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(54) **APPARATUS, METHOD AND ARTICLE FOR POWER STORAGE DEVICE FAILURE SAFETY**

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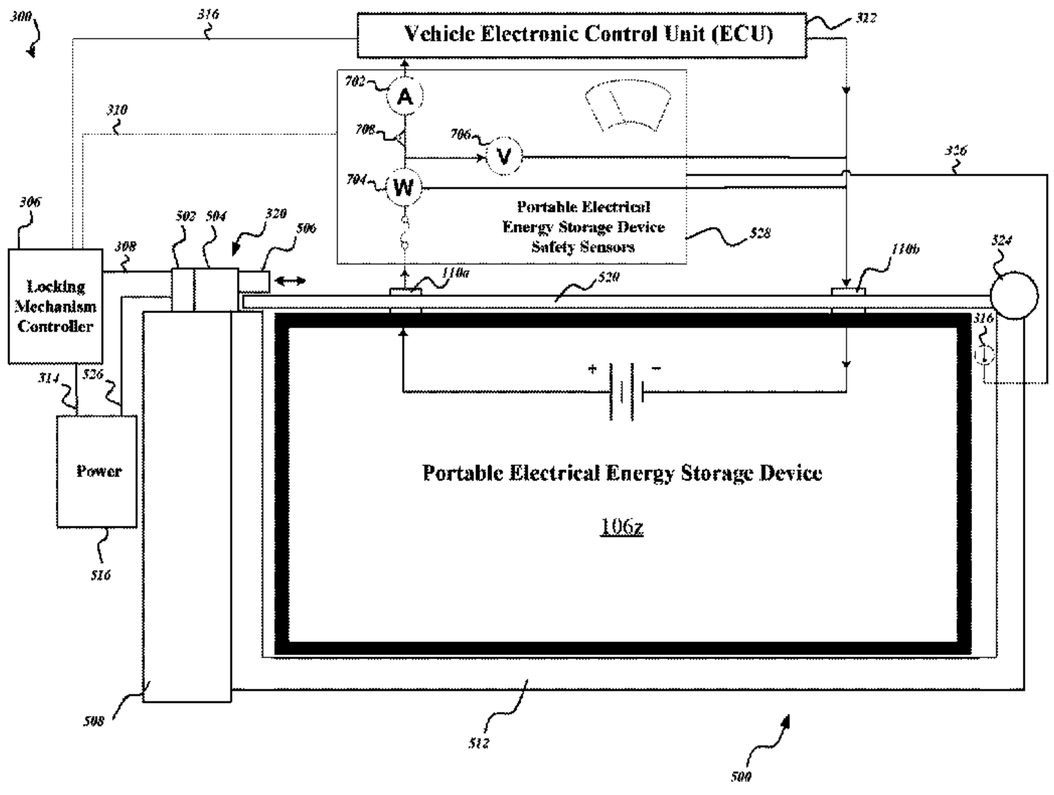
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(57) **ABSTRACT**

In response to receiving information regarding an unsafe condition from portable electrical energy storage device (e.g., battery) safety sensors, a locking mechanism controller determines whether the battery is in a desired state to, as a safety measure, have the compartment that holds the battery locked and/or to send a signal to reduce or eliminate current draw from the battery. If the locking mechanism controller determines the battery is in the desired state to have the compartment locked, then it sends a signal to a compartment locking mechanism causing the compartment locking mechanism to lock the compartment in which the battery is located to prevent a user from opening the compartment, and thus helps protect the user against the unsafe condition. In some embodiments, the unsafe condition may be a potential or existing catastrophic failure of the battery in the compartment (e.g., a meltdown, explosion or dangerous leak, etc.).

20 Claims, 10 Drawing Sheets



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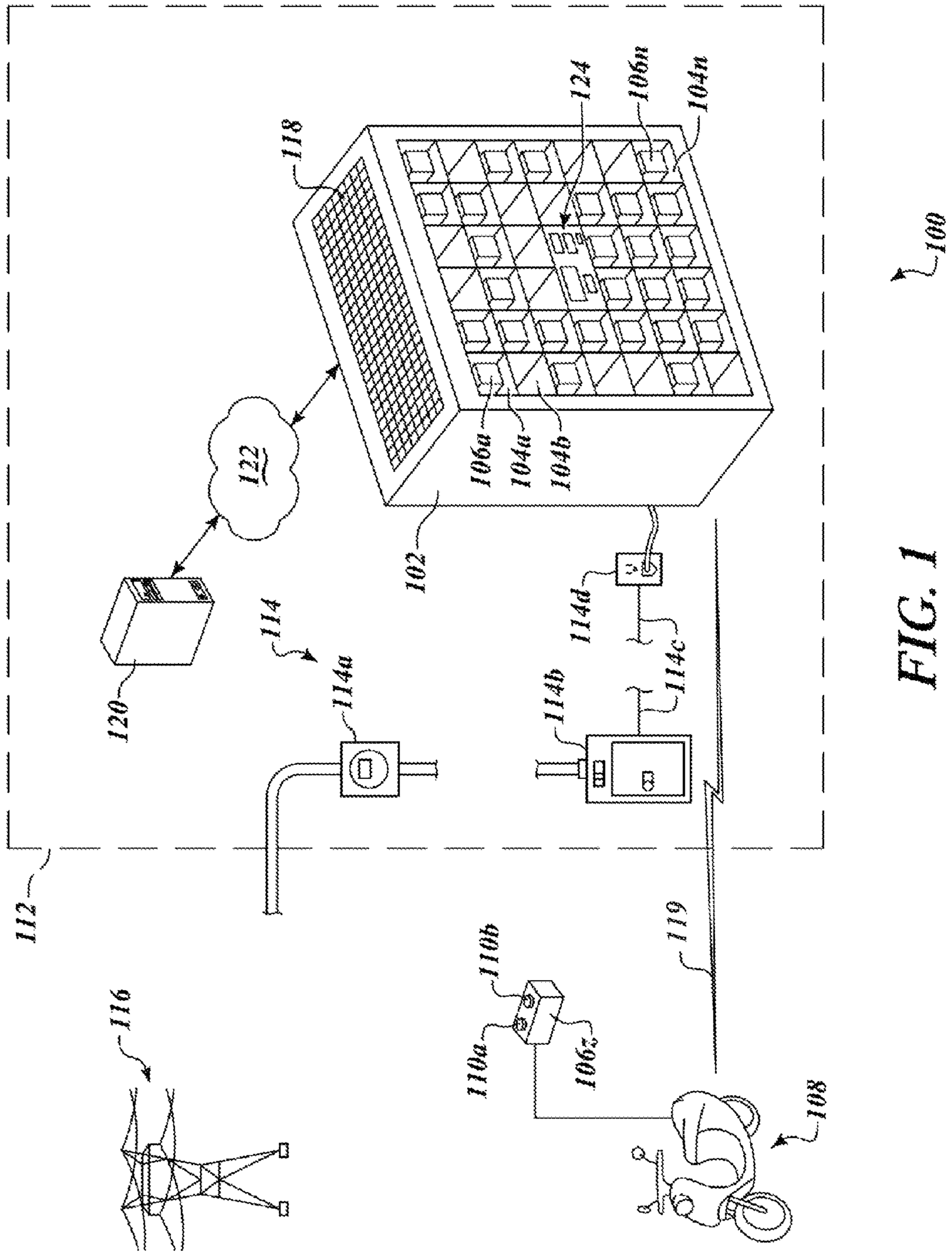

100
102
104a
104b
104n
106a
106b
106n
108
110a
110b
112
114
114a
114b
114c
114d
116
118
119
120
122
124

FIG. 1

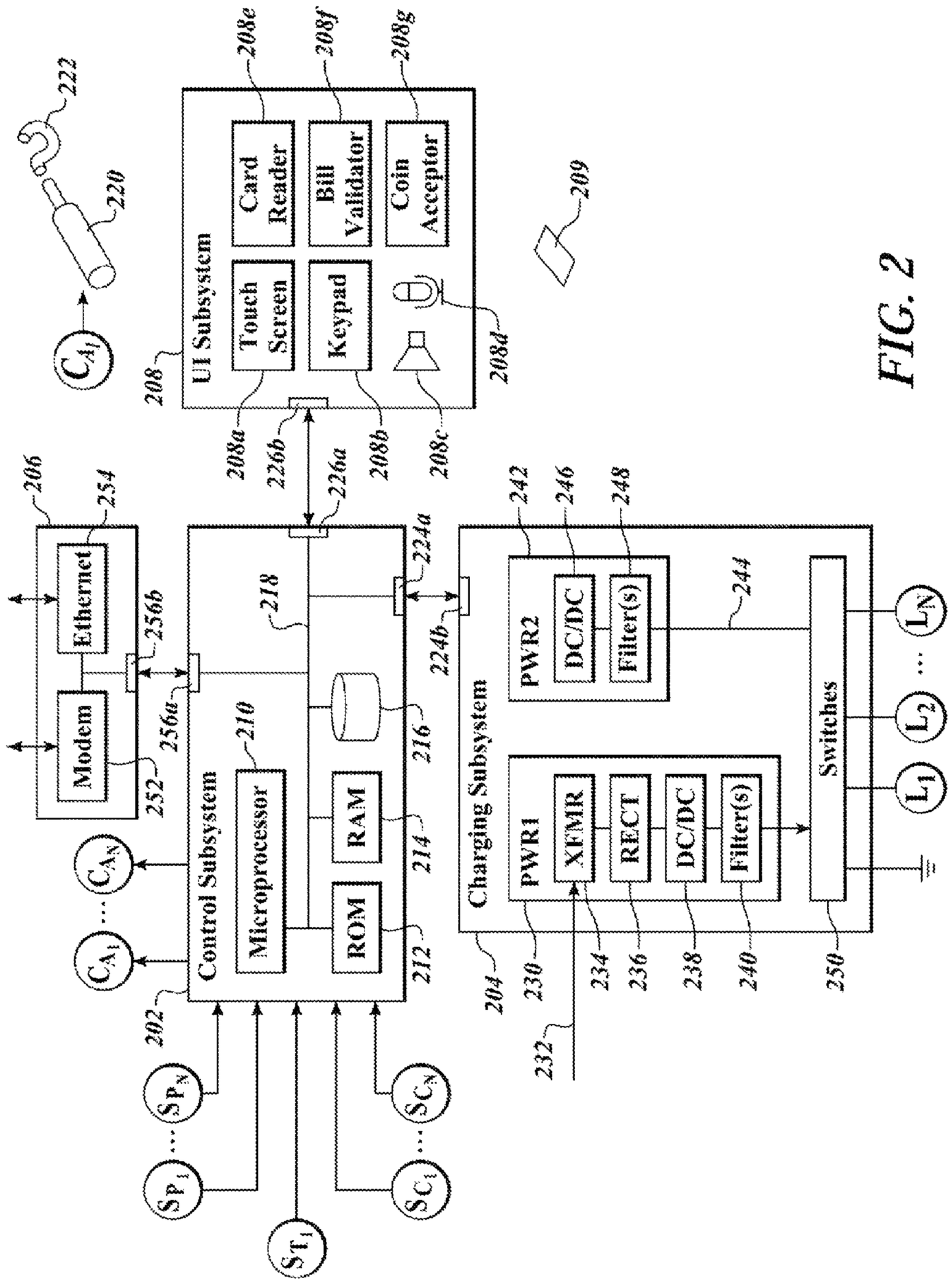

202
SP_1
SP_N
ST_1
SC_1
SC_N
Control Subsystem
Microprocessor
ROM
RAM
Modem
Ethernet
206
254
252
256b
256a
210
212
214
216
218
224a
224b
C_{A1}
C_{AN}
UI Subsystem
Touch Screen
Keypad
Card Reader
Bill Validator
Coin Acceptor
208
208a
208b
208c
208d
208e
208f
208g
226b
226a
222
220
209
Charging Subsystem
PWR1
XFMR
RECT
DC/DC
Filter(s)
PWR2
DC/DC
Filter(s)
Switches
204
230
234
236
238
240
242
244
246
248
250
232
L_1
L_2
L_N

FIG. 2

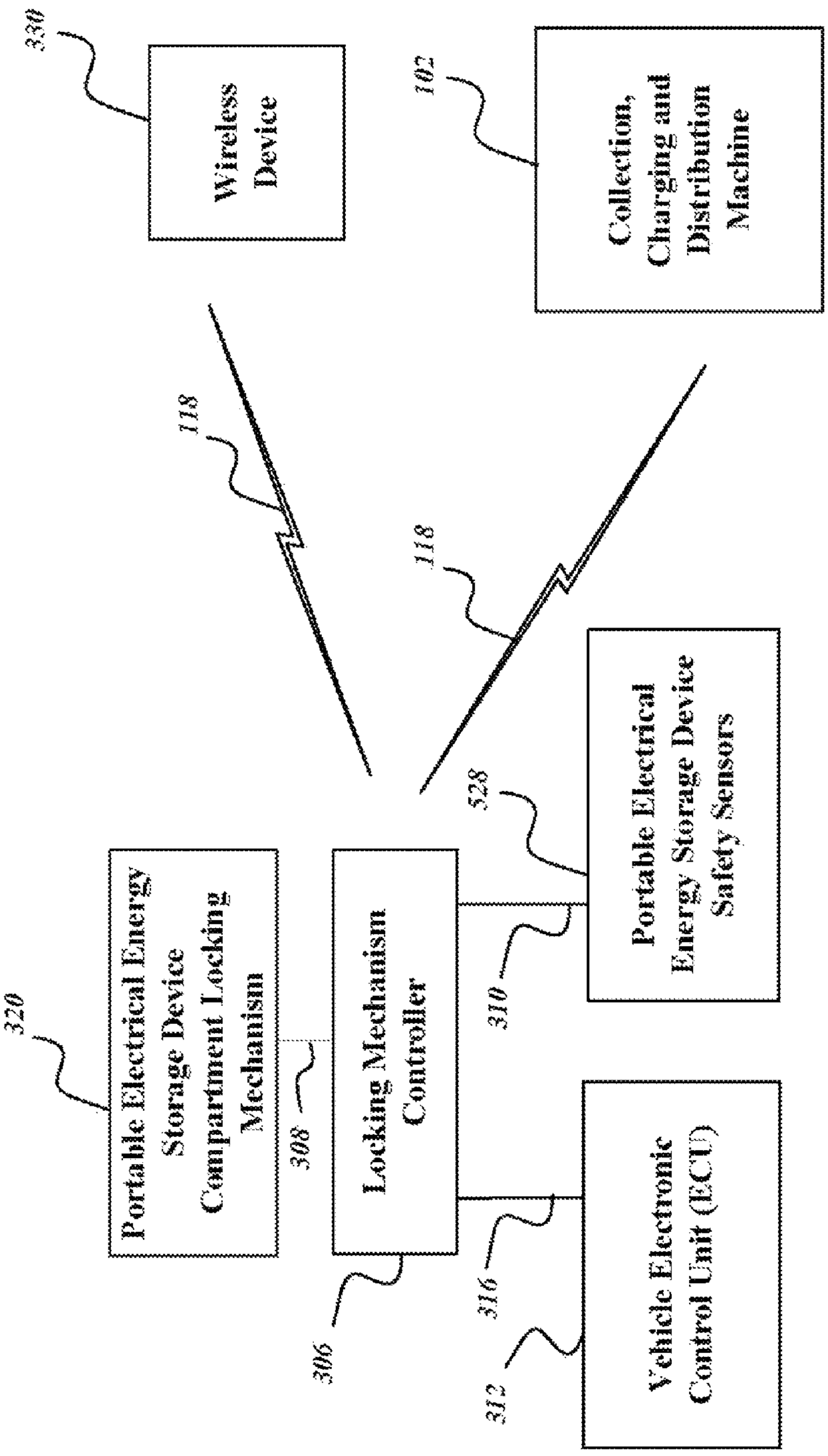

330
Wireless Device
102
Collection, Charging and Distribution Machine
118
118
300
320
Portable Electrical Energy Storage Device Compartment Locking Mechanism
308
306
Locking Mechanism Controller
528
310
Portable Electrical Energy Storage Device Safety Sensors
316
312
Vehicle Electronic Control Unit (ECU)

FIG. 3A

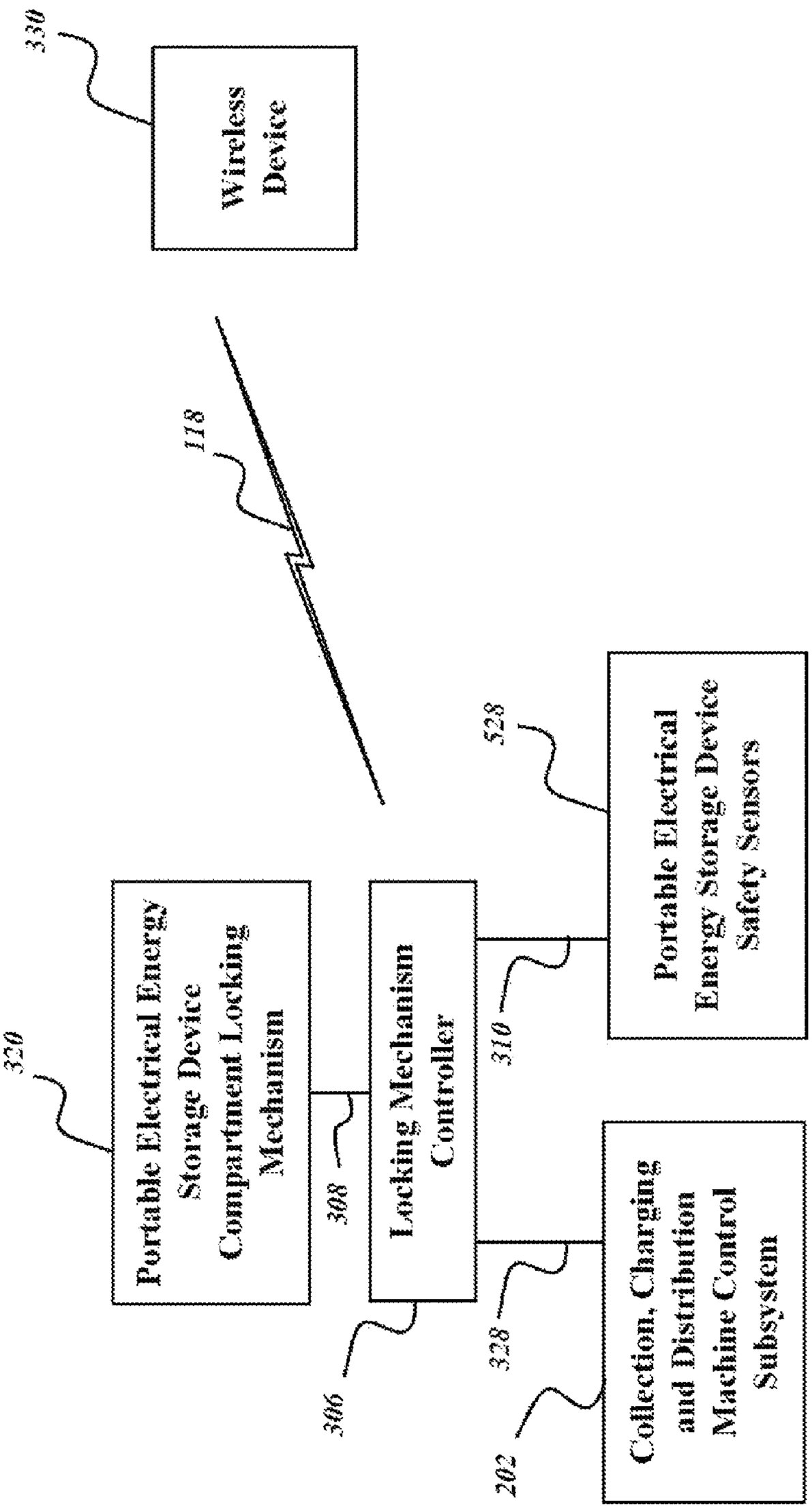

330
Wireless Device
300
118
320
Portable Electrical Energy Storage Device
Compartment Locking Mechanism
306
308
Locking Mechanism Controller
310
528
Portable Electrical Energy Storage Device Safety Sensors
328
202
Collection, Charging and Distribution Machine Control Subsystem

FIG. 3B

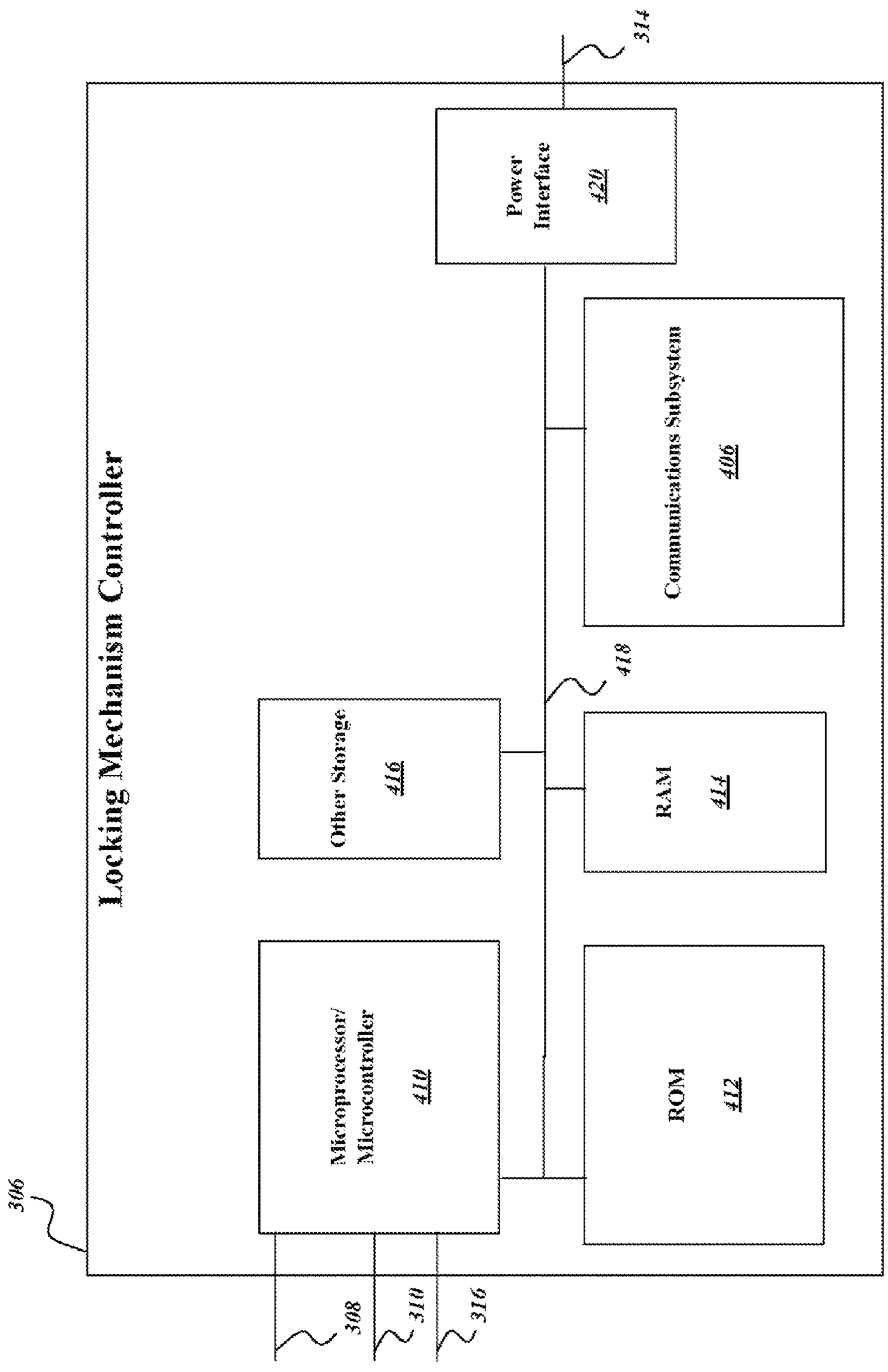

Locking Mechanism Controller
314
Power Interface
420
Communications Subsystem
406
418
Other Storage
416
RAM
414
Microprocessor/ Microcontroller
410
ROM
412
306
308
310
316

FIG. 4

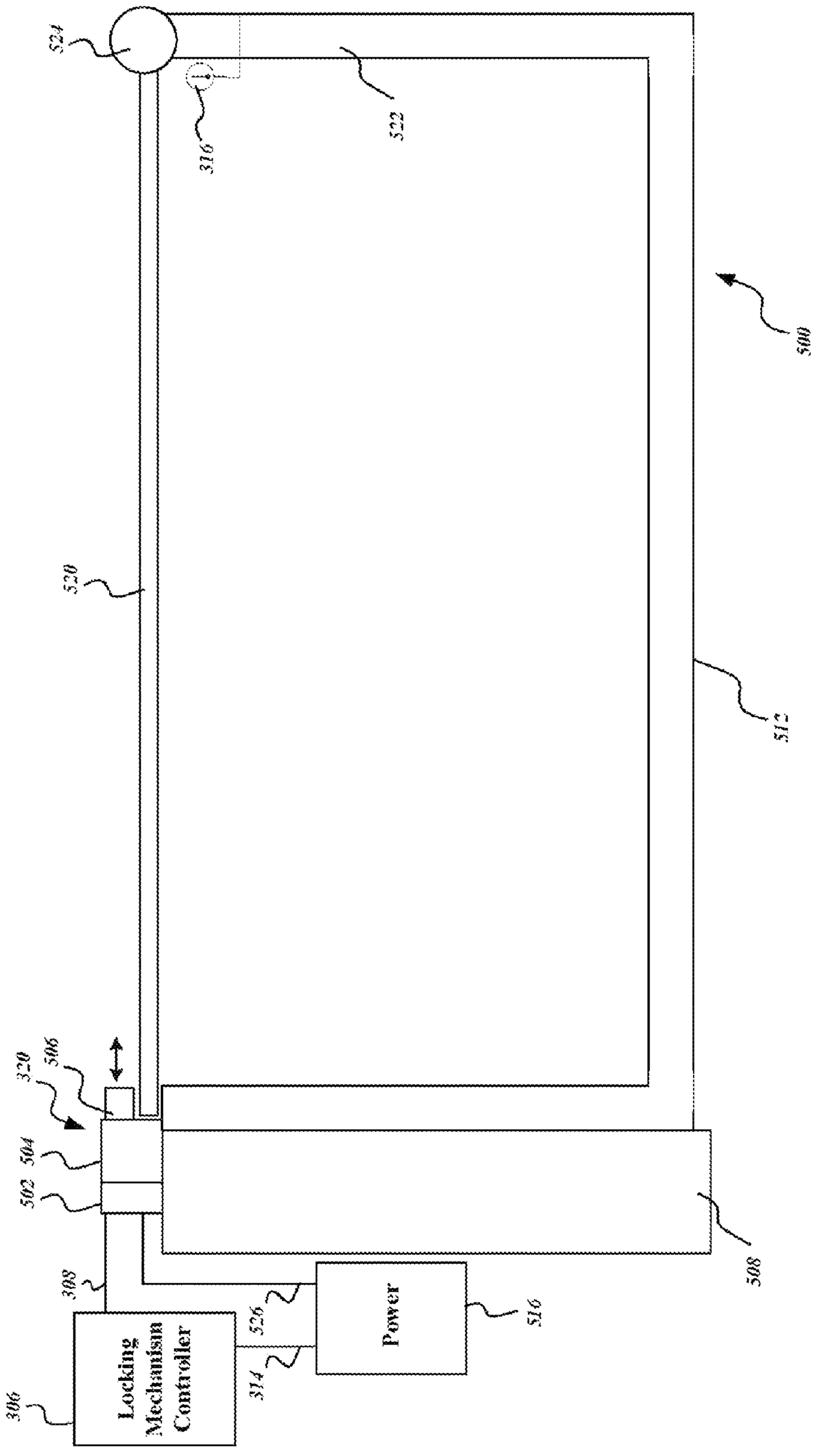

524
316
522
500
520
512
320
506
504
502
308
526
314
306
Locking Mechanism Controller
Power
516
508

FIG. 5

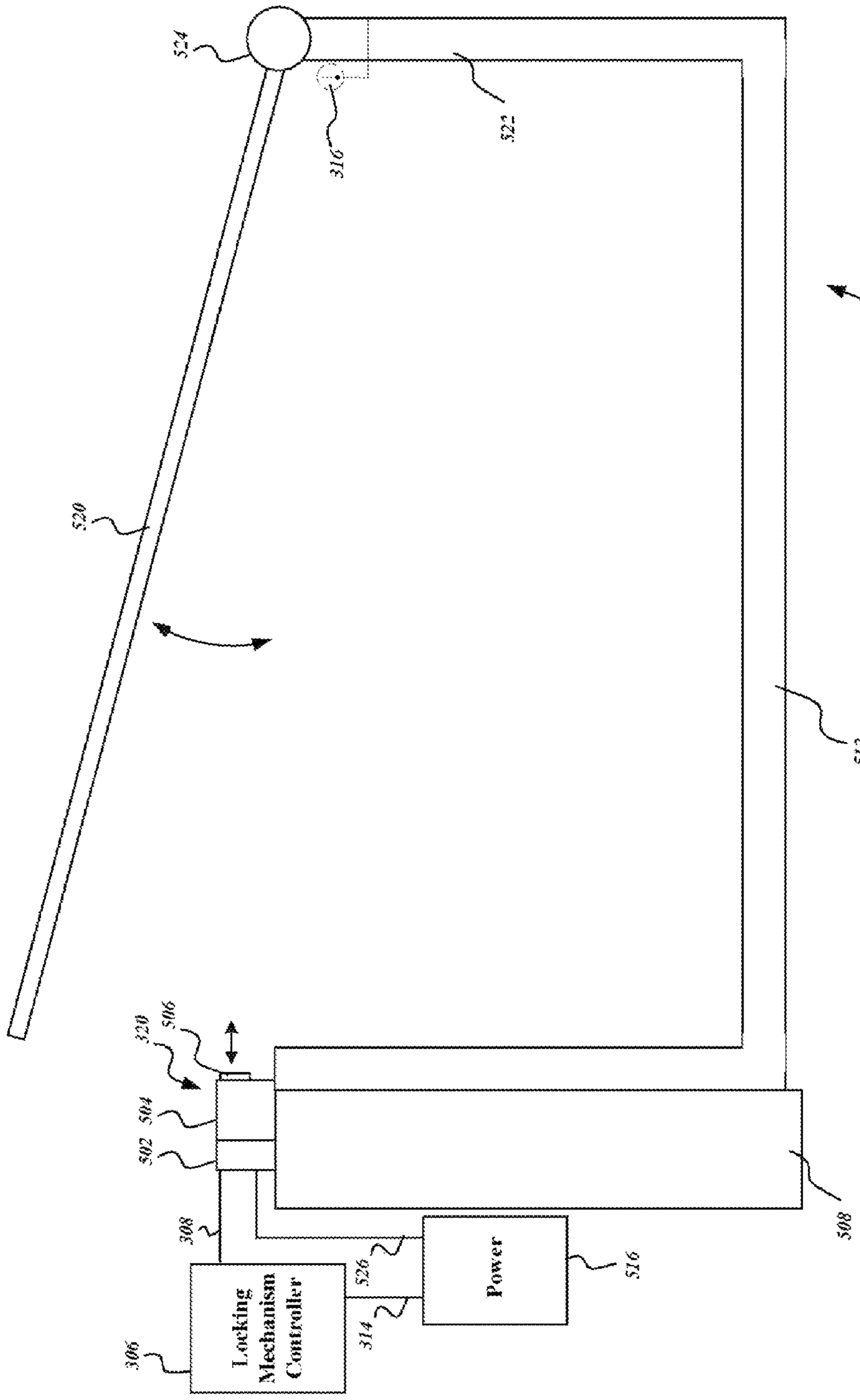

524
316
522
500
520
512
320
506
504
502
308
526
Power
516
508
306
Locking Mechanism Controller
314

FIG. 6

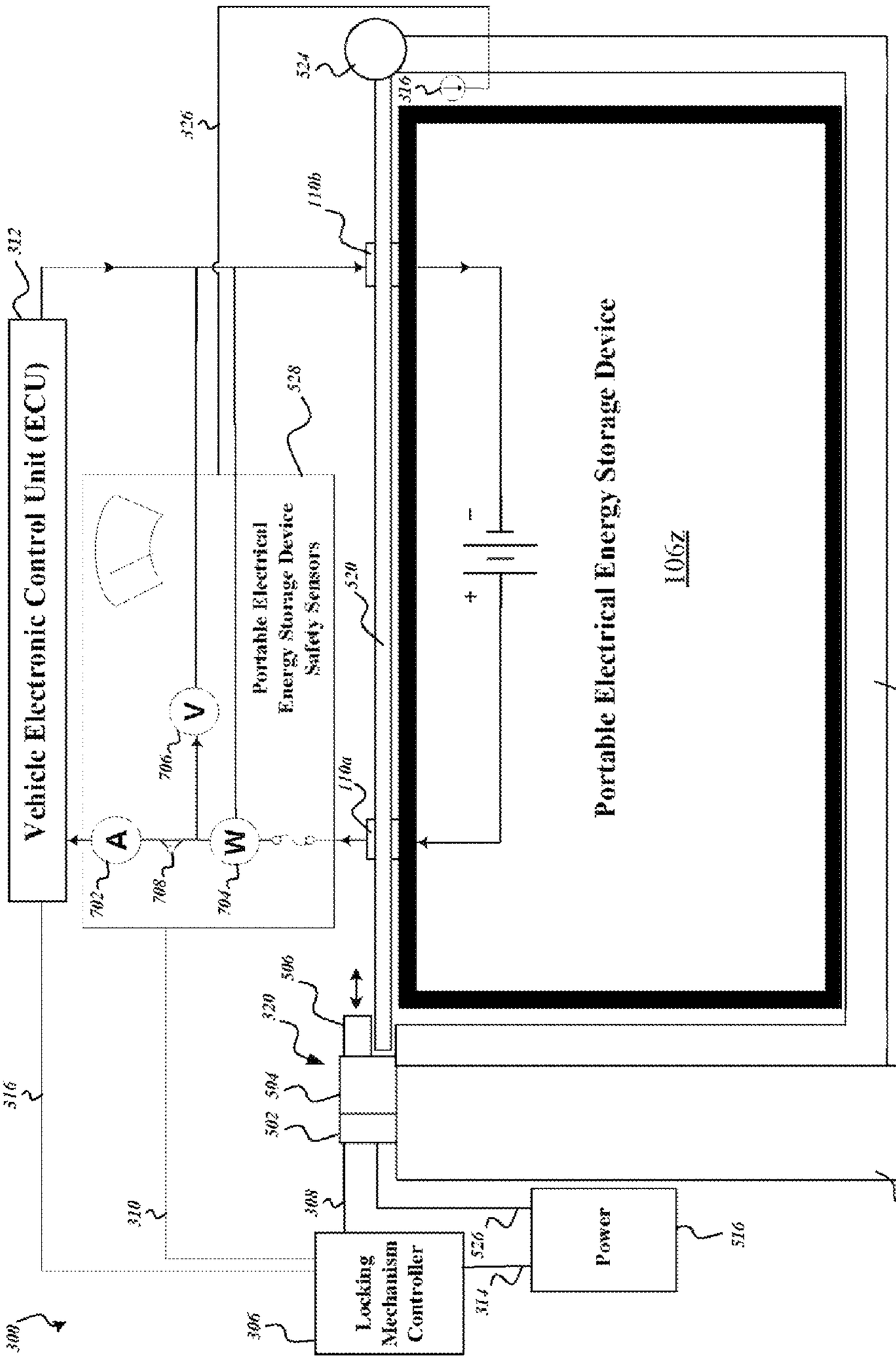

Vehicle Electronic Control Unit (ECU)
Portable Electrical Energy Storage Device Safety Sensors
A
V
W
Portable Electrical Energy Storage Device
106z
Locking Mechanism Controller
Power
524
316
526
110b
312
528
520
706
110a
702
708
704
506
320
504
502
310
308
526
514
516
512
508
500
300
306

FIG. 7

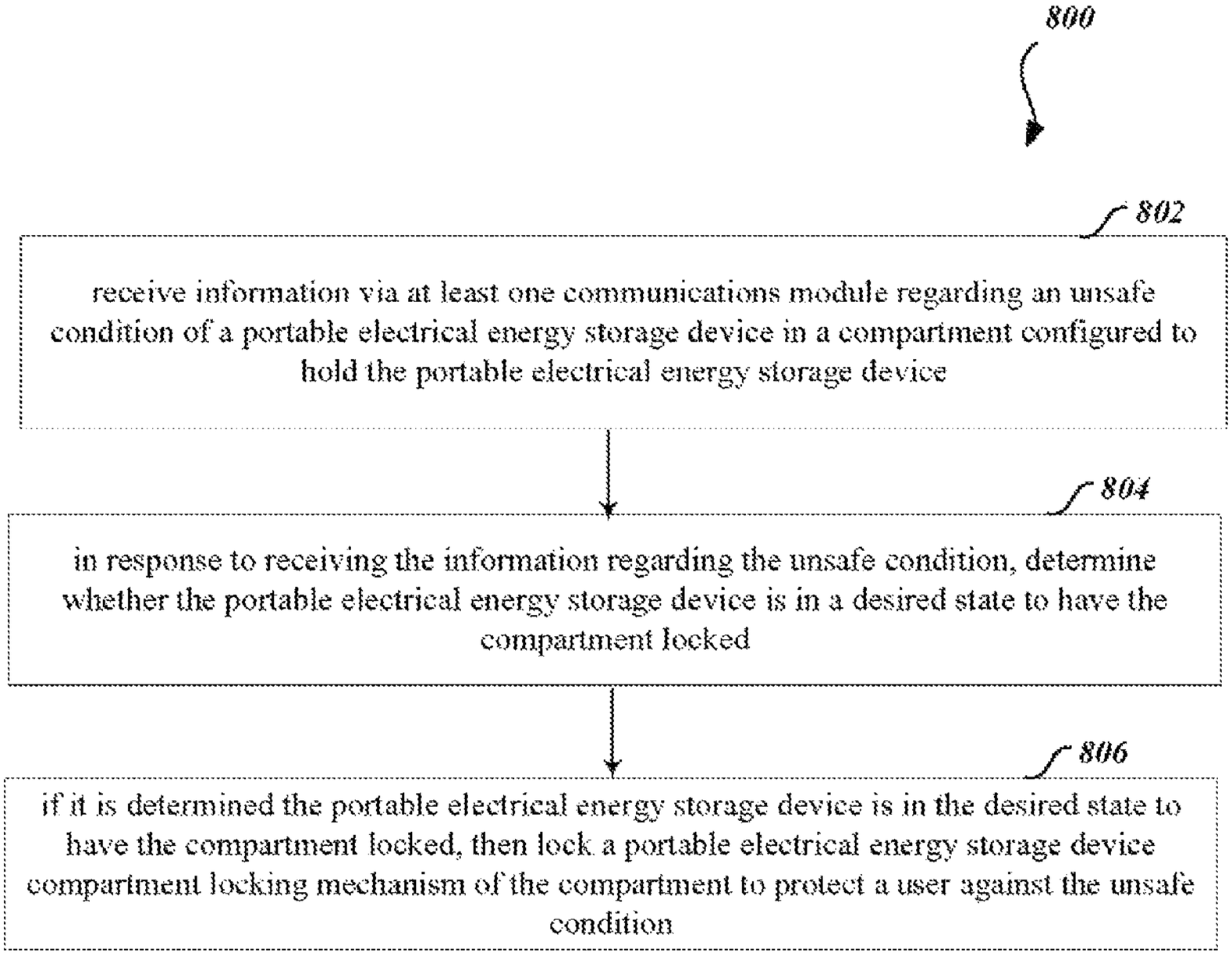

800
802
receive information via at least one communications module regarding an unsafe condition of a portable electrical energy storage device in a compartment configured to hold the portable electrical energy storage device
804
in response to receiving the information regarding the unsafe condition, determine whether the portable electrical energy storage device is in a desired state to have the compartment locked
806
if it is determined the portable electrical energy storage device is in the desired state to have the compartment locked, then lock a portable electrical energy storage device compartment locking mechanism of the compartment to protect a user against the unsafe condition

FIG. 8

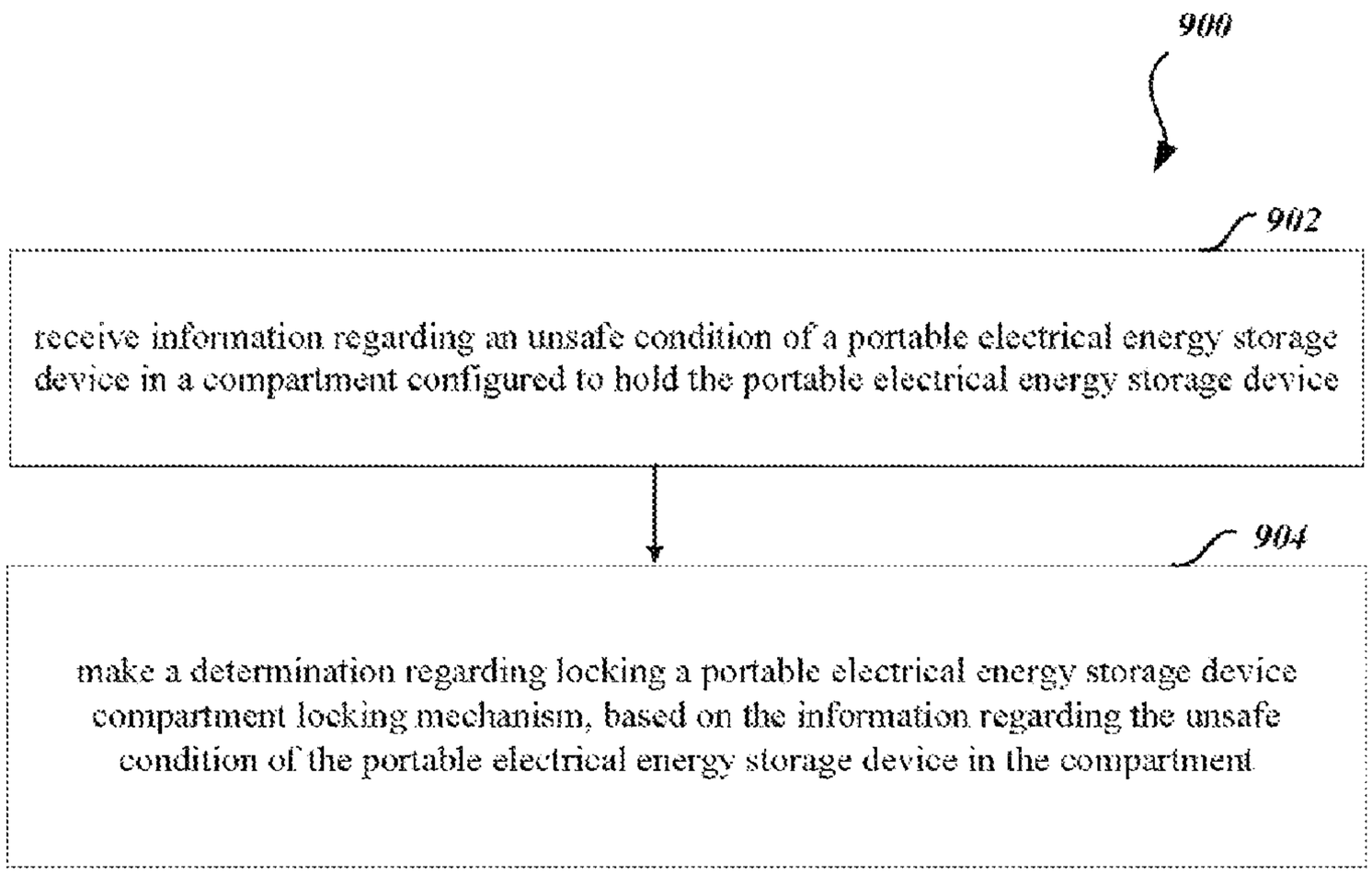

900
902
receive information regarding an unsafe condition of a portable electrical energy storage device in a compartment configured to hold the portable electrical energy storage device
904
make a determination regarding locking a portable electrical energy storage device compartment locking mechanism, based on the information regarding the unsafe condition of the portable electrical energy storage device in the compartment

FIG. 9

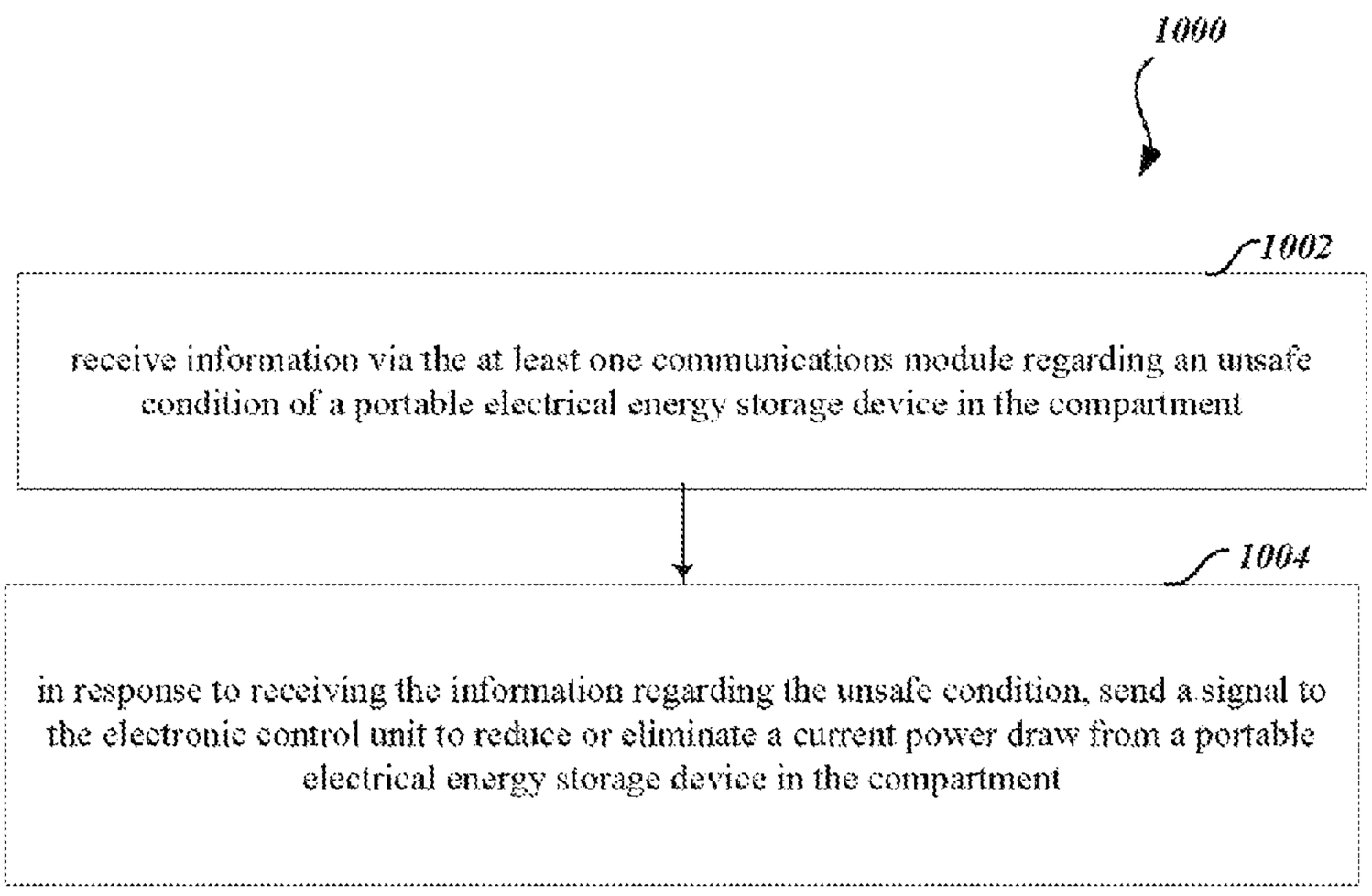

1000
1002
receive information via the at least one communications module regarding an unsafe condition of a portable electrical energy storage device in the compartment
1004
in response to receiving the information regarding the unsafe condition, send a signal to the electronic control unit to reduce or eliminate a current power draw from a portable electrical energy storage device in the compartment

FIG. 10

APPARATUS, METHOD AND ARTICLE FOR POWER STORAGE DEVICE FAILURE SAFETY

BACKGROUND

1. Technical Field

The present disclosure generally relates to power storage device failure, and particularly to power storage device failure in vehicles.

2. Description of the Related Art

There are a wide variety of uses or applications for portable electrical energy storage devices.

One such application is in the field of transportation. Hybrid and all-electric vehicles are becoming increasingly common. Such vehicles may achieve a number of advantages over traditional internal combustion engine vehicles. For example, hybrid or electrical vehicles may achieve higher fuel economy and may have little or even zero tail pipe pollution. In particular, all-electric vehicles may not only have zero tail pipe pollution, but may be associated with lower overall pollution. For example, electrical power may be generated from renewable sources (e.g., solar, hydro). Also, for example, electrical power may be generated at generation plants that produce no air pollution (e.g., nuclear plants). Also, for example, electrical power may be generated at generation plants that burn relatively "clean burning" fuels (e.g., natural gas), which have higher efficiency than internal combustion engines, and/or which employ pollution control or removal systems (e.g., industrial air scrubbers) which are too large, costly or expensive for use with individual vehicles.

Personal transportation vehicles such as combustion engine powered scooters and/or motorbikes are ubiquitous in many places, for example, in the many large cities of Asia. Such scooters and/or motorbikes tend to be relatively inexpensive, particularly as compared to automobiles, cars or trucks. Cities with high numbers of combustion engine scooters and/or motorbikes also tend to be very densely populated and suffer from high levels of air pollution. When new, many combustion engine scooters and/or motorbikes provide a relatively low polluting source of personal transportation. For instance, such scooters and/or motorbikes may have higher mileage ratings than larger vehicles. Some scooters and/or motorbikes may even be equipped with basic pollution control equipment (e.g., catalytic converter). Unfortunately, factory specified levels of emission are quickly exceeded if the scooters and/or motorbikes are used and not maintained and/or if the scooters and/or motorbikes are modified, for example, by intentional or unintentional removal of catalytic converters. Often owners or operators of scooters and/or motorbikes lack the financial resources or the motivation to maintain their vehicles.

It is known that air pollution has a negative effect on human health, being associated with causing or exacerbating various diseases (e.g., various reports tie air pollution to emphysema, asthma, pneumonia, and cystic fibrosis, as well as to various cardiovascular diseases). Such diseases take large numbers of lives and severely reduce the quality of life of countless others.

BRIEF SUMMARY

A portable electrical energy storage device compartment system may be summarized as including at least one controller; and at least one communications module coupled to the at least one controller, wherein the at least one controller: receives information via the at least one communications module regarding an unsafe condition of a portable electrical energy storage device in a compartment configured to hold the portable electrical energy storage device; and in response to receiving the information regarding the unsafe condition: determines whether the portable electrical energy storage device is in a desired state to have the compartment locked; and if it is determined the portable electrical energy storage device is in the desired state to have the compartment locked, then locks a portable electrical energy storage device compartment locking mechanism of the compartment to protect a user against the unsafe condition. The desired state to have the compartment locked may be a state in which one or more of a temperature level, a voltage level and a current level of a circuit to which the portable electrical energy storage device is connected is above a particular respective threshold. The unsafe condition may be a potential or existing catastrophic failure of the portable electrical energy storage device in the compartment. The desired state to have the compartment locked may be a state in which one or more of a temperature level of the portable electrical energy storage device and a temperature level of an inside of the compartment is above a particular respective threshold. The at least one communications module may receive the information regarding the unsafe condition from one or more sensors coupled to a circuit to which the portable electrical energy storage device is connected and may communicate the information to the at least one controller to enable the at least one controller to lock the portable electrical energy storage device compartment locking mechanism.

The portable electrical energy storage device compartment system may further include the portable electrical energy storage device compartment locking mechanism coupled to the at least one controller; and one or more sensors coupled to the at least one controller that sense conditions indicative of the unsafe condition, the conditions indicative of the unsafe condition including conditions regarding one or more of: a temperature level of a circuit to which the portable electrical energy storage device is connected, a voltage level of a circuit to which the portable electrical energy storage device is connected, a current level of a circuit to which the portable electrical energy storage device is connected, a temperature of the portable electrical energy storage device, a temperature of an inside of the compartment in which the portable electrical energy storage device is located, and a short circuit of a circuit to which the portable electrical energy storage device is connected, wherein the at least one controller sends a control signal in a manner to lock the portable electrical energy storage device compartment locking mechanism if the controller determines the portable electrical energy storage device is in the desired state to have the compartment locked based on the conditions indicative of the unsafe conditions sensed by the one or more sensors.

The at least one controller may further be configured to make a determination regarding unlocking the portable electrical energy storage device based on one or more of: information regarding the unsafe condition no longer being present and performance of a locking mechanism override operation. The configured portable electrical energy storage device compartment system may be coupled to a vehicle. The configured portable electrical energy storage device compartment system may be coupled to a collection, charging and distribution machine. The at least one controller may send the information regarding information regarding an unsafe condition to an external device via a wireless signal transmitted to the external device.

The portable electrical energy storage device compartment system may further include a power source, separate from the

portable electrical energy storage device, coupled to the at least one controller and the portable electrical energy storage device compartment locking mechanism to provide power to the portable electrical energy storage device compartment locking mechanism and the at least one controller.

A method of operating a portable electrical energy storage device compartment system may be summarized as including receiving, by the portable electrical energy storage device compartment system, information regarding an unsafe condition of a portable electrical energy storage device in a compartment configured to hold the portable electrical energy storage device; and making a determination, by the portable electrical energy storage device compartment system, regarding locking a portable electrical energy storage device compartment locking mechanism based on the information regarding the unsafe condition of the portable electrical energy storage device in the compartment.

The method may further include receiving, by a communications module of the portable electrical energy storage device compartment system, the information regarding the unsafe condition from one or more sensors coupled to a circuit to which the portable electrical energy storage device is connected; and communicating, by a communications module of the portable electrical energy storage device compartment system, the information to at least one controller of the portable electrical energy storage device compartment system to enable the at least one controller to lock the portable electrical energy storage device compartment locking mechanism. The received information regarding the unsafe condition may include information regarding one or more of: a temperature level of a circuit to which the portable electrical energy storage device is connected, a voltage level of a circuit to which the portable electrical energy storage device is connected, a current level of a circuit to which the portable electrical energy storage device is connected, a temperature of the portable electrical energy storage device, and a temperature of an inside of the compartment in which the portable electrical energy storage device is located.

A vehicle may be summarized as including a motor to propel the vehicle at least partially powered by a portable electrical energy storage device; an electronic control unit coupled to the portable electrical energy storage device that controls how much power to draw from the portable electrical energy storage device to power the motor; a compartment configured to hold the portable electrical energy storage device; at least one controller of a locking mechanism of the compartment; and at least one communications module coupled to the at least one controller, wherein the at least one controller: receives information via the at least one communications module regarding an unsafe condition of a portable electrical energy storage device in the compartment; and in response to receiving the information regarding the unsafe condition: determines whether the portable electrical energy storage device is in a desired state to have the compartment locked; and if it is determined the portable electrical energy storage device is in the desired state to have the compartment locked, then locks a portable electrical energy storage device compartment locking mechanism of the compartment to protect a user against the unsafe condition. The at least one controller: in response to receiving the information regarding the unsafe condition, may send a signal to the electronic control unit to reduce or eliminate a current power draw from a portable electrical energy storage device in the compartment. The information regarding the unsafe condition may be indicative of an unsafe current level of a circuit to which the portable electrical energy storage device and electronic control unit are connected.

A portable electrical energy storage device may be summarized as including at least one portable electrical energy storage device cell; and one or more sensors coupled to the at least one portable electrical energy storage device cell and to at least one controller, wherein the one or more sensors sense conditions indicative of an unsafe condition of the portable electrical energy storage device, the conditions indicative of the unsafe condition including conditions regarding one or more of: a temperature level of a circuit to which the portable electrical energy storage device is connected, a voltage level of a circuit to which the portable electrical energy storage device is connected, a current level of a circuit to which the portable electrical energy storage device is connected, a temperature of the portable electrical energy storage device, a temperature of an inside of a compartment in which the portable electrical energy storage device is located, and a short circuit of a circuit to which the portable electrical energy storage device is connected.

The portable electrical energy storage device may further include at least one communications module coupled to the to at least one controller, wherein the at least one communications module communicates information regarding the conditions indicative of an unsafe condition to the at least one controller; and the at least one controller, in response to receiving the information regarding the unsafe condition: determines whether a portable electrical energy storage device is in a desired state to have the compartment locked; and if it is determined the portable electrical energy storage device is in the desired state to have the compartment locked, then sends a signal to active a portable electrical energy storage device compartment locking mechanism. The at least one communications module may communicate information regarding the conditions indicative of an unsafe condition to an external device. The at least one communications module wirelessly may communicate information regarding the conditions indicative of an unsafe condition to the external device.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

In the drawings, identical reference numbers identify similar elements or acts. The sizes and relative positions of elements in the drawings are not necessarily drawn to scale. For example, the shapes of various elements and angles are not drawn to scale, and some of these elements may be enlarged and positioned to improve drawing legibility. Further, the particular shapes of the elements as drawn are not intended to convey any information regarding the actual shape of the particular elements, and have been solely selected for ease of recognition in the drawings.

FIG. **1** is a schematic view of a collection, charging and distribution machine along with a number of electrical power storage devices according to one non-limiting illustrated embodiment, along with an electric scooter or motorbike having an electrical power storage device compartment, and an electrical service provided via an electrical grid, according to one non-limiting illustrated embodiment.

FIG. **2** is a block diagram of the collection, charging and distribution machine of FIG. **1**, according to one non-limiting illustrated embodiment.

FIG. **3**A is a block diagram of a portable electrical energy storage device compartment locking system for the portable electrical energy storage device of the scooter or motorbike of FIG. **1**, according to one non-limiting illustrated embodiment.

FIG. **3**B is a block diagram of a portable electrical energy storage device compartment locking system for the collection, charging and distribution machine of FIG. **1**, according to one non-limiting illustrated embodiment.

FIG. **4** is a schematic view of the locking mechanism controller of FIG. **3**A, according to one non-limiting illustrated embodiment.

FIG. **5** is a cross-sectional elevation view of a locked, empty portable electrical energy storage device compartment configured to hold the portable electrical energy storage device of FIG. **1** coupled to the portable locking mechanism controller of FIG. **3**A, according to one non-limiting illustrated embodiment.

FIG. **6** is a cross-sectional elevation view of the empty portable electrical energy storage device compartment of FIG. **5** in an unlocked and open state, according to one non-limiting illustrated alternative embodiment.

FIG. **7** is a cross-sectional elevation view of the portable electrical energy storage device compartment of FIG. **5** in a locked state holding the portable electrical energy storage device of FIG. **1** and coupled to portable electrical energy storage device safety sensors of the portable electrical energy storage device compartment locking system, according to one non-limiting illustrated alternative embodiment.

FIG. **8** is a flow diagram showing a method of operating the locking mechanism controller of FIGS. **3-7**, according to one non-limiting illustrated embodiment.

FIG. **9** is a flow diagram showing a method of the locking mechanism controller of FIGS. **3-7** locking a portable electrical energy storage device compartment locking mechanism, according to one non-limiting illustrated embodiment.

FIG. **10** is a flow diagram showing a method of the locking mechanism controller of FIGS. **3-7** sending a signal to the electronic control unit to reduce or eliminate a current power draw from the portable electrical energy storage device, according to one non-limiting illustrated embodiment.

DETAILED DESCRIPTION

In the following description, certain specific details are set forth in order to provide a thorough understanding of various disclosed embodiments. However, one skilled in the relevant art will recognize that embodiments may be practiced without one or more of these specific details, or with other methods, components, materials, etc. In other instances, well-known structures associated with vending apparatus, batteries, locking mechanisms, wireless technologies, supercapacitors or ultracapacitors, temperature sensors, voltmeters, ammeters, multimeters, and power converters including but not limited to transformers, rectifiers, DC/DC power converters, switch mode power converters, controllers, and communications systems and structures and networks have not been shown or described in detail to avoid unnecessarily obscuring descriptions of the embodiments.

Unless the context requires otherwise, throughout the specification and claims which follow, the word "comprise" and variations thereof, such as "comprises" and "comprising" are to be construed in an open, inclusive sense that is as "including, but not limited to."

Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment.

The use of ordinals such as first, second and third does not necessarily imply a ranked sense of order, but rather may only distinguish between multiple instances of an act or structure.

Reference to portable electrical energy storage devices means any device capable of storing electrical power and releasing stored electrical power including but not limited to batteries, supercapacitors or ultracapacitors. Reference to batteries means chemical storage cell or cells, for instance rechargeable or secondary battery cells including but not limited to nickel cadmium alloy or lithium ion battery cells.

The headings and Abstract of the Disclosure provided herein are for convenience only and do not interpret the scope or meaning of the embodiments.

FIG. **1** shows an environment **100** including a collection, charging and distribution machine **102**, according to one illustrated embodiment.

The collection, charging and distribution machine **102** may take the form of a vending machine or kiosk. The collection, charging and distribution machine **102** has a plurality of receivers, compartments or receptacles **104***a*, **104***b*-**104***n* (only three called out in FIG. **1**, collectively **104**) to removably receive portable electrical energy storage devices (e.g., batteries, supercapacitors or ultracapacitors) **106***a*-**106***n* (collectively **106**) for collection, charging and distribution. As illustrated in FIG. **1**, some of the receivers **104** are empty, while other receivers **104** hold portable electrical energy storage devices **106**. While FIG. **1** shows a single portable electrical energy storage device **106** per receiver **104**, in some embodiments each receiver **104** may hold two or even more portable electrical energy storage devices **106**. For example, each of the receivers **104** may be sufficiently deep to receive three portable electrical energy storage devices **106**. Thus, for example, the collection, charging and distribution machine **102** illustrated in FIG. **1** may have a capacity capable of simultaneously holding 40, 80 or 120 portable electrical energy storage devices **106**.

The portable electrical energy storage devices **106** may take a variety of forms, for example, batteries (e.g., array of battery cells) or supercapacitors or ultracapacitors (e.g., array of ultracapacitor cells). For example, the portable electrical energy storage device **106***z* may take the form of rechargeable batteries (i.e., secondary cells or batteries). The portable electrical energy storage device **106***z* may, for instance, be sized to physically fit and electrically power personal transportation vehicles, such as all-electric scooters or motorbikes **108**, and may also be sized to physically fit in a portable electrical energy storage device compartment of the all-electric scooters or motorbikes **108**. As previously noted, combustion engine scooters and motorbikes are common in many large cities, for example, in Asia, Europe and the Middle East. The ability to conveniently access charged batteries throughout a city or region may facilitate the use of all-electric scooters and motorbikes **108** in place of combustion engine scooters and motorbikes, thereby alleviating air pollution, as well as reducing noise.

The portable electrical energy storage devices **106** (only visible for portable electrical energy storage device **106***z*) may include a number of electrical terminals **110***a*, **110***b* (two illustrated, collectively **110**), accessible from an exterior of the portable electrical energy storage device **106***z* and also may be accessible when the portable electrical energy storage device **106***z* is in a portable electrical energy storage device compartment of the all-electric scooters or motorbikes **108**. The electrical terminals **110** allow charge to be delivered from the portable electrical energy storage device **106***z*, as well as allow charge to be delivered to the portable electrical energy storage device **106***z* for charging or recharging the same.

While illustrated in FIG. **1** as posts, the electrical terminals **110** may take any other form which is accessible from an exterior of the portable electrical energy storage device **106***z* and a portable electrical energy storage device compartment, including electrical terminals positioned within slots in a housing of a battery and a battery compartment.

As the portable electrical energy storage devices **106** may encounter unsafe conditions while being used in a vehicle or when being charged or stored in the collection, charging and distribution machine **102**, it may be desirable to lock a compartment in which the portable electrical energy storage devices **106** is currently being held when such conditions occur. Such unsafe conditions may be caused by overheating, melting or explosion caused by a short circuit, system malfunction, environmental conditions or other catastrophic failure. Locking the compartment in which the portable electrical energy storage device is currently being held when such conditions occur may be performed as a safety measure that helps contain the unsafe condition inside the compartment or prevents injury to a user attempting to access the portable electrical energy storage device when such conditions are present or are imminent. Systems and methods for the operation of a portable electrical energy storage device compartment, including systems for controlling when the portable electrical energy storage device compartment is to be automatically locked or unlocked, are described in more detail below with reference to FIGS. **3A-10**, and are useful in the overall system for collection, charging and distribution of the portable electrical energy storage devices **106** described herein.

The collection, charging and distribution machine **102** is positioned at some location **112** at which the collection, charging and distribution machine **102** is conveniently and easily accessible by various end users. The location may take any of a large variety of forms, for example, a retail environment such as a convenience store, supermarket, gas or petrol station, or service center. Alternatively, the collection, charging and distribution machine **102** may stand alone at a location **112** not associated with an existing retail or other business, for example in public parks or other public places. Thus, for example, collection, charging and distribution machines **102** may be located at each store of a chain of convenience stores throughout a city or region. Such may advantageously rely on the fact that convenience stores are often sited or distributed based on convenience to the target population or demographic. Such may advantageously rely on pre-existing leases on storefronts or other retail locations to allow an extensive network of collection, charging and distribution machines **102** to be quickly developed in a city or region. Quickly achieving a large network that provides for convenient replacement and security of the portable electrical energy storage devices **106** used in the all-electric scooters or motorbikes **108** enhances the ability to depend on such a system and likely commercial success of such an effort.

The location **112** may include an electrical service **114** to receive electrical power from a generating station (not shown) for example via a grid **116**. The electrical service **114** may, for example, include one or more of an electrical service meter **114***a*, a circuit panel (e.g., circuit breaker panel or fuse box) **114***b*, wiring **114***c*, and electrical outlet **114***d*. Where the location **112** is an existing retail or convenience store, the electrical service **114** may be an existing electrical service, so may be somewhat limited in rating (e.g., 120 volts, 240 volts, 220 volts, 230 volts, 15 amps).

Optionally, the collection, charging and distribution machine **102** may include or be coupled to a source of renewable electrical power. For example, where installed in an outside location the collection, charging and distribution machine **102** may include an array of photovoltaic (PV) cells **118** to produce electrical power from solar insolation. Alternatively, the collection, charging and distribution machine **102** may be electrically coupled to a microturbine (e.g., wind turbine) or PV array positioned elsewhere at the location **112**, for instance on a roof top or mounted at a top of a pole (not shown).

The collection, charging and distribution machine **102** may be communicatively coupled to one or more remotely located computer systems, such as back end or back office systems (only one shown) **120**. The back end or back office systems **120** may collect data from and/or control a plurality of collection, charging and distribution machines **102** distributed about an area, such as a city. In some embodiments, the back end or back office systems **120** may collect data from and/or control a plurality of the portable electrical energy storage devices **106**, such as by generating, tracking, sending and/or receiving one or more codes included in a wireless signal **119** sent by the collection, charging and distribution machine **102** to an all-electric scooter or motorbike **108** or other vehicle. The sending and/or receiving one or more codes enables access to the portable electrical energy storage device compartments of the portable electrical energy storage devices **106** for placing a portable electrical energy storage device **106***z* in a respective all-electric scooter or motorbike **108** while the all-electric scooter or motorbike **108** is in the vicinity of the collection, charging and distribution machine **102** or other authorized external device. The communications between the back end or back office systems **120** and the collection, charging and distribution machine **102** may occur over one or more communications channels including one or more networks **122**, or non-networked communications channels. Also, in some embodiments, the back end or back office systems **120** may collect data from and/or control a plurality of the portable electrical energy storage devices **106**, such as by tracking, sending and/or receiving information regarding unsafe conditions of the portable electrical energy storage devices **106** that is included in a wireless signal **119** sent from the collection, charging and distribution machine **102**, from the portable electrical energy storage devices **106** and/or from the all-electric scooter or motorbike **108** or other vehicle. Communications may be over one or more wired communications channels (e.g., twisted pair wiring, optical fiber), wireless communications channels (e.g., radio, microwave, satellite, 801.11 compliant). Networked communications channels may include one or more local area networks (LANs), wide area networks (WANs), extranets, intranets, or the Internet including the World Wide Web portion of the Internet.

The collection, charging and distribution machine **102** may include a user interface **124**. The user interface may include a variety of input/output (I/O) devices to allow an end user to interact with the collection, charging and distribution machine **102**. Various I/O devices are called out and described in reference to FIG. **2**, which follows.

FIG. **2** shows the collection, charging and distribution machine **102** of FIG. **1**, according to one illustrated embodiment.

The collection, charging and distribution machine **102** includes a control subsystem **202**, a charging subsystem **204**, a communications subsystem **206**, and a user interface subsystem **208**.

The control subsystem **202** includes a controller **210**, for example a microprocessor, microcontroller, programmable logic controller (PLC), programmable gate array (PGA), application specific integrated circuit (ASIC) or another controller capable of receiving signals from various sensors,

performing logical operations, and sending signals to various components. Typically, the controller **210** may take the form of a microprocessor (e.g., INTEL, AMD, ATOM). The control subsystem **202** may also include one or more non-transitory processor- or computer-readable storage media, for example read-only memory (ROM) **212**, random access memory (RAM) **214**, and data store **216** (e.g., solid-state storage media such as flash memory or EEPROM, or spinning storage media such as hard disk). The non-transitory processor- or computer-readable storage media **212**, **214**, **216** may be in addition to any non-transitory storage medium (e.g., registers) which is part of the controller **210**. The control subsystem **202** may include one or more buses **218** (only one illustrated) coupling various components together, for example one or more power buses, instruction buses, data buses, etc.

As illustrated, the ROM **212**, or some other one of the non-transitory processor- or computer-readable storage media **212**, **214**, **216**, stores instructions and/or data or values for variables or parameters. The sets of data may take a variety of forms, for example a lookup table, a set of records in a database, etc. The instructions and sets of data or values are executable by the controller **210**. Execution of the instructions and sets of data or values causes the controller **210** to perform specific acts to cause the collection, charging and distribution machine **102** to collect, charge, and distribute portable energy storage devices, and to receive information regarding unsafe conditions of the portable electrical energy storage devices **106** that are in a respective portable electrical energy storage device compartment of an all-electric scooter or motorbike **108** or are in the respective compartments or receptacles **104***a*, **104***b*-**104***n* of the collection, charging and distribution machine **102**. Specific operation of the collection, charging and distribution machine **102** is described herein and also below with reference to FIG. **3**B to FIG. **10** in the context of locking respective compartments or receptacles **104***a*, **104***b*-**104***n* of the collection, charging and distribution machine **102** when unsafe conditions of portable electrical energy storage devices **106** are detected.

The controller **210** may use RAM **214** in a conventional fashion, for volatile storage of instructions, data, etc. The controller **210** may use data store **216** to log or retain information, for example one or more codes that enable access to the portable electrical energy storage device compartment while the scooter or motorbike **108** is in the vicinity of the collection, charging and distribution machine **102**, and/or information related to operation of the collection, charging and distribution machine **102** itself. The instructions are executable by the controller **210** to control operation of the collection, charging and distribution machine **102** in response to end user or operator input, and using data or values for the variables or parameters.

The control subsystem **202** receives signals from various sensors and/or other components of the collection, charging and distribution machine **102** which include information that characterizes or is indicative of operation, status, or condition of such other components, including the portable electrical energy storage devices **106**. Sensors are represented in FIG. **2** by the letter S appearing in a circle along with appropriate subscript letters.

For example, one or more position sensors S_{P1}-S_{PN} may detect the presence or absence of a portable electrical energy storage device **106** at each of the receivers or compartments **104**. The position sensors S_{P1}-S_{PN} may take a variety of forms. For example, the position sensors S_{P1}-S_{PN} may take the form of mechanical switches that are closed, or alternatively opened, in response to contact with a portion of a respective portable electrical energy storage device **106** when the portable electrical energy storage device **106** is inserted into the receiver **104**. Also for example, the position sensors S_{P1}-S_{PN} may take the form of optical switches (i.e., optical source and receiver) that are closed, or alternatively opened, in response to contact with a portion of a respective portable electrical energy storage device **106** when the portable electrical energy storage device **106** is inserted into the receiver **104**. Also for example, the position sensors S_{P1}-S_{PN} may take the form of electrical sensors or switches that are closed, or alternatively opened, in response to detecting a closed circuit condition created by contact with the terminals **110** of a respective portable electrical energy storage device **106** when the portable electrical energy storage device **106** is inserted into the receiver **104**, or an open circuit condition that results from the lack of a respective portable electrical energy storage device **106** in the receiver **104**. These examples are intended to be non-limiting, and it is noted that any other structures and devices for detecting the presence/absence or even the insertion of the portable electrical energy storage devices **106** into receivers may be employed.

For example, one or more charge sensors S_{C1}-S_{CN} may detect charge of the portable electrical energy storage devices **106** at each of the receivers **104**. Charge sensors S_{C1}-S_{CN} may detect the amount of charge stored by the portable electrical energy storage devices **106**. Charge sensors S_{C1}-S_{CN} may additionally detect an amount of charge and/or rate of charging being supplied to ones of the portable electrical energy storage devices **106** at each of the receivers **104**. Such may allow assessment of current (i.e., temporal) charge condition or status of each portable electrical energy storage device **106**, as well as allow feedback control over charging of same, including control over rate of charging. Charge sensors S_{C1}-S_{CN} may include any variety of current and/or voltage sensors. For example, one or more charge sensors S_{T1} (only one shown) may detect or sense a temperature at the receivers **104** or in the ambient environment. Such sensors may work individually or in combination to detect one or more unsafe conditions of a respective portable electrical energy storage device **106** (e.g., portable electrical energy storage device **106***n*) in the respective receiver or compartment (e.g., **104***n*). For example, this may be based on, but is not limited to, for example, one or more of: a temperature level of a circuit to which the portable electrical energy storage device **106***n* is connected, a voltage level of a circuit to which the portable electrical energy storage device **106***n* is connected, a current level of a circuit to which the portable electrical energy storage device **106***n* is connected, a temperature of the portable electrical energy storage device **106***n*, a temperature of an inside of a compartment or receiver **104***n* in which the portable electrical energy storage device **106***n* is located, and a short circuit of a circuit to which the portable electrical energy storage device **106***n* is connected, etc.

The control subsystem **202** provides signals to various actuators and/or other components responsive to control signals, which signals include information that characterizes or is indicative of an operation the component is to perform or a state or condition into which the components should enter. Control signals, actuators or other components responsive to control signals are represented in FIG. **2** by the letter C appearing in a circle along with appropriate subscript letters.

For example, one or more engine control signals C_{A1}-C_{AN} may affect the operation of one or more actuators **220** (only one illustrated). For instance, a control signal C_{A1} may cause movement of an actuator **220** between a first and a second position or change a magnetic field produced by the actuator **220**. The actuator **220** may take any of a variety of forms,

including but not limited to a solenoid, an electric motor such as a stepper motor, or an electromagnet. The actuator **220** may be coupled to operate a latch, lock or other retainer mechanism **222**. The latch, lock or other retainer mechanism **222** may selectively secure, cover and/or retain one or more portable electrical energy storage devices **106** (FIG. **1**) in the compartment or receiver **104** (FIG. **1**). For instance, the latch, lock or other retainer mechanism **222** may physically couple to a complimentary structure that is part of a housing of the portable electrical energy storage devices **106** (FIG. **1**). Alternatively, the latch, lock or other retainer mechanism **222** may magnetically couple to a complimentary structure that is part of a housing of the portable electrical energy storage devices **106** (FIG. **1**). Also for instance, the latch, lock or other retainer mechanism **222** may open a receiver **104** (FIG. **1**), or may allow a receiver **104** to be opened, to receive a partially or fully discharged portable electrical energy storage device **106** for charging. For example, the actuator may open and/or close a door to the receiver **104** (FIG. **1**), to selectively provide or prevent access to a portable electrical energy storage device **106** (FIG. **1**) received therein. Also for example, the actuator may open and/or close a latch or lock, allowing an end user to open and/or close a door to the receiver **104** (FIG. **1**), to selectively provide access to a portable electrical energy storage device **106** (FIG. **1**) received therein. Also, for example, one or more of the control signals C_{A1}-C_{AN} may cause operation of one or more actuators **220** to prevent access to the portable electrical energy storage device **106***n*, or close the compartment or receiver **104***n* when an unsafe condition of the portable electrical energy storage device **106***n* is detected by the control subsystem **202** based on information received by the control subsystem **202** from one or more of the sensors S_{C1}-S_{CN}. For example, such an unsafe condition may be defined by information from the sensors S_{C1}-S_{CN}, such as electric current level, voltage level, temperature, etc., reaching applicable thresholds levels.

The control subsystem **202** may include one or more ports **224***a* to provide control signals to one or more ports **224***b* of the charging subsystem **204**. The ports **224***a*, **224***b* may provide bi-directional communications. The control subsystem **202** may include one or more ports **226***a* to provide control signals to one or more ports **226***b* of the user interface subsystem **208**. The ports **226***a*, **226***b* may provide bi-directional communications.

The charging subsystem **204** includes various electrical and electronic components to charge portable electrical energy storage devices **106** when positioned or received in the receivers **104**. For example, the charging subsystem **204** may include one or more power buses or power bus bars, relays, contactors or other switches (e.g., insulated gate bipolar transistors or IGBTs, metal oxide semiconductor transistors or MOSFETs), rectifier bridge(s), current sensors, ground fault circuitry, etc. The electrical power is supplied via contacts that can take any of a variety of forms, for instance terminals, leads, posts, etc. The contacts allow electrical coupling of various components. Some possible implementations are illustrated in FIG. **2**. Such is not intended to be exhaustive. Additional components may be employed while other components may be omitted.

The illustrated charging subsystem **204** includes a first power converter **230** that receives electrical power from the electrical service **114** (FIG. **1**) via a line or cord **232**. The power will typically be in the form of single two- or three-phase AC electrical power. As such, the first power converter **230** may need to convert and otherwise condition the electrical power received via the electrical services **114** (FIG. **1**), for example for rectifying an AC waveform to DC, transforming voltage, current, and phase, as well as reducing transients and noise. Thus, the first power converter **230** may include a transformer **234**, rectifier **236**, DC/DC power converter **238**, and filter(s) **240**.

The transformer **234** may take the form of any variety of commercially available transformers with suitable ratings for handling the power received via the electrical service **114** (FIG. **1**). Some embodiments may employ multiple transformers. The transformer **234** may advantageously provide galvanic isolation between the components of the collection, charging and distribution machine **102** and the grid **116** (FIG. **1**). The rectifier **236** may take any of variety of forms, for example a full bridge diode rectifier or a switch mode rectifier. The rectifier **236** may be operated to transform AC electrical power to DC electrical power. The DC/DC power converter **238** may take any of a large variety of forms. For example, DC/DC power converter **238** may take the form a switch mode DC/DC power converter, for instance employing IGBTs or MOSFETs in a half or full bridge configuration, and may include one or more inductors. The DC/DC power converter **238** may have any number of topologies including a boost converter, buck converter, synchronous buck converter, buck-boost converter or fly-back converter. The filter(s) **240** may include one or more capacitors, resistors, Zener diodes or other elements to suppress voltage spikes, or to remove or reduce transients and/or noise.

The illustrated charging subsystem **204** may also receive electrical power from a renewable power source, for example the PV array **118** (FIG. **1**). Such may be converted or conditioned by the first power converter **230**, for example being supplied directly to the DC/DC power converter **238**, bypassing the transformer **236** and/or rectifier **236**. Alternatively, the illustrated charging subsystem **204** may include a dedicated power converter to convert or otherwise condition such electrical power.

The illustrated charging subsystem **204** may optionally include second power converter **242** that receives electrical power from one or more portable electrical energy storage devices **106** (FIG. **1**) via one or more lines **244**, for charging other ones of the portable electrical energy storage devices **106**. As such, the second power converter **242** may need to convert and/or otherwise condition the electrical power received from portable electrical energy storage devices **106**, for example optionally transforming voltage or current, as well as reducing transients and noise. Thus, the second power converter **242** may optionally include a DC/DC power converter **246** and/or filter(s) **248**. Various types of DC/DC power converters and filters are discussed above.

The illustrated charging subsystem **204** includes a plurality of switches **250** responsive to the control signals delivered via ports **224***a*, **224***b* from the control subsystem **202**. The switches may be operable to selectively couple a first number or set of portable electrical energy storage devices **106** to be charged from electrical power supplied by both the electrical service via the first power converter **230** and from electrical power supplied by a second number or set of portable electrical energy storage devices **106**. The first number or set of portable electrical energy storage devices **106** may include a single portable electrical energy storage device **106**, two, or even more portable electrical energy storage devices **106**. The second number or set of portable electrical energy storage devices **106** may include a single portable electrical energy storage device **106**, two, or even more portable electrical energy storage devices **106**. The portable electrical energy storage devices **106** are represented in FIG. **2** as loads L_1, L_2-L_N.

The communications subsystem **206** may additionally include one or more communications modules or components which facilitate communications with the various components of a back end or back office system **120** (FIG. **1**), various components of the all-electric scooter or motorbike **108**, various components of the portable electrical energy storage devices **106**, and/or various components of a portable electrical energy storage device compartment of the all-electric scooter or motorbike **108**. The communications subsystem **206** may, for example, include one or more modems **252** and/or one or more Ethernet cards or other types of communications cards or components **254**. A port **256***a* of the control subsystem **202** may communicatively couple the control subsystem **202** with a port **256***b* of the communications subsystem **206**. The communications subsystem **206** may provide wired and/or wireless communications. For example, the communications subsystem **206** may provide components enabling short range (e.g., via Bluetooth, near field communication (NFC), radio frequency identification (RFID) components and protocols) or longer range wireless communications (e.g., over a wireless LAN, satellite, or cellular network) with various other devices external to the collection, charging and distribution machine **102**, including various components of the all-electric scooter or motorbike **108**, various components of the portable electrical energy storage devices **106**, and/or various components of a portable electrical energy storage device compartment of the all-electric scooter or motorbike **108**. The communications subsystem **206** may include one or more ports, wireless receivers, wireless transmitters or wireless transceivers to provide wireless signal paths to the various remote components or systems. The communications subsystem **206** may include one or more bridges or routers suitable to handle network traffic including switched packet type communications protocols (TCP/IP), Ethernet or other networking protocols.

The user interface subsystem **208** includes one or more user input/output (I/O) components. For example, user interface subsystem **208** may include a touch screen display **208***a* operable to present information to an end user, and a graphical user interface (GUI) to receive indications of user selections. The user interface subsystem **208** may include a keyboard or keypad **208***b*, and/or a cursor controller (e.g., mouse, trackball, trackpad) (not illustrated) to allow an end user to enter information and/or select user selectable icons in a GUI. The user interface subsystem **208** may include a speaker **208***c* to provide aural messages to an end user and/or a microphone **208***d* to receive spoken user input such as spoken commands.

The user interface subsystem **208** may include a card reader **208***e* to read information from card type media **209**. The card reader **208***e* may take a variety of forms. For instance, the card reader **208***e* may take the form of, or include, a magnetic stripe reader for reading information encoded in a magnetic stripe carried by a card **209**. For instance, the card reader **208***e* may take the form of, or include, a machine-readable symbol (e.g., barcode, matrix code) card reader for reading information encoded in a machine-readable symbol carried by a card **209**. For instance, the card reader **208***e* may take the form of, or include, a smart card reader for reading information encoded in a non-transitory medium carried by a card **209**. Such may, for instance, include media employing radio frequency identification (RFID) transponders or electronic payment chips (e.g., near field communications (NFC) chips, such as used by electronic wallet (e-wallet) applications, etc.). Thus, the card reader **208***e* may be able to read information from a variety of card media **209**, for instance credit cards, debit cards, gift cards, and prepaid cards, as well as identification media such as driver licenses. The card reader **208***e* may also be able to read information encoded in a non-transitory medium carried by the portable electrical energy storage devices **106**, and may also include RFID transponders, transceivers, NFC chips and/or other communications devices to communicate information to various components of the all-electric scooter or motorbike **108**, various components of the portable electrical energy storage devices **106**, and/or various components of a portable electrical energy storage device compartment of the all-electric scooter or motorbike **108** (e.g., information regarding a current or previous unsafe condition of the portable electrical energy storage device **106**, information for authentication of the collection, charging and distribution machine **102** to the portable electrical energy storage device compartment of the all-electric scooter or motorbike **108**, or for authentication of the of the all-electric scooter or motorbike **108** to the collection, charging and distribution machine **102**).

The user interface subsystem **208** may include a bill acceptor **208***f* and a validator and/or coin acceptor **208***g* to accept and validate cash payments. Such may be highly useful in servicing populations lacking access to credit. Bill acceptor and validator **208***f* and/or coin acceptor **208***g* may take any variety of forms, for example those that are currently commercially available and used in various vending machines and kiosks.

FIG. **3**A is a block diagram of a portable electrical energy storage device compartment locking system **300** for the portable electrical energy storage device of the scooter or motorbike **108** of FIG. **1**, according to one non-limiting illustrated embodiment. In particular, FIG. **3**A shows a portable electrical energy storage device compartment locking system **300** for the portable electrical energy storage device **106***z* of the scooter or motorbike **108** of FIG. **1** in wireless communication in one instance with the collection, charging and distribution machine **102** of FIG. **1** and in another instance with an external wireless device **330**, according to one non-limiting illustrated embodiment.

Shown is a portable electrical energy storage device compartment locking mechanism **320** operably coupled to a locking mechanism controller **306** via communication line **308**. The locking mechanism controller **306** is also operably coupled to one or more portable electrical energy storage device safety sensors **528** via communication line **310** and to a vehicle electronic control unit **312** of the vehicle **108** via communication line **316**. In some alternative embodiments, the vehicle electronic control unit **312** may instead or also be coupled to the portable electrical energy storage device safety sensors **528** and/or the locking mechanism controller **306** may be part of the vehicle electronic control unit **312**. In some embodiments, the vehicle electronic control unit **312** may perform the functions of the locking mechanism controller **306** described herein.

In some embodiments, the portable electrical energy storage device compartment locking mechanism **320** and the locking mechanism controller **306** are part of a portable electrical energy storage device compartment (shown in FIGS. **5-7**) of the scooter or motorbike **108**. One or more of the portable electrical energy storage device safety sensors **528**, locking mechanism controller **306**, and portable electrical energy storage device compartment locking mechanism **320** may instead be operably located inside or attached to the portable electrical energy storage device **106***z*.

As the portable electrical energy storage devices **106***z* shown in FIG. **1** may be lent, leased, rented out, or otherwise provided to the public, it is desirable to control how and in what circumstances the portable electrical energy storage

device compartment for the portable electrical energy storage device **106***z* may be accessed. For example, the portable electrical energy storage device **106***z* may encounter unsafe conditions while being used or stored in the vehicle **108**. Thus, the locking mechanism controller **306** may cause a compartment in which the portable electrical energy storage device **106***z* is currently being held to lock when such conditions occur or are determined to be imminent. Such unsafe conditions may be caused by overheating, melting or explosion caused by a short circuit, system malfunction, environmental conditions or other catastrophic failure of the portable electrical energy storage device **106***z*. Locking the compartment in which the portable electrical energy storage device **106***z* is currently being held when such conditions occur may be a safety measure that helps contain the unsafe condition inside the compartment or may help prevent injury to a user attempting to access the portable electrical energy storage device **106***z* when such conditions are present or are determined to be imminent.

In some embodiments, in response to receiving information regarding an unsafe condition from the portable electrical energy storage device safety sensors **528** over communication line **310**, the locking mechanism controller **306** determines whether the portable electrical energy storage device is in a desired state to have the compartment locked. If the locking mechanism controller **306** determines the portable electrical energy storage device is in the desired state to have the compartment locked, then it sends a signal over communication line **308** to the portable electrical energy storage device compartment locking mechanism **320**, causing the portable electrical energy storage device compartment locking mechanism **320** to lock the compartment in which the portable electrical energy storage device **106***z* is located to prevent a user from opening the compartment and thus help protect the user against the unsafe condition. For example, the unsafe condition may be a potential or existing catastrophic failure of the portable electrical energy storage device **106***z* in the compartment (e.g., a meltdown, explosion or dangerous leak, etc.).

A temperature level, a voltage level and/or a current level of the portable electrical energy storage device **106***z* and/or a circuit to which the portable electrical energy storage device **106***z* is connected being above a particular respective threshold may be indicative of such an unsafe condition. Also, a temperature, contaminant level, or pressure level inside the compartment in which the portable electrical energy storage device **106***z* is located, or inside the portable electrical energy storage device **106***z* itself, being above a particular respective threshold may be indicative of such an unsafe condition. Thus, the desired state to have the compartment locked may be a state in which one or more of a temperature level, a voltage level and a current level of a circuit to which the portable electrical energy storage device **106***z* is connected is above a particular respective threshold. Also, alone or in combination with such factors, the desired state to have the compartment locked may be a state in which one or more of a temperature, contaminant level, or pressure level inside the compartment in which the portable electrical energy storage device **106***z* is located, or inside the portable electrical energy storage device **106***z* itself, is above a particular respective threshold.

In some embodiments, such thresholds may be according to, or otherwise dependent on, the type of portable electrical energy storage device **106***z* or other specifications of the portable electrical energy storage device **106***z*. For example, a particular portable electrical energy storage device may be able to operate at higher temperatures, current and/or voltage levels than other portable electrical energy storage devices. The locking mechanism controller **306** may select which threshold to use in its determination of whether to lock the compartment in which the portable electrical energy storage device **106***z* is located based on such portable electrical energy storage device specifications.

The portable electrical energy storage device safety sensors **528** may include one or more sensors coupled to the locking mechanism controller **306** via communication line **310** that sense such conditions indicative of the unsafe condition. For example, the conditions indicative of the unsafe condition may include conditions regarding one or more of: a temperature level of a circuit to which the portable electrical energy storage device is connected; a voltage level of a circuit to which the portable electrical energy storage device **106***z* is connected; a current level of a circuit to which the portable electrical energy storage device **106***z* is connected; a temperature of the portable electrical energy storage device **106***z*; a temperature inside the compartment in which the portable electrical energy storage device **106***z* is located; a contaminant level inside the compartment in which the portable electrical energy storage device **106***z* is located; a pressure level inside the compartment in which the portable electrical energy storage device **106***z* is located; a contaminant level inside the portable electrical energy storage device **106***z*; a pressure level inside the portable electrical energy storage device **106***z*; and a short circuit of a circuit to which the portable electrical energy storage device is connected. Thus, as applicable, in some embodiments, the portable electrical energy storage device safety sensors **528** may include one or more of: a volt sensor, a voltmeter, a current sensor, an ammeter, a watt sensor, a wattmeter, an electrical resistance sensor, an ohmmeter, a fuse, a temperature sensor, a resistance temperature detector (RTD), a thermistor, thermocouple, a diode, thermostat, a thermometer, a pressure sensor, an air pressure sensor, a contaminant sensor, etc., operably coupled to the portable electrical energy storage device **106***z* or to a circuit to which the portable electrical energy storage device **106***z* is connected. Such portable electrical energy storage device safety sensors **528** may be mechanical, analog, digital, integrated circuit sensors, or any applicable combination thereof.

In some embodiments, the locking mechanism controller **306**, in response to receiving the information regarding the unsafe condition of the portable electrical energy storage device **106***z*, sends a signal via communication line **316** to the vehicle's electronic control unit **312** to reduce or eliminate a current power draw by the vehicle **108** from the portable electrical energy storage device **106***z*. Such reduction or elimination of the current power draw by the vehicle **108** from the portable electrical energy storage device **106***z* may resolve, reduce or postpone such an unsafe condition and/or prevent it from worsening. This may be in addition to or instead of determining to lock the compartment in which the portable electrical energy storage device **106***z* is located. The locking mechanism controller **306** may select which threshold(s) to use in its determination of whether to send a signal to the vehicle's electronic control unit **312** to reduce or eliminate a current power draw by the vehicle **108** from the portable electrical energy storage device **106***z* and/or to lock the compartment in which the portable electrical energy storage device **106***z* is located based at least in part on such portable electrical energy storage device specifications as described above.

Also shown is the collection, charging and distribution machine **102** in wireless communication with the locking mechanism controller **306**. For example, the communications subsystem **206** (shown in FIG. **2**) of the collection, charging

and distribution machine **102** may provide components enabling short range (e.g., via Bluetooth, near field communication (NFC), radio frequency identification (RFID) components and protocols) or longer range wireless communications (e.g., over a wireless LAN, satellite, or cellular network) with various other devices external to the collection, charging and distribution machine **102**, including the locking mechanism controller **306**. The communications subsystem **206** of the collection, charging and distribution machine **102** may include one or more ports, wireless receivers, wireless transmitters or wireless transceivers to provide wireless signal paths to the locking mechanism controller **306**. The communications subsystem **206** of the collection, charging and distribution machine **102** may also or instead include connections to one or more bridges or routers suitable to handle network traffic including switched packet type communications protocols (TCP/IP), Ethernet or other networking protocols.

The control of the access to the portable electrical energy storage device compartment of the portable electrical energy storage device **106***z* may also be used to allow access to the portable electrical energy storage device by authorized personnel such as a technician or manufacturer based on authenticated information after such unsafe condition has been detected. Such control based on authenticated information also helps to prevent theft and/or misuse of the portable electrical energy storage device **106***z* and provides for convenient access to the portable electrical energy storage device **106***z* when replacing or putting a new portable electrical energy storage device **106***z* in the scooter or motorbike **108** (such as when replacing the portable electrical energy storage device **106***z* with a new portable electrical energy storage device **106***z* at the collection, charging and distribution machine **102**).

For example, the portable electrical energy storage device compartment may be locked or otherwise secured until the locking mechanism controller **306** detects a wireless signal **119** including authentication information from an external wireless device **330** or the collection, charging and distribution machine **102** via one or more wireless communications subsystems such as that described above with respect to the collection, charging and distribution machine **102**. Such external wireless devices including one or more wireless communications subsystems such as that described above with respect to the collection, charging and distribution machine **102** may include, but are not limited to: card keys, access cards, credit cards, access control key fobs, mobile computing devices, cellular telephones, personal digital assistants (PDAs), smart phones, battery chargers, other access control devices, etc. Also, information regarding detected unsafe conditions of the portable electrical energy storage device **106***z* may be communicated to such an external wireless device **330** to notify a user of such a condition or to communicate such conditions to the backend system **120** such that the information can be analyzed and acted upon by the backend system and/or collection, charging and distribution machine **102** accordingly.

FIG. **3**B is a block diagram of a portable electrical energy storage device compartment locking system for the collection, charging and distribution machine **102** of FIG. **1**, according to one non-limiting illustrated embodiment. As the portable electrical energy storage device **106***z* may encounter unsafe conditions while being charged or stored in the collection, charging and distribution machine **102**, it may be desirable to lock a compartment in which the portable electrical energy storage device **106** is currently being held when such conditions occur, cut off or reduce current to or from the portable electrical energy storage device **106***z*, lock other compartments in which other portable electrical energy storage devices **106** are being held in the collection, charging and distribution machine **102**, display or send an alert regarding the unsafe condition, and/or or otherwise prevent a user from accessing one or more portable electrical energy storage devices **106** in the collection, charging and distribution machine **102**. Such unsafe conditions may be caused by overheating, melting or explosion caused by a short circuit, system malfunction, environmental conditions or other catastrophic failure. Such actions may be safety measures that help contain the unsafe condition inside the compartment or collection, charging and distribution machine **102** or may prevent injury to a user attempting to access the portable electrical energy storage device **106***z* when such conditions are present or are imminent.

Shown is a portable electrical energy storage device compartment locking mechanism **320** operably coupled to the locking mechanism controller **306** via communication line **308**. The locking mechanism controller **306** is also operably coupled to one or more portable electrical energy storage device safety sensors **528** via communication line **310** and to a charging and distribution machine control subsystem **202** via communication line **328**. In some alternative embodiments, the charging and distribution machine control subsystem **202** may instead or also be coupled to the portable electrical energy storage device safety sensors **528** and/or the locking mechanism controller **306** may be part of the charging and distribution machine control subsystem **202**, or the charging and distribution machine control subsystem **202** may perform the functions of the locking mechanism controller **306** described herein. In some embodiments, the portable electrical energy storage device compartment locking mechanism **320** and the locking mechanism controller **306** are part of a portable electrical energy storage device **106***z*, the respective receivers, compartments or receptacles **104***a*, **104***b*-**104***n* of the collection, charging and distribution machine **102**. One or more of the portable electrical energy storage device safety sensors **528**, locking mechanism controller **306**, and portable electrical energy storage device compartment locking mechanism **320** may instead be operably located inside or attached to the portable electrical energy storage device **106***z*. Among other sensors, the portable electrical energy storage device safety sensors **528** may include the one or more charge sensors S_{C1}-S_{CN} that may detect charge of the portable electrical energy storage devices **106** at each of the receivers, compartments or receptacles **104***a*, **104***b*-**104***n* of the collection, charging and distribution machine **102**.

In some embodiments, in response to receiving information regarding an unsafe condition from the portable electrical energy storage device safety sensors **528** over communication line **310**, the locking mechanism controller **306** determines whether the compartment (e.g., compartment **104***n*) in the collection, charging and distribution machine **102** is in a desired state to have the compartment locked. The locking mechanism controller **306** may also or instead determine whether to cut off or reduce current to or from the portable electrical energy storage device **106***n* (e.g., shown in FIG. **1**), lock other compartments in which other portable electrical energy storage devices **106** are being held in the collection, charging and distribution machine **102**, display or send an alert regarding the unsafe condition, and/or or otherwise prevent a user from accessing one or more portable electrical energy storage devices **106** in the collection, charging and distribution machine **102**. If the locking mechanism controller **306** determines the portable electrical energy storage device is in the desired state to have the compartment locked,

to cut off or reduce current to or from the portable electrical energy storage device **106***n*, lock other compartments in which other portable electrical energy storage devices **106** are being held in the collection, charging and distribution machine **102**, and/or display or send an alert regarding the unsafe condition, then the locking mechanism controller **306** sends an appropriate signal to do so over communication line **308** to either the portable electrical energy storage device compartment locking mechanism **320**, causing the portable electrical energy storage device compartment locking mechanism **320** to lock the compartment **104***n* in which the portable electrical energy storage device **106***n* is located, and/or send an applicable signal(s) to the charging and distribution machine control subsystem **202** via communication line **328** to causing the charging and distribution machine control subsystem **202** to perform the other applicable actions.

The control of the access to the portable electrical energy storage device compartment of the portable electrical energy storage device **106***z* may also be used to allow access to the portable electrical energy storage device **106***n* by authorized personnel such as a technician or manufacturer based on authenticated information after such an unsafe condition has been detected. For example, the portable electrical energy storage device compartment **104***n* may be locked or otherwise secured until the locking mechanism controller **306** detects a wireless signal **119** including authentication information from an external wireless device **330**. Such external wireless devices including one or more wireless communications subsystems such as that described above with respect to the collection, charging and distribution machine **102** may include, but are not limited to: card keys, access cards, credit cards, access control key fobs, mobile computing devices, cellular telephones, personal digital assistants (PDAs), smart phones, battery chargers, other access control devices, etc. Also, information regarding detected unsafe conditions of the portable electrical energy storage device **106***n* may be communicated to such an external wireless device **330** or to the backend system **120** (shown in FIG. **1**) directly to notify a user of such a condition or to communicate such conditions to the backend system **120** such that the information can be analyzed and acted upon by the backend system and/or collection, charging and distribution machine **102** accordingly.

FIG. **4** is a schematic view of the locking mechanism controller **306** of FIG. **3**A that is connected to the vehicle electronic control unit **312**, according to one non-limiting illustrated embodiment. However, the schematic view of the locking mechanism controller **306** of FIG. **3**A may also correspondingly apply to that of the locking mechanism controller **306** of FIG. **3**B that is connected to the charging and distribution machine control subsystem **202** of FIG. **3**B.

In some embodiments, the locking mechanism controller **306** includes a controller **410**, a communications subsystem **406**, and a power interface **420**.

The controller **410**, for example, is a microprocessor, microcontroller, programmable logic controller (PLC), programmable gate array (PGA), application specific integrated circuit (ASIC) or another controller capable of receiving signals from various sensors, performing logical operations, and sending signals to various components. Typically, the controller **410** may take the form of a microprocessor (e.g., INTEL, AMD, ATOM). The controller **410** is coupled to the portable electrical energy storage device compartment locking mechanism **320** via a control line **308**, coupled to the vehicle electronic control unit **312** via a control line **316** and coupled to the portable electrical energy storage device safety sensors **528** via control line **310**. However, in embodiments where the locking mechanism controller **306** is part of the collection, charging and distribution machine **102**, such as that shown in FIG. **3**B, the controller **410** is part of the charging and distribution machine control subsystem **202**, or is otherwise coupled to the charging and distribution machine control subsystem **202** via communication line **328** as shown in FIG. **3**B instead of to the vehicle electronic control unit **312**.

The locking mechanism controller **306** may also include one or more non-transitory processor- or computer-readable storage media, for example read-only memory (ROM) **412**, random access memory (RAM) **414**, and other storage **416** (e.g., solid-state storage media such as flash memory or EEPROM, or spinning storage media such as hard disk). The non-transitory processor- or computer-readable storage media **412**, **414**, **416** may be in addition to any non-transitory storage medium (e.g., registers) which is part of the controller **410**. The locking mechanism controller **306** may include one or more buses **418** (only one illustrated) coupling various components together, for example one or more power buses, instruction buses, data buses, etc.

As illustrated, the ROM **412**, or some other one of the non-transitory processor- or computer-readable storage media **412**, **414**, **416**, stores instructions and/or data or values for variables or parameters. The sets of data may take a variety of forms, for example a lookup table, a set of records in a database, etc. The instructions and sets of data or values are executable by the controller **410**. Execution of the instructions and sets of data or values causes the controller **410** to perform specific acts to receive information from and send information to an external device and, based on such information, cause the locking mechanism controller **306** to generate control signals to lock or unlock the portable electrical energy storage device compartment locking mechanism **320**, determine whether to cut off or reduce current to or from the portable electrical energy storage device **106***z*, lock other compartments in which other portable electrical energy storage devices may be located, display or send an alert regarding the unsafe condition, and/or or otherwise prevent a user from accessing one or more portable electrical energy storage devices. Specific operation of the locking mechanism controller **306** is described herein and also below with reference to FIGS. **1**-**10**, including various flow diagrams (FIGS. **8**-**10**).

The controller **410** may use RAM **414** in a conventional fashion, for volatile storage of instructions, data, etc. The controller **410** may use data store **416** to log or retain information, for example, including, but not limited to, one or more of: information from sensors **528**; portable electrical energy storage device type and/or specifications; current, voltage, temperature, contaminant level and/or pressure information; current, voltage, temperature, contaminant level and/or pressure thresholds; user profile information, vehicle profile information, security codes, credentials, security certificates, passwords, vehicle information, historical vehicle usage and/or usage; patterns; vehicle diagnostic data; etc.

The instructions are executable by the controller **410** to control operation of the locking mechanism controller **306** in response to input from remote systems such as those of external devices including but not limited to: a volt sensor, a voltmeter, a current sensor, an ammeter, a watt sensor, a wattmeter, an electrical resistance sensor, an ohmmeter, a fuse, a temperature sensor, a resistance temperature detector (RTD), a thermistor, thermocouple, a diode, thermostat, a thermometer, a pressure sensor, an air pressure sensor, a contaminant sensor, etc., operably coupled to the portable electrical energy storage device **106***z* or to a circuit to which the portable electrical energy storage device **106***z* is connected, charging devices, vehicles, key fobs, user identification

devices (cards, electronic keys, etc.), vehicles, collection, charging and distribution machines, collection, charging and distribution machine service systems, service centers, user mobile devices, user vehicles, and end user or operator input, or any applicable combination thereof. The controller **410** may also receive signals from various sensors and/or components of an external device via the communications subsystem **406** of the locking mechanism controller **306**. This information may include information that characterizes or is indicative of the authenticity, authorization level, operation, status, or condition of such components and/or external devices.

The communications subsystem **406** may include one or more communications modules or components which facilitate communications with the sensors **528** and/or the various components of the wireless device **330**, collection, charging and distribution machine **102** of FIG. **1** (e.g., such as to receive a security code), and/or of other external devices, such that data may be exchanged between the locking mechanism controller **306** and the external devices for authentication purposes. The communications subsystem **406** may provide wired and/or wireless communications. The communications subsystem **406** may include one or more ports, wireless receivers, wireless transmitters or wireless transceivers to provide wireless signal paths to the various remote components or systems. The communications subsystem **406** may, for example, include components enabling short range (e.g., via Bluetooth, near field communication (NFC), radio frequency identification (RFID) components and protocols) or longer range wireless communications (e.g., over a wireless LAN, satellite, or cellular network) and may include one or more modems or one or more Ethernet or other types of communications cards or components for doing so. The remote communications subsystem **406** may include connections to one or more bridges or routers suitable to handle network traffic including switched packet type communications protocols (TCP/IP), Ethernet or other networking protocols.

In some embodiments, some or all of the components of the locking mechanism controller **306** actuate one or more actuators **502** (shown in FIGS. **5** to **7**) of the portable electrical energy storage device compartment locking mechanism **320** (e.g., by a wireless control signal) sent via the communications subsystem **406**.

The power interface **420** is configured to receive power from a power source **516** (shown in FIGS. **5-7**) via power connection **314** to provide power to the locking mechanism controller **306**. The power interface **420** includes various components operable for performing the above functions such as electrical transformers, converters, rectifiers, etc. The power source **516** may be a separate power source than the portable electrical energy storage device **106***z*.

FIG. **5** is a cross-sectional elevation view of a locked, empty portable electrical energy storage device compartment **500** configured to hold the portable electrical energy storage device **106***z* of FIG. **1** coupled to the portable locking mechanism controller **306** of FIG. **3**A, according to one non-limiting illustrated embodiment.

Shown is a portable electrical energy storage device compartment housing **512**, a part of a vehicle **508**, a portable electrical energy storage device compartment locking mechanism **320**, a locking mechanism controller **306** and a power source **516**. In one embodiment, the portable electrical energy storage device compartment locking mechanism **320** is located outside the portable electrical energy storage device compartment housing **512** and fixed to a part of the vehicle **508** (as shown in the example of FIG. **5**). In other embodiments, the portable electrical energy storage device compartment locking mechanism **320** is located inside or otherwise fixed to the portable electrical energy storage device compartment housing **512** and/or vehicle. In each embodiment, however, the portable electrical energy storage device compartment locking mechanism **320** is configured to lock, latch, unlock and/or unlatch, or otherwise secure or provide access to the portable electrical energy storage device compartment **500**.

For example, the portable electrical energy storage device compartment **500** has a top opening through which the portable electrical energy storage device **106***z* may be placed into the portable electrical energy storage device compartment **500** and removed from the portable electrical energy storage device compartment **500**. Once the portable electrical energy storage device **106***z* is placed in the portable electrical energy storage device compartment **500**, the portable electrical energy storage device compartment housing **512** surrounds the portable electrical energy storage device **106***z* except at the top opening. As shown in FIG. **5**, the portable electrical energy storage device compartment **500** has a lid **520** covering the top opening of the portable electrical energy storage device compartment **500**. The lid **420** is hingedly attached to the top of a side wall **522** of the portable electrical energy storage device compartment **500** at a hinge **524** such that when the lid **520** is opened, a portable electrical energy storage device **106***z* may be placed in the portable electrical energy storage device compartment **500** or removed from the portable electrical energy storage device compartment **500**.

The portable electrical energy storage device compartment locking mechanism **320** has a slidable bolt **506** which partially covers an end of the lid **520** opposite the hinge **524** when the lid **520** is in a closed position as shown in FIG. **5**. This puts the portable electrical energy storage device compartment **500** in a locked or latched state by blocking the lid **520** from moving upward on the hinge **524** to an open position. The slidable bolt **506** is slidable on a bolt track or through bolt housing **504** fixedly attached to the vehicle part **508**. However, in other embodiments, the bolt housing **504** may be fixedly attached to the compartment housing **512**. When the portable electrical energy storage device compartment locking mechanism **320** is in an unlocked state, the slidable bolt **506** is retracted into the bolt housing **504** to not cover any portion of the lid **520** and thus allow the lid **520** to be opened (as shown in FIG. **6**).

The portable electrical energy storage device compartment locking mechanism **320** is coupled to the locking mechanism controller **306** via a control line **308** and coupled to the power source via power line **526**. For example, one or more control signals received from the locking mechanism controller **306** via control line **308** may affect the operation of one or more actuators **502** (only one illustrated) to cause the slidable bolt **506** to move. For instance, a control signal may cause movement of an actuator **502** between a first and a second position or change a magnetic field produced by the actuator **502**. The actuator **502** may take any of a variety of forms, including but not limited to a solenoid, an electric motor such as a stepper motor, or an electromagnet. The actuator **502** may alternatively be coupled to operate a different latch, lock or other type of retainer mechanism for reversibly locking the portable electrical energy storage device compartment lid **520**.

The actuator **502** may be coupled to operate a latch, lock or other retainer mechanism (not shown) in addition to or instead of the bolt **506**. The latch, lock or other retainer mechanism may selectively secure or retain the lid **520** to prevent access to the portable electrical energy storage device compartment **500**. For instance, the latch, lock or other

retainer mechanism may physically couple to a complementary structure that is part of the housing **512** or the lid **520** of the portable electrical energy storage device compartment **500**. Also for example, the actuator **502** may open and/or close a different latch or lock, allowing an end user to open the lid **520** or allowing the lid **520** to open automatically via a spring or other device.

The compartment housing **512** may provide protection to prevent or deter tampering with the electrical energy storage device, and may be formed of suitably strong and resilient materials (e.g., ABS plastic). Such may not only prevent or deter tampering, but may leave a visible indication of any tampering attempts. For example, the housing **512** may include a strong outer layer of a first color (e.g., black) and a layer of a second color (e.g., fluorescent orange) therebeneath. Such will render attempts to cut through the housing **512** visibly apparent. In some embodiments, the compartment **500** may be sealed once closed to prevent leakage of fluid from the portable electrical energy storage device **106***z* and/or to withstand sudden changes in pressure within the compartment **500**, and may have pressure release valves (not shown), air vents (not shown), built-in sensors such as those of sensors **528** (e.g., thermometer or temperature sensor **316**, a pressure sensor (not shown), etc.), and/or windows (not shown) to read the various sensors or meters of the compartment or of the portable electrical energy storage device **106***z*, etc. One or more of such features may be activated, actuated and/or used by the locking mechanism controller **306** based on information from sensors **528** and/or other information regarding an unsafe condition of a portable electrical energy storage device **106***z* located inside the compartment **500**.

FIG. **6** shows a cross-sectional elevation view of the empty portable electrical energy storage device compartment **500** of FIG. **5** in an unlocked and open state, according to one non-limiting illustrated alternative embodiment.

In some embodiments, mechanical, electric and/or electronic mechanisms may be used that provide the locking mechanism controller **306** with an indication of whether the portable electrical energy storage device **106***z* is present in the portable electrical energy storage device compartment **500** via control line **308**. For example, if the portable electrical energy storage device compartment **500** were in the state shown in FIG. **5** (i.e., in a locked state without a portable electrical energy storage device detected by the detection mechanism **528** as being present in the portable electrical energy storage device compartment **500**), once the locking mechanism controller **306** receives information regarding authentication of a wireless external device (e.g., a driver's key fob or other wireless device), the locking mechanism controller **306** will cause the portable electrical energy storage device compartment locking mechanism **320** to automatically unlock or unlatch the lid **520** to allow the lid **520** to be opened as shown in FIG. **6**, and the portable electrical energy storage device **106***z* to be placed therein.

FIG. **7** is a cross-sectional elevation view of the portable electrical energy storage device compartment **500** of FIG. **5** in a locked state holding the portable electrical energy storage device of FIG. **1** and coupled to portable electrical energy storage device safety sensors **528** of the portable electrical energy storage device compartment locking system, according to one non-limiting illustrated alternative embodiment.

The locking mechanism controller **306** receives information regarding one or more unsafe conditions from the portable electrical energy storage device safety sensors **528** over communication line **310** connected to portable electrical energy storage device safety sensors **528**. In response to receiving information regarding an unsafe condition from the portable electrical energy storage device safety sensors **528** over communication line **310**, the locking mechanism controller **306** determines whether the compartment **500** configured to hold the portable electrical energy storage device **106***z* is in a desired state to have the compartment **500** locked. If the locking mechanism controller **306** determines the portable electrical energy storage device is in the desired state to have the compartment **500** locked, then it sends a signal over communication line **308** to the portable electrical energy storage device compartment locking mechanism **320** causing the portable electrical energy storage device compartment locking mechanism **320** to lock the compartment **500** in which the portable electrical energy storage device **106***z* is located to prevent a user from opening the compartment **500** and thus help protect the user against the unsafe condition. The compartment **500** is shown in such a locked position in FIG. **7**.

For example, the unsafe condition may be a potential or existing catastrophic failure of the portable electrical energy storage device **106***z* in the compartment (e.g., a meltdown, explosion or dangerous leak, etc.). Thus, a temperature level, a voltage level and/or a current level of the portable electrical energy storage device **106***z* and/or a circuit to which the portable electrical energy storage device **106***z* is connected being above a particular respective threshold may be indicative of such an unsafe condition. Also, a temperature, contaminant level or pressure level inside the compartment **500** in which the portable electrical energy storage device **106***z* is located, or inside the portable electrical energy storage device **106***z* itself, being above a particular respective threshold may be indicative of such an unsafe condition. Thus, the desired state to have the compartment locked may be a state in which one or more of a temperature level, a voltage level and a current level of a circuit to which the portable electrical energy storage device **106***z* is connected is above a particular respective threshold. Also, alone or in combination with such factors, the desired state to have the compartment locked may be a state in which one or more of a temperature, contaminant level, or pressure level inside the compartment **500** in which the portable electrical energy storage device **106***z* is located, or inside the portable electrical energy storage device **106***z* itself, is above a particular respective threshold. As explained above, such threshold may be based on the specifications of the portable electrical energy storage device **106***z*, including, for example, a maximum current level, temperature, or voltage level the portable electrical energy storage device **106***z* can sustain before failure.

In some embodiments, locking mechanism controller **306**, in response to receiving the information regarding the unsafe condition of the portable electrical energy storage device **106***z* from the portable electrical energy storage device safety sensors **528**, sends a signal via communication line **316** to the vehicle's electronic control unit **312** to reduce or eliminate a current power draw by the vehicle **108** from the portable electrical energy storage device **106***z*. Such reduction or elimination of the current power draw by the vehicle **108** from the portable electrical energy storage device **106***z* may resolve, reduce or postpone such an unsafe condition and/or prevent it from worsening. This may be in addition to or instead of determining to lock the compartment in which the portable electrical energy storage device **106***z* is located. The locking mechanism controller **306** may select which threshold(s) to use in its determination of whether to send a signal to the vehicle's electronic control unit **312** to reduce or eliminate a current power draw by the vehicle **108** from the portable electrical energy storage device **106***z* and/or to lock the compartment in which the portable electrical energy storage

device **106***z* is located based on such portable electrical energy storage device specifications as described above.

Accordingly, portable electrical energy storage device safety sensors **528** may include one or more sensors coupled to the locking mechanism controller **306** via communication line **310** that sense such conditions indicative of the unsafe condition. For example, as shown in FIG. **7**, such sensors may include, but are not limited to, a current sensor or ammeter **702**, a watt sensor or wattmeter **704** and/or a voltage sensor or voltage meter **706**, each operably coupled to the circuit including the portable electrical energy storage device **106***z* and the vehicle electronic control unit **312** as shown in FIG. **7** in order to detect unsafe conditions of the portable electrical energy storage device **106***z*. Also, a thermal sensor **708** may also be part of the portable electrical energy storage device safety sensors **528**. Additionally or alternatively a thermometer **316** located inside the compartment **500** may also be part of the portable electrical energy storage device safety sensors **528**, shown as operably connected via communication line **326** that goes through a side wall of the housing **512**. The portable electrical energy storage device safety sensors **528** may include additional, fewer or different combinations of sensors than those shown in FIG. **7**. Overall, in various applicable embodiments, the portable electrical energy storage device safety sensors **528** may include one or more of: a volt sensor, a voltmeter, a current sensor, an ammeter, a watt sensor, a wattmeter, an electrical resistance sensor, an ohmmeter, a fuse, a temperature sensor, a resistance temperature detector (RTD), a thermistor, thermocouple, a diode, thermostat, a thermometer, a pressure sensor, an air pressure sensor, a contaminant sensor, etc., operably coupled to the portable electrical energy storage device **106***z* or to a circuit to which the portable electrical energy storage device **106***z* is connected. Such portable electrical energy storage device safety sensors **528** may be mechanical, analog, digital, integrated circuit sensors, or any applicable combination thereof.

As shown in FIG. **7**, the lid **520** may have openings or holes to allow the terminals **110***a* and **110***b* of the portable electrical energy storage device **106***z* to be accessed when the portable electrical energy storage device **106***z* is present in the portable electrical energy storage device compartment **500** with the lid **520** closed, such that the terminals **110***a* and **110***b* may be operably connected to a vehicle such as the scooter or bike **108** to power the vehicle. However, in various other embodiments, such access to the terminals **110***a* and **110***b* of the portable electrical energy storage device **106***z* is not through the lid **520**, but instead through other holes or access passages (not shown) in the housing **512** of the compartment **500**. In yet other embodiments, the compartment **500** may also include one or more components of the vehicle **108** powered by the portable electrical energy storage device **106***z*, including the vehicle electronic control unit **312**, the motor (not shown), and/or one or more components of portable electrical energy storage device compartment locking system **300**. In this embodiment, no access holes or openings in the lid **520** leading out the compartment **500** are needed to connect the terminals **110***a* and **110***b* to such components located inside the compartment **500**.

FIG. **8** shows a method **800** of operating the locking mechanism controller **306** of FIGS. **3-7**, according to one non-limiting illustrated embodiment.

At **802**, the portable electrical energy storage device compartment locking system receives information via at least one communications module regarding an unsafe condition of a portable electrical energy storage device in a compartment configured to hold the portable electrical energy storage device.

At **804**, the portable electrical energy storage device compartment locking system, in response to receiving the information regarding the unsafe condition, determines whether the portable electrical energy storage device is in a desired state to have the compartment locked.

At **806**, if it is determined the portable electrical energy storage device is in the desired state to have the compartment locked, then the portable electrical energy storage device compartment locking system locks a portable electrical energy storage device compartment locking mechanism of the compartment to protect a user against the unsafe condition.

FIG. **9** shows a method **900** of the locking mechanism controller of FIGS. **3-7** making a determination regarding locking a portable electrical energy storage device compartment locking mechanism, according to one non-limiting illustrated embodiment.

At **902**, the portable electrical energy storage device compartment locking system receives information regarding an unsafe condition of a portable electrical energy storage device in a compartment configured to hold the portable electrical energy storage device.

At **904**, the portable electrical energy storage device compartment locking system makes a determination regarding locking a portable electrical energy storage device compartment locking mechanism, based on the information regarding the unsafe condition of the portable electrical energy storage device in the compartment.

FIG. **10** shows a high level method **1000** of the locking mechanism controller of FIGS. **3-7** sending a signal to the electronic control unit of the vehicle to reduce or eliminate a current power draw from the portable electrical energy storage device, according to one non-limiting illustrated embodiment.

At **1002**, the portable electrical energy storage device compartment locking system receives information via the at least one communications module regarding an unsafe condition of a portable electrical energy storage device in the compartment.

At **1004**, in response to receiving the information regarding the unsafe condition, the portable electrical energy storage device compartment locking system sends a signal to the electronic control unit to reduce or eliminate a current power draw from a portable electrical energy storage device in the compartment.

The various methods described herein may include additional acts, omit some acts, and/or may perform the acts in a different order than set out in the various flow diagrams.

The foregoing detailed description has set forth various embodiments of the devices and/or processes via the use of block diagrams, schematics, and examples. Insofar as such block diagrams, schematics, and examples contain one or more functions and/or operations, in light of the teaching of the disclosure herein, it will be understood by those skilled in the art that each function and/or operation within such block diagrams, flowcharts, or examples can be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In one embodiment, the present subject matter may be implemented via one or more microcontrollers. However, in light of the teaching of the disclosure herein, those skilled in the art will recognize that the embodiments disclosed herein, in whole or in part, can be equivalently implemented in standard integrated circuits (e.g., Application Specific Integrated Circuits or ASICs), as one or more computer programs executed by one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more

programs executed by on one or more controllers (e.g., microcontrollers) as one or more programs executed by one or more processors (e.g., microprocessors), as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and/or firmware would be well within the skill of one of ordinary skill in the art in light of the teachings of this disclosure.

When logic is implemented as software and stored in memory, logic or information can be stored on any applicable non-transitory computer-readable medium for use by or in connection with any processor-related system or method. In the context of this disclosure, a memory is a nontransitory computer- or processor-readable storage medium that is an electronic, magnetic, optical, or other physical device or means that non-transitorily contains or stores a computer and/or processor program. Logic and/or the information can be embodied in any computer-readable medium for use by or in connection with an instruction execution system, apparatus, or device, such as a computer-based system, processor-containing system, or other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions associated with logic and/or information.

In the context of this specification, a "computer-readable medium" can be any physical element that can store the program associated with logic and/or information for use by or in connection with the instruction execution system, apparatus, and/or device. The computer-readable medium can be, for example, but is not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus or device. More specific examples (a non-exhaustive list) of the computer readable medium would include the following: a portable computer diskette (magnetic, compact flash card, secure digital, or the like), a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM, EEPROM, or Flash memory), a portable compact disc read-only memory (CDROM), and digital tape.

The various embodiments described above can be combined to provide further embodiments. To the extent that they are not inconsistent with the specific teachings and definitions herein, all of the U.S. patents, U.S. patent application publications, U.S. patent applications, foreign patents, foreign patent applications and non-patent publications referred to in this specification and/or listed in the Application Data Sheet, including but not limited to: U.S. provisional patent application Ser. No. 61/511,900, entitled "APPARATUS, METHOD AND ARTICLE FOR COLLECTION, CHARGING AND DISTRIBUTING POWER STORAGE DEVICES, SUCH AS BATTERIES" and filed Jul. 26, 2011; U.S. provisional patent application Ser. No. 61/534,753, entitled "APPARATUS, METHOD AND ARTICLE FOR REDISTRIBUTING POWER STORAGE DEVICES, SUCH AS BATTERIES, BETWEEN COLLECTION, CHARGING AND DISTRIBUTION MACHINES" and filed Sep. 14, 2011; U.S. provisional patent application Ser. No. 61/534,761, entitled "APPARATUS, METHOD AND ARTICLE FOR AUTHENTICATION, SECURITY AND CONTROL OF POWER STORAGE DEVICES, SUCH AS BATTERIES" and filed Sep. 14, 2011; U.S. provisional patent application Ser. No. 61/534,772, entitled "APPARATUS, METHOD AND ARTICLE FOR AUTHENTICATION, SECURITY AND CONTROL OF POWER STORAGE DEVICES, SUCH AS BATTERIES, BASED ON USER PROFILES" and filed Sep. 14, 2011; U.S. provisional patent application Ser. No. 61/543,720, entitled "DETECTABLE INDICATION OF AN ELECTRIC MOTOR VEHICLE STANDBY MODE" and filed Oct. 5, 2011; U.S. provisional patent application Ser. No. 61/511,887, entitled "THERMAL MANAGEMENT OF COMPONENTS IN ELECTRIC MOTOR DRIVE VEHICLES" and filed Jul. 26, 2011; U.S. provisional patent application Ser. No. 61/511,880, entitled "DYNAMICALLY LIMITING VEHICLE OPERATION FOR BEST EFFORT ECONOMY" and filed Jul. 26, 2011; U.S. provisional patent application Ser. No. 61/546,411, entitled "DRIVE ASSEMBLY FOR ELECTRIC POWERED DEVICE" and filed Oct. 12, 2011; and U.S. provisional patent application Ser. No. 61/872,126, entitled "PORTABLE ELECTRICAL ENERGY STORAGE DEVICE" and filed Aug. 30, 2013 are incorporated herein by reference, in their entirety. Aspects of the embodiments can be modified, if necessary, to employ systems, circuits and concepts of the various patents, applications and publications to provide yet further embodiments.

While generally discussed in the environment and context of collection, charging and distribution of portable electrical energy storage devices for use with personal transportation vehicles such as all-electric scooters and/or motorbikes, the teachings herein can be applied in a wide variety of other environments, including other vehicular as well as non-vehicular environments.

The above description of illustrated embodiments, including what is described in the Abstract of the Disclosure, is not intended to be exhaustive or to limit the embodiments to the precise forms disclosed. Although specific embodiments and examples are described herein for illustrative purposes, various equivalent modifications can be made without departing from the spirit and scope of the disclosure, as will be recognized by those skilled in the relevant art in light of the teaching of the disclosure herein.

These and other changes can be made to the embodiments in light of the above-detailed description. In general, in the following claims, the terms used should not be construed to limit the claims to the specific embodiments disclosed in the specification and the claims, but should be construed to include all possible embodiments along with the full scope of equivalents to which such claims are entitled. Accordingly, the claims are not limited by the disclosure.

The invention claimed is:

1. A portable electrical energy storage device compartment system, comprising:

at least one controller; and

at least one communications module coupled to the at least one controller, wherein the at least one controller:

receives information via the at least one communications module regarding an unsafe condition of a portable electrical energy storage device in a compartment configured to hold the portable electrical energy storage device; and

in response to receiving the information regarding the unsafe condition:

determines whether the portable electrical energy storage device is in a desired state to have the compartment locked; and

if it is determined the portable electrical energy storage device is in the desired state to have the compartment locked, then locks a portable electrical energy storage device compartment locking mechanism of the compartment to protect a user against the unsafe condition.

2. The portable electrical energy storage device compartment system of claim **1** wherein the desired state to have the compartment locked is a state in which one or more of a temperature level, a voltage level and a current level of a

circuit to which the portable electrical energy storage device is connected is above a particular respective threshold.

3. The portable electrical energy storage device compartment system of claim **2** wherein the unsafe condition is a potential or existing catastrophic failure of the portable electrical energy storage device in the compartment.

4. The portable electrical energy storage device compartment system of claim **1** wherein the desired state to have the compartment locked is a state in which one or more of a temperature level of the portable electrical energy storage device and a temperature level of an inside of the compartment is above a particular respective threshold.

5. The portable electrical energy storage device compartment system of claim **1**, wherein the at least one communications module receives the information regarding the unsafe condition from one or more sensors coupled to a circuit to which the portable electrical energy storage device is connected and communicates the information to the at least one controller to enable the at least one controller to lock the portable electrical energy storage device compartment locking mechanism.

6. The portable electrical energy storage device compartment system of claim **1**, further comprising:

the portable electrical energy storage device compartment locking mechanism coupled to the at least one controller; and

one or more sensors coupled to the at least one controller that sense conditions indicative of the unsafe condition, the conditions indicative of the unsafe condition including conditions regarding one or more of: a temperature level of a circuit to which the portable electrical energy storage device is connected, a voltage level of a circuit to which the portable electrical energy storage device is connected, a current level of a circuit to which the portable electrical energy storage device is connected, a temperature of the portable electrical energy storage device, a temperature of an inside of the compartment in which the portable electrical energy storage device is located, and a short circuit of a circuit to which the portable electrical energy storage device is connected, wherein the at least one controller sends a control signal in a manner to lock the portable electrical energy storage device compartment locking mechanism if the controller determines the portable electrical energy storage device is in the desired state to have the compartment locked based on the conditions indicative of the unsafe conditions sensed by the one or more sensors.

7. The portable electrical energy storage device compartment system of claim **1** wherein the at least one controller is further configured to make a determination regarding unlocking the portable electrical energy storage device based on one or more of: information regarding the unsafe condition no longer being present and performance of a locking mechanism override operation.

8. The portable electrical energy storage device compartment system of claim **1** wherein the portable electrical energy storage device compartment system is coupled to a vehicle.

9. The portable electrical energy storage device compartment system of claim **1** wherein the portable electrical energy storage device compartment system is coupled to a collection, charging and distribution machine.

10. The portable electrical energy storage device compartment system of claim **1** wherein the at least one controller sends the information regarding an unsafe condition to an external device via a wireless signal transmitted to the external device.

11. The portable electrical energy storage device compartment system of claim **1**, further comprising a power source, separate from the portable electrical energy storage device, coupled to the at least one controller and the portable electrical energy storage device compartment locking mechanism to provide power to the portable electrical energy storage device compartment locking mechanism and the at least one controller.

12. A method of operating a portable electrical energy storage device compartment system, the method comprising:

receiving, by the portable electrical energy storage device compartment system, information regarding an unsafe condition of a portable electrical energy storage device in a compartment configured to hold the portable electrical energy storage device; and

making a determination, by the portable electrical energy storage device compartment system, regarding locking a portable electrical energy storage device compartment locking mechanism based on the information regarding the unsafe condition of the portable electrical energy storage device in the compartment.

13. The method of claim **12**, further comprising:

receiving, by a communications module of the portable electrical energy storage device compartment system, the information regarding the unsafe condition from one or more sensors coupled to a circuit to which the portable electrical energy storage device is connected; and

communicating, by a communications module of the portable electrical energy storage device compartment system, the information to at least one controller of the portable electrical energy storage device compartment system to enable the at least one controller to lock the portable electrical energy storage device compartment locking mechanism.

14. The method of claim **13** wherein the received information regarding the unsafe condition includes information regarding one or more of: a temperature level of a circuit to which the portable electrical energy storage device is connected, a voltage level of a circuit to which the portable electrical energy storage device is connected, a current level of a circuit to which the portable electrical energy storage device is connected, a temperature of the portable electrical energy storage device, and a temperature of an inside of the compartment in which the portable electrical energy storage device is located.

15. A vehicle, comprising:

a motor to propel the vehicle at least partially powered by a portable electrical energy storage device;

an electronic control unit coupled to the portable electrical energy storage device that controls how much power to draw from the portable electrical energy storage device to power the motor;

a compartment configured to hold the portable electrical energy storage device;

at least one controller of a locking mechanism of the compartment; and

at least one communications module coupled to the at least one controller, wherein the at least one controller:

receives information via the at least one communications module regarding an unsafe condition of a portable electrical energy storage device in the compartment; and

in response to receiving the information regarding the unsafe condition:

determines whether the portable electrical energy storage device is in a desired state to have the compartment locked; and

if it is determined the portable electrical energy storage device is in the desired state to have the compartment locked, then locks the locking mechanism of the compartment to protect a user against the unsafe condition.

16. The vehicle of claim **15** wherein the at least one controller:

in response to receiving the information regarding the unsafe condition, sends a signal to the electronic control unit to reduce or eliminate a current power draw from the portable electrical energy storage device in the compartment.

17. The vehicle of claim **16** wherein the information regarding the unsafe condition is indicative of an unsafe current level of a circuit to which the portable electrical energy storage device and electronic control unit are connected.

18. A portable electrical energy storage device, comprising: at least one portable electrical energy storage device cell; and one or more sensors coupled to the at least one portable electrical energy storage device cell and to at least one controller, wherein the one or more sensors sense conditions indicative of an unsafe condition of the portable electrical energy storage device, the conditions indicative of the unsafe condition including conditions regarding one or more of: a temperature level of a circuit to which the portable electrical energy storage device is connected, a voltage level of a circuit to which the portable electrical energy storage device is connected, a current level of a circuit to which the portable electrical energy storage device is connected, a temperature of the portable electrical energy storage device, a temperature of an inside of a compartment in which the portable electrical energy storage device is located, and a short circuit of a circuit to which the portable electrical energy storage device is connected; and

at least one communications module coupled to the at least one controller, wherein the at least one communications module communicates information regarding the conditions indicative of an unsafe condition to the at least one controller; and the at least one controller, in response to receiving the information regarding the unsafe condition: determines whether the portable electrical energy storage device is in a desired state to have the compartment locked; and if it is determined the portable electrical energy storage device is in the desired state to have the compartment locked, then sends a signal to activate a portable electrical energy storage device compartment locking mechanism.

19. The portable electrical energy storage device of claim **18**, wherein the at least one communications module communicates information regarding the conditions indicative of an unsafe condition to an external device.

20. The portable electrical energy storage device of claim **19** wherein the at least one communications module wirelessly communicates information regarding the conditions indicative of an unsafe condition to the external device.

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