main power harness despite the trailer being detached from the tractor, battery box **100** may also be used to selectively power additional sensors such as a TPMS sensor, cameras, cargo sensors, and so on. To do so, battery system **101** may include a third switch **130** that may selectively couple the battery **105** through a trailer lead to the desired sensor. A user may control the selective powering of a sensor through the third switch **130** through controller **103**. Similarly, controller **103** may also control the on/off states of the first switch **115** and the second switch **140**. Since the driver will typically verify proper operation of the marker lights before towing a trailer, battery box **100** may also advantageously use the marker light power to provide backup power to the main trailer harness. A power lead for the marker lights is typically a brown wire, which may be received by the first switch **115**. Should the tractor main power be insufficient, the first switch **115** may thus be controlled to select for the marker lights power lead to power the trailer main harness. As also shown in FIG. **1**, the charger may also couple to the power lead for the marker lights so that the battery **105** may be charged if the tractor main harness power voltage is insufficient.

[0023] Battery box **100** may be advantageously integrated with a nose box **205** as shown in the trailer system **200** of FIG. **2**. Nose box **205** includes a 7-way interface **220** for receiving the 7-way coupler or connection from the tractor. From the 7-way interface, the tractor main power harness routes to battery box **100** as discussed with respect to FIG. **1**. Should battery box **100** be reasonably close to nose box **205** or should such a routing not present any retrofitting issues of the trailer, the trailer main power harness from battery box **100** may be routed back to nose box **205**. In this fashion, nose box **205** may also monitor the trailer main power harness such as discussed for the smart nose box of the '895 application. Depending upon the voltage state of the tractor main power harness, battery box **100** may couple the tractor main power harness to the trailer main power harness or instead may power the trailer main power harness using the battery **105** (FIG. **1**). The trailer main harness from nose box **205** may then power the ABS controller **210** and also power telematics **215**. As discussed with regard to FIG. **1**, battery box **100** may provide backup power to the telematics **215**. In addition, battery box **100** may selectively power one or more sensors as also discussed with regard to FIG. **1**. The power lead for the marker lights (the brown wire of the tractor main power harness) routes from nose box **205** to the battery box **100** to provide the backup power for the trailer main harness as discussed previously.

[0024] An alternative trailer system **300** is shown in FIG. **3**. In trailer configuration **300**, battery box **100** continues to couple through the 7-way interface **220** to the trailer main harness. Referring again to trailer system **200**, note that there is a routing of the trailer main power harness from the battery box **100** to the nose box **205**. To free the user from any difficulty in routing the trailer main power harness from the battery box **100** to the nose box **205**, the trailer main power harness in the trailer system **300** routes directly from the battery box **100** to the trailer so as to power circuits such as the ABS controller **210**. With regard to powering the ABS controller **210**, note that as discussed earlier, battery box **100** may use the marker lights power lead (the brown wire) as a backup for powering the trailer main power harness should the tractor main power harness voltage be insufficient. The brown wire thus routes from the nose box **205** in trailer system **300** to the battery box **100**. Referring again to FIG. **1**, in this fashion the battery system **101** may power the ABS controller **210** using the marker light power for added safety and redundancy. The remainder of trailer system **300** is as discussed for trailer system **200**.

[0025] A housing **400** for a battery box as disclosed herein is shown in a side view in FIG. **4**A and in a plan view in FIG. **4**B. Housing **400** includes a port **410** for a lead from a solar panel **125** (illustrated in FIG. **1**). In this fashion, charger **110** may charge the battery **105** should the trailer be positioned such that the solar panel **125** is sufficiently illuminated. Housing **400** also includes a port **405** for the tractor main power harness to receive power from the tractor. In addition, housing **400** also includes a port **415** for the trailer main power harness to power components such as the ABS controller and the ATIS. Housing **400** also includes a port **420** for the lead providing the telematics backup power and a port **425** for the lead providing the selectively activated sensor power. For safety, housing **400** also includes a gas vent **430** to vent any gases from the charging and discharging of the battery **105**. To mount the housing to a suitable location on the trailer, housing **400** includes a plurality of bolt or fastener openings **435**.

[0026] A method of powering a trailer using a smart battery box will now be discussed with reference to the flowchart of FIG. **5**. The method includes an act **500** and an act **505** that both occur while the trailer is connected to a tractor through a 7-way connection. Act **500** includes routing a tractor power supply voltage through a housing including a first battery to power an ABS controller in the trailer in response to a detection that the tractor power supply voltage satisfies a threshold value. The routing through battery box **100** of FIGS. **2** and **3** is an example of act **500**. Act **505** includes powering the ABS controller using the first battery in response to a detection that the tractor power supply voltage does not satisfy the threshold value. The powering of the ABS controller **210** in FIG. **1**, **2**, or **3** in response to a detection that the tractor power supply voltage does not satisfy the threshold is an example of act **505**. Finally, the method includes an act **510** that occurs while the trailer is disconnected from the tractor and includes responding to a first command to couple the first battery to the ABS controller to power the ABS controller. The response of controller **102** of FIG. **1** to a command to power the ABS controller using battery **105** is an example of act **510**.

[0027] As those of some skill in this art will by now appreciate and depending on the particular application at hand, many modifications, substitutions and variations can be made in and to the materials, apparatus, configurations and methods of use of the devices of the present disclosure without departing from the scope thereof. In light of this, the scope of the present disclosure should not be limited to that of the particular embodiments illustrated and described herein, as they are merely by way of some examples thereof, but rather, should be fully commensurate with that of the claims appended hereafter and their functional equivalents.

We claim:

1. A trailer power system for a trailer, comprising:

a battery;

a charger configured to charge the battery using a tractor power supply voltage;

a detection circuit configured to detect whether the tractor power supply voltage is greater than a threshold value;

a first switch coupled between a lead carrying the tractor power supply voltage and a trailer main power lead for powering an ABS controller in the trailer;

a second switch coupled between the battery and the trailer main power lead; and

a controller configured to control the first switch to couple the lead carrying the tractor power supply voltage to the trailer main power lead in response to a detection by the detection circuit that the tractor power supply voltage is greater than the threshold value, and wherein the controller is configured to respond to a first command to control the second switch to couple the battery to the trailer main power lead while the trailer is disconnected from a tractor.

2. The trailer power system of claim **1**, further comprising:

a motion detector configured to detect whether the trailer is in motion, wherein the controller is further configured to control the second switch to couple the battery to the trailer main power lead in response to a detection that the tractor power supply voltage is less than the threshold value while the motion detector has detected that the trailer is in motion.

3. The trailer power system of claim **1**, wherein the first switch and the second switch comprise a single switch configured to select between the battery and the lead carrying the tractor power supply voltage.

4. The trailer power system of claim **1**, wherein the battery, the first switch, the second switch, the detection circuit, and the controller are all contained within a housing.

5. The trailer power system of claim **1**, further comprising:

a third switch coupled between the battery and a trailer lead for a trailer sensor, wherein the controller is further configured to respond to a second command to control the third switch to couple the battery to the trailer lead to power the trailer sensor while the trailer is disconnected from the tractor.

6. The trailer power system of claim **4**, further comprising:

a nose box including a 7-way interface for coupling to a 7-way connector from the tractor, wherein the trailer main power lead is routed from the housing to the nose box and routed from the nose box to the ABS controller.

7. The trailer power system of claim **4**, further comprising:

a nose box including a 7-way interface for coupling to a 7-way connector from the tractor, wherein the trailer main power lead is routed from the housing directly to the ABS controller.

8. The trailer power system of claim **1**, wherein the controller is further configured to respond to a third command to control the second switch to couple the battery to the trailer main power lead so that a test may be performed on an automatic tire inflation system (ATIS) coupled to the trailer main power lead.

9. The trailer power system of claim **5**, wherein the trailer sensor comprises a tire pressure monitoring system (TPMS) sensor.

10. The trailer power system of claim **6**, wherein the nose box contains a telematics unit for the trailer, and wherein the battery is configured to provide a backup power to the telematics unit.

11. The trailer system of claim **5**, wherein the trailer sensor comprises a cargo sensor.

12. The trailer system of claim **5**, wherein the trailer sensor comprises a camera.

13. The trailer system of claim **1**, wherein the controller is configured to respond to wireless commands, and wherein the first command is a wireless command.

14. The trailer system of claim **13**, wherein the controller is configured to respond to Bluetooth wireless commands.

15. The trailer system of claim **13**, wherein the controller is configured to respond to WiFi wireless commands.

16. The trailer system of claim **13**, wherein the controller is configured to respond to cellular wireless commands.

17. A method of powering a trailer, comprising:

while the trailer is connected to a tractor through a 7-way connection:

routing a tractor power supply voltage through a housing including a first battery to power an ABS controller in the trailer in response to a detection that the tractor power supply voltage satisfies a threshold value;

powering the ABS controller using the first battery in response to a detection that the tractor power supply voltage does not satisfy the threshold value; and

while the trailer is disconnected from the tractor and the 7-way connection:

responding to a first command to couple the first battery to the ABS controller to power the ABS controller.

18. The method of claim **17**, further comprising:

while the trailer is disconnected from the tractor and the 7-way connection:

responding to a second command to couple the first battery to a sensor in the trailer.

19. The method of claim **18**, wherein the sensor is a TPMS sensor.

20. The method of claim **17**, further comprising:

powering a telematics unit in the trailer using a second battery during a normal operation of the second battery; and

powering the telematics unit using the first battery in response to a fault condition of the second battery.

* * * * *