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(54) **MONITORING MODULES FOR HAND HYGIENE DISPENSERS**

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CPC ***A47K 5/1217*** (2013.01); ***G08B 21/245*** (2013.01); *G16H 40/20* (2018.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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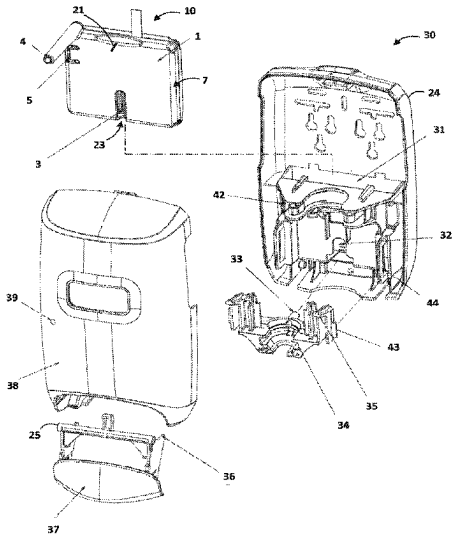
(57) **ABSTRACT**

A wireless dispenser beacon module for a product dispenser comprises a bottle presence trigger configured to detect one of presence or absence of a product bottle in the product dispenser; an actuation sensor configured to detect actuation of the product dispenser; and a module controller configured to wirelessly transmit dispenser data indicative of the detected one of presence or absence of the product bottle in the product dispenser associated with each detected actuation of the product dispenser.

24 Claims, 17 Drawing Sheets



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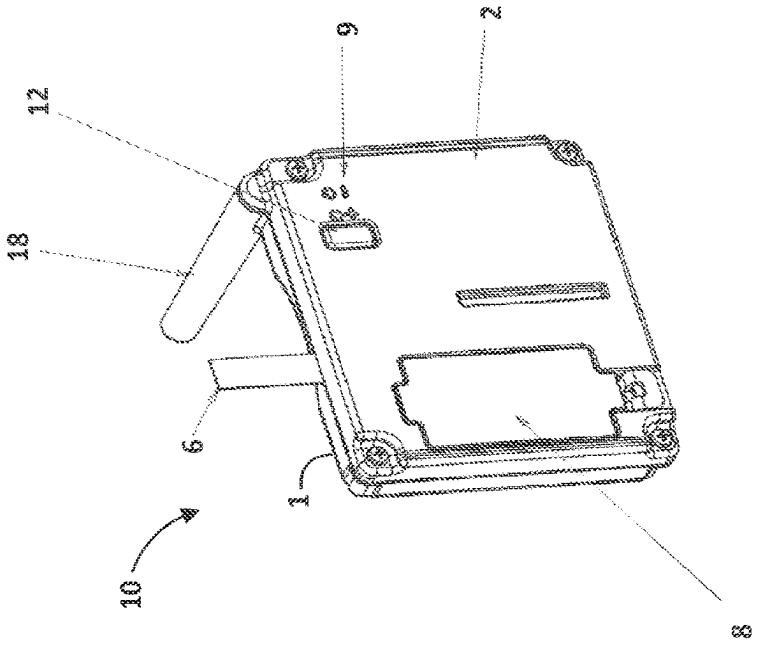


FIG. 2

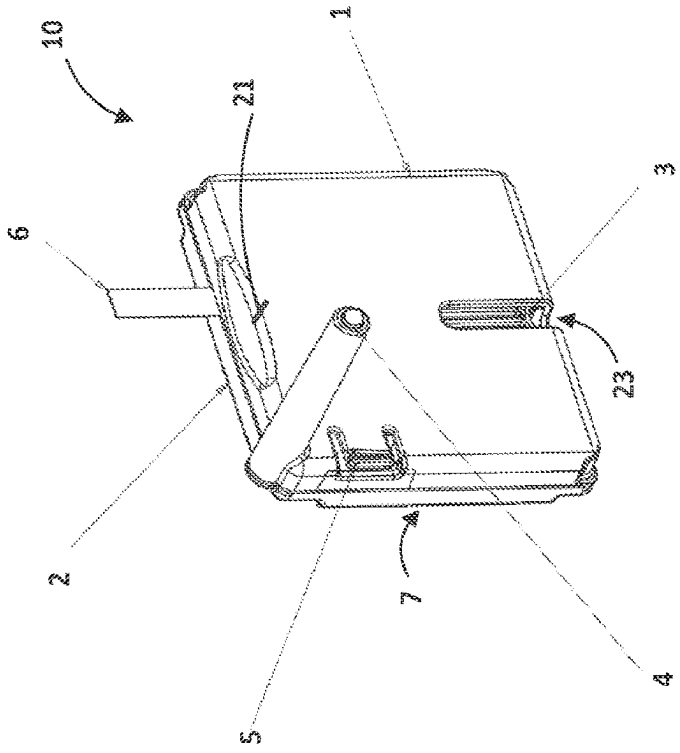


FIG. 1

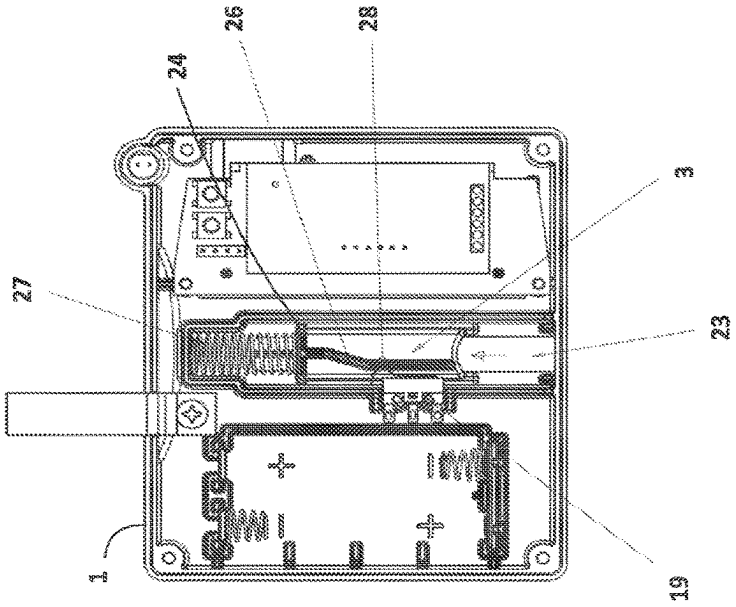
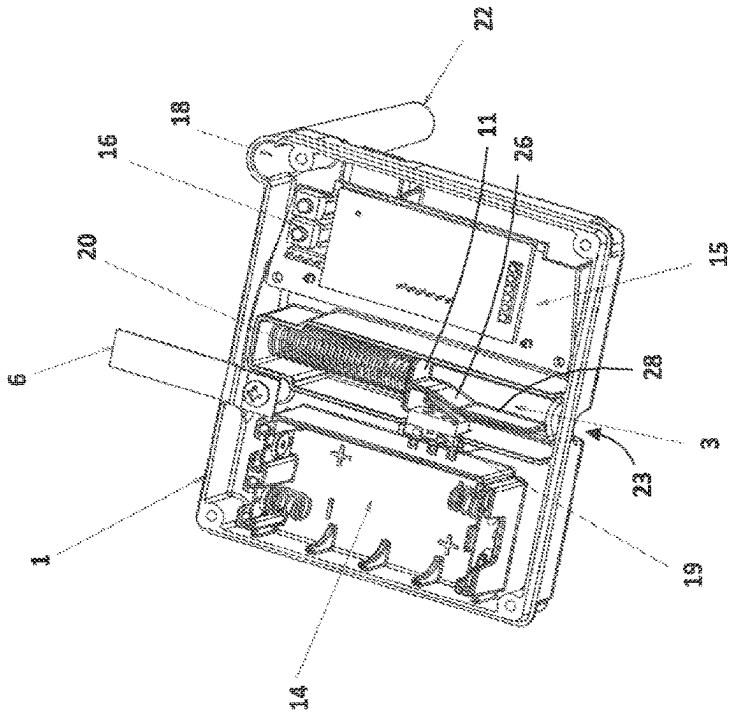


FIG. 4



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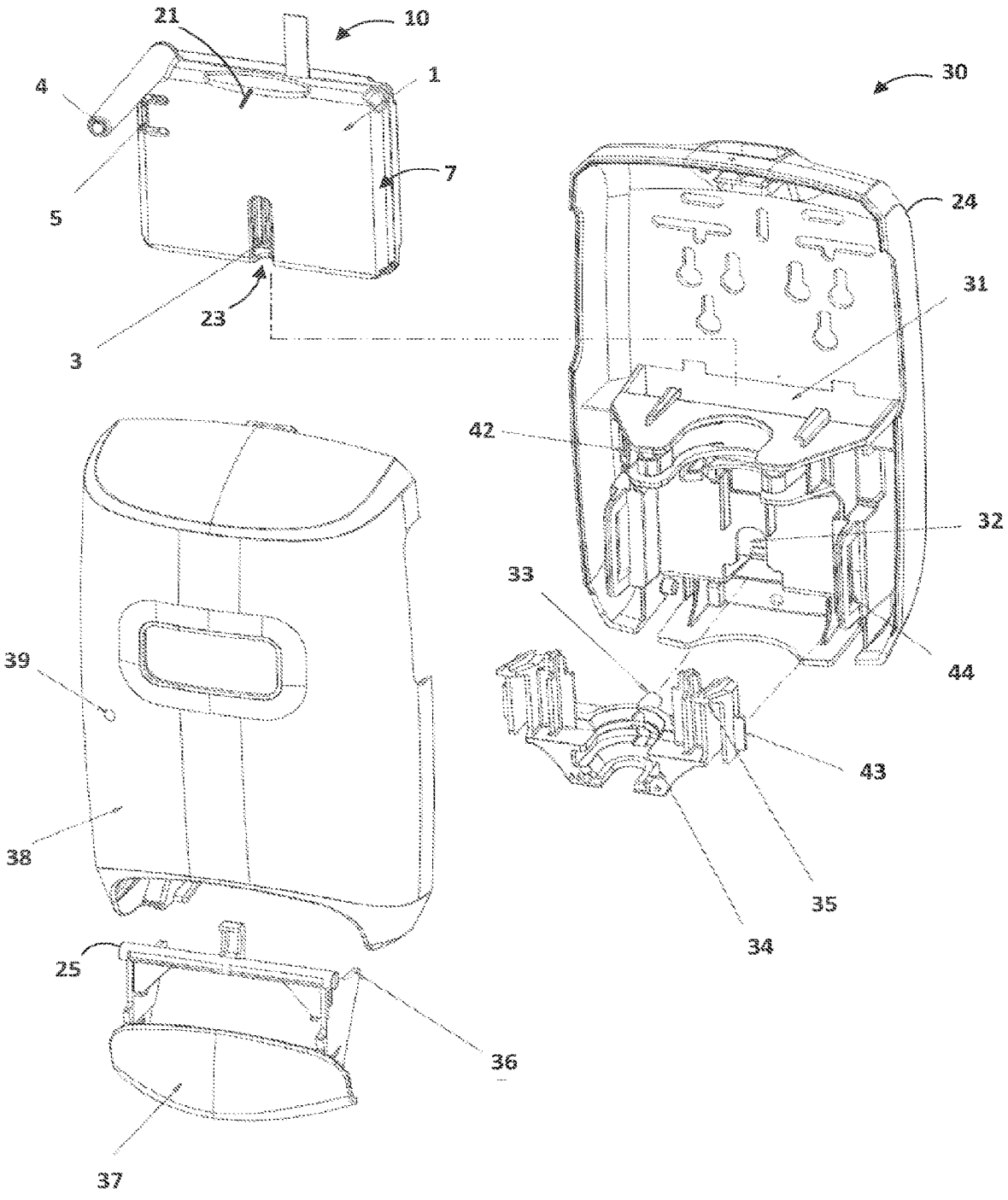


FIG. 5A

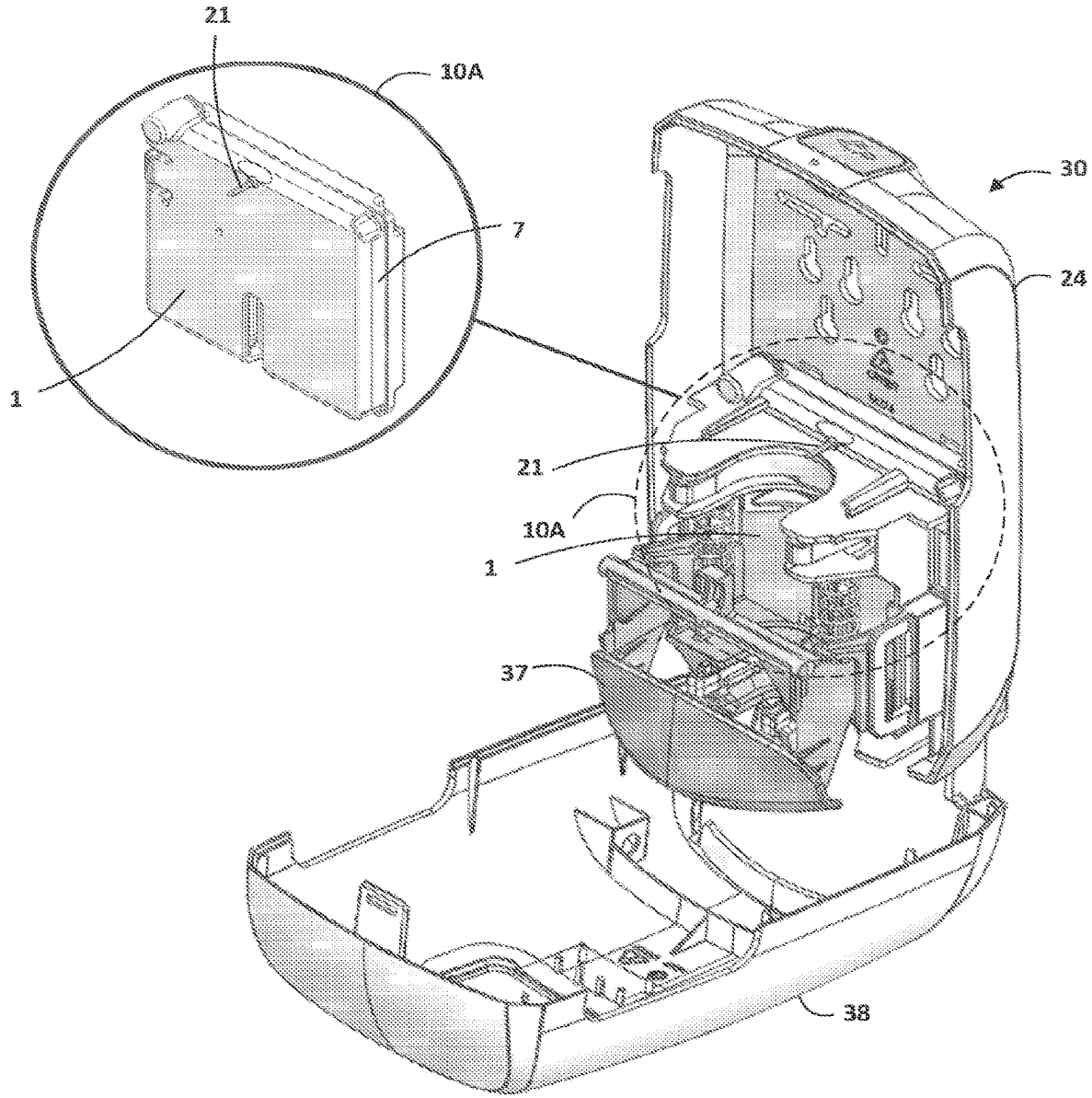


FIG. 5B

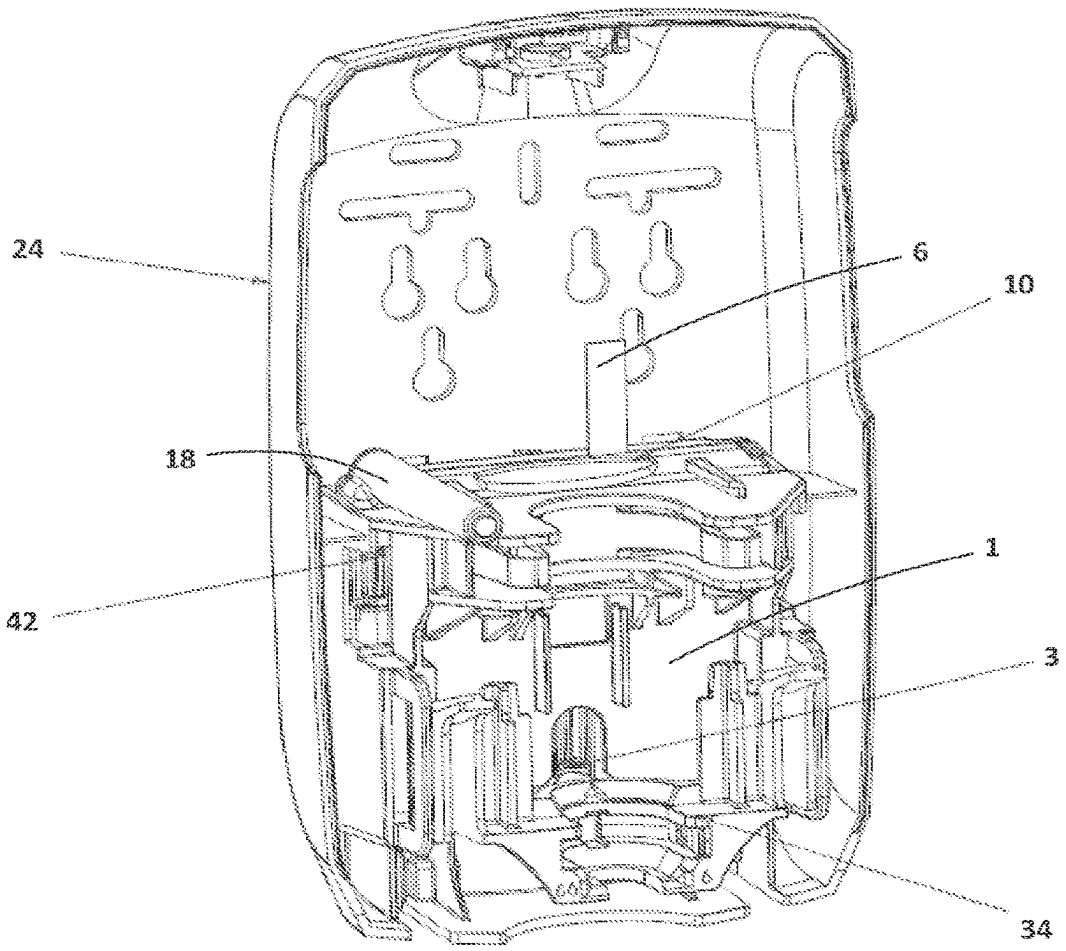


FIG. 6

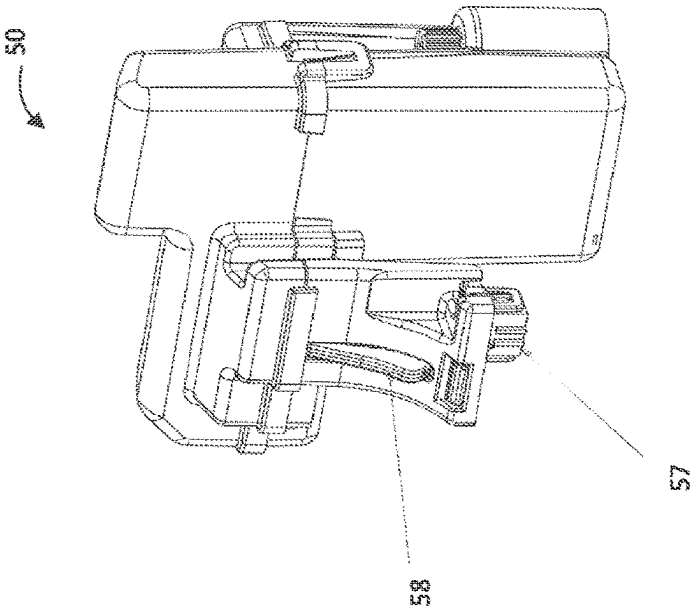


FIG. 8

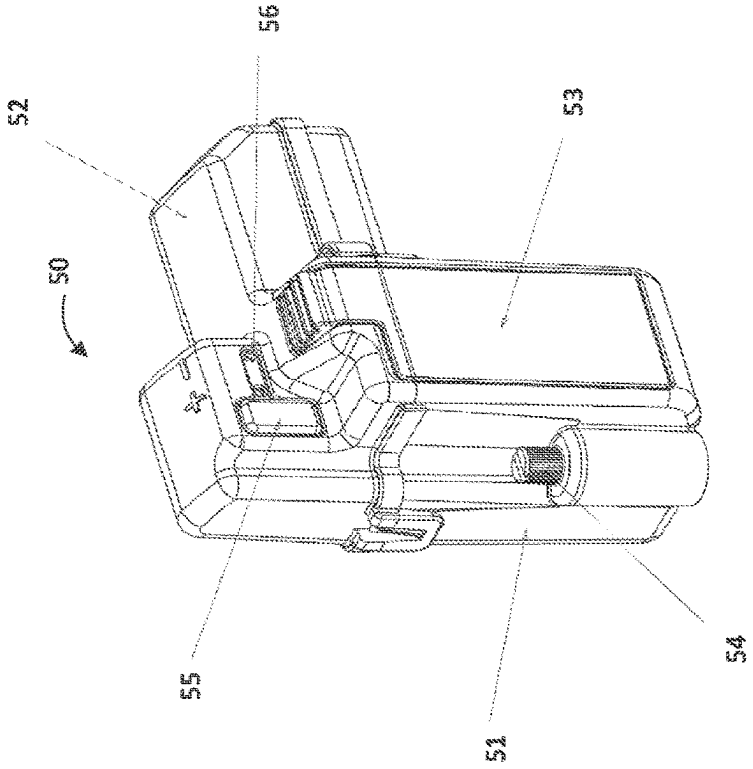


FIG. 7

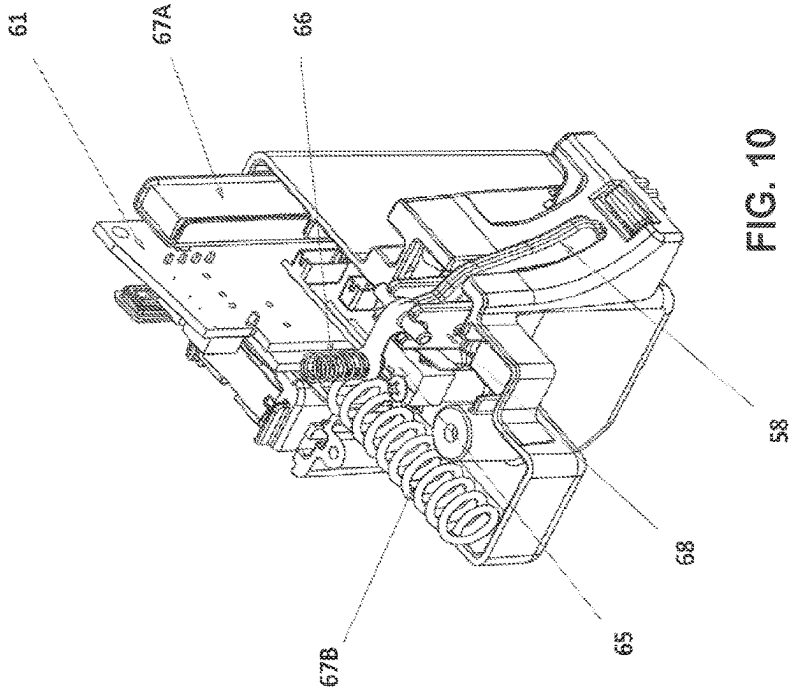


FIG. 10

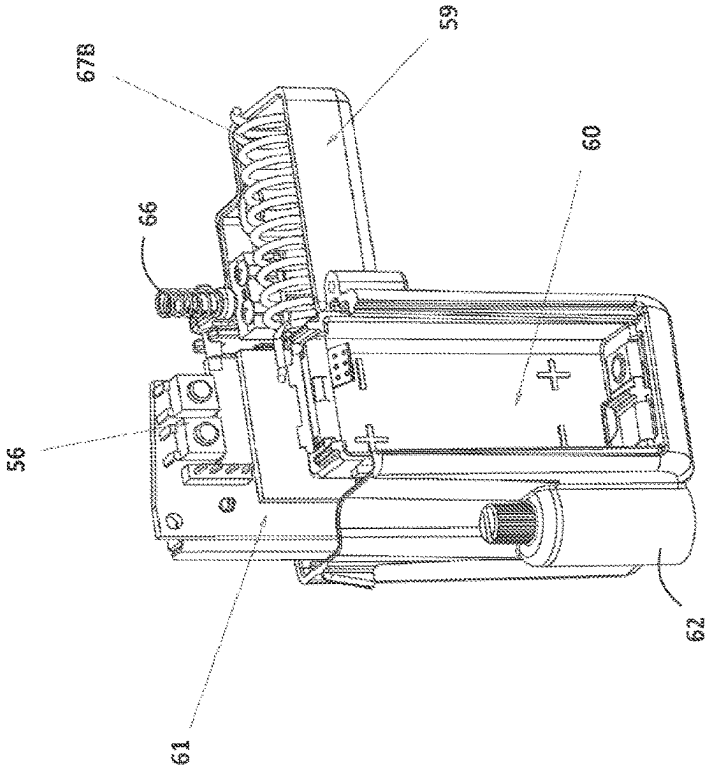


FIG. 9

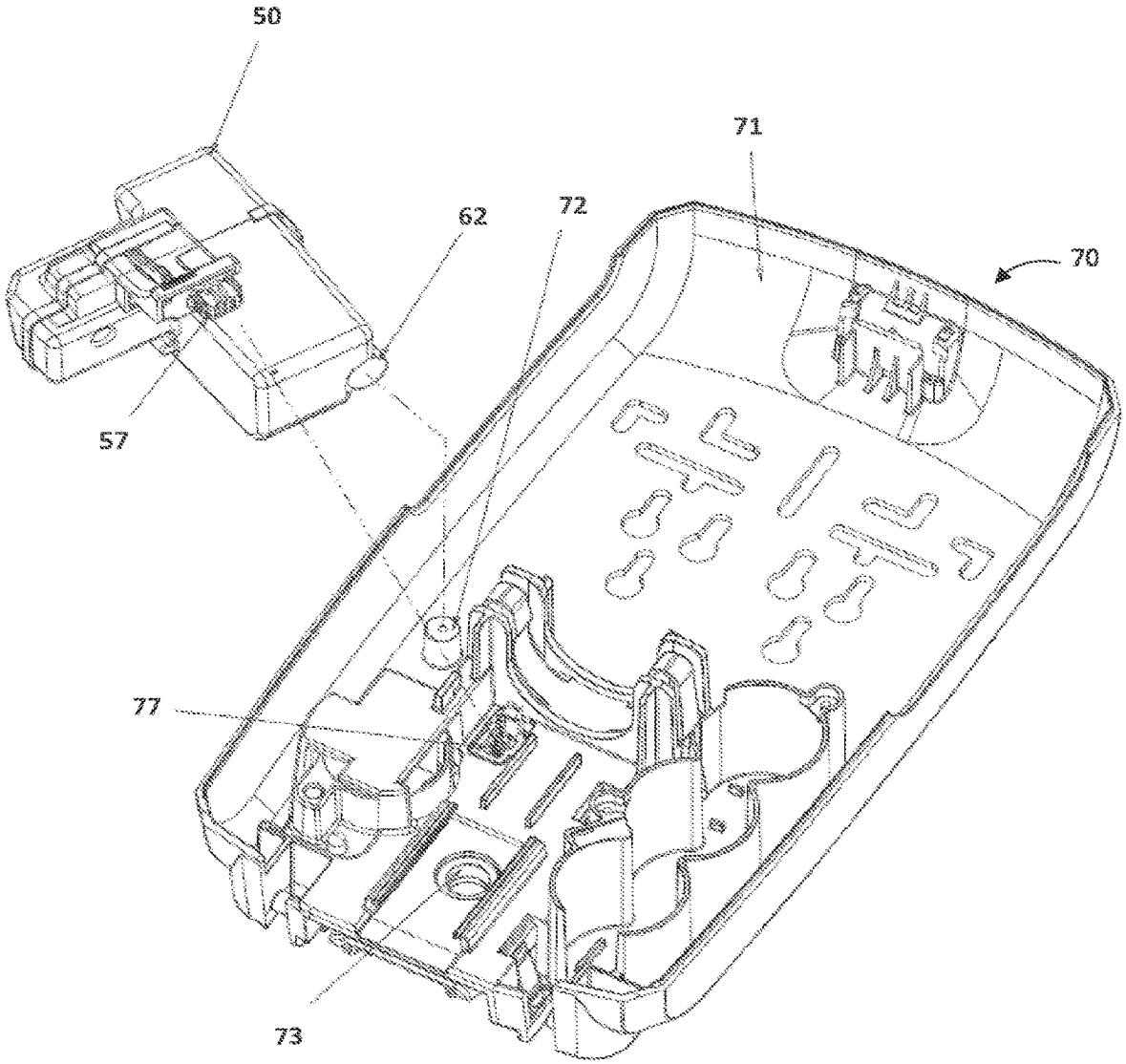


FIG. 11A

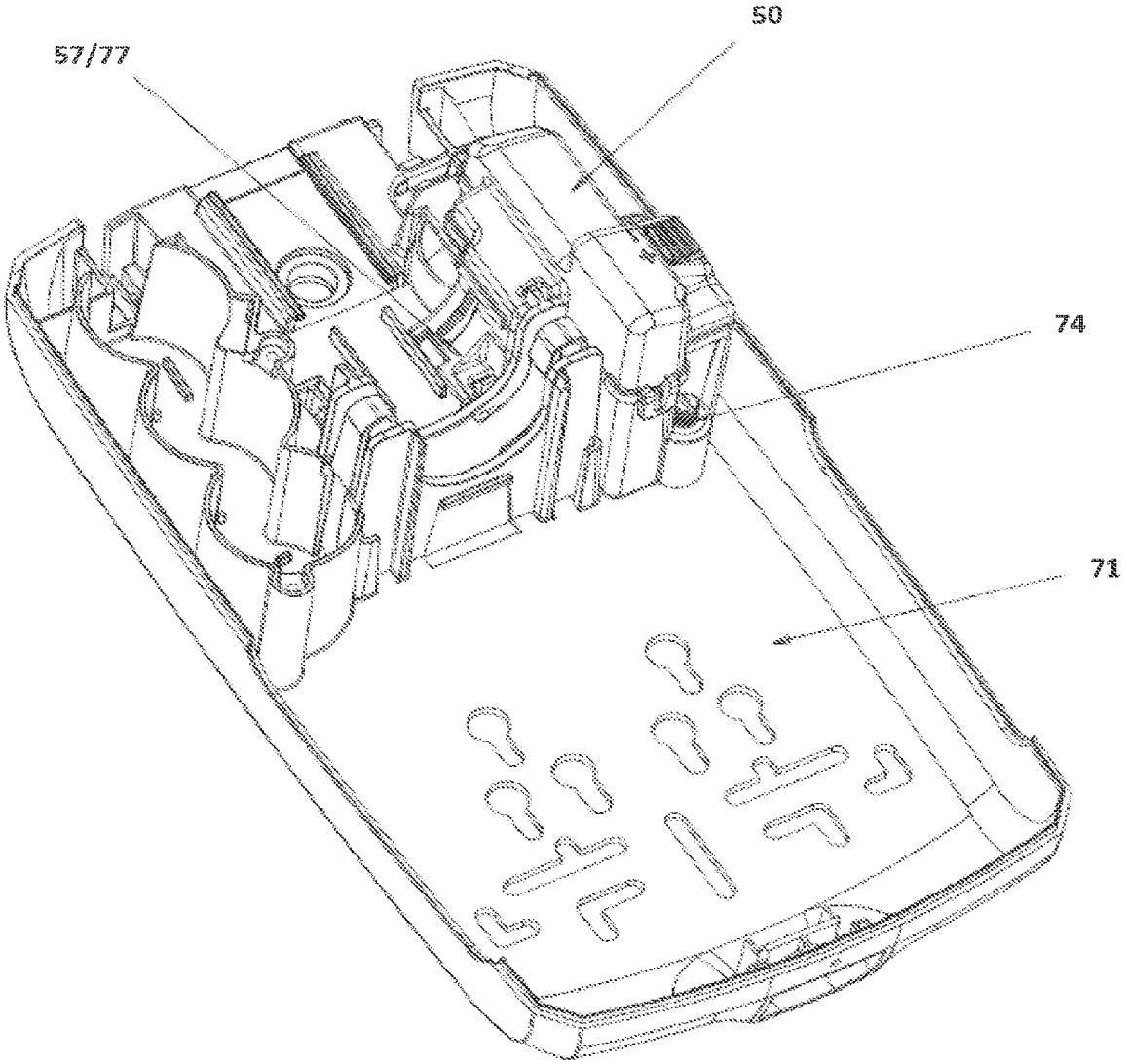
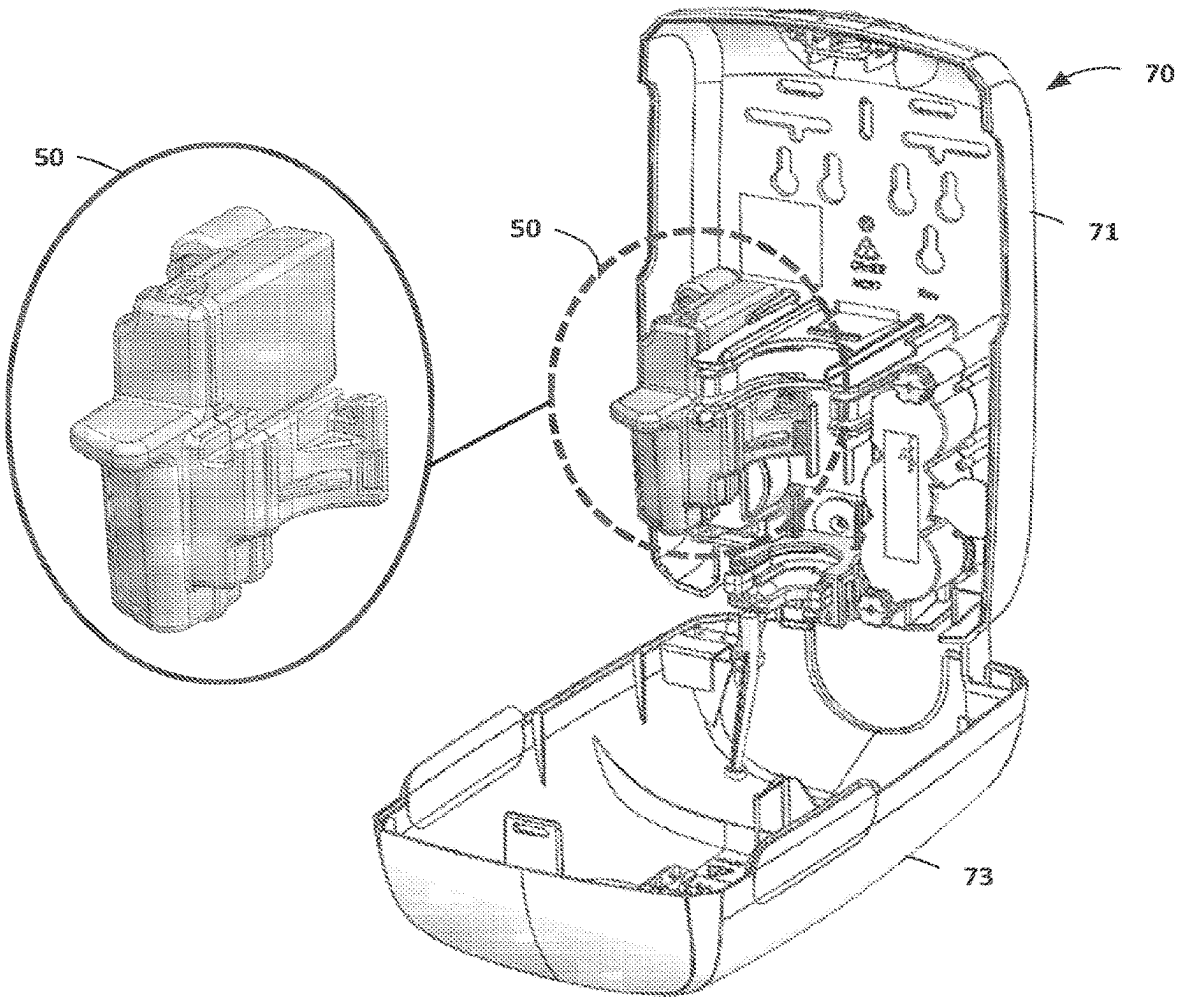


FIG. 11B



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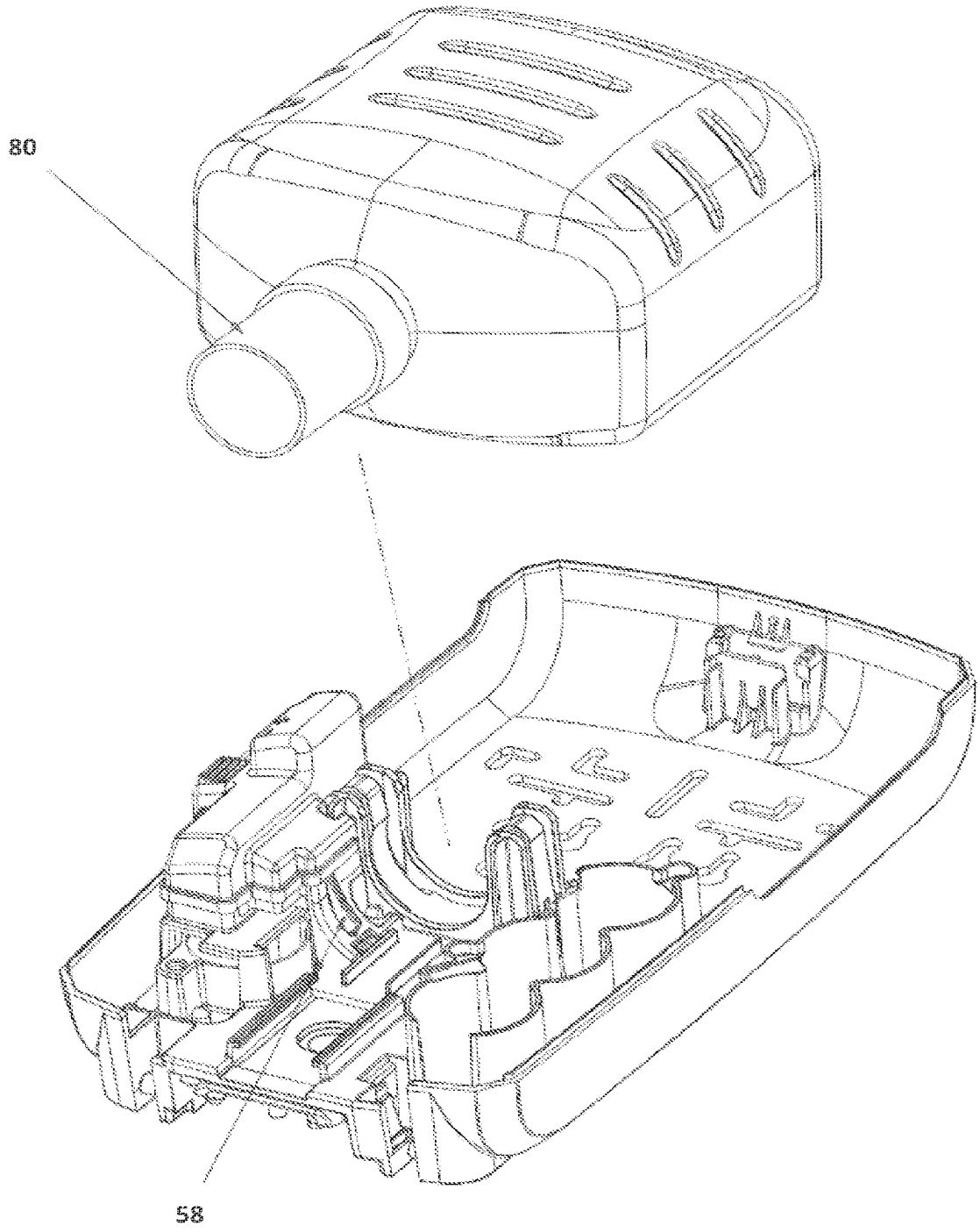

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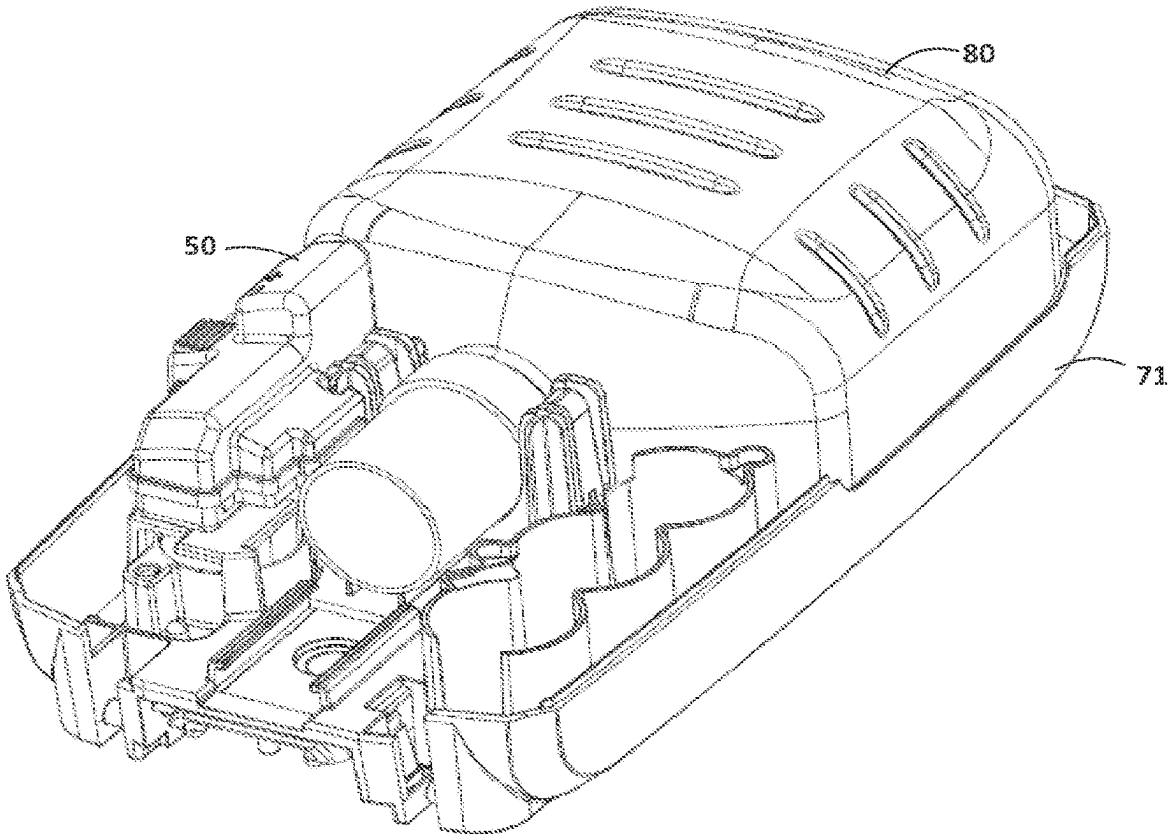
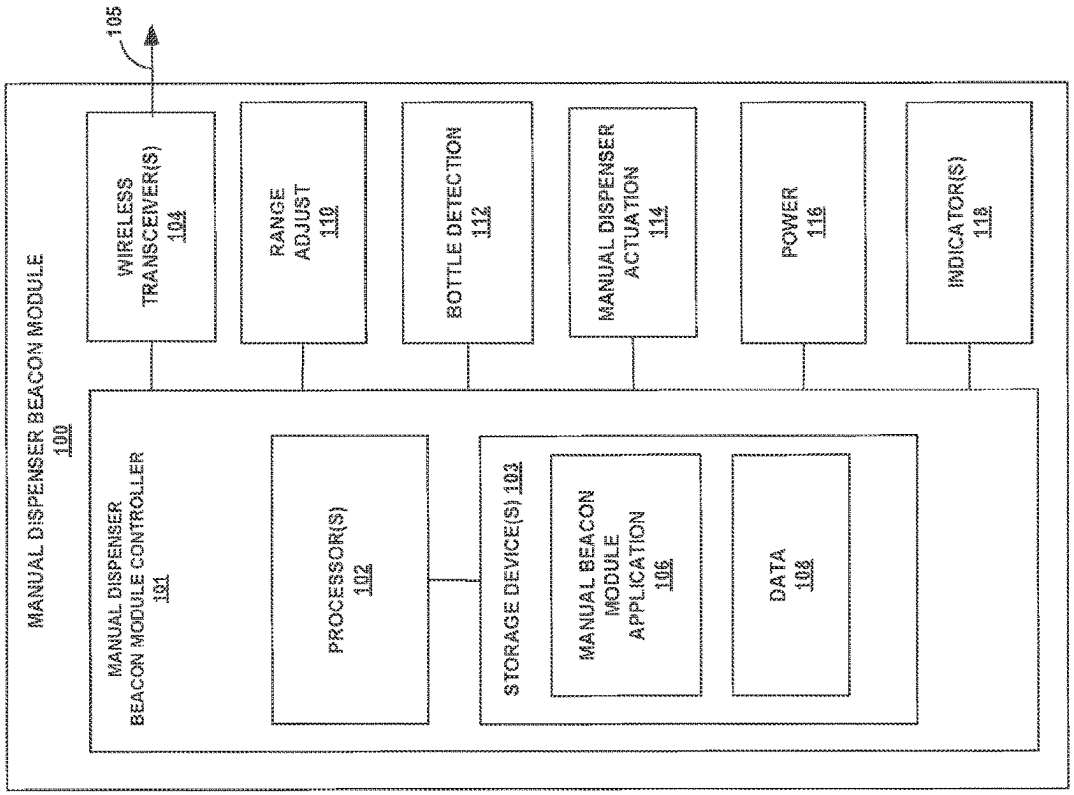


FIG. 14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MANUAL DISPENSER BEACON MODULE
100
WIRELESS TRANSCEIVER(S)
104
RANGE ADJUST
110
BOTTLE DETECTION
112
MANUAL DISPENSER ACTUATION
114
POWER
116
INDICATOR(S)
118
MANUAL DISPENSER BEACON MODULE CONTROLLER
101
PROCESSOR(S)
102
STORAGE DEVICE(S) 103
MANUAL BEACON MODULE APPLICATION
106
DATA
108

FIG. 15

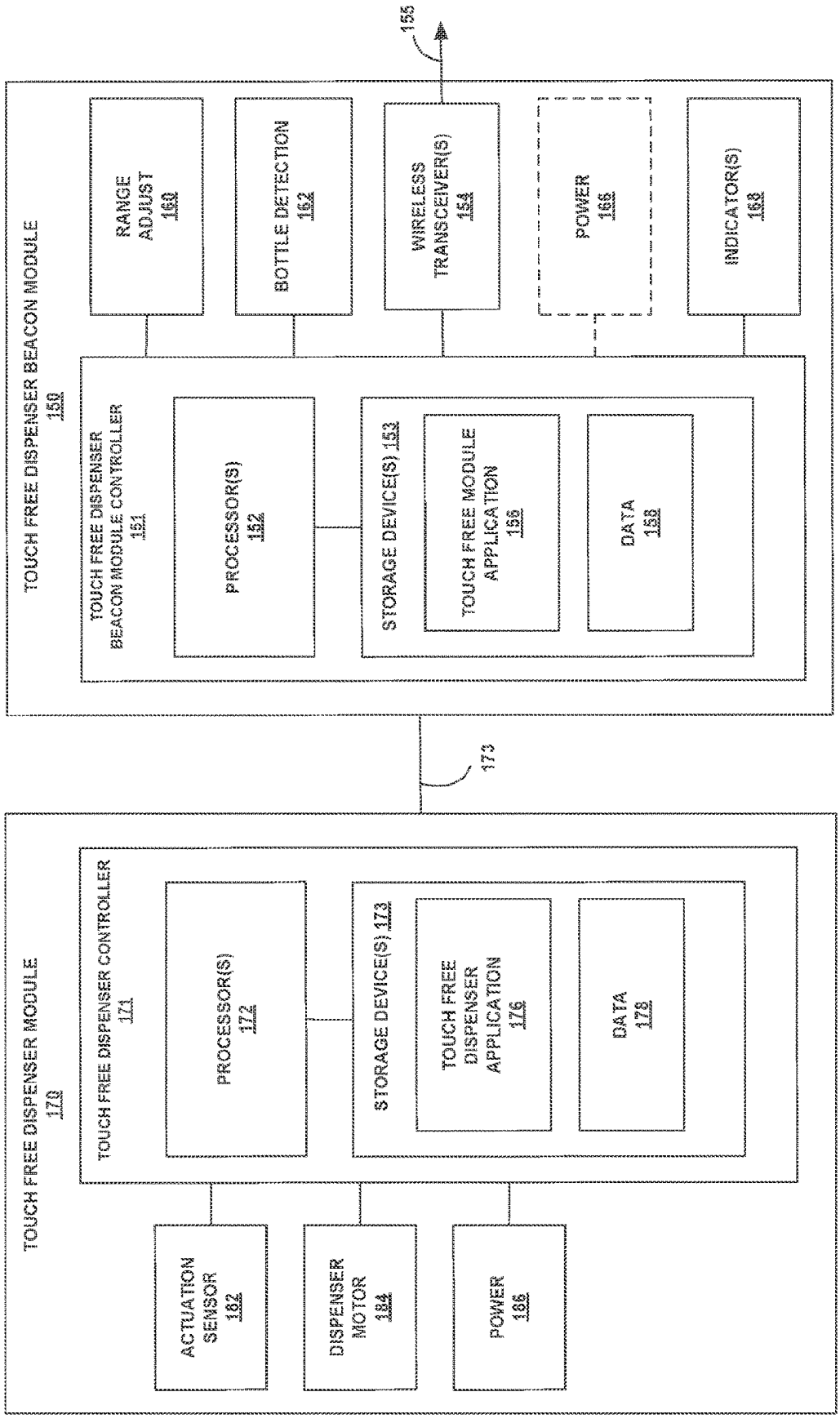
155
TOUCH FREE DISPENSER BEACON MODULE
150
RANGE ADJUST
160
BOTTLE DETECTION
162
WIRELESS TRANSCEIVER(S)
154
POWER
166
INDICATOR(S)
168
TOUCH FREE DISPENSER BEACON MODULE CONTROLLER
161
PROCESSOR(S)
152
STORAGE DEVICE(S) 153
TOUCH FREE MODULE APPLICATION
155
DATA
158
173
TOUCH FREE DISPENSER MODULE
170
TOUCH FREE DISPENSER CONTROLLER
171
PROCESSOR(S)
172
STORAGE DEVICE(S) 173
TOUCH FREE DISPENSER APPLICATION
176
DATA
178
ACTUATION SENSOR
182
DISPENSER MOTOR
184
POWER
186

FIG. 16

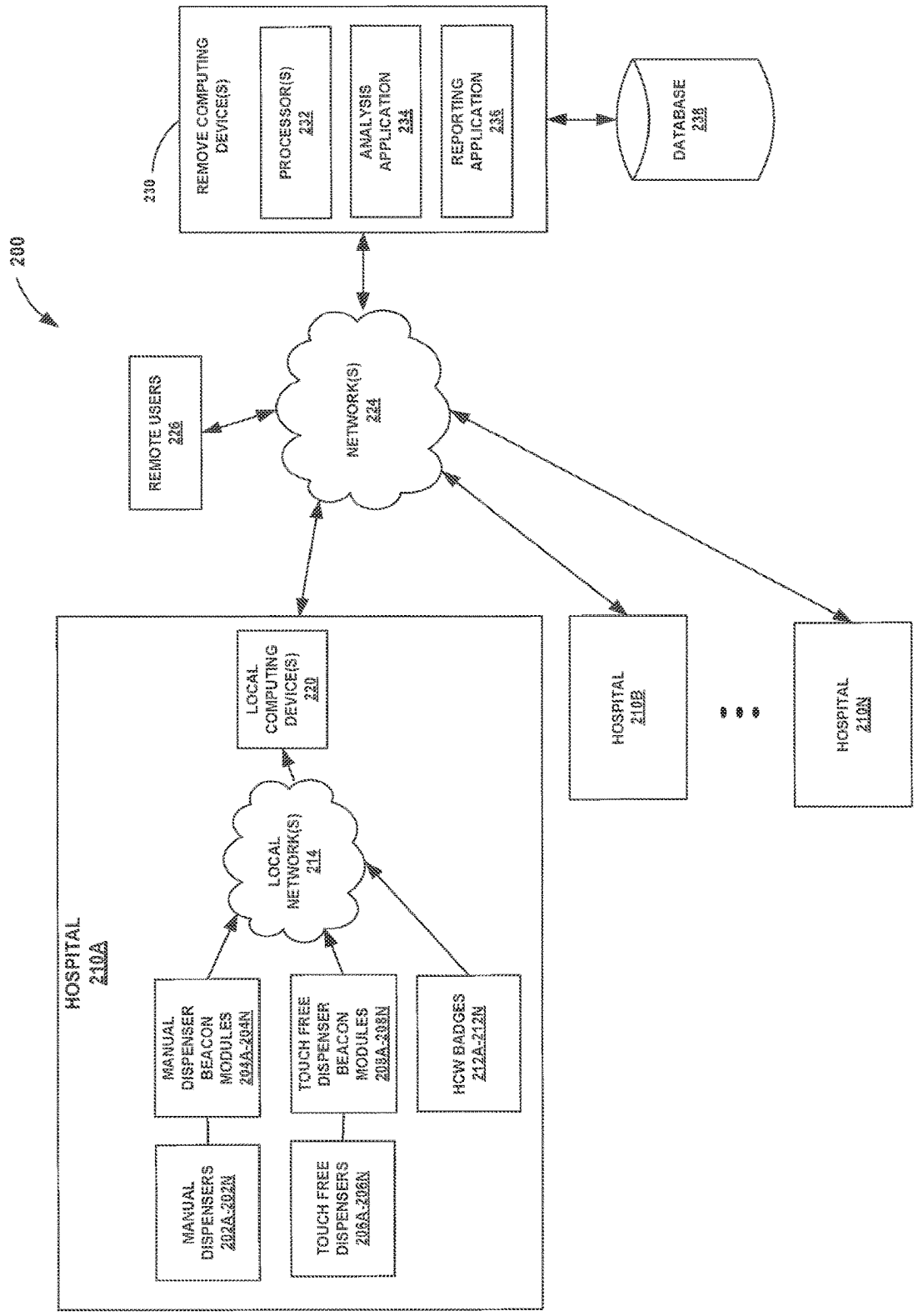
200
REMOVE COMPUTING DEVICE(S)
230
PROCESSOR(S)
232
ANALYSIS APPLICATION
234
REPORTING APPLICATION
236
DATABASE
238
NETWORK(S)
224
REMOTE USERS
226
HOSPITAL
210A
LOCAL COMPUTING DEVICE(S)
220
LOCAL NETWORK(S)
214
MANUAL DISPENSER BEACON MODULES
204A-204N
TOUCH FREE DISPENSER BEACON MODULES
208A-208N
HCW BADGES
212A-212N
MANUAL DISPENSERS
202A-202N
TOUCH FREE DISPENSERS
206A-206N
HOSPITAL
210B
HOSPITAL
210N

FIG. 17

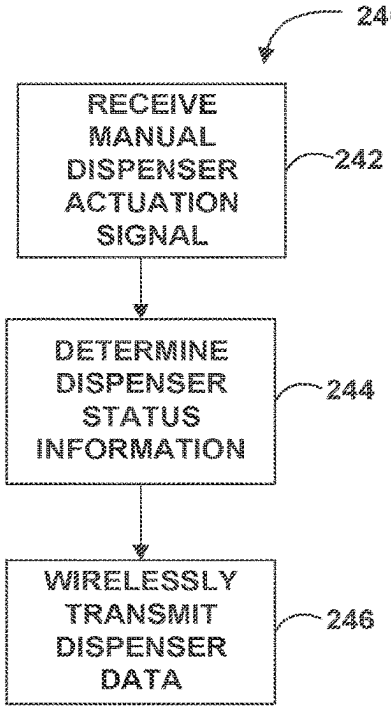
240
RECEIVE MANUAL DISPENSER ACTUATION SIGNAL
242
DETERMINE DISPENSER STATUS INFORMATION
244
WIRELESSLY TRANSMIT DISPENSER DATA
246

FIG. 18

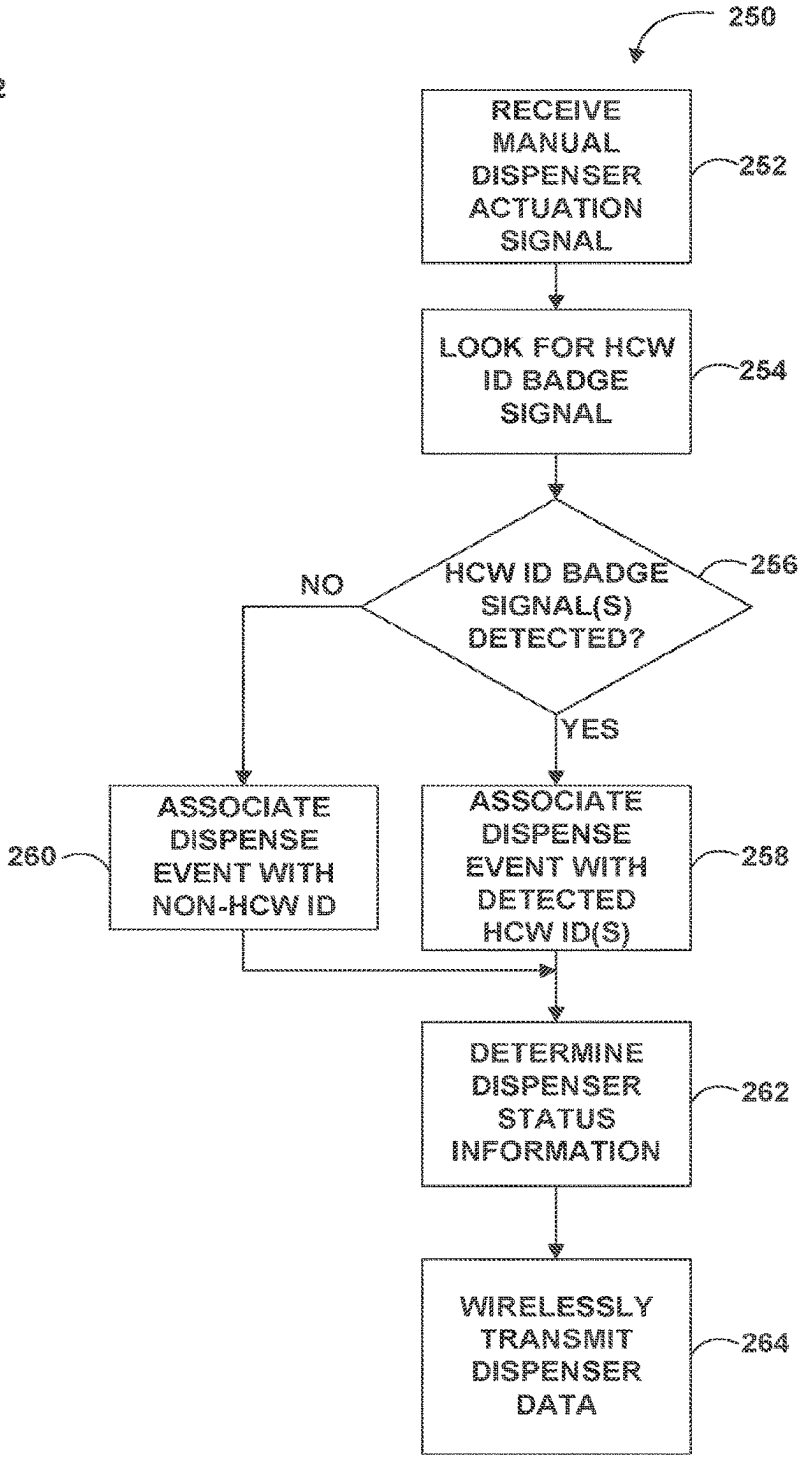
250
RECEIVE MANUAL DISPENSER ACTUATION SIGNAL
252
LOOK FOR HCW ID BADGE SIGNAL
254
HCW ID BADGE SIGNAL(S) DETECTED?
256
NO
YES
ASSOCIATE DISPENSE EVENT WITH NON-HCW ID
260
ASSOCIATE DISPENSE EVENT WITH DETECTED HCW ID(S)
258
DETERMINE DISPENSER STATUS INFORMATION
262
WIRELESSLY TRANSMIT DISPENSER DATA
264

FIG. 19

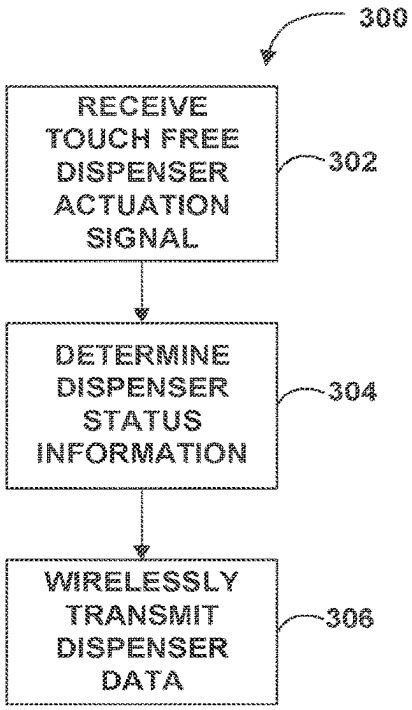
300
RECEIVE TOUCH FREE DISPENSER ACTUATION SIGNAL
302
DETERMINE DISPENSER STATUS INFORMATION
304
WIRELESSLY TRANSMIT DISPENSER DATA
306

FIG. 20

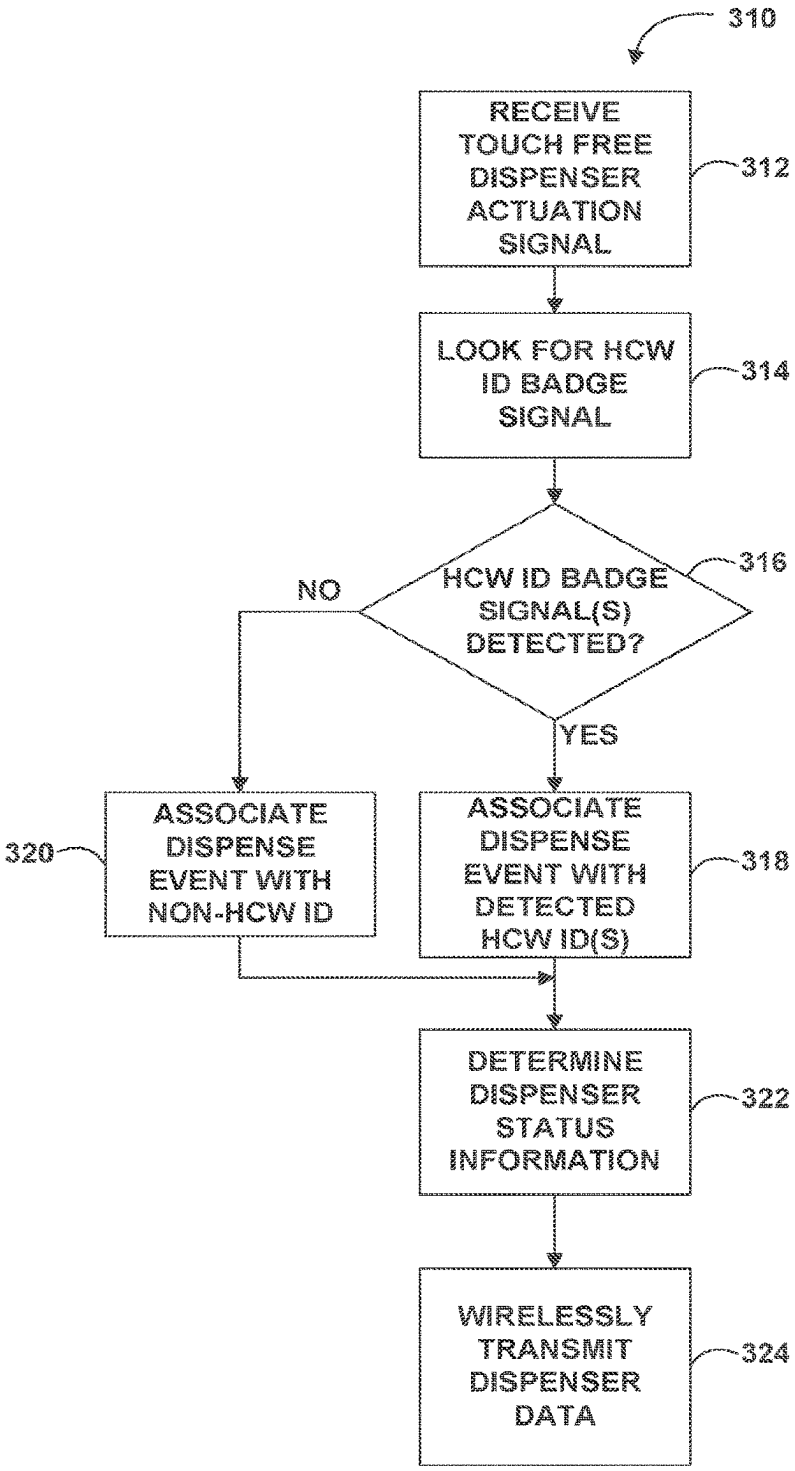
310
RECEIVE TOUCH FREE DISPENSER ACTUATION SIGNAL
312
LOOK FOR HCW ID BADGE SIGNAL
314
HCW ID BADGE SIGNAL(S) DETECTED?
316
NO
YES
ASSOCIATE DISPENSE EVENT WITH NON-HCW ID
320
ASSOCIATE DISPENSE EVENT WITH DETECTED HCW ID(S)
318
DETERMINE DISPENSER STATUS INFORMATION
322
WIRELESSLY TRANSMIT DISPENSER DATA
324

FIG. 21

MONITORING MODULES FOR HAND HYGIENE DISPENSERS

This application is a continuation of U.S. patent application Ser. No. 17/648,389, filed Jan. 19, 2022, now issued as U.S. Pat. No. 11,903,537, which is a continuation of U.S. patent application Ser. No. 15/912,999, filed Mar. 6, 2018, now issued as U.S. Pat. No. 11,272,815, which claims the benefit of U.S. Provisional Application No. 62/468,214 filed Mar. 7, 2017, each of which are incorporated by reference herein in their entirety.

TECHNICAL FIELD

The disclosure relates to monitoring of product dispensers.

BACKGROUND

Despite improvements in hand hygiene, stricter compliance requirements, and efforts to optimize isolation practices, hospitals and other healthcare facilities are losing the war on nosocomial or Hospital Acquired Infections (HAIs). A hospital acquired infection is an infection acquired in a hospital or other healthcare facility by a patient admitted for some reason other than that specific infection. Hospital acquired infections may include infections appearing 48 hours or more after hospital admission or within 30 days after discharge. They may also include infections due to transmission from colonized healthcare workers, or occupational exposure to infection among staff of the facility. Although the majority of hospital acquired infections are preventable, sadly their incidence has only increased.

Hospital acquired infections have become more rampant as antibiotic resistance spreads. Many factors contribute to the increased incidence of hospital acquired infections among hospital patients. For example, hospitals house large numbers of people who are sick and therefore have weakened immune systems. Medical staff move from patient to patient and see many patients a day, providing a way for pathogens to spread. Research indicates that hand hygiene practices are followed only 40% of the time by healthcare workers, even after exhaustive process improvements and training efforts. Many medical procedures, such as surgery, injections and other invasive procedures bypass the body's natural protective barriers, providing entry points for pathogens. The wide-spread use of antibiotics has contributed to the emergence of resistant strains of microorganisms in healthcare facilities and well as in the community.

Compliance with hand hygiene guidelines is considered the most effective action health care workers can take to reduce pathogen transmission in health care settings. Despite this, hand hygiene compliance remains low, and improvement efforts tend to lack sustainability.

SUMMARY

In general, the disclosure relates to systems and associated processes that monitor product dispensers. For example, a hand hygiene compliance system may monitor, analyze and report on hand hygiene compliance at a hospital or other healthcare facility.

In one example, the disclosure is directed to a device that monitors dispense events at a hand hygiene product dispenser, comprising a bottle presence trigger configured to detect presence of a hand hygiene product bottle in the dispenser, a module controller configured to receive a dispenser actuation signal, the module controller further configured to generate dispenser data upon receipt of the dispenser actuation signal, the dispenser data including a dispense event indication and a bottle presence indication, and a wireless transceiver configured to wirelessly transmit the dispenser data upon receipt of the dispenser actuation signal.

In some examples, the module controller is configured to receive the dispenser actuation signal from a switch that detects actuation of a manual hand hygiene product dispenser. In some examples, the module controller is configured to receive the dispenser actuation signal from a switch that detects actuation of a touch free hand hygiene product dispenser. In some examples, the hand hygiene product dispenser is a manually actuated hand hygiene product dispenser. In some examples, the hand hygiene product dispenser is a touch free hand hygiene product dispenser.

In some examples, the module controller is further configured to store a dispense event count upon receipt of the dispenser actuation signal. In some examples, the bottle presence trigger comprises a switch that moves from an open position to a closed position when a product bottle is installed into the hand hygiene product dispenser; and wherein the module controller is further configured to reset a dispense event count when the switch moves from the open position to a closed position.

In some examples, the dispenser data includes the dispense event count. In some examples, the dispenser beacon module further includes an indicator that is illuminated by the module controller upon receipt of the dispenser actuation signal. In some examples, the bottle presence trigger includes one of a plunger switch, a pin switch, or a rocker switch. In some examples, the bottle presence trigger is moved to a closed position when the hand hygiene product bottle is present in the hand hygiene product dispenser.

In another example, the disclosure is directed to a dispenser beacon module that provides for wireless communication of dispenser data from a manually actuated hand hygiene product dispenser, comprising a housing having a module base and a module cover, a bottle presence trigger on an outer surface of the housing that when closed provides a bottle presence signal indicative of presence of a hand hygiene container in the hand hygiene product dispenser, a dispenser actuation switch that when closed provides a dispenser actuation signal, the module base including a slot configured to slidably receive a portion of an actuator of the manually actuated hand hygiene product dispenser, an actuation slider configured to slidably engage the portion of the actuator and close the dispenser actuation switch when the actuator is manually actuated by a user, a controller that receives the dispenser actuation signal, detects a corresponding dispense event, and stores corresponding dispense event data, wherein the controller further determines status information corresponding to the dispense event, including a battery level, a bottle presence indicator, a dispense event count, and a number of dispenses remaining, and wherein the controller wirelessly transmits the dispense event data to a remote computing device, the dispense event data including the time and date of the detected dispense event, the battery level, the bottle presence indicator, the dispense event count, and the number of dispenses remaining.

In some examples, the housing is sized to be received into a receptacle within the hand hygiene product dispenser.

In some examples, the module controller detects a change in the bottle presence trigger from closed to open to detect removal of the product container from the hand hygiene product dispenser, and detects a subsequent closure of the

bottle presence trigger to detect installation of another product container into the hand hygiene product dispenser, and generates a product bottle replacement indication upon detection of the subsequent closure of the bottle presence trigger.

In some examples, the module controller compares a number of dispenses remaining associated with the product container to a predetermined alert level to determine whether the product container was replaced before the predetermined alert level was reached.

In some examples, the module controller is further configured to communicate with an identification badge associated with a user upon detection of a dispense event and to receive user identification information from the identification badge. In some examples, the dispenser data further includes the user identification information associated with the dispense event.

In another example, the disclosure is directed to a dispenser beacon module that provides for wireless communication of dispenser data from a touch free hand hygiene product dispenser, comprising a housing having a module base and a module cover, a bottle presence trigger on an outer surface of the housing that when closed provides a bottle presence signal indicative of presence of a hand hygiene product container in the touch free hand hygiene product dispenser, a controller that receives an indication of a touch free dispenser actuation from the touch free hand hygiene product dispenser, detects a corresponding dispense event, and stores corresponding dispense event data, wherein the controller further determines status information corresponding to the dispense event, including a battery level associated with the dispenser beacon module, a battery level associated with the touch free dispenser, a bottle presence indicator, a dispense event count, and a number of dispenses remaining, and wherein the controller wirelessly transmits the dispense event data to a remote computing device, the dispense event data including the time and date of the detected dispense event, the battery level associated with the dispenser beacon module, a battery level associated with the touch free dispenser, the bottle presence indicator, the dispense event count, and the number of dispenses remaining.

In some examples, the module controller detects a change in the bottle presence trigger from closed to open to detect removal of the product container from the hand hygiene product dispenser, and detects a subsequent closure of the bottle presence trigger to detect installation of another product container into the hand hygiene product dispenser, and generates a product bottle replacement indication upon detection of the subsequent closure of the bottle presence trigger.

In some examples, the module controller compares a number of dispenses remaining associated with the product container to a predetermined alert level to determine whether the product container was replaced before the predetermined alert level was reached.

In some examples, the dispenser beacon module further includes an indicator that is illuminated by the controller upon receipt of the dispenser actuation signal. In some examples, the bottle presence trigger includes one of a plunger switch, a pin switch, or a rocker switch.

In some examples, the module controller is further configured to communicate with an identification badge associated with a user upon detection of a dispense event and to receive user identification information from the identification badge. In some examples, the dispenser data further includes the user identification information associated with the dispense event.

The details of one or more examples are set forth in the accompanying drawings and the description below. Other features and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

FIGS. **1** and **2** show a front perspective view and a back perspective view, respectively, of an example manual dispenser beacon module.

FIGS. **3** and **4** show the internal components of an example manual dispenser beacon module with the module cover removed.

FIGS. **5**A and **5**B show exploded views of an example manual dispenser and example manual dispenser beacon modules.

FIG. **6** shows a perspective view of an example manual dispenser beacon module installed in a manual dispenser.

FIGS. **7** and **8** show a front perspective view and a back perspective view, respectively, of an example touch free dispenser beacon module.

FIGS. **9** and **10** show a front perspective view and a back perspective view, respectively, of the internal components of example touch free dispenser beacon module with the module cover removed.

FIGS. **11**A, **11**B and **12-14** show various views of portions of an example touch free dispenser with its cover removed and a touch free dispenser beacon module.

FIG. **15** is a block diagram illustrating an example implementation of the electronic components of a manual dispenser beacon module.

FIG. **16** is a block diagram illustrating an example implementation of a touch free dispenser beacon module.

FIG. **17** is a block diagram of an example hand hygiene compliance monitoring system.

FIG. **18** is a flowchart illustrating an example process by which a manual dispenser beacon module may detect manual actuations of a manual hand hygiene product dispenser and wirelessly transmit dispenser data associated with the dispense event.

FIG. **19** is a flowchart illustrating another example process by which a manual dispenser beacon module may detect manual actuations of a manual hand hygiene product dispenser and wirelessly transmit dispenser data associated with the dispense event.

FIG. **20** is a flowchart illustrating an example process by which a touch free dispenser beacon module may detect actuations of a touch free hand hygiene product dispenser and wirelessly transmit dispenser data associated with the dispense event.

FIG. **21** is a flowchart illustrating another example process by which a touch free dispenser beacon module may detect actuations of a touch free hand hygiene product dispenser and wirelessly transmit dispenser data associated with the dispense event.

DETAILED DESCRIPTION

In general, the disclosure relates to systems and associated processes that monitor hand hygiene compliance. For example, the hand hygiene compliance system may monitor, analyze and report on hand hygiene compliance at a hospital or other healthcare facility. The disclosure describes dispenser beacon modules that may be installed in existing

hand hygiene product dispensers to provide wireless communication of hand hygiene data to or from a dispenser. In one example, a manual dispenser beacon module is configured to be used with a manually actuated hand hygiene product dispenser to monitor hand hygiene compliance events associated with the dispenser, and to wirelessly transmit hand hygiene data to or from the manual dispenser. In another example, a touch free dispenser beacon module is configured to be used with a touch free hand hygiene product dispenser to monitor hand hygiene compliance events associated with the dispenser, and to wirelessly transmit hand hygiene data to or from the touch free dispenser. Additional dispenser status information may be included in the dispenser data, such as dispenser identification information, healthcare worker identification information, current battery levels, product bottle presence/absence, number of dispenser actuations, out-of-product indications, etc.

The manual and touch free dispenser beacon modules described herein may be used with any of the systems or incorporate any of the features shown and described in U.S. Pat. No. 8,502,680 issued Aug. 6, 2013; U.S. Pat. No. 8,395,515 issued Mar. 12, 2013; U.S. Pat. No. 8,264,343 issued Sep. 11, 2012; U.S. Pat. No. 8,564,431 issued Oct. 22, 2013; U.S. Pat. No. 8,674,840 issued Mar. 18, 2014; U.S. Pat. No. 8,482,406 issued Jul. 9, 2013; U.S. Pat. No. 8,872,665 issued Oct. 28, 2014; U.S. Pat. No. 8,783,511 issued Jul. 22, 2014; and U.S. Pat. No. 8,633,816 issued Jan. 21, 2014; each of which is incorporated herein by reference in its entirety.

FIGS. **1** and **2** show a front perspective view and a back perspective view, respectively, of an example manual dispenser beacon module **10**. Manual dispenser beacon module may be used with a manually actuated hand hygiene product dispenser to monitor hand hygiene events associated with the manual dispenser, and to wirelessly transmit hand hygiene data (including data concerning the monitored hand hygiene events) to or from the manual dispenser. Dispenser beacon module **10** includes a housing **7** having a module base **1** and a module cover **2**, an actuation slider **3**, an LED indicator **4**, a locking mechanism **5**, a release strap **6**, a battery compartment door **8**, and a firmware access port **12**. Module base **1** is configured to form a slot **23** through which a manual dispenser actuator may engage with an actuation slider **3** (see FIG. **5**A).

In some examples, the manual dispenser beacon module **10** is further configured to wirelessly transmit and/or receive communication from one or more computing device(s). For example, the beacon module **10** may receive remote software updates, remote configuration settings (e.g., range settings, product empty settings, settings for a number of dispense events before a product bottle should be refilled or replaced, etc.) from one or more computing devices. The beacon module **10** may further communicate with one or more other beacon modules in healthcare setting, such as those associated with other dispensers, with motion detectors in a patient room or other defined area, with patient zone beacons in a patient room or other defined area, or other such devices in a healthcare setting that may be useful for monitoring of hand hygiene compliance. The beacon module **10** may be further configured to wirelessly communicate (both transmit and receive) with one or more uniquely assigned healthcare worker identification badges. For example, the beacon module **10** may be configured to communicate with a badge, obtain healthcare worker identification information from the badge, and associate a detected dispense event with the healthcare worker identification information.

FIGS. **3** and **4** show the internal components of example manual dispenser beacon module **10** with module cover **2** removed. In FIG. **3**, actuation slider **3** is in an open (at rest or non-actuated) position. In FIG. **4**, actuation slider **3** is in a closed (actuated) position. The internal components of the manual dispenser beacon module **10** include a PCB assembly **15**, actuation slider **3** and a return spring **20**, a micro switch **19**, and a battery compartment **14**. In this example, battery compartment **14** is configured to receive 2 AA batteries that provide power to PCB assembly **15**. In other examples, manual dispenser beacon module may be powered using different batteries or may be hard-wired to the electrical system of the building.

Pull strap **6** is fastened to module base **1** and provides for removal of module **10** from a manual dispenser (see FIG. **5**A). PCB assembly **15** includes range adjustment buttons **16** that may be accessed through holes **9** in the module cover **2** (see FIG. **2**). LED indicator **4** is connected to PCB **15** through LED tube **18** and is seated at a distal end **22** of LED tube **18**. This permits LED indicator **4** to be exposed through the front cover of a manual dispenser **30** as shown in FIG. **5**A. In another example, a manual dispenser beacon module **10**A as shown in FIG. **5**B does not include an LED light tube or LED indicator.

When the pushbar (see ref. num. **37**, FIGS. **5**A and **5**B) is pressed by a user to dispense product, the mechanical movement of the pushbar is converted to an electrical signal by actuation slider **3** and micro switch **19**, which initiates a communication sequence between the electronic components of PCB assembly **15** and other components of the beacon module. Actuation slider **3** includes a flat portion **28**, a spring engagement portion **11**, and a ramp portion **26** connected between the flat portion **28** and spring engagement portion **11**. Switch **19** is connected and communicates with PCB assembly **15**. When actuation slider **3** is at rest (FIG. **3**), switch **19** is positioned with respect to a higher end of ramp portion **26** such that switch **9** is in the open position. When actuation slider **3** is moved toward the closed position (FIG. **4**), ramp portion **26** of actuation slider **3** moves over switch **19** until flat portion **28** is positioned over switch **19**, thus closing switch **19**. This closure of switch **19** communicates to PCB assembly **15** that the dispenser has been actuated. Return spring **27** compresses as actuation slider **3** moves toward the closed position. When the dispenser bottle actuator **34** is released, return spring **27** returns actuation slider **3** to its resting position (FIG. **3**).

FIG. **5**A shows an exploded view of an example manual dispenser **30** and example manual dispenser beacon module **10**. FIG. **5**B shows a perspective view of example manual dispenser beacon module **10** installed in manual dispenser **30**. Example manual dispenser **30** includes a base **24**, a front cover **38** having a LED window **39**, and a push bar **37**. Push bar **37** snaps into dispenser cover **38**. Push bar **37** freely rotates on hinge **25** once manual dispenser **30** is assembled. Manual dispenser **30** further includes a receptacle **31** configured to receive housing **7** of manual dispenser beacon module **10**.

Manual dispenser beacon module **10** is configured to detect actuation of push bar **37** by a user to dispense a quantity of hand hygiene product. Manual dispenser **30** includes a bottle actuator **34** that includes slider ribs **43** that snap into mating slots **44**. These features are symmetrical on both sides of dispenser base **24**. Bottle actuator **34** includes a slot **32** configured to align with slot **23** of module **10**) and thus allow engagement of activation slider **3** with module

interface post **33** (FIG. **6**). Bottle actuator **34** includes its own return springs (not shown) to return actuator **34** to its resting position.

When manual dispenser beacon module **10** is installed within manual dispenser **30**, that is, when housing **7** is received within receptacle **31** of manual dispenser **30**, actuation slider **3** is actuated by a module interface post **33** on bottle actuator **34**. Push bar lifting ribs **36** rest against lift journals **35** on bottle actuator **34**. When push bar **37** is activated by a user, lifting ribs **36** press up against lift journals **35**, raising the bottle actuator **34** in slots **44**, and raising module interface post **33**. Interface post **33** engages the activation slider **3**, lifting it to activate switch **19** and send an actuation signal to a processor on PCB assembly **15** indicating that the dispenser has been actuated.

When module **10** is installed in dispenser **30** (in this example, when housing **7** is received within receptacle **31**), module-side locking mechanism **5** locks module **10** to dispenser base **24** at a dispenser-side locking mechanism **42**. In addition, LED indicator **4** lines up with light pipe **39** on dispenser cover **38**. Indicator **4** is the visual interface with the user. A processor (see FIG. **15**) on PCB assembly **15** receives the actuation signal from switch **19** and causes indicator **4** to be illuminated each time actuation of push bar **37** is detected. Once assembled, to remove module **10**, locking mechanism **5** is pressed at the same time the user pulls on the release strap **6**. This allows access to the batteries by removing battery door **8**.

Manual dispenser beacon module **10** further includes a bottle detection switch (or bottle presence trigger) **21**. Bottle presence trigger **21** is configured to be depressed or moved to the closed position when a product bottle is installed or received in the hand hygiene product dispenser. In this example, bottle presence trigger **21** is implemented using a plunger or pin switch; however, it shall be understood that any other type of switch configured to detect bottle presence could be used. When no bottle is installed in dispenser **30**, bottle presence trigger **21** is not depressed (open). When a bottle of hand hygiene product is installed into manual dispenser **30**, the neck of the product bottle will depress bottle presence trigger **21**. When the bottle presence trigger is thus closed, switch **21** communicates a bottle present signal to the PCB assembly **15** and thus communicates to the processor on PCB assembly **15** that a bottle is installed in the dispenser. When the bottle is removed, bottle presence trigger **21** returns to its open position, communicating to PCB assembly **61** (and thus the processor thereon) that the bottle **80** has been removed. Bottle presence or absence information may be communicated as part of the dispenser data from the module **50** along with each dispense event and a count of the total number of dispense since bottle replacement.

Inclusion of a product bottle detection feature such as bottle presence trigger **21** allows tracking of the replacement of hand hygiene product in the dispenser, so the system can determine when product needs to be replaced and also that the product is replaced at the appropriate time. For example, a time/date stamped event may be recorded when a product bottle has been taken out of a dispenser (e.g., when the switch is opened) and another event may be recorded when a product bottle has been replaced into the dispenser (e.g., when the switch is closed). The module **50** or a remote computing system may count the number of dispenses since bottle replacement (e.g., a switch opening event followed by a subsequent switch closing event), and may count down the number of events to a predetermined "alert" level for replacement. The module **50** or a remote computing system may compare the number of dispense events that occurred at the time of bottle replacement to the predetermined alert level to determine whether the product bottle was replaced too early, thus possibly wasting hand hygiene product by incomplete emptying of the product bottle. Bottle presence trigger **21** also allows for the module **50** (or a remote computing system) and hand hygiene compliance personnel to identify when a dispenser is being used without any hand hygiene product (e.g., when actuation of the hand hygiene product dispenser is detected but the bottle presence switch is not closed). The module **50** or the remote computing system may generate an alert to communicate to hand hygiene compliance personnel that the hand hygiene product dispenser is being used without any hand hygiene product and to inform them that product needs to be installed in that particular dispenser.

FIGS. **7** and **8** show a front perspective view and a back perspective view, respectively, of an example touch free dispenser beacon module **50**. Touch free dispenser beacon module **50** is configured to be used with a touch free hand hygiene product dispenser to monitor hand hygiene events associated with the dispenser, and to wirelessly transmit hand hygiene data (including data concerning the monitored hand hygiene events) to or from the touch free dispenser **50**. Touch free dispenser beacon module **50** includes a module base **51**, a module cover **52**, a battery door **53**, a captive mounting screw **54**, a firmware access port **55**, a connector **57**, and a bottle presence trigger **58** (implemented using a rocker arm assembly in this example).

In some examples, the touch free dispenser beacon module **50** is further configured to wirelessly transmit and/or receive communication from one or more computing device (s). For example, the beacon module **50** may receive remote software updates, remote configuration settings (e.g., range settings, product empty settings, settings for a number of dispense events before a product bottle should be refilled or replaced, etc.) from one or more computing devices. The beacon module **50** may further communicate with one or more other beacon modules in a healthcare setting, such as those associated with other dispensers, with motion detectors in a patient room or other defined area, with patient zone beacons in a patient room or other defined area, or other such devices in a healthcare setting that may be useful for monitoring of hand hygiene compliance. The beacon module **50** may be further configured to wirelessly communicate (both transmit and receive) with one or more uniquely assigned healthcare worker identification badges. For example, the beacon module **50** may be configured to communicate with a badge, obtain healthcare worker identification information from the badge, and associate a detected dispense event with the healthcare worker identification information.

FIGS. **9** and **10** show a front perspective view and a back perspective view, respectively, of the internal components of example touch free dispenser beacon module **50** with module cover **52** removed. Touch free dispenser beacon module **50** includes a battery enclosure **60**, a PCB assembly **61** including a controller (see FIG. **16**), bottle presence trigger **58**, bottle detection micro switch **65**, rocker return spring **66**, and connector/rocker retainer **68**. PCT assembly **61** includes two antennas, a high frequency antenna **67**A and a low frequency coil antenna **67**B. Range buttons **56** are accessed through holes in module cover **52**. In this example, range buttons **56** adjust the range of low frequency antenna **67**A.

Battery enclosure **60** is connected to, and provides power to PCB assembly **61**. In this example, touch free dispenser beacon module **50** is powered using 2 AA batteries. How-

ever, it shall be understood that other means of powering module **50** may be used, and that the disclosure is not limited in this respect. In other examples, manual dispenser beacon module may be powered using different types of batteries, may be hard-wired to the electrical system of the building, may receive power from the batteries or the controller of the touch free dispenser.

Dispenser/module communication connector **57** communicatively couples PCB assembly **61** (and thus the touch free dispenser beacon module controller) with the controller of a touch free dispenser.

Inclusion of a bottle detection feature such as bottle presence trigger **58** allows tracking of the replacement of hand hygiene product in the dispenser, so the beacon module **150** or a remote computing device or system can determine when hand hygiene product needs to be replaced. For example, a time/date stamped event may be recorded when a product bottle has been taken out and another time/date stamped event may be recorded when the product bottle has been replaced. The module or the system may count the number of dispenses since product bottle replacement, and may count down the number of events to a predetermined "alert" level for replacement. Bottle presence trigger **58** also allows for hand hygiene compliance personnel to identify when a dispenser is being used without any hand hygiene product, so that the likelihood of dispensers being used without any hand hygiene product is reduced. In general, some or all of the functionality described above with respect to the bottle detection feature of the manual hand hygiene product dispenser may also be implemented by the bottle detection feature of the touch free hand hygiene product dispenser.

FIGS. **11**A, **11**B and **12-14** show various views of portions of an example touch free dispenser **70** and a touch free dispenser beacon module **50**. Touch free dispenser **70** includes a base **71**, a cover **73**, and an electromechanical gearbox **73** that includes a communications connector **77**. Communications connector **77** communicatively couples touch free dispenser controller (see FIG. **16**) with the touch free dispenser beacon module controller (see FIG. **16**). The touch free dispenser controller manages operation of touch free dispenser **70**, and includes a signal output indicative of actuation of the touch free dispenser, which is communicated to the touch free dispenser beacon module controller via the interface of connectors **57**/**77** as shown in FIG. **16**. Base **71** of touch free dispenser **70** includes a mounting boss **72** that mates with a mounting receiver **62** on touch free module **50**.

When touch free module **50** is installed into base **71** of touch free dispenser **70**, as shown in FIGS. **11**B and **12**, connector **57** on touch free beacon module **50** is connected with connector **77** of the touch free dispenser controller, allowing dispenser controller and dispenser beacon module **50** to communicate. A mounting screw **74** may fit over the mating mounting boss **72** and fastens touch free module **50** to touch free dispenser **70**.

When there is no bottle installed in touch free dispenser **70**, bottle detection rocker arm **58** is spring loaded by rocker return spring **66**, compressing on the inside of module cover **52**. When the system is at rest (i.e., no bottle installed in the dispenser), bottle detection micro switch **65** is not pressed. When a bottle **30** is installed (FIGS. **13** and **14**) the neck of the product bottle **80** presses and rotates rocker arm **58**, depressing micro switch **65**. Switch **65** communicates to the PCB assembly **61** that a bottle is installed. When the bottle **80** is removed, rocker arm **58** returns to its spring-loaded position releasing bottle detection micro switch **65**, communicating to PCB assembly **61** that the bottle **80** has been removed.

FIG. **15** is a block diagram illustrating an example implementation of the electronic components of a manual dispenser beacon module **100**. In this example, manual dispenser beacon module **100** includes a controller **101** that includes one or more processors **102** and storage device(s)/media **103**. Processors **102**, in one example, are configured to implement functionality and/or process instructions for execution within manual dispenser beacon module **100**. For example, processors **102** may execute instructions stored in storage devices **103**. Examples of processors **102** may include, any one or more of a microprocessor, a controller, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or equivalent discrete or integrated logic circuitry, including other hardware processors.

Example manual dispenser beacon module **100** further includes one or more wireless transceiver(s) **104**, range adjustment buttons **110**, a bottle detection switch **112**, a manual dispenser actuation switch **114**, a power supply **116**, and one or more audible of visual indicators **118**.

In some examples, the wireless transceiver(s) **104** of manual dispenser beacon module **100** is further configured to wirelessly transmit and/or receive communication from one or more computing device(s). For example, the beacon module **100** may receive remote software updates, remote configuration settings (e.g., range settings, product empty settings, settings for a number of dispense events before a product bottle should be refilled or replaced, etc.) from one or more computing devices. The beacon module **100** may further communicate with one or more other beacon modules in healthcare setting, such as those associated with other dispensers, with motion detectors in a patient room or other defined area, with patient zone beacons in a patient room or other defined area, or other such devices in a healthcare setting that may be useful for monitoring of hand hygiene compliance. The beacon module **100** may be further configured to wirelessly communicate (both transmit and receive) with one or more uniquely assigned healthcare worker identification badges. For example, the beacon module **100** may be configured to communicate with a badge, obtain healthcare worker identification information from the badge, and associate a detected dispense event with the healthcare worker identification information.

One or more storage devices **103** may be configured to store information within manual dispenser beacon module controller. Storage devices **103**, in some examples, can be described as a computer-readable storage medium. In some examples, storage devices **103** are a temporary memory, meaning that a primary purpose of storage devices **103** is not long-term storage. Storage devices **103**, in some examples, may be described as a volatile memory, meaning that storage devices **103** do not maintain stored contents when the computer is turned off. Examples of volatile memories include random access memories (RAM), dynamic random access memories (DRAM), static random access memories (SRAM), and other forms of volatile memories known in the art. In some examples, storage devices **103** are used to store program instructions for execution by processors **102**, such as manual module application **106**. Storage devices **103**, in one example, are used by software or application **156** running on controller **101** to temporarily store information during program execution.

Storage devices **103**, in some examples, also include one or more computer-readable storage media. Storage devices

103 may be configured to store larger amounts of information than volatile memory. Storage devices 103 may further be configured for long-term storage of information. In some examples, storage devices 103 may include non-volatile storage elements. Examples of such non-volatile storage elements include magnetic flash memories, or forms of electrically programmable memories (EPROM) or electrically erasable and programmable memories (EEPROM).

Storage device(s) 103 may store program instructions, such as touch free module application 156, for execution by processors 102. Manual module application 106 includes instructions that, when executed by processors 102, allow controller 101 to implement the manual dispenser beacon module functionality, such as monitor dispense events occurring at the manual free dispenser, store dispenser data concerning the dispense events, and wirelessly transmit (as indicated by reference numeral 105) the dispenser data via wireless transceiver 104. The dispenser data may include, for example, one or more of a dispenser id, a beacon module id, and a time and date stamp for each dispense event. The dispenser data may further include, for example, a current battery status, a total number of dispense events occurring during a predetermined time interval or since the last time the dispenser was refilled, a number of dispenses remaining before the dispenser runs out of hand hygiene product, an out-of-product or low product status, and/or other dispenser status information, etc.

Storage device(s) 103 may store various data (108) generated or used by processor(s) 102 during execution of the manual module application instructions 106. For example, storage device(s) may generate and store dispense event data, beacon module identification information, battery levels, bottle detection/presence information, range information, or other data associated with the manual dispenser beacon module 100.

Example manual dispenser beacon module 100 receives, for example, an indication of actuation of the manual dispenser from manual dispenser actuation switch 114. One example implementation for switch 114 is switch 19 of FIGS. 3 and 4. However, it shall be understood that other implementations and mechanisms for detecting actuation of a manual dispenser may be used, and that the disclosure is not limited in this respect. Controller 101 may store information concerning the received indication as a dispense event in data storage 108. In some examples, controller 101 may attach a time and date stamp, dispenser identification information and/or beacon module identification information to the dispense event data. Controller 101 may wirelessly transmit (as indicated by reference numeral 105) via wireless transceiver(s) 104 the dispense event data upon receipt of each indication of a manual actuation, or may wirelessly transmit (as indicated by reference numeral 105) multiple dispense events on a periodic basis or on demand. In other examples, controller 101 wirelessly transmits (as indicated by reference numeral 105) via wireless transceiver(s) 104 dispenser data indicative of a dispense event upon receipt of each indication of dispenser actuation from manual dispenser actuation without appending a time and date stamp. A computing device configured to receive dispenser data from multiple manual and/or touch free dispenser beacon modules within a healthcare or other facility may associate each dispense event with a time and date stamp, and may analyze the dispense event data to monitor hand hygiene within the facility.

When beacon module 100 in installed in a manual hand hygiene product dispenser and a bottle is installed into the dispenser, bottle detection switch 112 (such as switch 21 in FIGS. 1 and 5) is depressed (closed) and switch 112 generates a bottle present signal, which is in turn received by the beacon module controller 101. As long as a product bottle remains installed in the dispenser, the switch 112 remains closed and beacon module controller 101 may store the bottle present information in data store 108. If the bottle is removed, the switch 112 will return to the resting (open) state and the bottle present signal will no longer be present. Beacon module controller 101 may store information that no bottle is present in data store 108. Manual beacon module application 106 may cause processor(s) 103 to determine whether a bottle is present in the dispenser each time a dispense event occurs, and may wirelessly transmit the bottle present information as part of the dispenser data each time a dispense event occurs. In this way, users may be informed as to whether a hand hygiene product is actually installed in the dispenser, and may take remedial measures (refill the dispenser with a product bottle) if the dispenser data indicates that no bottle is present.

FIG. 16 is a block diagram illustrating an example implementation of a touch free dispenser beacon module 150. In this example, touch free dispenser beacon module 150 further includes a controller 151 that includes one or more processors 152 and storage device(s)/media 153. Processors 152, in one example, are configured to implement functionality and/or process instructions for execution within touch free dispenser beacon module 150. For example, processors 152 may be capable of processing instructions stored in storage devices 153. Examples of processors 152 may include, any one or more of a microprocessor, a controller, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or equivalent discrete or integrated logic circuitry, including other hardware processors.

Example touch free dispenser beacon module 150 further includes one or more wireless transceiver(s) 154, range adjustment buttons 160, a bottle detection switch 162, a power supply 166, and one or more audible of visual indicators 168.

In some examples, the wireless transceiver(s) 154 of touch free dispenser beacon module 150 is further configured to wirelessly transmit and/or receive communication from one or more computing device(s). For example, the beacon module 150 may receive remote software updates, remote configuration settings (e.g., range settings, product empty settings, settings for a number of dispense events before a product bottle should be refilled or replaced, etc.) from one or more computing devices. The beacon module 150 may further communicate with one or more other beacon modules in healthcare setting, such as those associated with other dispensers, with motion detectors in a patient room or other defined area, with patient zone beacons in a patient room or other defined area, or other such devices in a healthcare setting that may be useful for monitoring of hand hygiene compliance. The beacon module 150 may be further configured to wirelessly communicate (both transmit and receive) with one or more uniquely assigned healthcare worker identification badges. For example, the beacon module 150 may be configured to communicate with a badge, obtain healthcare worker identification information from the badge, and associate a detected dispense event with the healthcare worker identification information.

One or more storage devices 153 may be configured to store information within touch free dispenser beacon module controller. Storage devices 153, in some examples, can be described as a computer-readable storage medium. In some examples, storage devices 153 are a temporary memory,

meaning that a primary purpose of storage devices **153** is not long-term storage. Storage devices **153**, in some examples, may be described as a volatile memory, meaning that storage devices **153** do not maintain stored contents when the computer is turned off. Examples of volatile memories include random access memories (RAM), dynamic random access memories (DRAM), static random access memories (SRAM), and other forms of volatile memories known in the art. In some examples, storage devices **153** are used to store program instructions for execution by processors **152**, such as touch free module application **156**. Storage devices **153**, in one example, are used by software or application **156** running on controller **151** to temporarily store information during program execution.

Storage devices **153**, in some examples, also include one or more computer-readable storage media. Storage devices **153** may be configured to store larger amounts of information than volatile memory. Storage devices **153** may further be configured for long-term storage of information. In some examples, storage devices **153** may include non-volatile storage elements. Examples of such non-volatile storage elements include magnetic flash memories, or forms of electrically programmable memories (EPROM) or electrically erasable and programmable memories (EEPROM).

Storage device(s) **153** may store program instructions, touch free module application **156**, for execution by processors **152**. Touch free module application **156** includes instructions that, when executed by processors **152**, allow controller **151** to implement the touch free dispenser beacon module functionality, such as monitor dispense events occurring at the touch free dispenser, store dispenser data concerning the dispense events, and wirelessly transmit the dispenser data via wireless transceiver **154**. The dispenser data may include, for example, one or more of a dispenser id, a beacon module id, and a time and date stamp for each dispense event. The dispenser data may further include, for example, a current battery status, a total number of dispense events occurring since a predetermined time interval or since the last time the dispenser was refilled, a number of dispenses remaining before the dispenser runs out of hand hygiene product, an out-of-product or low product status, and/or other dispenser status information, etc.

Storage device(s) **153** may store various data (**158**) generated or used by processor(s) **152** during execution of the touch free module application instructions **156**. For example, storage device(s) may generate and store dispense event data, beacon module identification information, battery levels, bottle detection data, range information, or other data associated with the touch free dispenser beacon module **150**.

Example touch free dispenser beacon module **150** electronically communicates with a touch free dispenser module **170** via communication link(s) **171**. Touch free dispenser module **170** includes a touch free dispenser controller **171** that executes instructions stored on storage device(s) **173** to manage and control operation of a touch free dispenser, such as touch free dispenser **70**. Dispenser controller **171** includes one or more processor(s) **172** and storage device(s) **173**. A touch free dispenser application **176** stored in storage media **173** includes instructions that when executed by processors **172**, implement control of the functionality for the touch free dispenser. Storage devices **173** may further include data **178** that is used or generated during execution of touch free dispenser application **176**.

Touch free dispenser module **170** further includes an actuation sensor **182** that senses actuation of the touch free dispenser and generates a corresponding actuation signal that is in turn received by controller **171**. Actuation sensor **182** may include, for example, one or more of a photo interrupter, an infrared sensor, an optical sensor, a motion sensor, or other touchless or touch free mechanism for detecting presence of a user's hands. Touch free dispenser **170** further includes a dispenser motor **184** that is activated by controller **171** upon receipt for the actuation signal, thus causing a standardized dose of hand hygiene product to be dispensed from the touch free dispenser.

Communication link(s) **173** may be implemented in the example of FIGS. **11** and **12** via connectors **57**/**77**. In this way, controller **151** of beacon module **150** receives, for example, an indication of touch free dispenser actuation from touch free dispenser controller **171** via communication link(s) **173**. Controller **151** may store information concerning the received indication as a dispense event. In some examples, controller **151** may attach a time and date stamp, dispenser identification information and/or beacon module identification information to the dispense event data. Controller **151** may wirelessly transmit (as indicated by reference numeral **155**) via wireless transceivers **154** the dispense event data upon receipt of each indication of a manual actuation, or may wirelessly transmit (as indicated by reference numeral **155**) multiple dispense events on a periodic basis or on demand. In other examples, controller **151** wirelessly transmits (as indicated by reference numeral **155**) via wireless transceivers **154** dispenser data indicative of a dispense event upon receipt of each indication of dispenser actuation from touch free dispenser controller without appending a time and date stamp. A computing device configured to receive dispenser data from multiple manual and/or touch free dispenser beacon modules within a healthcare or other facility may associate each dispense event with a time and date stamp, and may analyze the dispense event data to monitor hand hygiene within the facility.

Power source **166** is indicated in dashed lines to indicate that beacon module **150** power may alternatively by powered from touch free dispenser module **170**. In such an example, instead of having dedicated batteries/power source **166**, touch free dispenser beacon module **150** may be configured to receive power from the touch free dispenser **70**. For example, controller **151** may receive power from touch free dispenser controller **170** via communication link(s) **173**. This may reduce the overall physical size of the touch free dispenser beacon module **150**, as it would not need to be sized to accommodate one or more batteries within the housing. The physical size and configuration of the housings for dispenser beacon module **50** shown in FIGS. **7-11**, for example, may therefore be designed without a battery compartment **60** or battery cover **53**, thus reducing the overall external dimensions of beacon module **50** and potentially making it easier to fit within the housing of a touch free dispenser.

In some examples, there may be advantages to the touch free dispenser beacon module to have its own internal batteries. Each time the dispenser activates, a load is placed on the batteries. As the batteries approach the end of their life, their internal resistance increases and the load will cause the battery voltage to "droop" significantly. If the touch free dispenser beacon module is powered by the dispenser's batteries and if the battery voltage droops below the reset voltage threshold of the touch free beacon module controller, the touch free beacon module controller will be held in reset until the battery voltage recovers to a point above the reset threshold. Battery voltage recovery could take long enough to delay badge communication until the end of the dispense cycle. It could also take so long that the

user which activated the dispenser has already left the area of the dispenser before the touch free beacon module controller has come out of reset and can communicate with that user's badge. The result may be that the user's badge has not been set to a clean hygienic state and the event is not reported. However, if the touch free beacon module has its own batteries, it is not affected by the voltage droop of the dispenser's batteries during activation and badge communication is more likely to ensue at the beginning of the dispense cycle.

Another benefit may be that a touch free beacon module, with its own batteries, will not reduce the life of the dispenser's batteries thus allowing the dispenser to meet specified battery life expectations. Also, the touch free beacon module may include the ability to monitor the level of the dispenser's batteries as well as its own batteries. It may be able to report the level of the dispenser's batteries even after their voltage has dropped below a level that would not allow the touch free beacon module to function had it been using the dispenser's batteries.

In some examples, a plurality of manual dispenser beacon module(s) **100** and/or touch free dispenser beacon module(s) **150** may be used to monitor hand hygiene compliance in a healthcare setting or other setting in which hand hygiene compliance monitoring is desired. For example, the modular hand hygiene compliance system may be adapted for use in applications such as hotel room cleaning, education facilities, long term care, restaurants, food service, food and beverage facilities, food packing, eating areas, rest rooms, food preparation areas, cooking areas, etc.

In such a system, each healthcare worker (HCW) is assigned a compliance badge that is uniquely associated with the HCW. Each time a HCW dispenses hand hygiene product from one of the manual or touch free dispensers having a manual beacon module **100** or touch free beacon module **150**, the corresponding beacon module **100/150** may communicate with the HCW badge, receive HCW identification information from the badge, and associate the HCW identification information with the dispense event. Example dispenser data stored and/or wirelessly transmitted upon each dispenser actuation is shown in Table 1:

TABLE 1

Example Dispenser Data with HCW Badge ID	
Dispenser ID	12345678
Dispense event	Yes
Time and Date	12:36:15, 6 MAR. 2015
Badge ID	9876543AB
Bottle presence	Yes
Battery level	92%
Range setting	2
Dispense event count since last product refill	78
Dispenses remaining until out of product/refill	547

In other examples, (such as those in which the beacon modules do not communicate with an id badge), the dispenser data may include only an indication of the dispense event and an indication of bottle presence (yes or no). In other examples, the dispenser data may include an indication of a valid battery voltage instead of or in addition to the current battery level. In other examples, the dispenser data may include any one or all of the example dispenser data listed in Table 1, and/or other dispenser data. The dispense event count since last product refill may be reset each time a product bottle removal/replacement is detected by bottle presence triggers of the manual or touch free beacon modules.

FIG. **17** is a block diagram of an example hand hygiene compliance monitoring system **200**. A plurality of healthcare facilities, such as hospitals **210**A-**210**N, each include a plurality of manual hand hygiene product dispensers **202**A-**202**N and/or a plurality of touch free hand hygiene product dispensers **206**A-**206**N. For simplicity of illustration, these are shown with respect to hospital **210**A. Each of the plurality of manual dispensers **202**A-**202**N is associated with a different one of a plurality of manual dispenser beacon modules **204**A-**204**N that provide for wireless transmission of dispenser data. Similarly, each of the plurality of touch free dispensers **206**A-**206**N is associated with a different one of a plurality of touch free dispenser beacon modules **208**A-**208**N that provide for wireless transmission of dispenser data.

Dispenser beacon modules **203**A-**204**N and **208**A-**208**N wirelessly transmit their respective dispenser data to one or more local computing device(s) **220** via local network(s) **214**. In the example where beacon modules transmit dispenser data upon the occurrence of each dispense event and does not include a time and date stamp in the dispenser data, local computing device will associate a time and date stamp with the dispense event.

In some examples, such as that shown in FIG. **17**, hand hygiene compliance monitoring system **200** includes HCW badges **212**A-**212**N. In this example, therefore, the dispenser data transmitted by beacon modules **204**A-**204**N and/or **208**A-**208**N may include HCW identification information received from badges **212**A-**212**N.

To monitor hand hygiene compliance, dispenser data from the plurality of dispenser beacon modules **100/150** are wirelessly transmitted to one or more local computing device(s) **220** located within the healthcare facility and/or to remote computing device(s) **230** for data analysis and reporting. As shown in FIG. **17**, for example, computing devices **230** may include one or more processor(s) **232**, an analysis application **234**, a reporting application **236**, and a data base **238** that stores the requisite data used or generated by system **200**. Analysis application **234**, when executed by processors **232**, analyzes the hand hygiene data in accordance with one or more compliance rules so as to monitor hand hygiene compliance with the healthcare facility. Reporting application **236**, when executed by processors **232**, generates reports regarding hand hygiene compliance. For example, computing devices **230** may analyze the hand hygiene data to monitor hand hygiene compliance by individual HCW, type of HCW (e.g., nurses, doctors, environmental services (EVS), etc.), department, type of department, individual hospital, type of hospital, across multiple hospitals, or by various other selected parameters. Computing devices **230** may generate a variety of reports to provide users local to each hospital **210**A-**210**N or remote users **226** with both qualitative and quantitative data regarding hand hygiene compliance at their hospital, to compare data over time to determine whether improvement has occurred, and/or to benchmark hand hygiene compliance at one hospitals, at multiple hospitals, or to view and compare hand hygiene compliance over time. Analysis and reporting application may also be stored locally on hospital computing devices **220** so that analysis and reporting of hand hygiene data may be done locally if desired.

FIG. **18** is a flowchart illustrating an example process (**240**) by which a manual dispenser beacon module, such as beacon module **100**, may detect manual actuations of a

manual hand hygiene product dispenser and wirelessly transmit dispenser data associated with the dispense event. Beacon module **100** receives a dispenser actuation signal (**242**) indicative of actuation of the manual hand hygiene product dispenser. The actuation signal may be received from, for example, a switch configured to detect manual actuation of a manual hand hygiene product dispenser, such as switch **19** of FIGS. **3** and **4** and/or switch **114** of FIG. **15**.

Beacon module **100** may further determine additional dispenser status information (**244**). For example, beacon module **100** may determine the current battery level, whether a bottle is present in the manual dispenser, may increment a count of the number of dispenses, may determine a number of dispenses remaining before the product bottle needs to be replaced or refilled, etc. Beacon module **100** then wirelessly transmits the dispense event data (**246**).

FIG. **19** is a flowchart illustrating another example process (**250**) by which a manual dispenser beacon module, such as beacon module **100**, may detect manual actuations of a manual hand hygiene product dispenser and wirelessly transmit dispenser data associated with the dispense event. Beacon module **100** receives a dispenser actuation signal (**252**) indicative of actuation of the manual hand hygiene product dispenser. The actuation signal may be received from, for example, a switch configured to detect manual actuation of a manual hand hygiene product dispenser, such as switch **19** of FIGS. **3** and **4** and/or switch **114** of FIG. **15**. In this example, beacon module controller **100** may then look for any HCW ID badge signals within range of the dispenser (**254**). For example, a wireless transceiver on beacon module controller may have an initial range of 0-1 meter or some other appropriate distance that helps to ensure that only the HCW ID badge associated with the HCW who initiated the dispense event is detected and not another nearby HCW id tag.

If a HCW ID badge signal is detected within a predefined period of time (**256**) (such as 0.5 seconds, 1 second, 2 seconds, 5 seconds or other appropriate time interval, for example), beacon module **100** associates the dispense event with the detected HCW identification information (**258**). If no HCW ID badge signal is detected within a predefined period of time, beacon module **100** associates the dispense event with non-HCW identification information (**260**).

Beacon module **100** may further determine additional dispenser status information (**262**). For example, beacon module **100** may determine the current battery level, whether a bottle is present in the manual dispenser, may increment a count of the number of dispenses, may determine a number of dispenses remaining before the product bottle needs to be replaced or refilled, etc. Beacon module **100** then wirelessly transmits the dispense event data (**264**).

FIG. **20** is a flowchart illustrating an example process (**300**) by which a touch free dispenser beacon module, such as beacon module **150**, may detect actuations of a touch free hand hygiene product dispenser and wirelessly transmit dispenser data associated with the dispense event. Beacon module **150** receives a dispenser actuation signal (**302**) indicative of actuation of the touch free hand hygiene product dispenser. The actuation signal may be received from, for example, a touch free dispenser module (such as touch free dispenser module **170** of FIG. **16**) that controls operation of, and thus detects actuation of, the touch free hand hygiene product dispenser.

Beacon module **150** may further determine additional dispenser status information (**304**). For example, beacon module **150** may determine the current battery level, whether a bottle is present in the touch free dispenser, may increment a count of the number of dispenses, may determine a number of dispenses remaining before the product bottle needs to be replaced or refilled, etc. Beacon module **150** then wirelessly transmits the dispense event data (**306**).

FIG. **21** is a flowchart illustrating another example process (**310**) by which a touch free dispenser beacon module, such as beacon module **150**, may detect actuations of a touch free hand hygiene product dispenser and wirelessly transmit dispenser data associated with the dispense event. Beacon module **150** receives a dispenser actuation signal (**312**) indicative of actuation of the touch free hand hygiene product dispenser. The actuation signal may be received from, for example, a touch free dispenser module (such as touch free dispenser module **170** of FIG. **16**) that controls operation of, and thus detects actuation of, the touch free hand hygiene product dispenser.

In this example, beacon module controller **150** may then look for any HCW ID badge signals within range of the dispenser (**316**). For example, a wireless transceiver on beacon module controller may have an initial range of 0-1 meter or some other appropriate distance that helps to ensure that only the HCW ID badge associated with the HCW who initiated the dispense event is detected and not another nearby HCW id tag.

If a HCW ID badge signal is detected within a predefined period of time (**316**) (such as 0.5 seconds, 1 second, 2 seconds, 5 seconds or other appropriate time interval, for example), beacon module **100** associates the dispense event with the detected HCW identification information (**318**). If no HCW ID badge signal is detected within a predefined period of time, beacon module **150** associates the dispense event with non-HCW identification information (**320**).

Beacon module **150** may further determine additional dispenser status information (**322**). For example, beacon module **150** may determine the current battery level, whether a bottle is present in the manual dispenser, may increment a count of the number of dispenses, may determine a number of dispenses remaining before the product bottle needs to be replaced or refilled, etc. Beacon module **150** then wirelessly transmits the dispense event data (**324**).

In accordance with one or more aspects of this disclosure, the term "or" may be interrupted as "and/or" where context does not dictate otherwise. Additionally, while phrases such as "one or more" or "at least one" or the like may have been used in some instances but not others, those instances where such language was not used may be interpreted to have such a meaning implied where context does not dictate otherwise.

In one or more examples, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over, as one or more instructions or code, a computer-readable device or medium and executed by a hardware-based processing unit. Computer-readable media may include computer-readable storage media, which corresponds to a tangible medium such as data storage media, or communication media including any medium that facilitates transfer of a computer program from one place to another, e.g., according to a communication protocol. In this manner, computer-readable media generally may correspond to non-transitory tangible computer-readable storage media. Data storage media may be any available media that can be accessed by one or more computers or one or more processors to retrieve instructions, code and/or data structures for implementation of the techniques described in this disclosure. A computer program product may include a computer-readable medium.

By way of example, and not limitation, such computer-readable storage media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage, or other magnetic storage devices, flash memory, or any other medium that can be used to store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if instructions are transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. It should be understood, however, that computer-readable storage media and data storage media do not include connections, carrier waves, signals, or other transient media, but are instead directed to non-transient, tangible storage media. Disk and disc, as used, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc, where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

Instructions may be executed by one or more processors, such as one or more digital signal processors (DSPs), general purpose microprocessors, application specific integrated circuits (ASICs), field programmable logic arrays (FPGAs), or other equivalent integrated or discrete logic circuitry. Accordingly, the term "processor," as used may refer to any of the foregoing structure or any other structure suitable for implementation of the techniques described. In addition, in some aspects, the functionality described may be provided within dedicated hardware and/or software modules. Also, the techniques could be fully implemented in one or more circuits or logic elements.

The techniques of this disclosure may be implemented in a wide variety of devices or apparatuses, including a wireless handset, an integrated circuit (IC) or a set of ICs (e.g., a chip set). Various components, modules, or units are described in this disclosure to emphasize functional aspects of devices configured to perform the disclosed techniques, but do not necessarily require realization by different hardware units. Rather, as described above, various units may be combined in a hardware unit or provided by a collection of interoperating hardware units, including one or more processors as described above, in conjunction with suitable software and/or firmware.

Various examples have been described. These and other examples are within the scope of the following claims.

The invention claimed is:

1. A dispenser system comprising:

a dispenser beacon module configured to monitor actuations of a product dispenser, the dispenser beacon module including:

a module controller configured to generate dispenser data for each of a plurality of detected actuations of the product dispenser; and

one or more wireless transceivers configured to wirelessly transmit and/or receive data, wherein at least one of the one or more wireless transceivers is configured to wirelessly transmit and/or receive at least a portion of the dispenser data,

wherein the dispenser beacon module further includes a module housing sized to fit within a housing of the product dispenser, the module housing including a module base, and a bottle presence trigger configured on or about an outer surface of the module housing such that presence of a product bottle in the housing of the product dispenser provides a bottle presence signal indicative of presence of the product bottle in the housing of the product dispenser.

2. The system of claim **1**, wherein the module controller is configured to receive identification information from one of a plurality of badges associated with one or more of the plurality of detected actuations of the product dispenser.

3. The system of claim **2**, wherein the dispenser data for each of the plurality of detected actuations of the product dispenser includes the identification information.

4. The system of claim **2**, wherein the product dispenser is one of a manually actuated hand hygiene product dispenser or a touch free hand hygiene product dispenser.

5. The system of claim **1**, wherein the module controller is configured to receive a dispenser actuation signal from a switch that detects actuation of the product dispenser.

6. The system of claim **1**, wherein the product dispenser is one of a manual product dispenser or a touch free product dispenser.

7. The system of claim **1**, wherein the module controller is further configured to store a dispense event count upon receipt of a dispenser actuation signal.

8. The system of claim **1**, further comprising a bottle presence trigger including a switch that changes from a first state to a second state when a product bottle is installed into the product dispenser; and wherein the module controller is further configured to reset a dispense event count when the product bottle is installed.

9. The system of claim **8**, wherein the dispenser data includes the dispense event count.

10. The system of claim **8**, wherein the bottle presence trigger includes one of a plunger switch, a pin switch, or a rocker switch.

11. The system of claim **1**, further including an indicator that is illuminated by the module controller upon receipt of a dispenser actuation signal.

12. The system of claim **1**, wherein the module housing further includes a module cover.

13. The system of claim **1**, wherein the module housing is sized to be received into a receptacle within the housing of the product dispenser.

14. The system of claim **1**, wherein the module controller is internal to the module housing.

15. The system of claim **1**, wherein the module controller further determines status information corresponding to each of the detected actuations of the product dispenser, the status information including at least one of a battery level associated with the dispenser beacon module or a battery level associated with the product dispenser.

16. The system of claim **1**, wherein the dispenser data for each of the plurality of the detected actuations of the product dispenser further includes at least one of a battery level associated with the dispenser beacon module, a battery level associated with the product dispenser, and a dispense event count.

17. The system of claim **1**, wherein the dispenser beacon module further includes a power source that provides power to the module controller.

18. The system of claim **1**, wherein the module controller receives power from the product dispenser.

19. The system of claim **1**, wherein the module controller receives power from one or more batteries that also provide power to the product dispenser.

20. The system of claim **1**, further comprising a computing system including:

one or more processors; and

one or more non-transitory storage devices comprising instructions that when executed by the one or more processors cause the one or more processors to:

for each of a plurality of product dispensers, analyze dispenser data received for each of a plurality of detected actuations of the product dispenser and identify one or more of the detected actuations of the product dispenser for which the dispenser data includes a product bottle absence indication.

21. The system of claim **20**, further comprising instructions that when executed by the one or more processors cause the one or more processors to generate an alert including the detected product bottle absence indication.

22. The system of claim **20**, further comprising instructions that when executed by the one or more processors cause the one or more processors to, for each of the plurality of product dispensers, detect installation of a product bottle in the product dispenser.

23. The system of claim **20**, wherein the computing device is configured to generate a product bottle replacement indication upon detection of installation of the product bottle in the product dispenser.

24. The system of claim **20**, wherein the computing device is configured to generate a product bottle removal indication upon detection of removal of the product bottle from the product dispenser.

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