



- (51) International Patent Classification:
A61B 5/00 (2006.01)
- (21) International Application Number:
PCT/US2013/025384
- (22) International Filing Date:
8 February 2013 (08.02.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/597,126 9 February 2012 (09.02.2012) US
61/625,584 17 April 2012 (17.04.2012) US
61/703,713 20 September 2012 (20.09.2012) US
- (71) Applicant: MASIMO CORPORATION [US/US]; 40 Parker, Irvine, CA 92618 (US).
- (72) Inventors: MUHSIN, Bilal; 43 Via Torina, San Clemente, CA 92673 (US). KIANI, Massi Joe, E.; 1 Point Catalina, Laguna Niguel, CA 92677 (US). AL-ALI, Ammar; 30312 Via Bella, San Juan Capistrano, CA 92675 (US). DE-JONG, Chad, A.; 880 W. 1st Street #516, Los Angeles,

CA 90012 (US). BARKER, Nicholas, Evan; 1900 Catalina St., Laguna Beach, CA 92651 (US). KINAST, Eric, Karl; 2409 N. Heliotrope Dr., Santa Ana, CA 92706 (US).

(74) Agent: ALTMAN, Daniel, E.; Knobbe Martens Olson & Bear, LLP, 2040 Main Street, Fourteenth Floor, Irvine, CA 92614 (US).

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

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

[Continued on next page]

(54) Title: WIRELESS PATIENT MONITORING DEVICE

(57) Abstract: A device for obtaining physiological information of a medical patient and wirelessly transmitting the obtained physiological information to a wireless receiver.

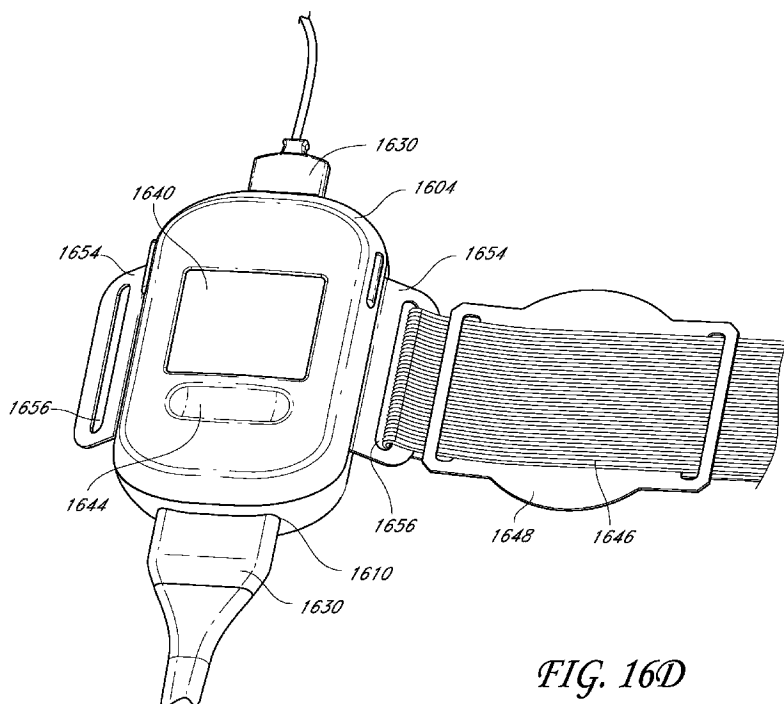


FIG. 16D



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

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

WIRELESS PATIENT MONITORING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority benefit under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Serial No. 61/597,126, filed February 9, 2012, titled *Wireless Patient Monitoring System*, U.S. Provisional Patent Application Serial No. 61/625,584, filed April 17, 2012, titled *Wireless Patient Monitoring Device*, and U.S. Provisional Patent Application Serial No. 61/703,713, filed September 20, 2012, titled *Wireless Patient Monitoring Device*, all of which applications are hereby incorporated by reference in their entirety.

BACKGROUND

Field

In general, the disclosure relates to methods and apparatuses for wirelessly monitoring a patient's physiological information.

Description of the Related Art

Hospitals, nursing homes, and other patient care facilities typically include patient monitoring devices at one or more bedsides in the facility. Patient monitoring devices generally include sensors, processing equipment, and displays for obtaining and analyzing a medical patient's physiological parameters such as blood oxygen saturation level, respiratory rate, and the like. Clinicians, including doctors, nurses, and other medical personnel, use the physiological parameters obtained from patient monitors to diagnose illnesses and to prescribe treatments. Clinicians also use the physiological parameters to monitor patients during various clinical situations to determine whether to increase the level of medical care given to patients.

For example, the patient monitoring devices can be used to monitor a pulse oximeter. Pulse oximetry is a widely accepted noninvasive procedure for measuring the oxygen saturation level of arterial blood, an indicator of a person's oxygen supply. A typical pulse oximetry system utilizes an optical sensor clipped onto a fingertip to measure the relative

Oxygen saturation (SpO₂), pulse rate, a plethysmograph waveform, perfusion index (PI), pleth variability index (PVI), methemoglobin (MetHb), carboxyhemoglobin (CoHb), total hemoglobin (tHb), glucose, and/or otherwise can be displayed on a monitor accordingly.

The patient monitoring devices can also communicate with an acoustic sensor comprising an acoustic transducer, such as a piezoelectric element. The acoustic sensor can detect respiratory and other biological sounds of a patient and provide signals reflecting these sounds to a patient monitor. An example of such an acoustic sensor, which can implement any of the acoustic sensing functions described herein, is described in U.S. Application No. 12/643,939, filed December 21, 2009, titled "Acoustic Sensor Assembly," and in U.S. Application No. 61/313,645, filed March 12, 2010, titled "Acoustic Respiratory Monitoring Sensor Having Multiple Sensing Elements," the disclosures of which are hereby incorporated by reference in their entirety.

Blood pressure is another example of a physiological parameter that can be monitored. Many devices allow blood pressure to be measured by sphygmomanometer systems that utilize an inflatable cuff applied to a person's arm. The cuff is inflated to a pressure level high enough to occlude a major artery. When air is slowly released from the cuff, blood pressure can be estimated by detecting "Korotkoff" sounds using a stethoscope or other detection means placed over the artery. Other Examples of physiological parameters that can be measured include respiration rate, blood analyte measurements, such as oxygen saturation, and ECG.

SUMMARY

One aspect of the disclosure is a wireless patient monitoring device including one or more sensors configured to obtain physiological information. The one or more sensors can include an optical sensor, an acoustic respiratory sensor, and/or a blood pressure measurement device. Other sensors, including but not limited to, an EEG, ECG, and/or a sedation state sensor can also be used with the present disclosure. The one or more sensors are connected to a wireless monitor configured to receive the sensor data and to wirelessly transmit sensor data or physiological parameters reflective of the sensor data to a bedside

communication channel, and/or communication status.

Another aspect of the disclosure is directed toward a system configured to wirelessly communicate physiological information, the system including a battery, a housing, a rechargeable electrical storage module, and a memory module configured to store wireless communication information.

In some aspects of the disclosure, the wireless communication information stored on the data storage component facilitates communication between the wireless monitor and the bedside monitor. The information may be a unique identifier used to pair the wireless monitor with the bedside monitor. The information may be a password used to make sure only the correct receiver has access to the transmitted physiological data. The information may be channel information to make certain the wireless monitor and bedside monitor communicate on the same channel.

In some aspects of the disclosure, the bedside monitor can be configured to receive and recharge the removable battery. The battery may include a data storage component configured to store wireless communication information. In some embodiments, the bedside monitor communicates wireless communication information to the battery through a hard wired connection, and the battery stores the information. In some embodiments, the battery communicates wireless communication information to the bedside monitor through a hard wired connection.

Another aspect of the disclosure is directed toward a bedside monitor configured to receive the wireless monitor. In some embodiments, the bedside monitor communicates wireless communication information to the wireless monitor when the wireless monitor is physically and electrically connected with the bedside monitor. In some embodiments, the wireless monitor communicates information to the bedside monitor when the wireless monitor is physically and electrically connected with the bedside monitor.

In another aspect of the disclosure, the wireless monitor can be configured to transmit physiological data over a first wireless technology when a signal strength of the first wireless technology is sufficiently strong and transmit physiological data over a second wireless technology when the signal strength of the first wireless technology is not sufficiently strong.

transmit physiological data over a first wireless technology when the wireless monitor is within a pre-determined distance from the wireless receiver and transmit physiological data over a second wireless technology when the wireless monitor is not within a pre-determined distance from the bedside monitor.

In another aspect of the disclosure, the battery includes a display. The display can be configured to activate when the wireless transmitter transmits physiological data over a first wireless technology and deactivate when the wireless transmitter transmits physiological data over a second wireless technology.

One aspect of the disclosure is a method of wirelessly monitoring physiological information. The method includes providing a battery including a data storage component, physically connecting the battery to a bedside monitor, storing data on the data storage component of the battery, connecting the battery to a wireless monitor, and transmitting physiological data from the wireless monitor to the bedside monitor.

In another aspect of the disclosure, transmitting physiological data from the wireless monitor to the bedside monitor includes transmitting physiological data over a first wireless technology when the wireless monitor is within a pre-determined distance from the bedside monitor and transmitting physiological data over a second wireless technology when the wireless monitor is not within a pre-determined distance from the bedside monitor. In some embodiments of the disclosure, the first wireless technology is Bluetooth or ZigBee, and the second wireless technology is Wi-Fi or cellular telephony.

In yet another aspect of the disclosure, transmitting physiological data from the wireless monitor to the bedside monitor includes transmitting physiological data over a first wireless technology when a signal strength of the first wireless technology is sufficiently strong and transmitting physiological data over a second wireless technology when the signal strength of the first wireless technology is not sufficiently strong.

In some aspects of the disclosure, the wireless monitor can be configured to be coupled to an arm band attached to the patient. Alternatively, the wireless monitor can be configured to be coupled to a patient's belt, can be carried by the patient (e.g., via a shoulder

locations.

In another aspect of the disclosure, the wireless monitor battery includes a display screen. When the wireless monitor is within a pre-determined distance from the bedside monitor and transmits data over Bluetooth or Zigbee, the display screen deactivates. When the wireless monitor is not within a pre-determined distance from the bedside monitor and transmits data over Wi-Fi or cellular telephony, the display screen activates. Alternatively, independent of the communication protocol used by the device, when the wireless monitor is a pre-determined distance from the bedside monitor, the display screen activates. Similarly when the wireless monitor is within a pre-determined distance to the bedside monitor, the display screen deactivates.

In certain aspects of the disclosure, a blood pressure device can be used. The blood pressure device can be coupled to a medical patient and a wireless transceiver electrically coupled with the blood pressure device. The wireless transceiver can wirelessly transmit blood pressure data received by the blood pressure device and physiological data received from one or more physiological sensors coupled to the blood pressure device. To further increase patient mobility, in some embodiments, a single cable can be provided for connecting multiple different types of sensors together.

In certain aspects of the disclosure, a wireless patient monitoring device for measuring one or more parameters can be secured to an arm of the patient. For example, a wireless measurement device for measuring oxygen saturation and respiration rate can be secured to the arm of a patient. The wireless monitoring device can connect to an oximeter probe and an acoustic respiration probe. The monitor can have a display screen and/or can transmit wireless information to a bedside monitor. In an embodiment, a docking station can be provided for the wireless monitoring device to dock it to a docking station forming a bedside monitor.

In some aspects of the disclosure, the patient monitoring devices can be coupled to a blood pressure cuff and measure blood pressure.

In some aspects of the disclosure, the patient monitoring system can include a sensor configured to obtain physiological information, an anchor connected to the sensor, and a

anchor and a second cable can connect the anchor to the wireless transceiver. In certain aspects, the anchor can adhere to the patient or be carried by the patient in any manner discussed herein.

In some aspects of the disclosure, the patient monitoring system can include one or more sensors configured to obtain physiological information and a wireless transceiver configured to receive the physiological information. The wireless transceiver can include a housing having a first side and a second side. At least one connector can be positioned on the first side and at least one connector can be positioned on the second side. In certain aspects, the first side of housing can be opposite the second side of the housing.

In some aspects of the disclosure, a docking station can include a bedside monitor having a docking port configured to receive a first patient monitor and a docking station adapter configured to adapt the docking port to receive a second patient monitor. The second patient monitor can be a different size than the first patient monitor. In certain aspects, the first patient monitor can communicate with the bedside monitor over a wired connection when the first patient monitor is connected to the docking port. In certain aspects, the second patient monitor can communicate with the bedside monitor over a wired connection when the second patient monitor is connected to the docking station adapter and the docking station adapter is connected to the docking port.

In some aspects of the disclosure, a patient monitoring system can include a first sensor, a second sensor, and a wireless patient monitor configured to receive physiological information from the first sensor and the second sensor. The patient monitoring system can include a single cable connecting the first sensor and the second sensor to the wireless patient monitor. In certain aspects, the single cable can include a first cable section connecting the wireless patient monitor and the first sensor and a second cable section connecting the first sensor and the second sensor. In certain aspects, the first sensor and the second sensor can be powered by a shared power line and/or can transmit signals over a shared signal line.

In some aspects of the disclosure, a patient monitoring system can include one or more sensors configured to obtain physiological information, a patient monitor configured to receive the physiological information, and a cable hub having one or more inlet connectors

monitor. In certain aspects, the one or more inlet connectors can be positioned on a first end of the cable hub and the outlet connector can be positioned on a second end of the cable hub, opposite the first end. In certain aspects, the patient monitor can include a wireless transceiver. In certain aspects, the patient monitor can be configured to be worn by the patient. In certain aspects, the cable hub can be configured to adhere to the patient. In certain aspects, a first cable extends from at least one of the one or more sensors to one of the one or more inlet connectors, and a second cable extends from the outlet connector to the patient monitor.

Some aspects of the disclosure describe a method of using a patient monitoring system. The method can include providing a wireless transceiver having a first end and a second end opposite the first end, a first connector positioned on the first end, and a second connector positioned on the second end. The method can include connecting a first end of a first cable to the first connector, and connecting a first end of a second cable to the second connector. In certain aspects, the method can include connecting a second end of the first cable to a first sensor. In certain aspects, the method can include connecting a second end of the second cable to a second sensor or a cable hub connected to one or more sensors. In certain aspects, the method can include connecting a third sensor and/or anchor to the second cable. In certain aspects, the method can include connecting a third cable to a third connector on the second end of the wireless transceiver.

Certain aspects of this disclosure are directed toward a wireless monitor including a housing, a battery, and a strap. The housing can include one or more outlets configured to receive one or more sensors. The battery can be configured to removably engage the housing. A portion of the strap can be disposed between the housing and the battery when the housing is engaged with the battery. In certain aspects, the portion of the strap disposed between the housing and the battery can be a separately formed component from a remainder of the strap. In certain aspects, the portion of the strap can include one or more mating features configured to mate with corresponding features of the housing. In certain aspects, the one or more mating features are flush with the corresponding features of the housing. In certain aspects, the housing can include a recessed portion for receiving the strap.

features of the inventions have been described herein. It is to be understood that not necessarily all such advantages can be achieved in accordance with any particular embodiment of the inventions disclosed herein. Thus, the inventions disclosed herein can be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other advantages as can be taught or suggested herein.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments will be described hereinafter with reference to the accompanying drawings. These embodiments are illustrated and described by example only, and are not intended to limit the scope of the disclosure. In the drawings, similar elements have similar reference numerals.

FIGURES 1A and 1B illustrate embodiments of wireless patient monitoring systems.

FIGURES 1C and 1D illustrate further embodiments of wireless patient monitoring systems.

FIGURE 1E illustrates the embodiment of the wireless patient monitoring system illustrated in FIGURES 1A-1B in schematic form.

FIGURES 2A and 2B illustrate embodiments of wireless patient monitoring systems having a single cable connection system.

FIGURES 3A and 3B illustrates additional embodiment of patient monitoring systems.

FIGURES 4A and 4B illustrate embodiments of an optical ear sensor and an acoustic sensor connected via a single cable connection system.

FIGURE 5 illustrates an embodiment of a wireless transceiver that can be used with any of the patient monitoring systems described above.

FIGURES 6A through 6C illustrate additional embodiments of patient monitoring systems.

FIGURE 7 illustrates an embodiment of a physiological parameter display that can be used with any of the patient monitoring systems described above.

FIGURES 9A-9D illustrate an embodiment of a wireless patient monitoring system.

FIGURE 10 illustrates the embodiment of the wireless patient monitoring system illustrated in FIGURES 9A-9D in schematic form.

FIGURE 11 illustrates one embodiment of a method of using a wireless patient monitoring system.

FIGURE 12 illustrates a wireless monitor having a display screen.

FIGURES 13-15 illustrate methods of using a wireless monitor having a display screen.

FIGURES 16A-16G illustrate another embodiment of a wireless patient monitoring system.

FIGURES 17A-17C illustrate another embodiment of a wireless patient monitoring system.

FIGURES 18A-18C illustrate an animation of patient movement created using a wireless patient monitor.

DETAILED DESCRIPTION

In clinical settings, medical sensors are often attached to patients to monitor physiological parameters of the patients. Some examples of medical sensors include, but are not limited to, blood oxygen sensors, such as pulse oximetry sensors, acoustic respiratory sensors, EEGs, ECGs, blood pressure sensors, sedation state sensors, etc. Typically, each sensor attached to a patient is connected to a bedside monitoring device with a cable. The cables limit the patient's freedom of movement and impede a care providers access to the patient. The cables connecting the patient to the bedside monitoring device also make it more difficult to move the patient from room to room or switch to different bedside monitors.

This disclosure describes embodiments of wireless patient monitoring systems that include a wireless device coupled to a patient and to one or more sensors. In one embodiment, the wireless device transmits sensor data obtained from the sensors to a patient monitor. By transmitting the sensor data wirelessly, these patient monitoring systems can advantageously replace some or all cables that connect patients to bedside monitoring devices. To further increase patient mobility and comfort, in some embodiments, a single

together.

These patient monitoring systems are primarily described in the context of an example blood pressure cuff that includes a wireless transceiver. The blood pressure cuff and/or wireless transceiver can also be coupled to additional sensors, such as optical sensors, acoustic sensors, and/or electrocardiograph sensors. The wireless transceiver can transmit blood pressure data and sensor data from the other sensors to a wireless receiver, which can be a patient monitor. These and other features described herein can be applied to a variety of sensor configurations, including configurations that do not include a blood pressure cuff. In an embodiment, an arm band without a blood pressure cuff can be used to secure a wireless patient monitor connected to various sensors.

FIGURES 1A and 1B illustrate embodiments of wireless patient monitoring systems 100A, 100B, respectively. In the wireless patient monitoring systems 100 shown, a blood pressure device 110 is connected to a patient 101. The blood pressure device 110 includes a wireless transceiver 116, which can transmit sensor data obtained from the patient 101 to a wireless transceiver 120. Thus, the patient 101 is advantageously not physically coupled to a bedside monitor in the depicted embodiment and can therefore have greater freedom of movement.

Referring to FIGURE 1A, the blood pressure device 110a includes an inflatable cuff 112, which can be an oscillometric cuff that is actuated electronically (e.g., via intelligent cuff inflation and/or based on a time interval) to obtain blood pressure information. The cuff 112 is coupled to a wireless transceiver 116. The blood pressure device 110a is also coupled to a fingertip optical sensor 102 via a cable 107. The optical sensor 102 can include one or more emitters and detectors for obtaining physiological information indicative of one or more blood parameters of the patient 101. These parameters can include various blood analytes such as oxygen, carbon monoxide, methemoglobin, total hemoglobin, glucose, proteins, lipids, a percentage thereof (e.g., concentration or saturation), and the like. The optical sensor 102 can also be used to obtain a photoplethysmograph, a measure of plethysmograph variability, pulse rate, a measure of blood perfusion, and the like.

a cable 105. The cable 105 connecting the acoustic sensor 104a to the blood pressure device 110 includes two portions, namely a cable 105a and a cable 105b. The cable 105a connects the acoustic sensor 104a to an anchor 104b, which is coupled to the blood pressure device 110a via the cable 105b. The anchor 104b can be adhered to the patient's skin to reduce noise due to accidental tugging of the acoustic sensor 104a.

The acoustic sensor 104a can be a piezoelectric sensor or the like that obtains physiological information reflective of one or more respiratory parameters of the patient 101. These parameters can include, for example, respiratory rate, inspiratory time, expiratory time, inspiration-to-expiration ratio, inspiratory flow, expiratory flow, tidal volume, minute volume, apnea duration, breath sounds, rales, rhonchi, stridor, and changes in breath sounds such as decreased volume or change in airflow. In addition, in some cases the respiratory sensor 104a, or another lead of the respiratory sensor 104a (not shown), can measure other physiological sounds such as heart rate (e.g., to help with probe-off detection), heart sounds (e.g., S1, S2, S3, S4, and murmurs), and changes in heart sounds such as normal to murmur or split heart sounds indicating fluid overload. In some implementations, a second acoustic respiratory sensor can be provided over the patient's 101 chest for additional heart sound detection. In one embodiment, the acoustic sensor 104 can include any of the features described in U.S. Patent Application No. 12/643,939, filed December 21, 2009, titled "Acoustic Sensor Assembly," the disclosure of which is hereby incorporated by reference in its entirety.

The acoustic sensor 104 can be used to generate an exciter waveform that can be detected by the optical sensor 102 at the fingertip, by an optical sensor attached to an ear of the patient (see FIGURES 2A, 3), by an ECG sensor (see FIGURE 2C), or by another acoustic sensor (not shown). The velocity of the exciter waveform can be calculated by a processor (such as a processor in the wireless transceiver 120, described below). From this velocity, the processor can derive a blood pressure measurement or blood pressure estimate. The processor can output the blood pressure measurement for display. The processor can also use the blood pressure measurement to determine whether to trigger the blood pressure cuff 112.

advantageously combined with an ECG electrode (such as in structure 208 of FIGURE 2B), thereby providing dual benefit of two signals generated from a single mechanical assembly. The timing relationship from fiducial markers from the ECG signal, related cardiac acoustic signal and the resulting peripheral pulse from the finger pulse oximeters produces a transit time that correlates to the cardiovascular performance such as blood pressure, vascular tone, vascular volume and cardiac mechanical function. Pulse wave transit time or PWTT in currently available systems depends on ECG as the sole reference point, but such systems may not be able to isolate the transit time variables associated to cardiac functions, such as the pre-ejection period (PEP). In certain embodiments, the addition of the cardiac acoustical signal allows isolation of the cardiac functions and provides additional cardiac performance metrics. Timing calculations can be performed by the processor in the wireless transceiver 120 or a distributed processor found in an on-body structure (e.g., such as any of the devices herein or below: 112, 210, 230, 402, 806).

In certain embodiments, the wireless patient monitoring system 100 uses some or all of the velocity-based blood pressure measurement techniques described in U.S. Patent No. 5,590,649, filed April 15, 1994, titled "Apparatus and Method for Measuring an Induced Perturbation to Determine Blood Pressure," or in U.S. Patent No. 5,785,659, filed Jan 17, 1996, titled "Automatically Activated Blood Pressure Measurement Device," the disclosures of which are hereby incorporated by reference in their entirety. An example display related to such blood pressure calculations is described below with respect to FIGURE 7.

The wireless transceiver 116 can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like. The wireless transceiver 116 can perform solely telemetry functions, such as measuring and reporting information about the patient 101. Alternatively, the wireless transceiver 116 can be a transceiver that also receives data and/or instructions, as will be described in further detail below.

The wireless receiver 120 receives information from and/or sends information to the wireless transceiver via an antenna 122. In certain embodiments, the wireless receiver 120 is

process sensor signals received from the wireless transceiver 116 corresponding to the sensors 102a, 102b, 104, and/or 106 in order to derive any of the physiological parameters described above. The wireless transceiver 120 can also display any of these parameters, including trends, waveforms, related alarms, and the like. The wireless receiver 120 can further include a computer-readable storage medium, such as a physical storage device, for storing the physiological data. The wireless transceiver 120 can also include a network interface for communicating the physiological data to one or more hosts over a network, such as to a nurse's station computer in a hospital network.

Moreover, in certain embodiments, the wireless transceiver 116 can send raw data for processing to a central nurse's station computer, to a clinician device, and/or to a bedside device (e.g., the receiver 116). The wireless transceiver 116 can also send raw data to a central nurse's station computer, clinician device, and/or to a bedside device for calculation, which retransmits calculated measurements back to the blood pressure device 110 (or to the bedside device). The wireless transceiver 116 can also calculate measurements from the raw data and send the measurements to a central nurse's station computer, to a pager or other clinician device, or to a bedside device (e.g., the receiver 116). Many other configurations of data transmission are possible.

In addition to deriving any of the parameters mentioned above from the data obtained from the sensors 102a, 102b, 104, and/or 106, the wireless transceiver 120 can also determine various measures of data confidence, such as the data confidence indicators described in U.S. Patent No. 7,024,233 entitled "Pulse oximetry data confidence indicator," the disclosure of which is hereby incorporated by reference in its entirety. The wireless transceiver 120 can also determine a perfusion index, such as the perfusion index described in U.S. Patent No. 7,292,883 entitled "Physiological assessment system," the disclosure of which is hereby incorporated by reference in its entirety. Moreover, the wireless transceiver 120 can determine a plethysmograph variability index (PVI), such as the PVI described in U.S. Publication No. 2008/0188760 entitled "Plethysmograph variability processor," the disclosure of which is hereby incorporated by reference in its entirety.

transceiver 116 in some embodiments. For instance, the wireless transceiver 120 can intelligently determine when to inflate the cuff 112 and can send inflation signals to the transceiver 116. Similarly, the wireless transceiver 120 can remotely control any other sensors that can be attached to the transceiver 116 or the cuff 112. The transceiver 120 can send software or firmware updates to the transceiver 116. Moreover, the transceiver 120 (or the transceiver 116) can adjust the amount of signal data transmitted by the transceiver 116 based at least in part on the acuity of the patient, using, for example, any of the techniques described in U.S. Patent Publication No. 2009/0119330, filed Jan 7, 2009, titled "Systems and Methods for Storing, Analyzing, and Retrieving Medical Data," the disclosure of which is hereby incorporated by reference in its entirety.

In alternative embodiments, the wireless transceiver 116 can perform some or all of the patient monitor functions described above, instead of or in addition to the monitoring functions described above with respect to the wireless transceiver 120. In some cases, the wireless transceiver 116 might also include a display that outputs data reflecting any of the parameters described above (see, e.g., FIGURE 5). Thus, the wireless transceiver 116 can either send raw signal data to be processed by the wireless transceiver 120, can send processed signal data to be displayed and/or passed on by the wireless transceiver 120, or can perform some combination of the above. Moreover, in some implementations, the wireless transceiver 116 can perform at least some front-end processing of the data, such as bandpass filtering, analog-to-digital conversion, and/or signal conditioning, prior to sending the data to the transceiver 120. An alternative embodiment may include at least some front end processing embedded in any of the sensors described herein (such as sensors 102, 104, 204, 202, 208, 412, 804, 840, 808) or cable hub 806 (see FIGURE 8).

In certain embodiments, the cuff 112 is a reusable, disposable, or resposable device. Similarly, any of the sensors 102, 104a or cables 105, 107 can be disposable or resposable. Resposable devices can include devices that are partially disposable and partially reusable. Thus, for example, the acoustic sensor 104a can include reusable electronics but a disposable contact surface (such as an adhesive) where the sensor 104a comes into contact with the

reusable, disposable, or resposable.

The cuff 112 can also can have its own power (e.g., via batteries) either as extra power or as a sole source of power for the transceiver 116. The batteries can be disposable or reusable. In some embodiments, the cuff 112 can include one or more photovoltaic solar cells or other power sources. Likewise, batteries, solar sources, or other power sources can be provided for either of the sensors 102, 104a.

Referring to FIGURE 1B, another embodiment of the system 100B is shown. In the system 100B, the blood pressure device 110b can communicate wirelessly with the acoustic sensor 104a and with the optical sensor 102. For instance, wireless transceivers (not shown) can be provided in one or both of the sensors 102, 104a, using any of the wireless technologies described above. The wireless transceivers can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like. The wireless transceivers can transmit data, raw signals, processed signals, conditioned signals, or the like to the blood pressure device 110b. The blood pressure device 110b can transmit these signals on to the wireless transceiver 120. In addition, in some embodiments, the blood pressure device 110b can also process the signals received from the sensors 102, 104a prior to transmitting the signals to the wireless transceiver 120. The sensors 102, 104a can also transmit data, raw signals, processed signals, conditioned signals, or the like directly to the wireless transceiver 120 or patient monitor. In one embodiment, the system 100B shown can be considered to be a body LAN, piconet, or other individual network.

FIGURES 1C and 1D illustrate another embodiment in which a wireless monitor 150 is secured to the arm of the patient. The wireless monitor 150 is a fully functional stand-alone monitor capable of various physiological measurements. The wireless monitor is small and light enough to comfortably be secured to and carried around on the arm of a patient. In the embodiment shown in FIGURE 1C, the wireless monitor 150 connects to an acoustic respiration sensor 104A on a first side of patient monitor 150 and an oximeter sensor 102 on a second side of patient monitor 150. This configuration of connected sensors to opposite

includes a screen 154. The wireless monitor 150 couples to and is held to the arm of the patient by arm band 152. In FIGURE 1C, the arm band is not an inflatable blood pressure cuff, however, as described with respect to the other figures, the arm band 152 can incorporate a blood pressure cuff for blood pressure readings.

The wireless monitor 150 can transmit data to a bedside monitor using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

In an embodiment shown in FIGURE 1D, the monitor 150 can be docked to a docking station 163. The docking station 163 includes a bedside monitor 164 and docking station adapter 160. Docking station adapter 160 adapts an otherwise incompatible docking port of bedside monitor 164 so that patient monitor 150 can dock. The docking station adapter 162 includes a port 162 for docking with the patient monitor 150. When the patient monitor 150 is physically docked in the docking station adapter 160, the patient monitor 150 can communicate with the bedside monitor 164 over a wired connection.

Also shown in FIGURE 1D is handheld patient monitor 166. Handheld monitor 166 is configured to dock directly to bedside monitor 164 without the need for a docking station adapter 162. When the handheld monitor 166 is physically docked in the bedside monitor 164, the handheld monitor 166 can communicate with the bedside monitor 164 over a wired connection.

FIGURE 1E illustrates details of an embodiment of the wireless monitoring system 100A in a schematic form. Although other types of sensors can be used, the wireless monitoring system 100A is drawn in connection with the acoustic sensor 104a and the optical sensor 102. The system 100A sends signals from the acoustic sensor 104a and the optical sensor 102 to the sensor interface 170 and passes the signals to the DSP 172 for processing into representations of physiological parameters. In some embodiments, the DSP also communicates with a memory or information element, such as a resistor or capacitor, located on one of the sensors, such memory typically contains information related to the properties of

wavelengths.

In some embodiments, the physiological parameters are passed to an instrument manager 174, which may further process the parameters for display. The instrument manager 174 may include a memory buffer 176 to maintain this data for processing throughout a period of time. Memory buffer 176 may include RAM, Flash or other solid state memory, magnetic or optical disk-based memories, combinations of the same or the like.

The wireless transceiver 120 is capable of wirelessly receiving the physiological data and/or parameters from DSP 172 or instrument manager 174. The bedside monitor 916 can include one or more displays 178, control buttons, a speaker for audio messages, and/or a wireless signal broadcaster. The wireless transceiver 120 can also include a processor 180 to further process the data and/or parameters for display.

FIGURES 2A and 2B illustrate additional embodiments of patient monitoring systems 200A and 200B, respectively. In particular, FIGURE 2A illustrates a wireless patient monitoring system 200A, while FIGURE 2B illustrates a standalone patient monitoring system 200B.

Referring specifically to FIGURE 2A, a blood pressure device 210a is connected to a patient 201. The blood pressure device 210a includes a wireless transceiver 216a, which can transmit sensor data obtained from the patient 201 to a wireless receiver at 220 via antenna 218. The wireless transceiver 216a can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

In the depicted embodiment, the blood pressure device 210a includes an inflatable cuff 212a, which can include any of the features of the cuff 112 described above. Additionally, the cuff 212a includes a pocket 214, which holds the wireless transceiver 216a (shown by dashed lines). The wireless transceiver 216a can be electrically connected to the cuff 212a via a connector (see, e.g., FIGURE 5) in some embodiments. As will be described elsewhere herein, the form of attachment of the wireless transceiver 216a to the cuff 212a is not restricted to a pocket connection mechanism and can vary in other implementations.

including an acoustic sensor 204a and/or an optical ear sensor 202a. The acoustic sensor 204a can have any of the features of the acoustic sensor 104 described above. The ear clip sensor 202a can be an optical sensor that obtains physiological information regarding one or more blood parameters of the patient 201. These parameters can include any of the blood-related parameters described above with respect to the optical sensor 102. In one embodiment, the ear clip sensor 202a is an LNOP TC-I ear reusable sensor available from Masimo® Corporation of Irvine, CA. In some embodiments, the ear clip sensor 202a is a concha ear sensor (see FIGURES 4A and 4B).

Advantageously, in the depicted embodiment, the sensors 202a, 204a are coupled to the wireless transceiver 216a via a single cable 205. The cable 205 is shown having two sections, a cable 205a and a cable 205b. For example, the wireless transceiver 216a is coupled to an acoustic sensor 204a via the cable 205b. In turn, the acoustic sensor 204a is coupled to the optical ear sensor 202a via the cable 205a. Advantageously, because the sensors 202a, 204a are attached to the wireless transceiver 216 in the cuff 212 in the depicted embodiment, the cable 205 is relatively short and can thereby increase the patient's 201 freedom of movement. Moreover, because a single cable 205 is used to connect two or more different types of sensors, such as sensors 202a, 204a, the patient's mobility and comfort can be further enhanced.

In some embodiments, the cable 205 is a shared cable 205 that is shared by the optical ear sensor 202a and the acoustic sensor 204a. The shared cable 205 can share power and ground lines for each of the sensors 202a, 204a. Signal lines in the cable 205 can convey signals from the sensors 202a, 204a to the wireless transceiver 216 and/or instructions from the wireless transceiver 216 to the sensors 202a, 204a. The signal lines can be separate within the cable 205 for the different sensors 202a, 204a. Alternatively, the signal lines can be shared as well, forming an electrical bus.

The two cables 205a, 205a can be part of a single cable or can be separate cables 205a, 205b. As a single cable 205, in one embodiment, the cable 205a, 205b can connect to the acoustic sensor 204a via a single connector. As separate cables, in one embodiment, the

be coupled to a second port on the acoustic sensor 204a.

FIGURE 2B further illustrates an embodiment of the cable 205 in the context of a standalone patient monitoring system 200B. In the standalone patient monitoring system 200B, a blood pressure device 210b is provided that includes a patient monitor 216b disposed on a cuff 212b. The patient monitor 216b includes a display 219 for outputting physiological parameter measurements, trends, waveforms, patient data, and optionally other data for presentation to a clinician. The display 219 can be an LCD display, for example, with a touch screen or the like. The patient monitor 216b can act as a standalone device, not needing to communicate with other devices to process and measure physiological parameters. In some embodiments, the patient monitor 216b can also include any of the wireless functionality described above. For example, the patient monitor 216b can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

The patient monitor 216b can be integrated into the cuff 212b or can be detachable from the cuff 212b. In one embodiment, the patient monitor 216b can be a readily available mobile computing device with a patient monitoring software application. For example, the patient monitor 216b can be a smart phone, personal digital assistant (PDA), or other wireless device. The patient monitoring software application on the device can perform any of a variety of functions, such as calculating physiological parameters, displaying physiological data, documenting physiological data, and/or wirelessly transmitting physiological data (including measurements or uncalculated raw sensor data) via email, text message (e.g., SMS or MMS), or some other communication medium. Moreover, any of the wireless transceivers or patient monitors described herein can be substituted with such a mobile computing device.

In the depicted embodiment, the patient monitor 216b is connected to three different types of sensors. An optical sensor 202b, coupled to a patient's 201 finger, is connected to the patient monitor 216b via a cable 207. In addition, an acoustic sensor 204b and an electrocardiograph (ECG) sensor 206 are attached to the patient monitor 206b via the cable 205. The optical sensor 202b can perform any of the optical sensor functions described

described above. The ECG sensor 206 can be used to monitor electrical activity of the patient's 201 heart.

Advantageously, in the depicted embodiment, the ECG sensor 206 is a bundle sensor that includes one or more ECG leads 208 in a single package. For example, the ECG sensor 206 can include one, two, or three or more leads. One or more of the leads 208 can be an active lead or leads, while another lead 208 can be a reference lead. Other configurations are possible with additional leads within the same package or at different points on the patient's body. Using a bundle ECG sensor 206 can advantageously enable a single cable connection via the cable 205 to the cuff 212b. Similarly, an acoustical sensor can be included in the ECG sensor 206 to advantageously reduce the overall complexity of the on-body assembly.

The cable 205a in FIGURE 2B can connect two sensors to the cuff 212b, namely the ECG sensor 206 and the acoustic sensor 204b. Although not shown, the cable 205a can further connect an optical ear sensor to the acoustic sensor 204b in some embodiments, optionally replacing the finger optical sensor 202b. The cable 205a shown in FIGURE 2B can have all the features described above with respect to cable 205a of FIGURE 2A.

Although not shown, in some embodiments, any of the sensors, cuffs, wireless sensors, or patient monitors described herein can include one or more accelerometers or other motion measurement devices (such as gyroscopes). For example, in FIGURE 2B, one or more of the acoustic sensor 204b, the ECG sensor 206, the cuff 212b, the patient monitor 216b, and/or the optical sensor 202b can include one or more motion measurement devices. A motion measurement device can be used by a processor (such as in the patient monitor 216b or other device) to determine motion and/or position of a patient. For example, a motion measurement device can be used to determine whether a patient is sitting up, lying down, walking, or the like.

Movement and/or position data obtained from a motion measurement device can be used to adjust a parameter calculation algorithm to compensate for the patient's motion. For example, a parameter measurement algorithm that compensates for motion can more aggressively compensate for motion in response to high degree of measured movement. When less motion is detected, the algorithm can compensate less aggressively. Movement

measurements. Blood pressure, for instance, can change during patient motion due to changes in blood flow. If the patient is detected to be moving, the patient's calculated blood pressure (or other parameter) can therefore be adjusted differently than when the patient is detected to be sitting.

A database can be assembled that includes movement and parameter data (raw or measured parameters) for one or more patients over time. The database can be analyzed by a processor to detect trends that can be used to perform parameter calculation adjustments based on motion or position. Many other variations and uses of the motion and/or position data are possible.

Although the patient monitoring systems described herein, including the systems 100A, 100B, 200A, and 200B have been described in the context of blood pressure cuffs, blood pressure need not be measured in some embodiments. For example, the cuff can be a holder for the patient monitoring devices and/or wireless transceivers and not include any blood pressure measuring functionality. Further, the patient monitoring devices and/or wireless transceivers shown need not be coupled to the patient via a cuff, but can be coupled to the patient at any other location, including not at all. For example, the devices can be coupled to the patient's belt (see FIGURES 3A and 3B), can be carried by the patient (e.g., via a shoulder strap or handle), or can be placed on the patient's bed next to the patient, among other possible locations.

Additionally, various features shown in FIGURES 2A and 2B can be changed or omitted. For instance, the wireless transceiver 216 can be attached to the cuff 212 without the use of the pocket 214. For example, the wireless transceiver can be sewn, glued, buttoned or otherwise attached to the cuff using any various known attachment mechanisms. Or, the wireless transceiver 216 can be directly coupled to the patient (e.g., via an armband) and the cuff 212 can be omitted entirely. Instead of a cuff, the wireless transceiver 216 can be coupled to a non-occlusive blood pressure device. Many other configurations are possible.

FIGURES 3A and 3B illustrate further embodiments of a patient monitoring system 300A, 300B having a single cable connecting multiple sensors. FIGURE 3A depicts a tethered patient monitoring system 300A, while FIGURE 3B depicts a wireless patient

embodiments where a single cable 305 can be used to connect multiple sensors, without using a blood pressure cuff.

Referring to FIGURE 3A, the acoustic and ECG sensors 204b, 206 of FIGURE 2 are again shown coupled to the patient 201. As above, these sensors 204b, 206 are coupled together via a cable 205. However, the cable 250 is coupled to a junction device 230a instead of to a blood pressure cuff. In addition, the optical sensor 202b is coupled to the patient 201 and to the junction device 230a via a cable 207. The junction device 230a can anchor the cable 205b to the patient 201 (such as via the patient's belt) and pass through any signals received from the sensors 202b, 204b, 206 to a patient monitor 240 via a single cable 232.

In some embodiments, however, the junction device 230a can include at least some front-end signal processing circuitry. In some embodiments, the junction device 230a also includes a processor for processing physiological parameter measurements. Further, the junction device 230a can include all the features of the patient monitor 216b in some embodiments, such as providing a display that outputs parameters measured from data obtained by the sensors 202b, 204b, 206.

In the depicted embodiment, the patient monitor 240 is connected to a medical stand 250. The patient monitor 240 includes parameter measuring modules 242, one of which is connected to the junction device 230a via the cable 232. The patient monitor 240 further includes a display 246. The display 246 is a user-rotatable display in the depicted embodiment.

Referring to FIGURE 3B, the patient monitoring system 300B includes nearly identical features to the patient monitoring system 300A. However, the junction device 230b includes wireless capability, enabling the junction device 230b to wirelessly communicate with the patient monitor 240 and/or other devices. The wireless patient monitoring system 300B can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

FIGURES 4A and 4B illustrate embodiments of patient monitoring systems 400A, 400B that depict alternative cable connection systems 410 for connecting sensors to a patient

advantageously enhance patient mobility and comfort.

Referring to FIGURE 4A, the patient monitoring system 400A includes a patient monitor 402a that measures physiological parameters based on signals obtained from sensors 412, 420 coupled to a patient. These sensors include an optical ear sensor 412 and an acoustic sensor 420 in the embodiment shown. The optical ear sensor 412 can include any of the features of the optical sensors described above. Likewise, the acoustic sensor 420 can include any of the features of the acoustic sensors described above.

The optical ear sensor 412 can be shaped to conform to the cartilaginous structures of the ear, such that the cartilaginous structures can provide additional support to the sensor 412, providing a more secure connection. This connection can be particularly beneficial for monitoring during pre-hospital and emergency use where the patient can move or be moved. In some embodiments, the optical ear sensor 412 can have any of the features described in U.S. Application No. 12/658,872, filed February 16, 2010, entitled "Ear Sensor," the disclosure of which is hereby incorporated by reference in its entirety.

An instrument cable 450 connects the patient monitor 402a to the cable connection system 410. The cable connection system 410 includes a sensor cable 440 connected to the instrument cable 250. The sensor cable 440 is bifurcated into two cable sections 416, 422, which connect to the individual sensors 412, 420 respectively. An anchor 430a connects the sensor cable 440 and cable sections 416, 422. The anchor 430a can include an adhesive for anchoring the cable connection system 410 to the patient, so as to reduce noise from cable movement or the like. Advantageously, the cable connection system 410 can reduce the number and size of cables connecting the patient to a patient monitor 402a. The cable connection system 410 can also be used to connect with any of the other sensors, patient-worn monitors, or wireless devices described above.

FIGURE 4B illustrates the patient monitoring system 400B, which includes many of the features of the monitoring system 400A. For example, an optical ear sensor 412 and an acoustic sensor 420 are coupled to the patient. Likewise, the cable connection system 410 is shown, including the cable sections 416, 422 coupled to an anchor 430b. In the depicted embodiment, the cable connection system 410 communicates wirelessly with a patient

wireless dongle or other device (not shown) can couple to the anchor 430b. The anchor 430b can be connected to a blood pressure cuff, wireless transceiver, junction device, or other device in some embodiments. The wireless transceiver, wireless dongle, or other device can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

FIGURE 5 illustrates a more detailed embodiment of a wireless transceiver 516. The wireless transceiver 516 can have all of the features of the wireless transceiver 516 described above. For example, the wireless transceiver 516 can connect to a blood pressure cuff and to one or more physiological sensors, and the transceiver 516 can transmit sensor data to a wireless receiver. The wireless transceiver 516 can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

The depicted embodiment of the transceiver 516 includes a housing 530, which includes connectors 552 for sensor cables (e.g., for optical, acoustic, ECG, and/or other sensors) and a connector 560 for attachment to a blood pressure cuff or other patient-wearable device. The transceiver 516 further includes an antenna 518, which although shown as an external antenna, can be internal in some implementations.

The transceiver 516 can include one or more connectors on one or more sides of the housing 530. Providing connectors on different sides of the housing 530 allows for convenient sensor connection and prevents the sensor cables from tangling. For example, as shown in FIGURE 5, the housing can include two connectors 552 on a first side of the housing 530 and an additional connector 560 on a second side of the housing 530.

In addition, the transceiver 516 includes a display 554 that depicts values of various parameters, such as systolic and diastolic blood pressure, SpO₂, and respiratory rate (RR). The display 554 can also display trends, alarms, and the like. The transceiver 516 can be implemented with the display 554 in embodiments where the transceiver 516 also acts as a

manipulate settings and functions of the transceiver 516.

FIGURES 6A through 6C illustrate embodiments of wireless patient monitoring systems 600. These wireless patient monitoring systems can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

FIGURE 6A illustrates a patient monitoring system 600A that includes a wireless transceiver 616, which can include the features of any of the transceivers 216, 216 described above. The transceiver 616 provides a wireless signal over a wireless link 612 to a patient monitor 620. The wireless signal can include physiological information obtained from one or more sensors, physiological information that has been front-end processed by the transceiver 616, or the like.

The patient monitor 620 can act as the wireless receiver 220 of FIGURE 2. The patient monitor 620 can process the wireless signal received from the transceiver 616 to obtain values, waveforms, and the like for one or more physiological parameters. The patient monitor 620 can perform any of the patient monitoring functions described above with respect to FIGURES 2 through 5.

In addition, the patient monitor 620 can provide at least some of the physiological information received from the transceiver 616 to a multi-patient monitoring system (MMS) 640 over a network 630. The MMS 640 can include one or more physical computing devices, such as servers, having hardware and/or software for providing the physiological information to other devices in the network 630. For example, the MMS 640 can use standardized protocols (such as TCP/IP) or proprietary protocols to communicate the physiological information to one or more nurses' station computers (not shown) and/or clinician devices (not shown) via the network 630. In one embodiment, the MMS 640 can include some or all the features of the MMS described in U.S. Publication No. 2008/0188760, referred to above.

The network 630 can be a LAN or WAN, wireless LAN ("WLAN"), or other type of network used in any hospital, nursing home, patient care center, or other clinical location. In

clinical locations, which can be remote from one another, through the Internet, one or more Intranets, a leased line, or the like. Thus, the MMS 640 can advantageously distribute the physiological information to a variety of devices that are geographically co-located or geographically separated.

FIGURE 6B illustrates another embodiment of a patient monitoring system 600B, where the transceiver 616 transmits physiological information to a base station 624 via the wireless link 612. In this embodiment, the transceiver 616 can perform the functions of a patient monitor, such as any of the patient monitor functions described above. The transceiver 616 can provide processed sensor signals to the base station 624, which forwards the information on to the MMS 640 over the network 630.

FIGURE 6C illustrates yet another embodiment of a patient monitoring system 600B, where the transceiver 616 transmits physiological information directly to the MMS 640. The MMS 640 can include wireless receiver functionality, for example. Thus, the embodiments shown in FIGURES 6A through 6C illustrate that the transceiver 616 can communicate with a variety of different types of devices.

FIGURE 7 illustrates an embodiment of a physiological parameter display 700. The physiological parameter display 700 can be output by any of the systems described above. For instance, the physiological parameter display 700 can be output by any of the wireless receivers, transceivers, or patient monitors described above. The parameter display 700 can be output over a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like. Advantageously, in certain embodiments, the physiological parameter display 700 can display multiple parameters, including noninvasive blood pressure (NIBP) obtained using both oscillometric and non-oscillometric techniques.

The physiological parameter display 700 can display any of the physiological parameters described above, to name a few. In the depicted embodiment, the physiological parameter display 700 is shown displaying oxygen saturation 702, heart rate 704, and

pressure 708, including systolic and diastolic blood pressure.

The display 700 further shows a plot 710 of continuous or substantially continuous blood pressure values measured over time. The plot 710 includes a trace 712a for systolic pressure and a trace 712b for diastolic pressure. The traces 712a, 712b can be generated using a variety of devices and techniques. For instance, the traces 712a, 712b can be generated using any of the velocity-based continuous blood pressure measurement techniques described above and described in further detail in U.S. Patent Nos. 5,590,649 and 5,785,659, referred to above.

Periodically, oscillometric blood pressure measurements (sometimes referred to as Gold Standard NIBP) can be taken, using any of the cuffs described above. These measurements are shown by markers 714 on the plot 710. By way of illustration, the markers 714 are "X's" in the depicted embodiment, but the type of marker 714 used can be different in other implementations. In certain embodiments, oscillometric blood pressure measurements are taken at predefined intervals, resulting in the measurements shown by the markers 714.

In addition to or instead of taking these measurements at intervals, oscillometric blood pressure measurements can be triggered using ICI techniques, e.g., based at least partly on an analysis of the noninvasive blood pressure measurements indicated by the traces 712a, 712b. Advantageously, by showing both types of noninvasive blood pressure measurements in the plot 710, the display 700 can provide a clinician with continuous and oscillometric blood pressure information.

FIGURE 8 illustrates another embodiment of a patient monitoring system 800. The features of the patient monitoring system 800 can be combined with any of the features of the systems described above. Likewise, any of the features described above can be incorporated into the patient monitoring system 800. Advantageously, in the depicted embodiment, the patient monitoring system 800 includes a cable hub 806 that enables one or many sensors to be selectively connected and disconnected to the cable hub 806.

Like the patient monitoring systems described above, the monitoring system 800 includes a cuff 810 with a patient device 816 for providing physiological information to a

blood pressure cuff or merely a holder for the patient device 816. The patient device 816 can instead be a wireless transceiver having all the features of the wireless devices described above. The wireless transceiver can transmit data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

The patient device 816 is in coupled with an optical finger sensor 802 via cable 807. Further, the patient device 816 is coupled with the cable hub 806 via a cable 805a. The cable hub 806 can be selectively connected to one or more sensors. In the depicted embodiment, example sensors shown coupled to the cable hub 806 include an ECG sensor 808a and a brain sensor 840. The ECG sensor 808a can be single-lead or multi-lead sensor. The brain sensor 840 can be an electroencephalography (EEG) sensor and/or an optical sensor. An example of EEG sensor that can be used as the brain sensor 840 is the SEDLine™ sensor available from Masimo® Corporation of Irvine, CA, which can be used for depth-of-anesthesia monitoring among other uses. Optical brain sensors can perform spectrophotometric measurements using, for example, reflectance pulse oximetry. The brain sensor 840 can incorporate both an EEG/depth-of-anesthesia sensor and an optical sensor for cerebral oximetry.

The ECG sensor 808a is coupled to an acoustic sensor 804 and one or more additional ECG leads 808b. For illustrative purposes, four additional leads 808b are shown, for a 5-lead ECG configuration. In some embodiments, one or two additional leads 808b are used instead of four additional leads . In some embodiments, up to at least 12 leads 808b can be included. Acoustic sensors can also be disposed in the ECG sensor 808a and/or lead(s) 808b or on other locations of the body, such as over a patient's stomach (e.g., to detect bowel sounds, thereby verifying patient's digestive health, for example, in preparation for discharge from a hospital). Further, in some embodiments, the acoustic sensor 804 can connect directly to the cable hub 806 instead of to the ECG sensor 808a.

As mentioned above, the cable hub 806 can enable one or many sensors to be selectively connected and disconnected to the cable hub 806. This configurability aspect of the cable hub 806 can allow different sensors to be attached or removed from a patient based

a single, light-weight cable 832 couples to the monitor 820 in certain embodiments, or wireless technology can be used to communicate with the monitor 820 (see, e.g., FIGURE 1). A patient's monitoring needs can change as the patient is moved from one area of a care facility to another, such as from an operating room or intensive care unit to a general floor. The cable configuration shown, including the cable hub 806, can allow the patient to be disconnected from a single cable to the monitor 820 and easily moved to another room, where a new monitor can be coupled to the patient. Of course, the monitor 820 may move with the patient from room to room, but the single cable connection 832 rather than several can facilitate easier patient transport.

Further, in some embodiments, the cuff 810 and/or patient device 816 need not be included, but the cable hub 806 can instead connect directly to the monitor wirelessly or via a cable. Additionally, the cable hub 806 or the patient device 816 may include electronics for front-end processing, digitizing, or signal processing for one or more sensors. Placing front-end signal conditioning and/or analog-to-digital conversion circuitry in one or more of these devices can make it possible to send continuous waveforms wirelessly and/or allow for a small, more user-friendly wire (and hence cable 832) routing to the monitor 820.

The cable hub 806 can also be attached to the patient via an adhesive, allowing the cable hub 806 to become a wearable component. Together, the various sensors, cables, and cable hub 806 shown can be a complete body-worn patient monitoring system. The body-worn patient monitoring system can communicate with a patient monitor 820 as shown, which can be a tablet, handheld device, a hardware module, or a traditional monitor with a large display, to name a few possible devices.

FIGURES 9A-9D illustrate another embodiment of a wireless monitoring system 900 including a wireless monitor 902 coupled to a sensor 930. The wireless monitoring system 900 is configured to connect to one or more sensors and/or a bedside monitor. The features of the wireless monitoring system 900 can be combined with any of the features of the systems described above. Likewise, any of the features described above can be incorporated into the patient monitoring system 900. The wireless monitor 902 includes a removable battery 904 having a data storage component. The removable battery 904 can be used to pair

904 is positioned on the front side of the wireless monitor 902, so the battery 904 can be replaced without disconnecting a wireless monitor housing from the patient. Further details of these drawings are described below.

FIGURE 10 illustrates details of an embodiment of the wireless monitoring system 900 in a schematic form. Typically, the sensor 930 includes energy emitters 1016 located on one side of a patient monitoring site 1018 and one or more detectors 1020 located generally opposite. The patient monitoring site 1018 is usually a patient's finger (as pictured), toe, ear lobe, or the like. Energy emitters 1016, such as LEDs, emit particular wavelengths of energy through the flesh of a patient at the monitoring site 1018, which attenuates the energy. The detector(s) 1020 then detect the attenuated energy and send representative signals to the wireless monitor 902.

The wireless monitor 902 can include a sensor interface 1024 and a digital signal processor (DSP) 1026. The sensor interface 1024 receives the signals from the sensor 930 detector(s) 1020 and passes the signals to the DSP 1026 for processing into representations of physiological parameters. In some embodiments, the DSP 1026 also communicates with a memory or information element, such as a resistor or capacitor, 1030 located on the sensor 930, such memory typically contains information related to the properties of the sensor that may be useful in processing the signals, such as, for example, emitter 1016 energy wavelengths.

In some embodiments, the physiological parameters are passed to an instrument manager 1028, which may further process the parameters for display by a bedside monitor 916. The instrument manager 1028 may include a memory buffer 1034 to maintain this data for processing throughout a period of time. Memory buffer 1034 may include RAM, Flash or other solid state memory, magnetic or optical disk-based memories, combinations of the same or the like.

In some embodiments, the wireless monitor is able to display one or more physiological parameters. The wireless monitor 902 can include one or more displays 1036, control buttons 1040, one or more speakers 1038 for audio messages. Control buttons 1040 may comprise a keypad, a full keyboard, a touch screen, a track wheel, and the like.

battery 904 directly or indirectly powers the sensor interface 1024, DSP 1026, and the instrument manager 1028.

The battery 904 includes memory 932, such memory stores wireless communication information needed for the wireless monitor 902 to wirelessly communicate with bedside monitor 916. The battery 904 can communicate the information stored on the memory 932 to the wireless monitor 902 or bedside monitor 916, and the memory 932 can store information received from the wireless monitor 902 or bedside monitor 916.

The bedside monitor 916 wirelessly receives the physiological data and/or parameters from the wireless monitor 902 and is able to display one or more physiological parameters. The bedside monitor 916 can include one or more displays 1008, control buttons 1010, a speaker 1012 for audio messages, and/or a wireless signal broadcaster. Control buttons 1010 may comprise a keypad, a full keyboard, a track wheel, and the like.

As shown in FIGURE 10, the wireless monitor 902 can include an optional internal battery 905 capable of powering the wireless monitor 902 when the battery 904 is disconnected from the wireless monitor 902. The internal battery 905 can include additional backup memory 933 to store information when the battery 904 is disconnected from the wireless monitor 902. The internal battery 905 can be useful when a caregiver replaces the battery 904 with a different, fully-charged battery. While the battery 904 is disconnected from the wireless monitor 902, the wireless monitor 902 can continue to display and communicate information.

In several embodiments, the wireless patient monitoring system includes one or more sensors, including, but not limited to, a sensor 930 to monitor oxygen saturation and pulse rate. These physiological parameters can be measured using a pulse oximeter. In general, the sensor 930 has light emitting diodes that transmit optical radiation of red and infrared wavelengths into a tissue site and a detector that responds to the intensity of the optical radiation after absorption (e.g. by transmission or transreflectance) by pulsatile arterial blood flowing within the tissue site. Based on this response, a processor determines measurements for SpO₂, pulse rate, and can output representative plethsmographic waveforms. Thus, “pulse oximetry” as used herein encompasses its broad ordinary meaning known to one of

parameters of circulating blood through spectroscopy.

The wireless monitoring system 900 can include any of the sensors described herein in addition to or in alternative to the pulse oximeter. For example, the wireless monitoring system 900 can also include sensors for monitoring acoustics, sedation state, blood pressure, ECG, body temperature, and/or cardiac output. The wireless monitor may also include an accelerometer or gyroscope. The wireless patient monitoring system may include any of the above-mentioned sensors alone or in combination with each other.

In several embodiments, the wireless monitor 902 includes a wireless transmitter to transmit sensor data and/or a wireless receiver to receive data from another wireless transmitter or transceiver. By transmitting the sensor data wirelessly, the wireless monitor 902 can advantageously replace some or all cables that connect patients to bedside monitoring devices. Alternatively, the wireless monitor 902 calculates physiological parameters based on the sensor data and wirelessly transmits the physiological parameters and/or the sensor data itself to the bedside monitor. The physiological parameter can be numerical information, such as oxygen saturation (SpO₂) or pulse rate, or a graphical depiction of the sensor data. The data processors can be positioned in the wireless monitor housing or the battery. By configuring the wireless monitor 902 to calculate the physiological parameter, less data transfer is required to transmit information from the wireless monitor to the bedside monitor. Processing the sensor data in the wireless monitor 902 also improves the quality of the signal transferred to the bedside monitor.

As shown in FIGURES 9B-9C, the wireless monitor 902 includes a removable battery 904 and a base 906. The base 906 can include processing and wireless transmission capabilities and/or share processing function with the battery 904. Removable battery 904 includes a release mechanism 912 to release the battery 904 from the base 906. As depicted in FIGURE 9B, the base 906 can include a battery receiving portion 914 and a notch 917 to lock the removable battery 904 in place. Wireless monitor 902 can have one or more outlets 910 to plug in the sensor 930, such as the pulse oximeter, acoustic respiratory sensor, ECG, sedation sensor, blood pressure cuff, or any other sensor. In some embodiments, one or more outlets 910 can be positioned on one or more sides of the wireless monitor 902. For example,

an outlet on an opposite side for a pulse oximeter.

Wireless monitor 902 can include an opening 908 through which an arm band 934 can be passed to secure the wireless monitor 902 to the arm of the patient, as shown in FIGURE 9A. The arm band 934 can be reusable, disposable or resposable. Similarly, any of the sensors 930 can be disposable or resposable. Resposable devices can include devices that are partially disposable and partially reusable. Thus, for example, the acoustic sensor can include reusable electronics, but a disposable contact surface (such as an adhesive) where the sensor comes into contact with the patient's skin.

The sensors 930 and/or wireless monitor 902 need not be worn around the patient's arm, but can be worn at any other location, including not at all. The sensors 930 and/or wireless monitor 902 need not be coupled to an arm band, but can be coupled to a patient's belt or a chest strap, can be carried by the patient (e.g., via a shoulder strap or handle), or can be placed on the patient's bed next to the patient, among other locations.

FIGURE 9D illustrates the battery 904 docked with a bedside monitor 916. Bedside monitor 916 has a battery charging station 922 for receiving and charging removable battery 904. When the wireless monitor 902 is using a first battery, the battery charging station 922 can charge a second battery, so when the battery levels of the first battery are low, a second battery is readily available. Each battery is capable of powering the wireless monitor 902 for at least one nursing shift, so each nurse only has to replace the battery once either at the beginning or end of each shift.

An adapter 918 can be integrated with the bedside monitor or separately connected to bedside monitor 916. The bedside monitor 916 includes a release mechanism 926 to release the adaptor 918 from the bedside monitor 916. Adaptor 918 includes docking station 920 to receive the entire wireless monitor (not shown). Locking mechanism 924 holds the wireless monitor 902 in place. Other components may be connected to the bedside monitor 916 instead of the adaptor 918, such as a handheld patient monitor device.

In some embodiments, the adaptor 918 includes a docking station 920 to receive the entire wireless monitor 902. The wireless monitor 902 can be placed in the docking station 920 when it is not in use to prevent the wireless monitor 902 from being lost. The bedside

bedside monitor 916. In certain aspects, the bedside monitor 916 can communicate a password, unique identifier, appropriate channel information, or other wireless communication information to the wireless monitor 902, and vice versa, when the wireless monitor 902 is connected to the bedside monitor 916.

As shown in FIGURE 9D, the bedside monitor 916 is capable of simultaneously receiving a first battery and a wireless monitor 902 having a second battery. The bedside monitor 916 is configured to charge and sync both the first and second batteries. When the first battery and/or the wireless monitor 902 and second battery are physically docked in the bedside monitor 916, the first and/or second battery can communication with the bedside monitor 916 over a wired connection.

The bedside monitor 916 can include a display screen 928 for displaying the physiological parameters, including trends, waveforms, related alarms, and the like. In certain aspects, the bedside monitor 916 can display the appropriate channel for communication and/or whether the wireless monitor 902 is properly communicating with the bedside monitor 916.

The bedside monitor 916 can include a computer-readable storage medium, such as a physical storage device, for storing the physiological data. In certain aspects, the bedside monitor can include a network interface for communicating the physiological data to one or more hosts over a network, such as to a nurse's station computer in a hospital network.

The wireless monitor 902 can transmit data to the bedside monitor 916 using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth, ZigBee, cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like. The wireless monitor 902 can perform solely telemetry functions, such as measuring and reporting information about the patient.

The wireless monitor 902, or any of the wireless monitor embodiments discussed herein, can be configured to utilize different wireless technologies. In certain scenarios, it may be desirable to transmit data over Bluetooth or ZigBee, for example, when the distance between the wireless monitor 902 and the bedside monitor 916 is within range of Bluetooth or ZigBee communication. Transmitting data using Bluetooth or ZigBee is advantageous

scenarios, it may be desirable to transmit data using Wi-Fi or cellular telephony, for example, when the wireless monitor is out of range of communication for Bluetooth or ZigBee. A wireless monitor 902 may be able to transmit data over a greater distance using Wi-Fi or cellular telephony than other wireless technologies. In still other scenarios, it may be desirable to transmit data using a first wireless technology and automatically switch to a second wireless technology in order to maximize data transfer and energy efficiency.

In some embodiments, the wireless monitor 902 automatically transmits data over Bluetooth or ZigBee when the wireless monitor 902 is within a pre-determined distance from bedside monitor 916. The wireless transmitter 902 automatically transmits data over Wi-Fi or cellular telephony when the wireless monitor 902 is beyond a pre-determined distance away from the bedside monitor 916. In certain embodiments, the wireless monitor 902 can automatically convert from Bluetooth or ZigBee to Wi-Fi or cellular telephony, and vice versa, depending on the distance between the wireless monitor 902 and bedside monitor 916.

In some embodiments, the wireless monitor 902 automatically transmits data over Bluetooth or ZigBee when the Bluetooth or ZigBee signal strength is sufficiently strong or when there is interference with Wi-Fi or cellular telephony. The wireless monitor 902 automatically transmits data over Wi-Fi or cellular telephony when the Bluetooth or ZigBee signal strength is not sufficiently strong. In certain embodiments, the wireless monitor 902 can automatically convert from Bluetooth or ZigBee to Wi-Fi or cellular telephony, and vice versa, depending on signal strength.

Existing wireless bedside monitoring devices can be difficult to use because it can be difficult to pair the wireless device with the correct bedside monitor, making it difficult to switch wireless devices or switch bedside monitors. Some wireless systems require the care provider to program the wireless device to communicate with the correct patient monitor. Other wireless systems require a separate token or encryption key and several steps to pair the wireless device with the correct bedside monitors. Some systems require the token to be connected to the bedside monitor, then connected to the wireless device, and then reconnected to the bedside monitor.

between a wireless monitor 902 and a bedside monitor 916 without a separate token or encryption key. In some embodiments, the removable battery 904 includes a data storage component, such as memory 932, capable of storing wireless communication information. The battery 904 is configured to connect to both the wireless monitor 902 and the bedside monitor 916. Combining the battery 904 with a data storage component can decrease the total number of components and decrease the number of steps it takes to transfer wireless communication information between the wireless monitor 902 and bedside monitor 916 because a separate token or encryption key is not needed. This method of data transfer also eliminates user input errors arising from users having to program the wireless monitor 902 and/or bedside monitor 916 and allows for easy transfer of wireless communication information between the wireless monitor 902 and bedside monitor 916.

For security purposes, it may be desirable to use security tokens to ensure that the correct bedside monitor 916 receives the correct wirelessly transmitted data. Security tokens prevent the bedside monitor 916 from accessing the transmitted data unless wireless monitor 902 and bedside monitor 916 share the same password. The password may be a word, passphrase, or an array of randomly chosen bytes.

When the battery 904 is connected to the bedside monitor 916, the bedside monitor 916 can communicate a password to the battery 904, and the battery 904 stores the password on its data storage component. The battery 904 can communicate a password for the wireless monitor 902 to the bedside monitor 916. The battery 904 can then be disconnected from the bedside monitor 916 and connected to the wireless monitor 902. When the battery 904 is connected to the wireless monitor 902, the battery 904 can communicate the password to the wireless monitor 902. The wireless monitor 902 can then communicate wirelessly with the correct bedside monitor 916.

In some scenarios, it may be desirable to pair the wireless monitor 902 with the bedside monitor 916 to avoid interference from other wireless devices. When the removable battery 904 is connected to the bedside monitor 916, the bedside monitor 916 communicates a unique identifier to the battery 904, and the battery 904 stores the unique identifier on its data storage component. The battery 904 can communicate a unique identifier for the

from the bedside monitor 916 and connected to the wireless monitor 902. When the battery 904 is connected to the wireless monitor 902, the battery 904 can communicate the unique identifier to the wireless monitor 902, so that the wireless monitor 902 can transmit data to the correct bedside monitor 916.

In some scenarios, it is desirable for the wireless monitor 902 to be configured to transmit data over the correct channel. Channels provide a mechanism to avoid sources of wireless interference. When the removable battery 904 is connected to the bedside monitor 916, the bedside monitor 916 communicates the appropriate channel to the battery 904, and the battery 904 stores the channel information on its data storage component. If necessary, the battery 904 can communicate a wireless monitor channel the bedside monitor 916. The battery 904 is then disconnected from the bedside monitor 916 and connected to the wireless monitor 902. When the battery 904 is connected to the wireless monitor 902, the battery 904 can communicate the appropriate channel information to the wireless monitor 902, thereby ensuring the wireless monitor 902 transmits data over the correct channel.

The battery 904, or any battery embodiment described herein, can receive or communicate any one or combination of passwords, tokens, or channels as described above. The wireless communication information can include information to communicate over each protocol the wireless monitor 902 is configured to communicate over. For example, if the wireless monitor 902 is capable of communicating over Wi-Fi and Bluetooth, then the battery 904 is capable of receiving wireless communication information to communicate over both Wi-Fi and Bluetooth.

In some scenarios, the method in any of the above mentioned methodologies may be reversed. For example, in some embodiments, the battery 904 is initially connected to the wireless monitor 902. When the battery 904 is connected to the wireless monitor 902, the wireless monitor 902 can communicate wireless communication information identifying the wireless monitor 902 to the battery 904, and the battery 904 can store the information on its data storage component. The battery can communicate wireless communication information identifying the bedside monitor 916 to the wireless monitor 902. After the battery 904 is disconnected from the wireless monitor 902, the battery 904 is connected to the bedside

stored on the data storage component to the bedside monitor 916, such as a password, unique identifier, channel, or other data information.

FIGURE 11 illustrates an embodiment for using the wireless patient monitoring system that can be used in connection with any wireless patient monitoring system described herein. The operator connects the removable battery to the bedside monitor (block 1102) and the bedside monitor and the battery communicate wireless communication information with each other (block 1104). The operator then disconnects the battery from the bedside monitor (block 1106) and connects the battery to the wireless monitor (block 1108). The battery and the wireless monitor communicate wireless communication information with each other (block 1110). After the wireless monitor receives data from the one or more sensors (block 1112), the wireless monitor processes the sensor data into representations of physiological parameters (block 1114). The wireless monitor then wireless communicates the physiological parameters and/or the sensor data to the bedside monitor (block 1116).

In some embodiments, the data storage component of the battery 904 stores wireless communication information related to the wireless monitor 902. The wireless communication information can be a password, unique identifier, channel, etc. When the battery 904 is engaged with the bedside monitor 916, the bedside monitor 916 can communicate wireless communication information to the battery 904, and the battery 904 can communicate wireless communication information to the bedside monitor 916. The battery 904 is then disconnected from the bedside monitor 16 and connected to the wireless monitor 902. Since the battery 904 already communicated the wireless communication information to the bedside monitor 916, the battery 904 provides all remaining wireless communication information to the wireless monitor. The wireless monitor reconfigures itself according to the information on the battery and no further information is required to be communicated with the bedside monitor 916. This reduces the total number of steps necessary to pair the wireless monitor 902 with the correct bedside monitor 916.

FIGURE 12 illustrates another embodiment of the wireless patient monitor 1202. The features of the wireless patient monitor 1202 can be combined with any of the features of the

into the patient monitor 1202.

As shown in FIGURE 12, the wireless patient monitor 1202 can include a housing 1205 that removably engages a battery 1204. The monitor 1202 can include a release mechanism 1212 for releasing the battery 1204 from the housing 1206 and/or one or more outlets 1210 for engaging one or more sensors.

The wireless patient monitor 1202 can include a wireless transceiver capable of transmitting data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

As shown in FIGURE 12, the battery 1204 can include a display screen 1240. The display screen 1240 can indicate any number of parameters, including, but not limited to, physiological parameters, battery levels, and wireless signal strength. Positioning the display screen 1240 on the battery 1204 helps reduce the size of the housing.

The display screen 1240 can include a touch interface to permit a user to access different parameters or settings (e.g., display settings, connectivity settings, etc.). In certain aspects, the display screen 1240 can rotate depending on the orientation of the battery 1204.

To save energy, the display screen 1240 can selectively display certain parameters depending on the location of the battery 1204. For example, if the battery is connected to the bedside monitor or disconnected from the wireless monitor, the battery may only display battery levels. If the battery is connected to the wireless monitor, then the battery may display additional parameters other than battery levels.

The display screen 1240 can selectively display certain parameters depending on the distance between the wireless monitor 1202 and the bedside monitor 1216. Referring to FIGURE 13, if the wireless monitor 1202 is within a predetermined distance from the bedside monitor - (block 1300), then the display screen 1240 deactivates (block 1302). If the wireless monitor 1202 is not within a predetermined distance from the bedside monitor (block 1300), then the display screen 1240 initializes (block 1304). The display screen 1240 only needs to be active when the patient is not close to the bedside monitor.

type of wireless connection between the wireless monitor 1202 and the bedside monitor and/or hospital IT infrastructure. Referring to FIGURE 14, if the wireless monitor 1202 wirelessly communicates physiological parameters and/or sensor data over Bluetooth (block 1410), then the display screen deactivates (block 1412). If the wireless monitor 1202 wirelessly communicates physiological parameters and/or sensor data over Wi-Fi (block 1414), then the display screen 1240 initializes (block 1416).

The wireless monitor 1202 can selectively transmit information over different wireless connections and display certain parameters depending on the distance between the wireless monitor 1202 and the bedside monitor. Referring to FIGURE 15, if the wireless monitor 1202 is within a predetermined distance from the bedside monitor (block 1520), then the wireless monitor 1202 wirelessly communicates physiological parameters and/or sensor data to the bedside monitor over Bluetooth (block 1522). If the wireless monitor 1202 wirelessly communicates to the bedside monitor over Bluetooth (block 1522), then the display screen 1240 deactivates (block 1524). The display screen 1240 does not need to be active since the bedside monitor is nearby.

If the wireless monitor 1202 is not within a predetermined distance from the bedside monitor (block 1520), then the wireless monitor 1202 wirelessly communicates physiological parameters and/or sensor data to the bedside monitor over Wi-Fi (block 1526). If the wireless monitor 1202 wirelessly communicates to the bedside monitor over Wi-Fi (block 1526), then the display screen 1240 initializes (block 1528). If the wireless monitor 1202 is communicating over Wi-Fi, then it is more likely that the patient is not in the patient room. In that case, it is necessary to have a secondary display screen available to monitor the patient's physiological parameters.

Although FIGURES 14 and 15 were discussed in reference to Bluetooth and Wi-Fi, the system can wirelessly communication information over ZigBee or cellular telephony. Also, the system may convert from a first wireless technology (e.g., Bluetooth) to a second wireless technology (Wi-Fi) based on signal strength rather than distance.

The wireless monitor 1202 can help the hospital staff monitor the patient when the patient is not close to the bedside monitor. When the patient is close to the bedside monitor,

irregular by activating an audible alarm and/or by alerting a staff member using the hospital IT infrastructure. When the patient is more than a pre-determined distance from the bedside monitor, the wireless monitor 1202 can send the physiological parameters and/or sensor data directly over the hospital IT infrastructure, so the hospital staff can continuously monitor the patient at the nurse's station or any other location. If the patient exhibits any irregular physiological parameters, the wireless monitor 1202 can activate an audible alarm and/or alert a staff member using the hospital IT infrastructure. The wireless monitor 1202 can use triangulation to provide the location of the patient, so the staff member can quickly find the patient. By configuring the wireless monitor 1202 to process the sensor data, the wireless monitor 1202 is capable of communicating physiological parameters over the hospital IT infrastructure without the bedside monitor.

Any of the systems described herein can include a display screen and can be configured to carry out any of the methods described in FIGURES 13-15.

FIGURES 16A-F illustrate another embodiment of a wireless patient monitoring system. The features of the wireless patient monitoring system can be combined with any of the features of the systems described above. Likewise, any of the features described above can be incorporated into the wireless patient monitoring system.

FIGURE 16A illustrates the wireless monitor 1602 with the battery 1604 detached from the base 1606. The base 1606 can include processing and wireless transmission capabilities and/or share processing function with the battery 1604. The battery 1602 removably engages an anterior surface of the base 1606. The battery 1602 can engage the housing 1602 via a magnet, a clip, a band, a snap fit, a friction fit, or otherwise. The housing 1602 can include one or more outlets 1610 for engaging one or more sensors 1630. As shown in FIGURE 16A, the housing 1206 can include an outlet on one end of the housing and another outlet on the opposite end of the housing. Disposing outlets on opposite ends of the housing can be useful to prevent sensor cables from tangling.

The battery 1604 can include a display screen 1640 and a user input device 1644. The user input device can activate the screen, adjust display settings, select physiological parameters to display, and/or otherwise control the display screen 1640. As shown in

select a feature and/or swipe in different directions to change selections. For example, the user can swipe right or left to change the parameters displayed on the display screen. Other functions can also be performed using the three inputs of the touch pad – left swipe, right swipe, and tap. Other user input devices 1644 can include one or more buttons, switches, or other control. In certain aspects, the display screen can be the user input device.

FIGURE 16B illustrates a strap 1646 for securing the wireless monitor 1602 to the patient. The strap 1646 can include any fabric, elastic, or otherwise flexible material. In certain aspects, the strap 1646 can be waterproof. One or both ends of the strap 1646 can be tapered. One or both ends of the strap 1646 can include a covering to protect the strap ends.

The strap 1646 can be secured to the patient as an arm band, a shoulder strap, a belt, or in any other configuration. A portion of the strap 1646 can be secured to another portion of the strap 1646 using Velcro 1660, clasps, adhesive, snap-fits, or any other connector. The strap 1646 can include a band (not shown) for securing an excess portion of the strap 1646.

As shown in FIGURE 16B, the strap 1646 can include a connector 1650 for engaging the wireless monitor 1602 and an adjustment mechanism 1648 to adjust the length of the strap 1646 and/or secure any excess strap 1646. The connector 1650 can be an integral portion of the strap 1646 or a separately formed component secured to the strap 1646. As shown in FIGURE 16B, the connector 1650 can include an opening 1656 on opposite sides of the connector 1650 for securing either end of the strap 1646. One or both ends of the strap 1646 can be removably secured to the connector 1650.

In certain aspects, the connector 1650 engages the housing by being disposed between the base 1606 and the battery 1604. At least a portion of the connector 1650 can overlay a portion of the housing. The connector 1650 can include certain features to mate with a corresponding feature of the base 1606 and/or battery 1604. For example, the connector 1650 can include one or more recesses 1652 configured to mate with one or more protrusions 1658 on the base 1606. As shown in FIGURE 16C, the connector 1650 can include a recess 1652 on opposite ends of the connector 1650 that mate with protrusions 1658 on opposite ends of the base 1606. The connector 1650 can be flush with the protrusions 1658 to provide a flat surface for the battery 1604.

monitor. For example, as shown in Figure 12, the wireless monitor can include an opening 1208 for engaging the strap 1646. In still other aspects, the connector 1650 can engage the wireless monitor 1602 using clips, ties, buckles, buttons, or any other connector.

The wireless monitor 1602 can include a wireless transceiver capable of transmitting data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

FIGURES 16D-16F illustrate a bedside monitor 1616 configured to receive the wireless monitor 1602. The bedside monitor can include one or more input ports 1627 configured to receive cables. In certain aspects, the bedside monitor 1616 can include a port 1617 configured to receive a handheld device, such as the handheld monitor 166 shown in FIGURE 1D. Further details about the handheld device can be found in U.S. Application No. 13/651,167, filed October 12, 2012, entitled "Medical Monitoring Hub," which is hereby incorporated by reference in its entirety.

The port 1617 can removably engage an adapter 1618. For example, the adapter 1618 can include a release mechanism 1626 to release the adapter 1618 from the port 1617. In certain aspects, the release mechanism 1626 is studded, so a user must use one or more tools to release the release mechanism 1626.

The adapter 1618 can be configured to receive a battery 1604 and/or a wireless monitor 1602. The adapter 1618 can include a docking adaptor door 1620 configured to receive the stand alone battery 1604 and/or and a port for receiving a the wireless monitor 1602 including a battery 1604. In certain aspects, as shown in FIGURE 16F, the docking adaptor door 1620 can pivot to facilitate insertion and removal of the wireless monitor 1602. When the battery 1604 and/or wireless monitor 1602 having a battery 1604 is physically connected to the adapter 1618, the batteries 1606 can charge and can communicate and/or receive information from the bedside monitor 1616 over a wired connection.

FIGURES 17A-17C illustrate another embodiment of a wireless monitor 1702. The wireless monitor 1702 can include any of the other wireless monitor features described

include any of the features of the wireless monitor 1702.

The wireless monitor 1702 can include a battery 1704 removably engaged with a base 1706. The base 1706 can include processing and wireless transmission capabilities and/or share processing function with the battery 1704. FIGURE 17A illustrates an exploded view of the wireless monitor 1702. The housing can include one or more outlets 1710 configured to connect to one or more sensors (not shown). The battery can include a display 1740 capable of displaying physiological parameters, connectivity information, and/or other content. The battery 1704 can include a touch pad 1744 or other user input device. The touch pad 1744 can permit the user to swipe right, swipe left, or tap to control the wireless monitor 1702. The battery 1704 can include an additional user input device (e.g., button 1745) that can activate/deactivate the wireless monitor or provide other functionality.

The battery can include one or more protrusions, ribs, struts, detents, or the like configured to be received in corresponding grooves, notches, recesses, openings, or the like in the base 1706. FIGURE 17B illustrates views of an inner portion of the battery 1704 and an inner portion of the housing. The battery 1704 can include two protrusions 1741 on each end of the battery 1704 and along an inner portion of the battery 1704. One or more of the protrusions 1741 can be a different size or shape from the other protrusions 1741. The base 1706 can include two grooves 1743 on each end of the base 1706 and along an inner portion of the base 1706. Each of the grooves 1743 can be configured to receive one of the protrusions 1741. One or more of the grooves 1743 can be a different size or shape from the other grooves 1743. FIGURE 17C illustrates a perspective view of the battery 1704 engaged with the base 1706.

The wireless monitor 1702 can include a wireless transceiver capable of transmitting data using any of a variety of wireless technologies, such as Wi-Fi (802.11x), Bluetooth (802.15.2), Zigbee (802.15.4), cellular telephony, infrared, RFID, satellite transmission, proprietary protocols, combinations of the same, and the like.

As described above, any of the wireless monitoring systems described herein can include an accelerometer or gyroscope that can be used to detect one or more of patient orientation, patient movement, whether the patient is falling, or the like. In certain aspects,

patient is falling, getting out of bed, or otherwise moving in a prohibited manner. The alert can be an audible and/or visual alarm on the monitoring system or transmitted to a caregiver (e.g., nurses' station, pager, home computer, or otherwise).

In certain aspects, the information received by the accelerometer or gyroscope can be used to create an indication and/or animation of patient movement. This animation can be displayed on the patient monitor or transmitted to a nurses station or other off-site location to enable the care giver to monitor the patient. The animation can be viewed real time and/or be recorded for playback. For example, if an alarm alerts the care giver that the patient has fallen out of bed, the care giver can be presented playbacks of one or more of the patient's movement during that period of time.

FIGURES 18A-18C illustrate examples of the animation that can be displayed on a bedside monitor, nurses' station monitor, or other display screen. FIGURE 18A illustrates a patient lying in bed 1801, and the patient rolling over 1803. FIGURE 18B illustrates the patient lying in bed 1805, and the patient sitting up 1807. FIGURE 18C illustrates the patient lying in bed 1809, and the patient getting out of bed 1811. Other patient movements can also be illustrated, such as a patient falling, walking, or otherwise. Depending on the embodiment, certain acts, events, or functions of any of the methods described herein can be performed in a different sequence, can be added, merged, or left out altogether (e.g., not all described acts or events are necessary for the practice of the method). Moreover, in certain embodiments, acts or events can be performed concurrently, e.g., through multi-threaded processing, interrupt processing, or multiple processors, rather than sequentially.

The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein can be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. The described functionality can be implemented in varying ways for each particular application,

scope of the disclosure.

The various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein can be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor can be a microprocessor, but in the alternative, the processor can be any conventional processor, controller, microcontroller, or state machine. A processor can also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

The steps of a method or algorithm described in connection with the embodiments disclosed herein can be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module can reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium is coupled to the processor such the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium can be integral to the processor. The processor and the storage medium can reside in an ASIC. The ASIC can reside in a user terminal. In the alternative, the processor and the storage medium can reside as discrete components in a user terminal.

Conditional language used herein, such as, among others, "can," "may," "might," "could," "e.g.," and the like, unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while some embodiments do not include, certain features, elements and/or steps. Thus, such conditional language is not generally intended to imply that features, elements and/or steps are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without author input or prompting, whether

embodiment.

While the above detailed description has shown, described, and pointed out novel features as applied to various embodiments, it will be understood that various omissions, substitutions, and changes in the form and details of the device or process illustrated can be made without departing from the spirit of the disclosure. As will be recognized, certain embodiments of the inventions described herein can be embodied within a form that does not provide all of the features and benefits set forth herein, as some features can be used or practiced separately from others. The scope of the inventions is indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

1. A wireless patient monitoring system comprising:
one or more optical sensors configured to obtain physiological information;
and
a wireless monitor configured to receive the physiological information and to wirelessly transmit physiological data reflective of the physiological information to a bedside monitor,
wherein the wireless monitor comprises a removable battery, the removable battery including a data storage component.
2. The wireless patient monitoring system of Claim 1, wherein the data storage component is configured to store information communicated from the bedside monitor.
3. The wireless patient monitoring system of Claim 1, wherein the wireless monitor is configured to be coupled to an arm band attached to the patient.
4. The wireless patient monitoring system of Claim 1, wherein the bedside monitor is configured to receive the removable battery.
5. The wireless patient monitoring system of Claim 1, wherein the bedside monitor is configured to receive the wireless monitor.
6. The wireless patient monitoring device of Claim 1, wherein the wireless transmitter is configured to transmit physiological data over a first wireless technology when a signal strength of the first wireless technology is sufficiently strong and transmit physiological data over a second wireless technology when the signal strength of the first wireless technology is sufficiently weak.
7. The wireless patient monitoring device of Claim 1, wherein the wireless transmitter is configured to transmit physiological data over a first wireless technology when the wireless transmitter is within a pre-determined distance from the wireless receiver and transmit physiological data over a second wireless technology when the wireless transmitter is not within a pre-determined distance from the wireless receiver.
8. The wireless patient monitoring device of Claim 1, wherein the removable battery includes a display.

configured to activate when the wireless transmitter transmits physiological data over a first wireless technology and deactivate when the wireless transmitter transmits physiological data over a second wireless technology.

10. A method of wirelessly monitoring physiological information, the method comprising:

providing a battery including a data storage component;

connecting the battery to a bedside monitor;

transferring data from the bedside monitor to the data storage component;

connecting the battery to a wireless monitor;

obtaining physiological information from one or more optical sensors; and

transmitting physiological data reflective of the physiological information from the wireless monitor to the bedside monitor.

11. The method of Claim 10, wherein the transferred data is a unique identifier.

12. The method of Claim 10, wherein the transferred data is a password.

13. The method of Claim 10, wherein the transferred data is channel information.

14. The method of Claim 10, wherein transmitting physiological data from the wireless monitor to the bedside monitor comprises:

transmitting physiological data over a first wireless technology when the wireless monitor is within a pre-determined distance from the bedside monitor; and

transmitting physiological data over a second wireless technology when the wireless monitor is not within a pre-determined distance from the bedside monitor.

15. The method of Claim 14, wherein the first wireless technology is Bluetooth or ZigBee.

16. The method of Claim 14, wherein the second wireless technology is Wi-Fi or cellular telephony.

17. The method of Claim 10, wherein transmitting physiological data from the wireless monitor to the bedside monitor comprises:

transmitting physiological data over the first wireless technology when a signal strength of the first wireless technology is sufficiently strong; and

signal strength of the first wireless technology is not sufficiently strong.

18. The method of Claim 14, wherein transmitting physiological data over the second wireless technology activates a display on the battery.

19. The method of Claim 17, wherein transmitting physiological data over the second wireless technology activates a display on the battery.

20. A system configured to wirelessly communicate physiological information including a battery, the battery comprising:

a housing;

a rechargeable electrical storage module; and

a memory module configured to store wireless communication information.

21. The system of Claim 20, wherein the wireless communication information pairs a wireless monitor with a bedside monitor.

22. The system of Claim 20, wherein the rechargeable electric storage module includes a display.

23. A patient monitoring system comprising:

a sensor configured to obtain physiological information;

an anchor connected to the sensor; and

a wireless transceiver connected to the anchor, the wireless transceiver configured to receive the physiological information.

24. The patient monitoring system of Claim 23, wherein a first cable connects the sensor to the anchor and a second cable connects the anchor to the wireless transceiver.

25. The patient monitoring system of Claim 23, wherein the anchor is configured to adhere to the patient.

26. A patient monitoring system comprising:

one or more sensors configured to obtain physiological information; and

a wireless transceiver configured to receive the physiological information, the wireless transceiver comprising:

a housing having a first side and a second side, and

connector positioned on the second side.

27. The patient monitoring system of Claim 26, wherein the first side is opposite the second side.

28. The patient monitoring system of Claim 26, wherein two connectors are positioned on the first side.

29. A docking station comprising:

a bedside monitor comprising a docking port configured to receive a first patient monitor; and

a docking station adapter configured to adapt the docking port to receive a second patient monitor, wherein the second patient monitor is a different size than the first patient monitor.

30. The docking station of Claim 29, wherein the first patient monitor is configured to communicate with the bedside monitor over a wired connection when the first patient monitor is connected to the docking port.

31. The docking station of Claim 29, wherein the second patient monitor is configured to communicate with the bedside monitor over a wired connection when the second patient monitor is connected to the docking station adapter and the docking station adapter is connected to the docking port.

32. A patient monitoring system comprising:

a first sensor;

a second sensor;

a wireless patient monitor configured to receive physiological information from the first sensor and the second sensor; and

a single cable comprising a first cable section and a second cable section, the cable connecting the first sensor and the second sensor to the wireless patient monitor.

33. The patient monitoring system of Claim 32, wherein the first cable section extends from the wireless patient monitor to the first sensor and the second cable section extends from the first sensor to the second sensor.

and the second sensor are powered by a shared power line.

35. The wireless patient monitoring system of Claim 32, wherein the first sensor and the second sensor transmit signals over a shared signal line.

36. A patient monitoring system comprising:
one or more sensors configured to obtain physiological information;
a patient monitor configured to receive the physiological information; and
a cable hub comprising one or more inlet connectors connected to the one or more sensors and an outlet connector connected to the patient monitor.

37. The patient monitoring system of Claim 36, wherein the one or more inlet connectors are positioned on a first end of the cable hub and the outlet connector is positioned on a second end of the cable hub.

38. The patient monitoring system of Claim 37, wherein the first end is opposite the second end.

39. The patient monitoring system of Claim 36, wherein the patient monitor is a wireless transceiver.

40. The patient monitoring system of Claim 36, wherein the patient monitor is configured to be worn by the patient.

41. The patient monitoring system of Claim 36, wherein the cable hub is configured to adhere to the patient.

42. The patient monitoring system of Claim 36, wherein a first cable extends from at least one of the one or more sensors to one of the one or more inlet connectors.

43. The patient monitoring system of Claim 36, wherein a second cable extends from the outlet connector to the patient monitor.

44. A method of using a patient monitoring system, the method comprising:
providing a wireless transceiver comprising a housing, the housing having a first end and a second end opposite the first end, a first connector positioned on the first end and a second connector positioned on the second end;
connecting a first end of a first cable to the first connector;
connecting a second end of the first cable to a first sensor; and

45. The method of Claim 44, further comprising connecting a second end of the second cable to a second sensor.

46. The method of Claim 45, further comprising connecting a third sensor to the second cable.

47. The method of Claim 44, further comprising connecting a second end of the second cable to a cable hub.

48. The method of Claim 47, wherein the cable hub is connected to one or more sensors.

49. The method of Claim 44, further comprising connecting an anchor to the second cable.

50. The method of Claim 44, further comprising connecting a third cable to a third connector on the second end of the wireless transceiver housing.

51. A wireless monitor comprising:

a housing including one or more outlets configured to receive one or more sensors;

a battery configured to removably engage the housing;

a strap, a portion of the strap disposed between the housing and the battery when the housing is engaged with the battery.

52. The wireless monitoring system of Claim 51, wherein the portion of the strap disposed between the housing and the battery is separately formed from a remainder of the strap.

53. The wireless monitoring system of Claim 51, wherein the portion of the strap includes one or more mating features configured to mate with corresponding features of the housing.

54. The wireless monitoring system of Claim 53, wherein the one or more mating features are flush with the corresponding features of the housing.

55. The wireless monitoring system of Claim 53, wherein the housing includes a recessed portion for receiving the strap.

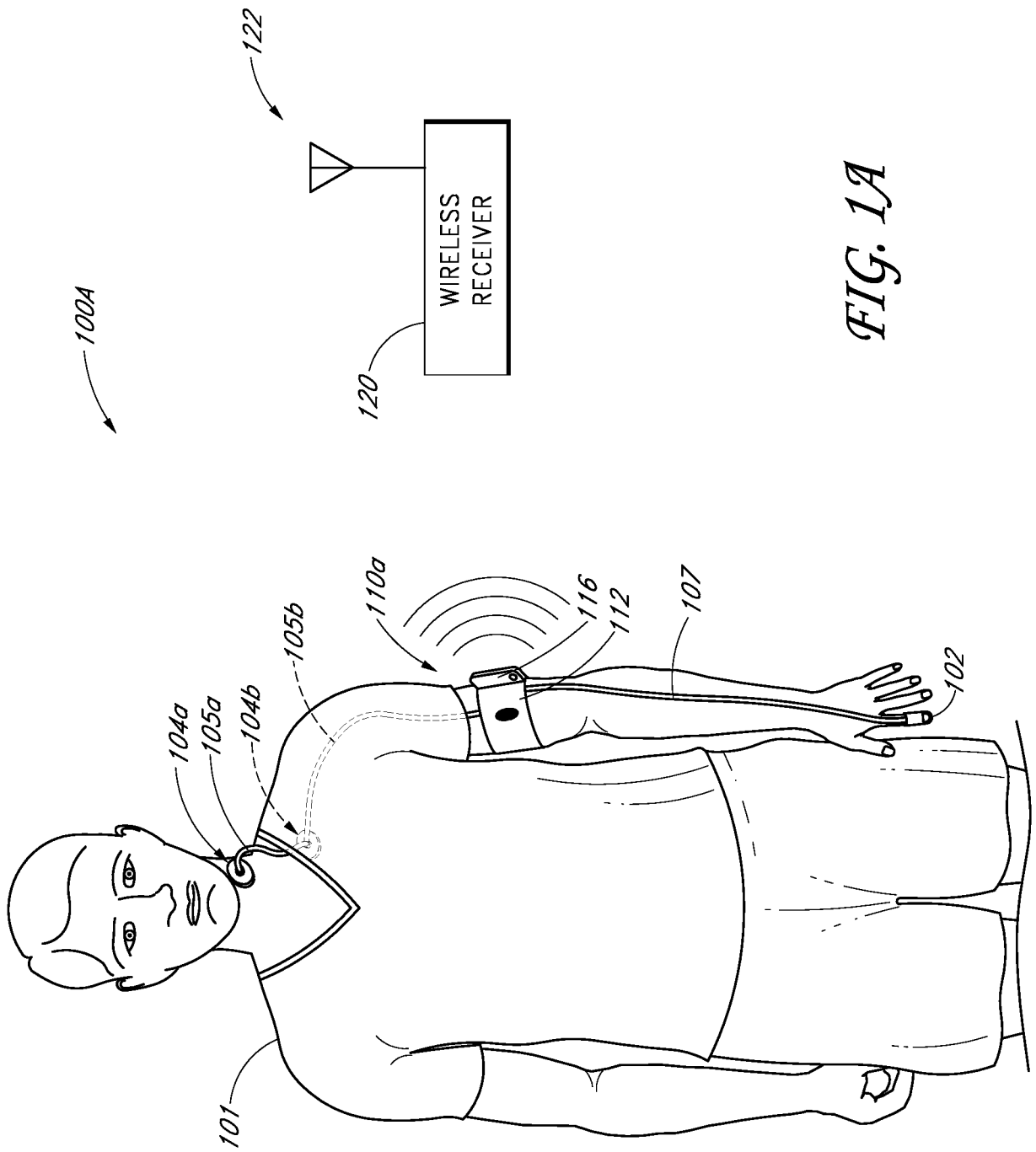


FIG. 1A

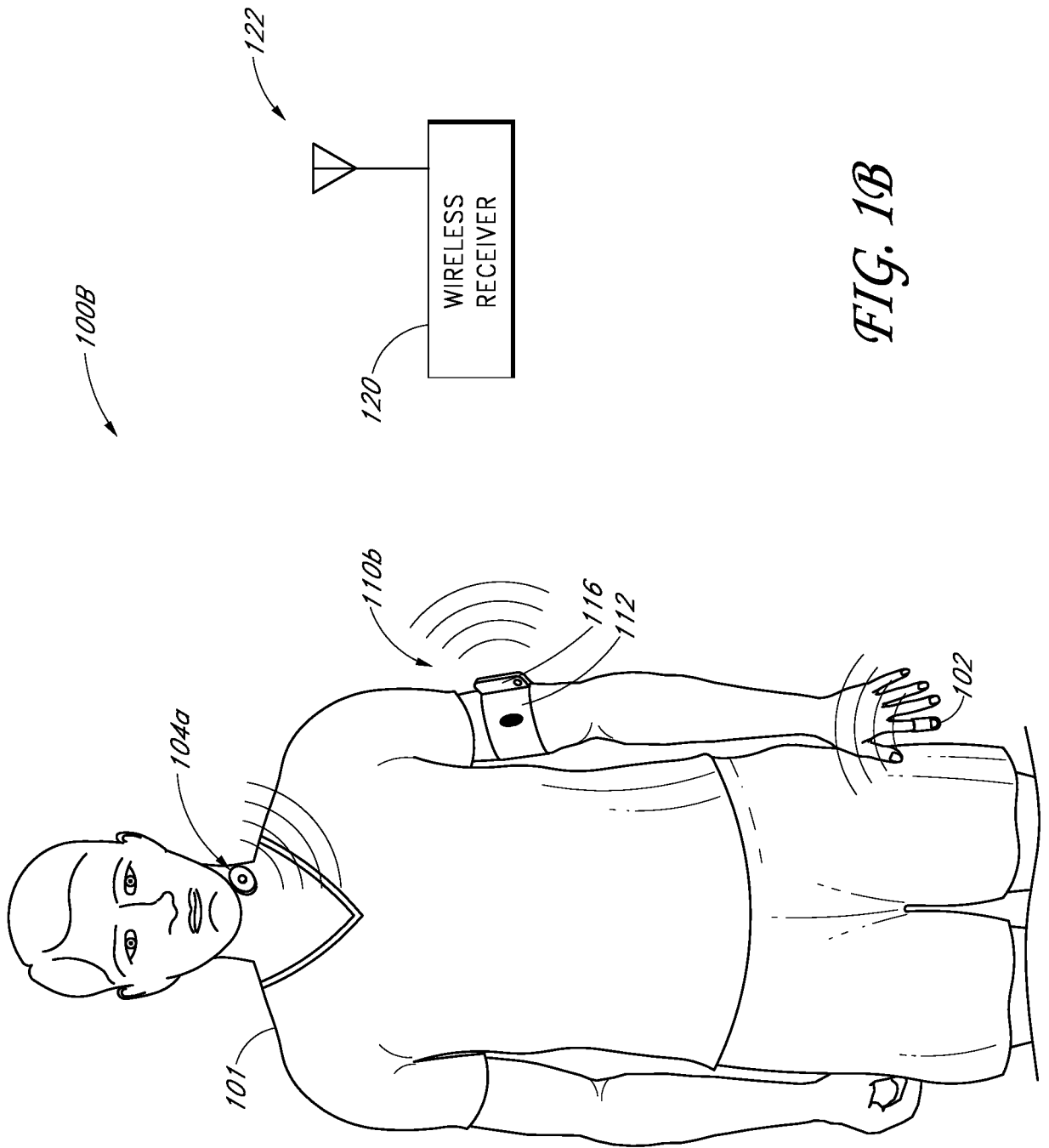


FIG. 1B

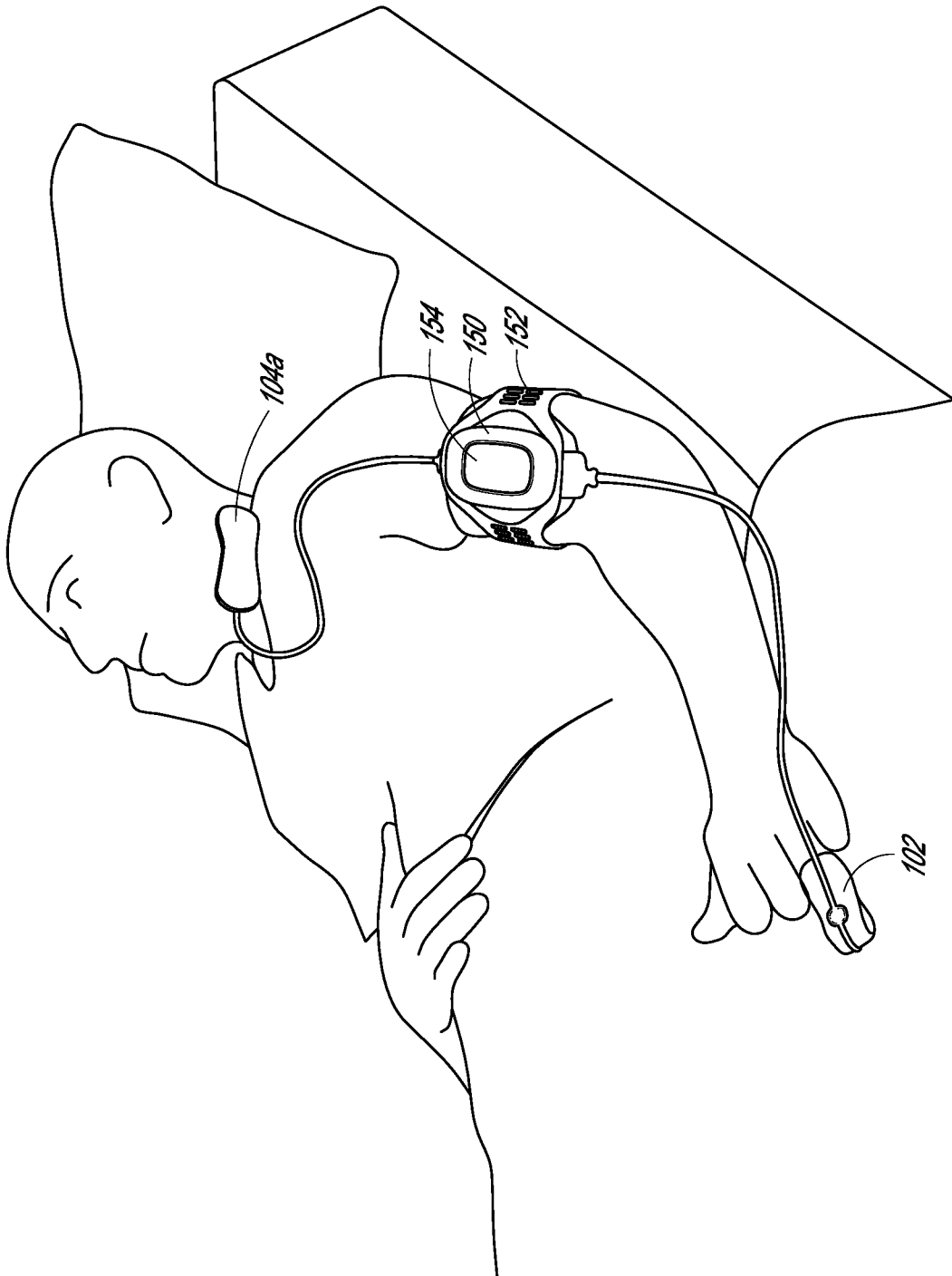


FIG. 1C

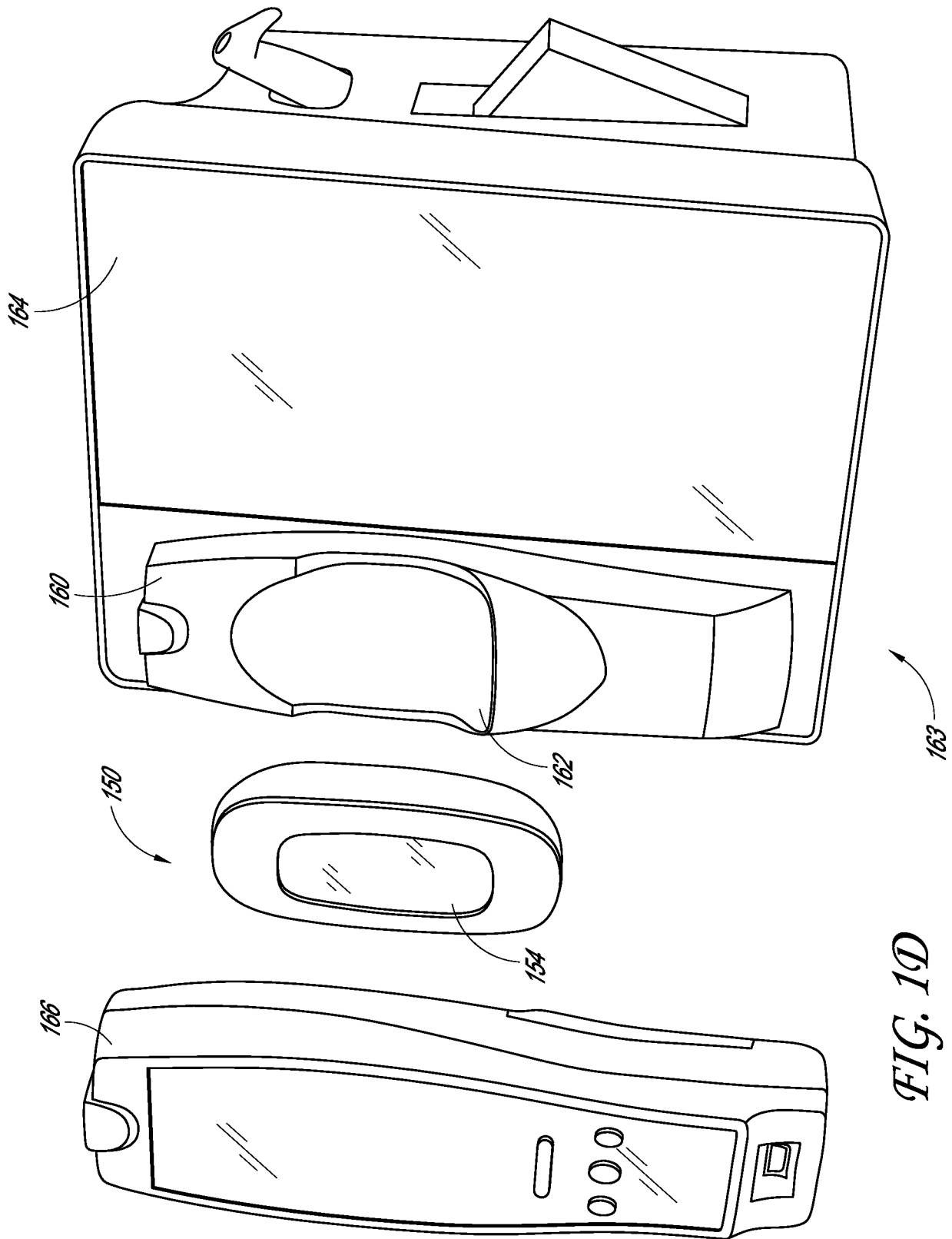


FIG. 1D

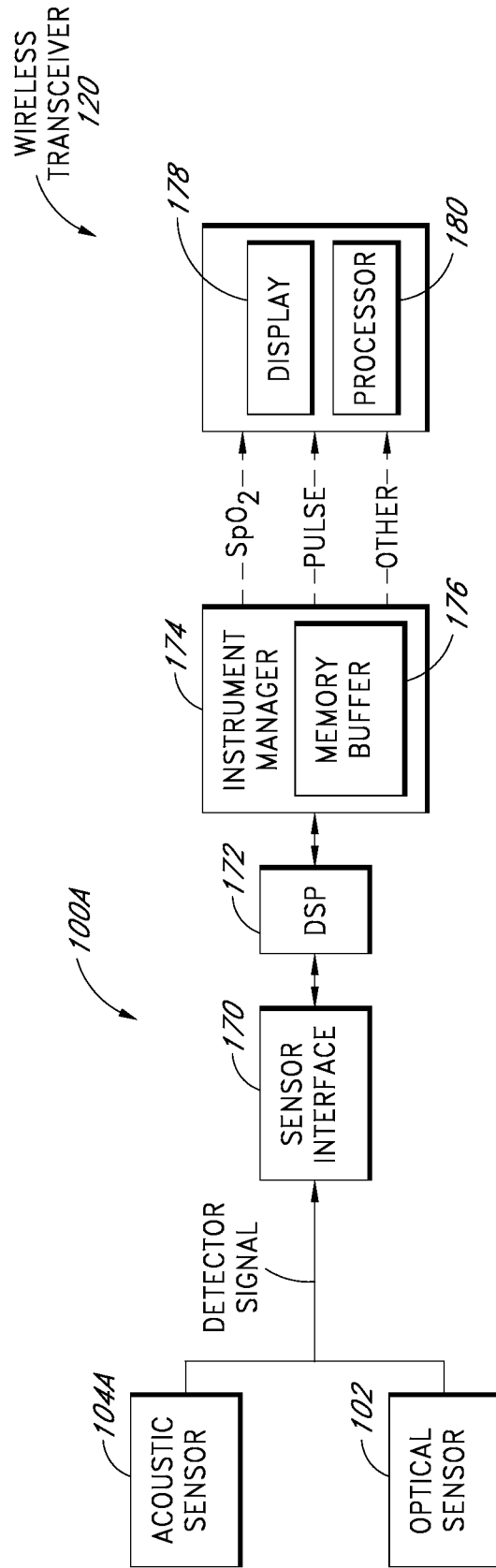


FIG. 1E

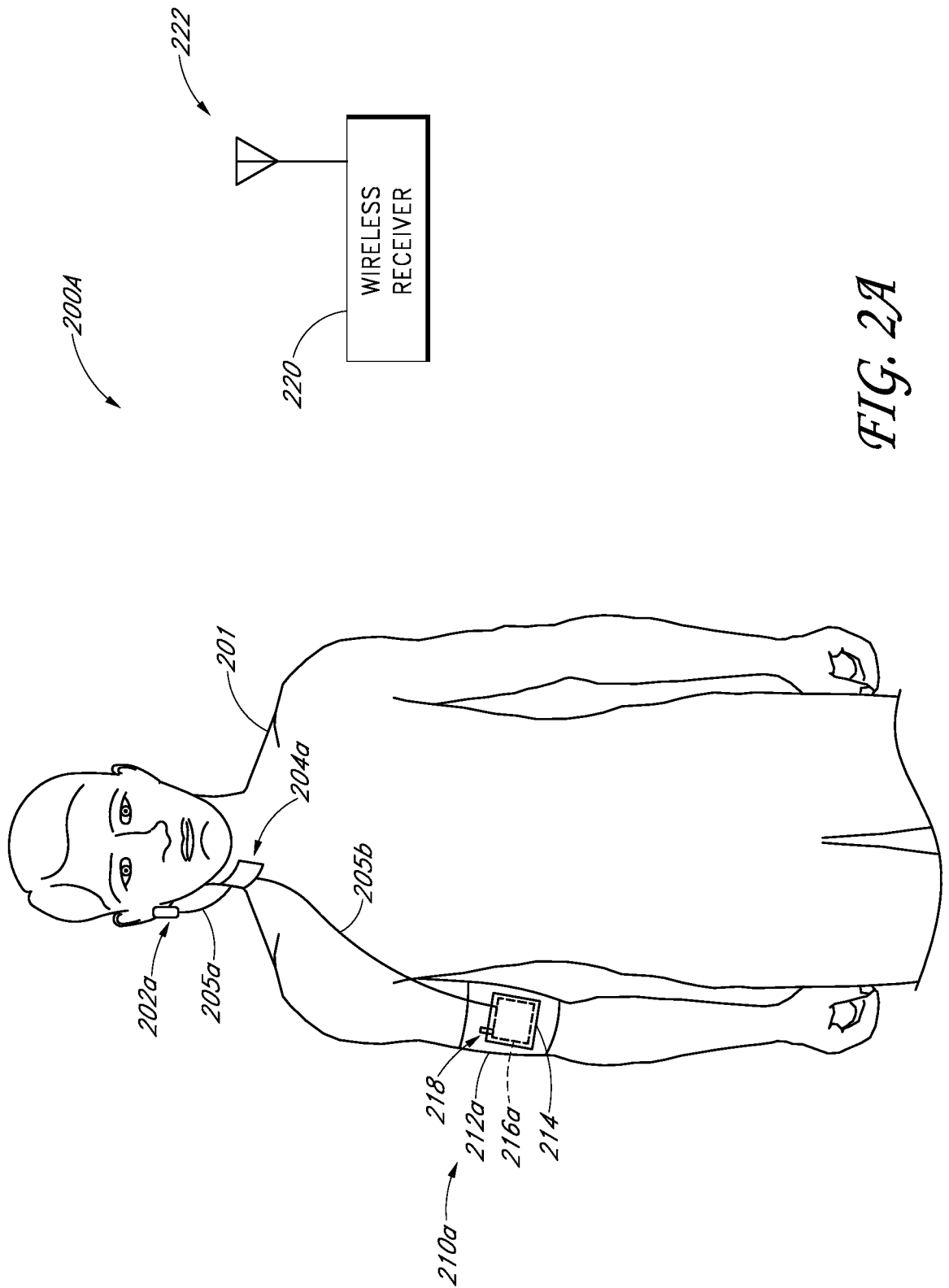


FIG. 2A

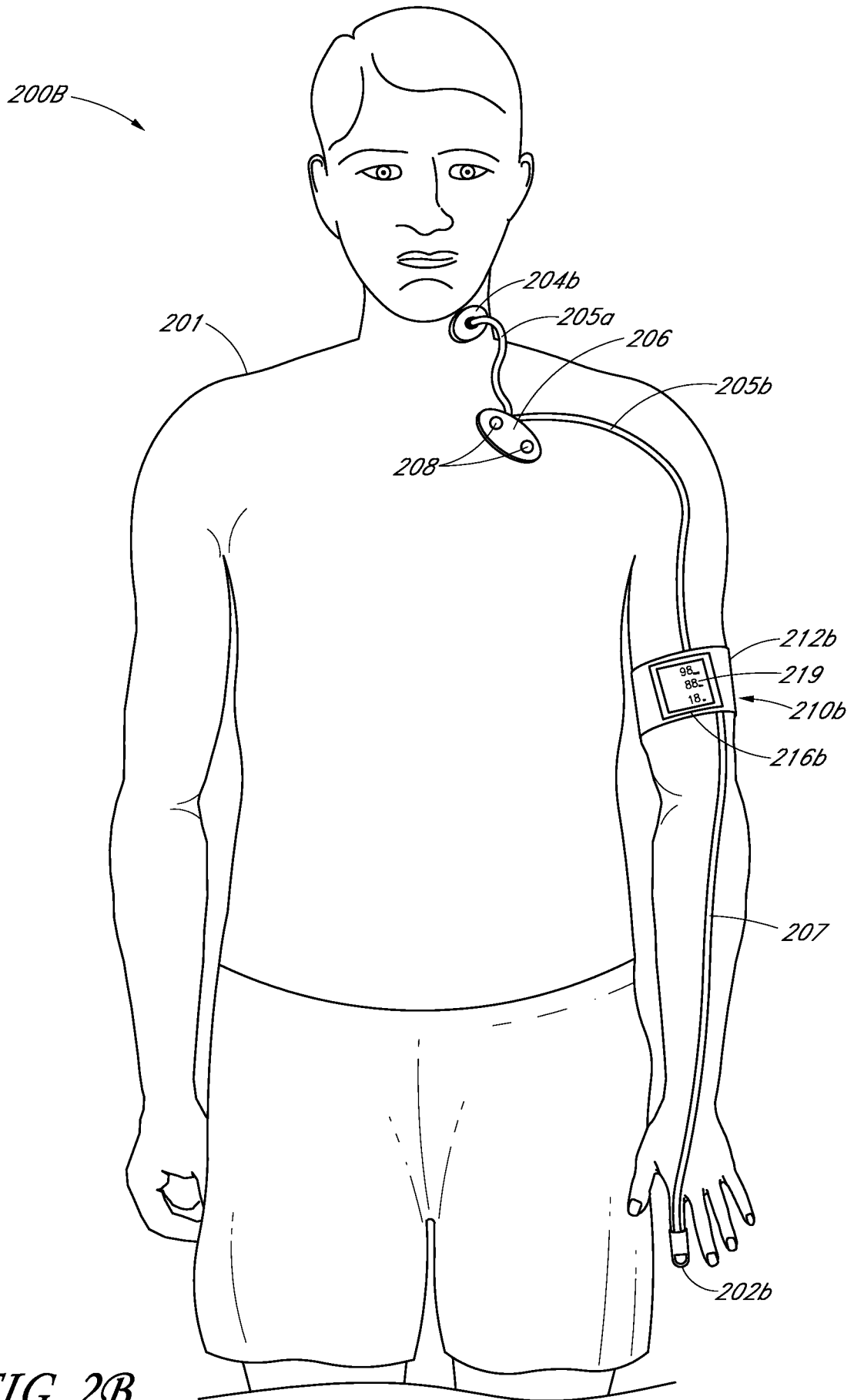


FIG. 2B

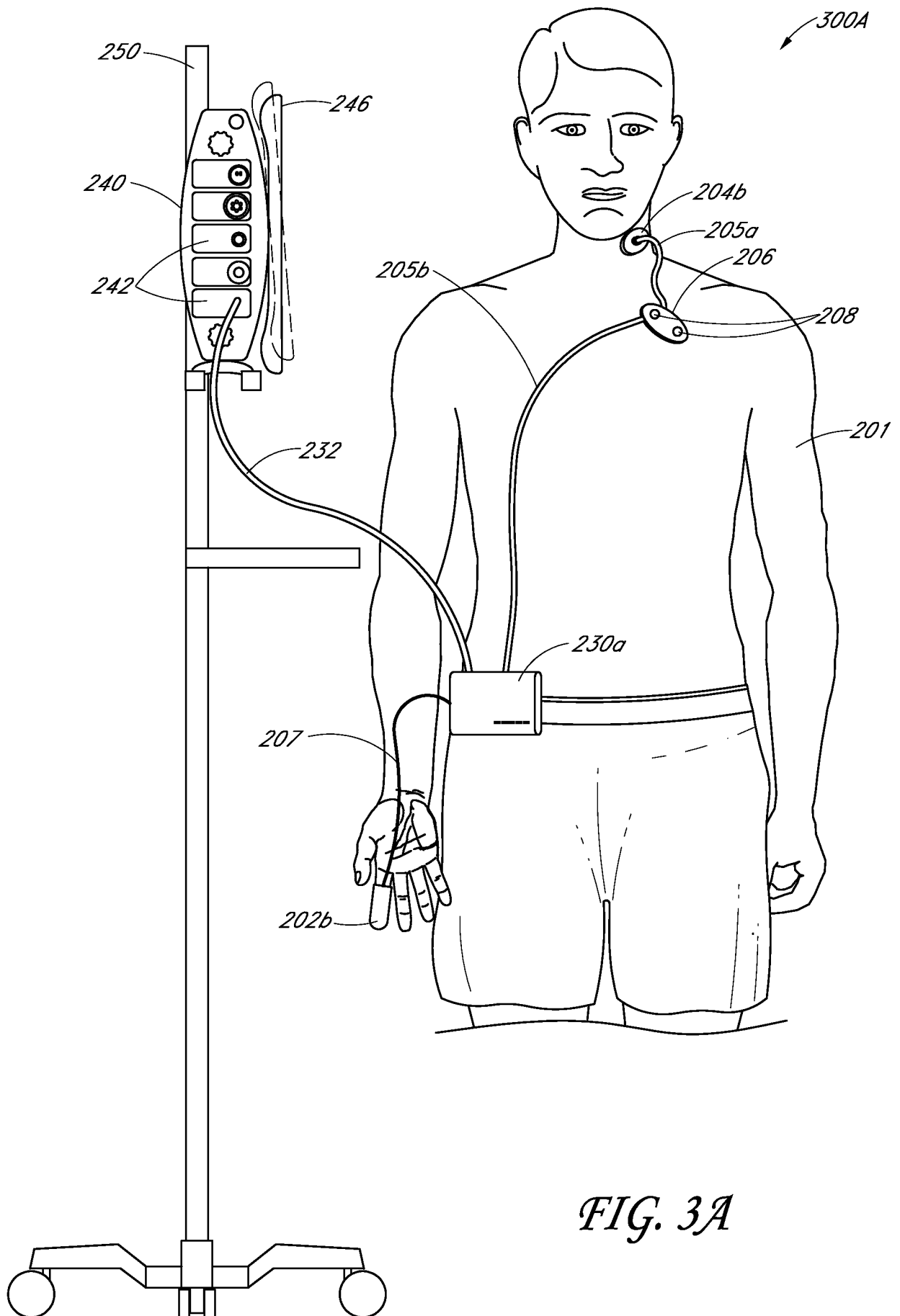


FIG. 3A

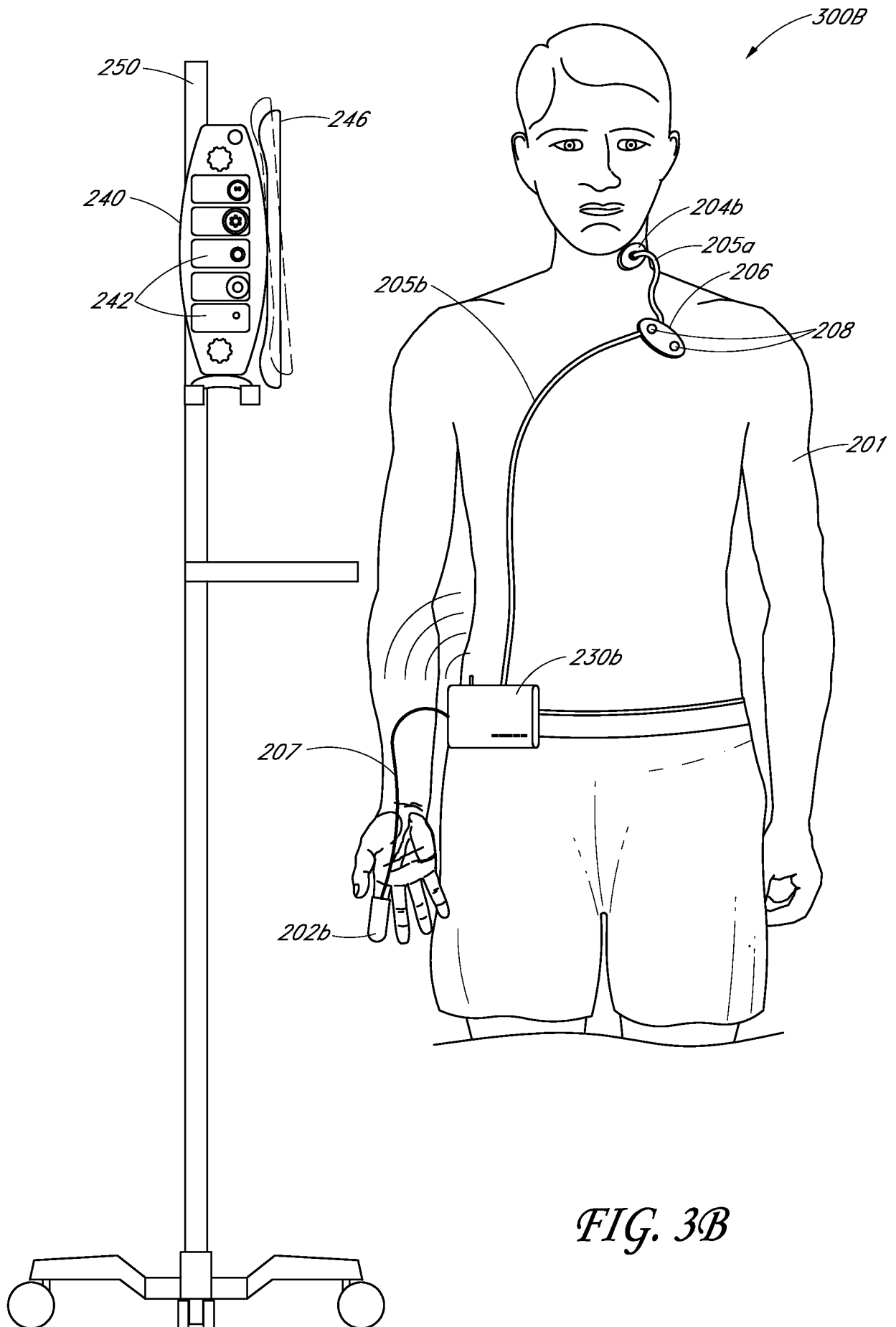


FIG. 3B

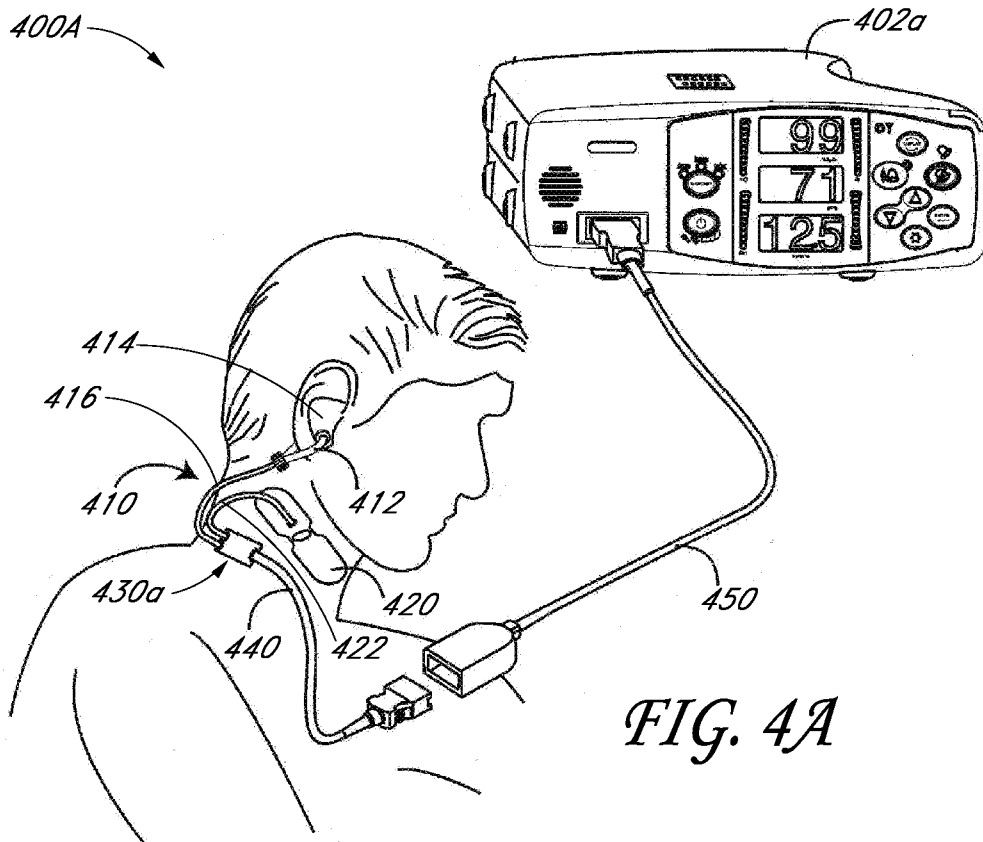


FIG. 4A

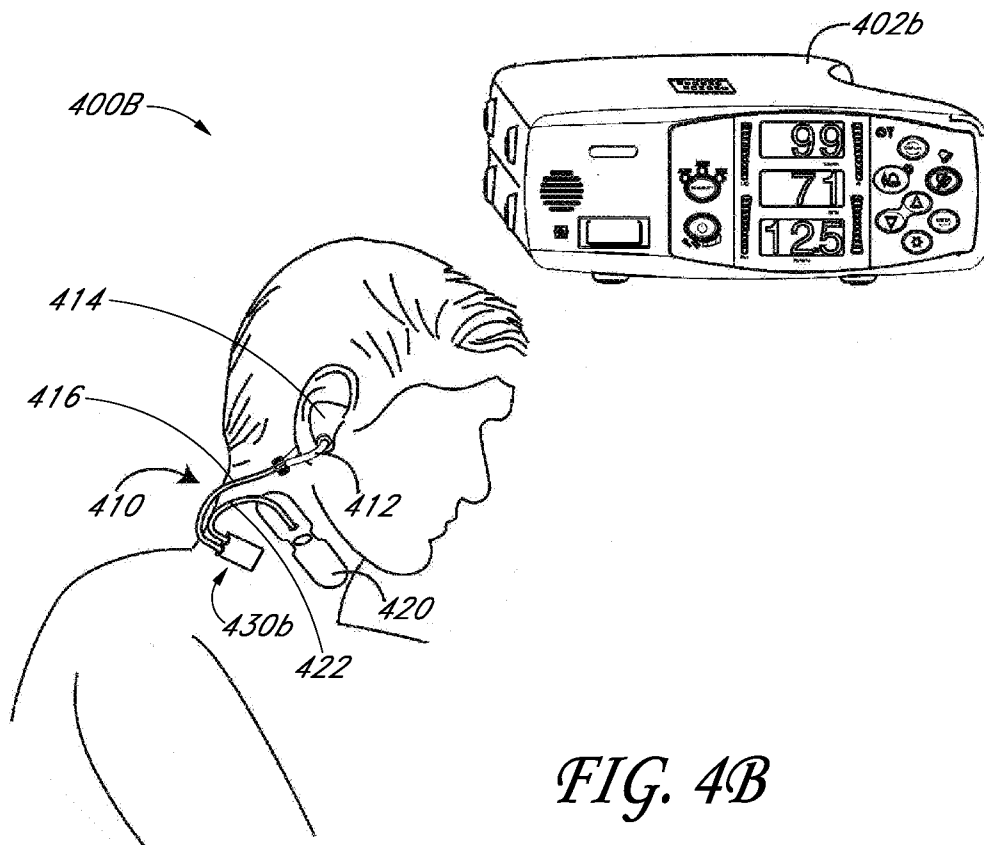


FIG. 4B

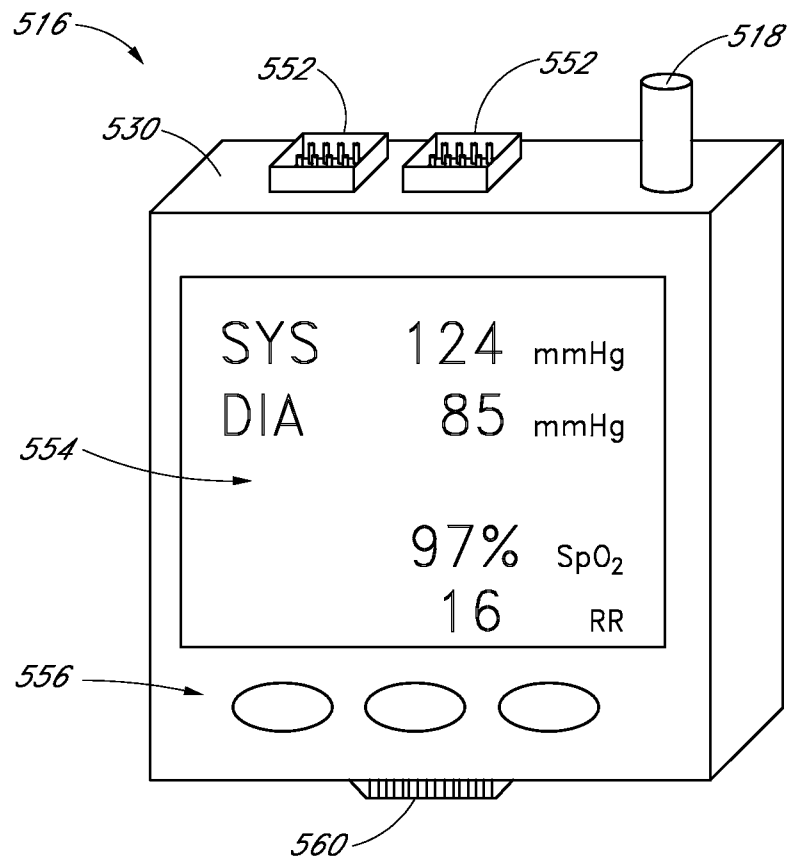


FIG. 5

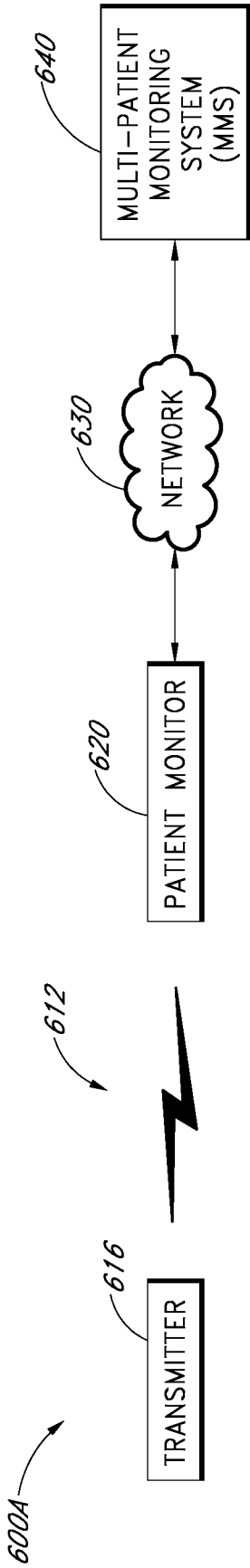


FIG. 6A

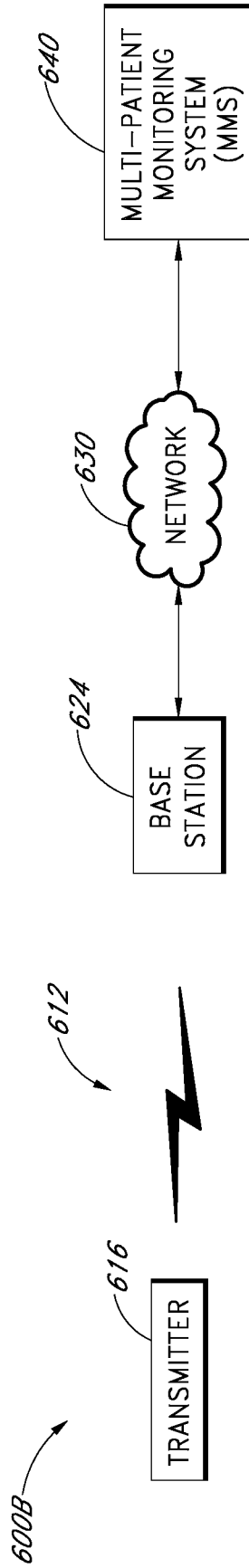


FIG. 6B

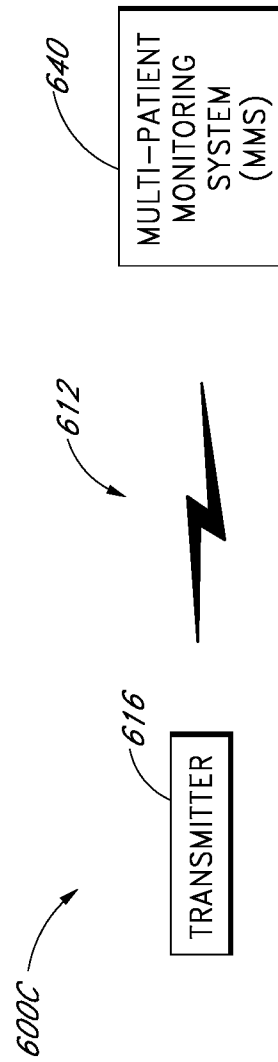


FIG. 6C

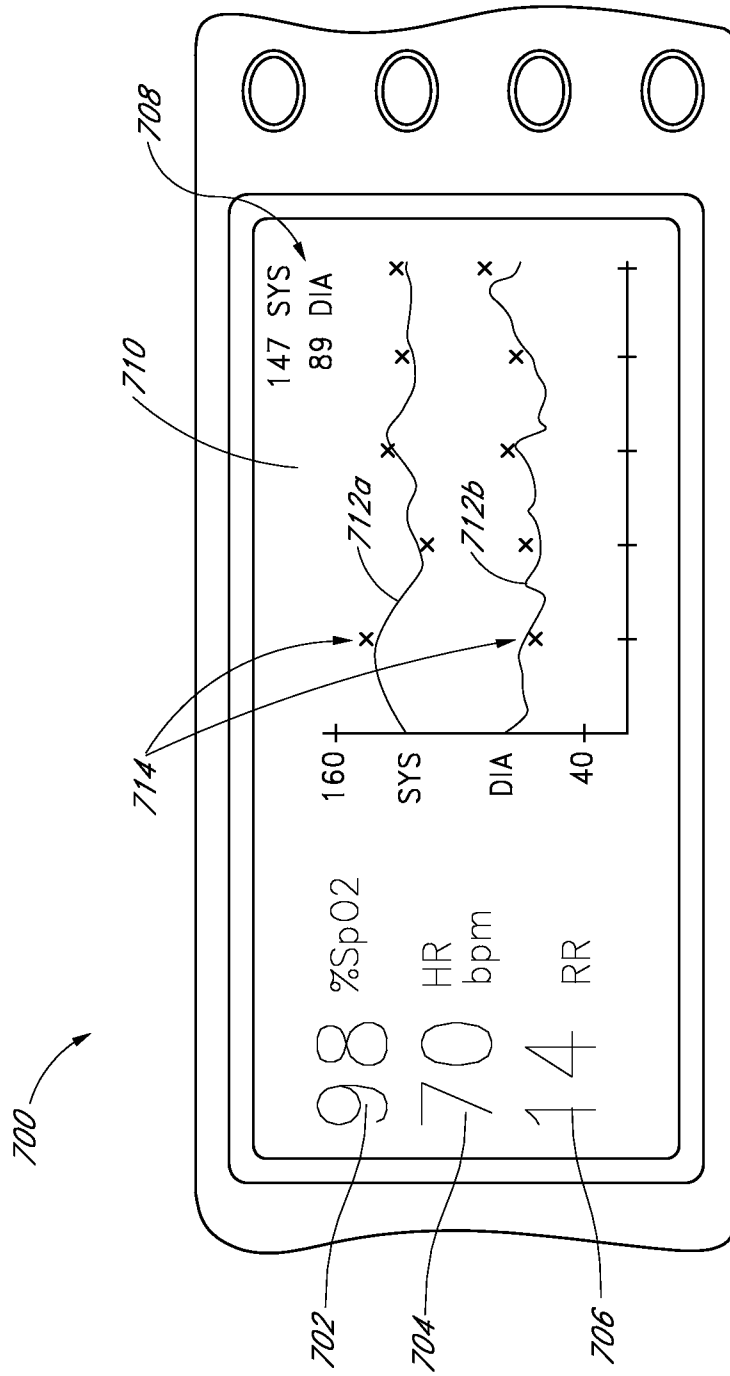


FIG. 7

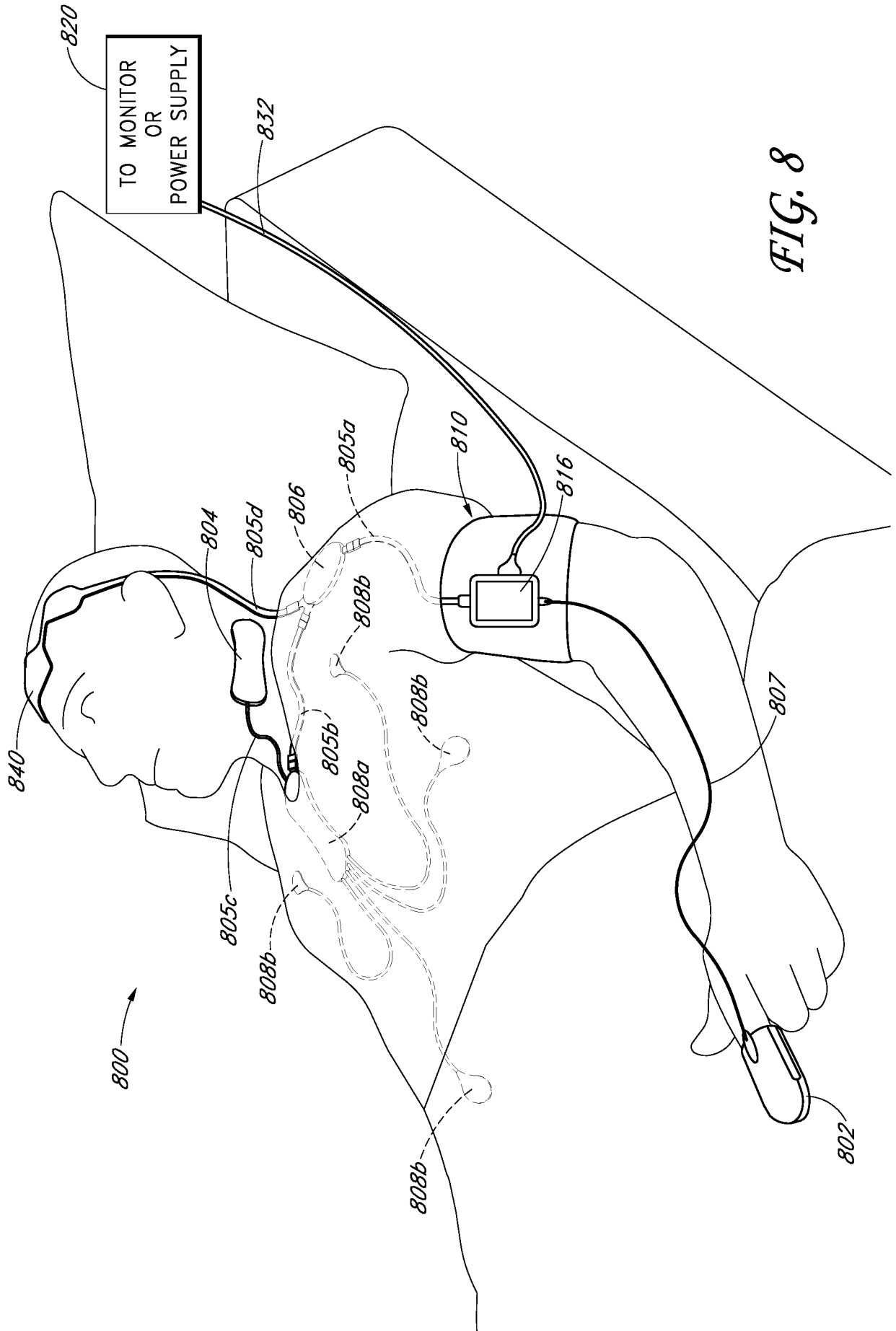


FIG. 8

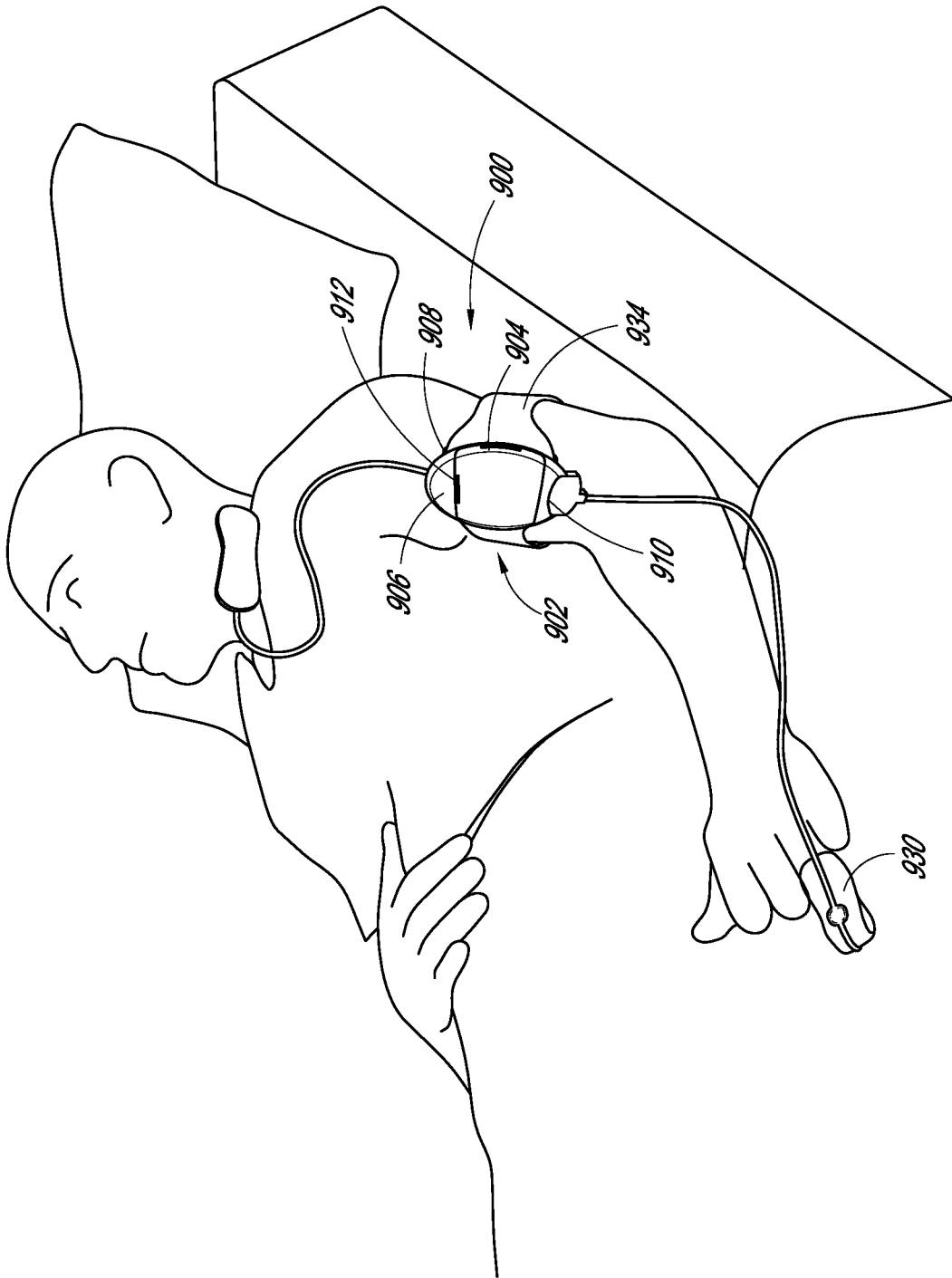


FIG. 9A

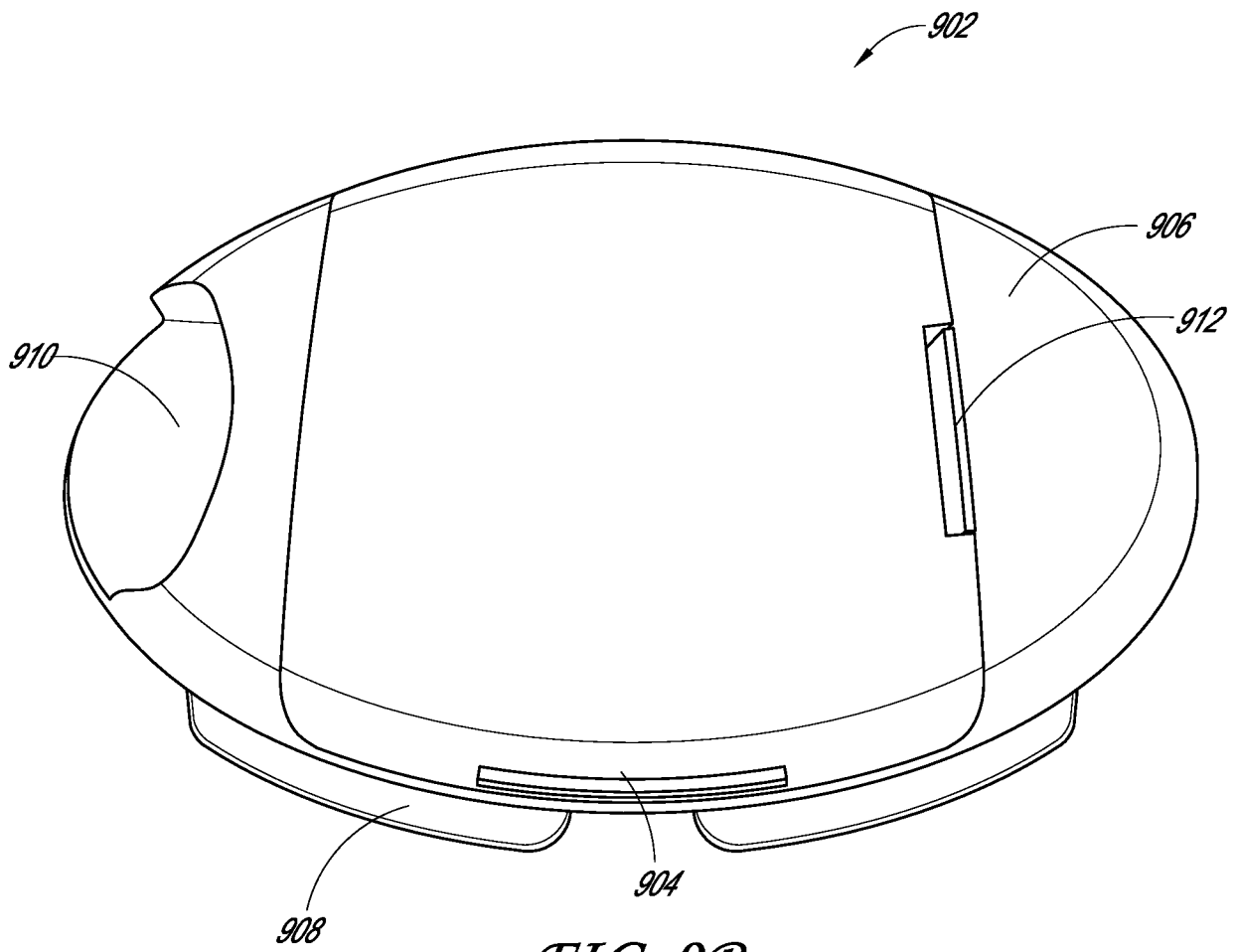


FIG. 9B

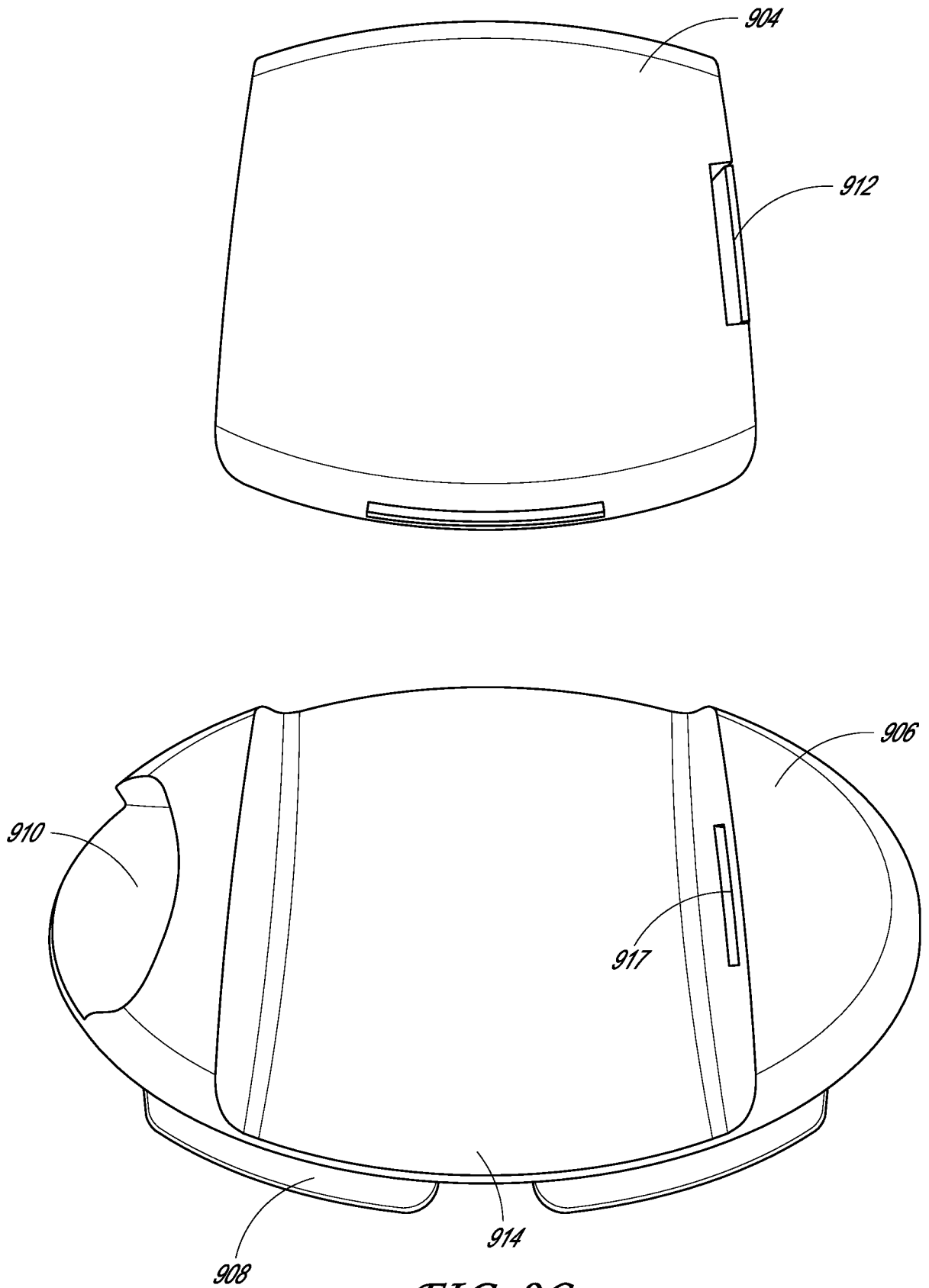


FIG. 9C

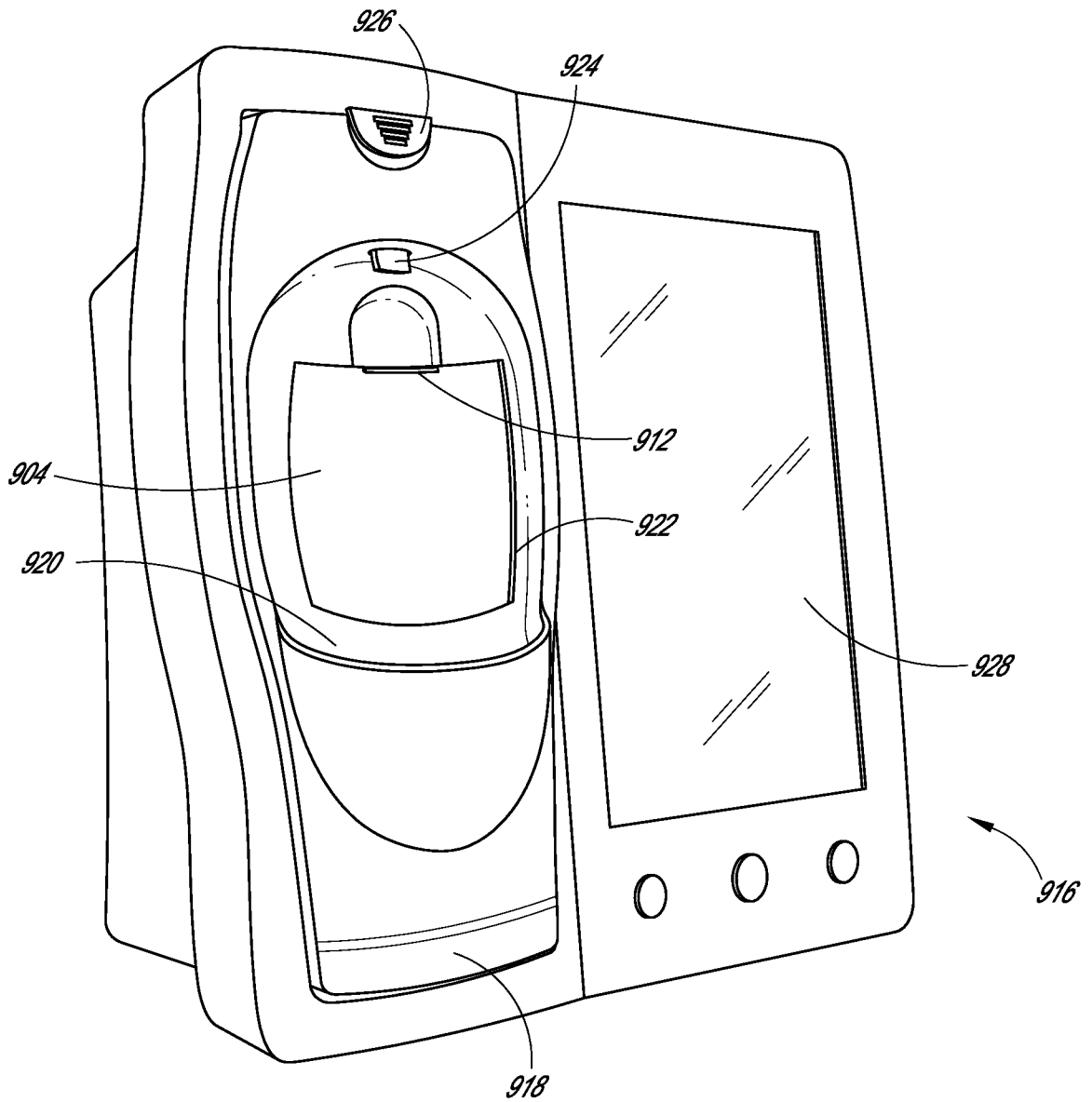


FIG. 9D

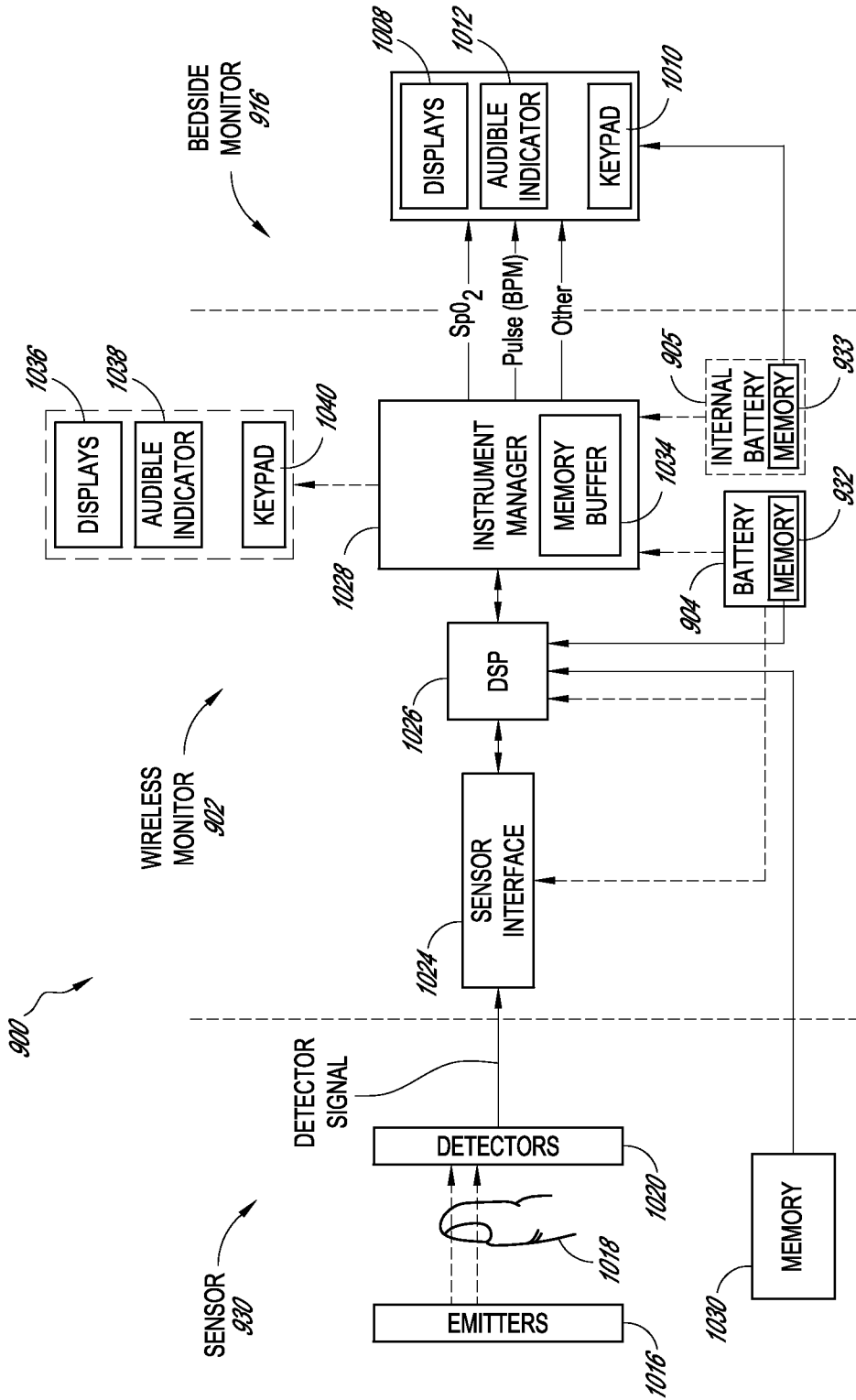
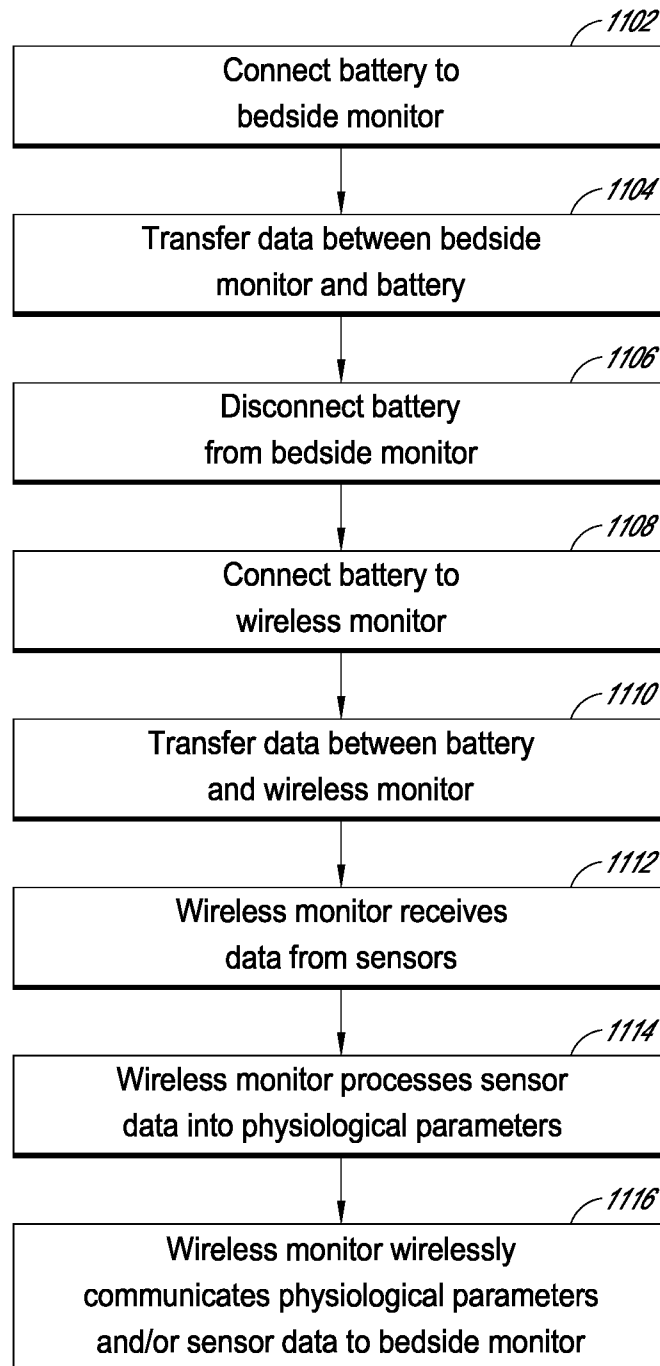


FIG. 10

*FIG. 11*

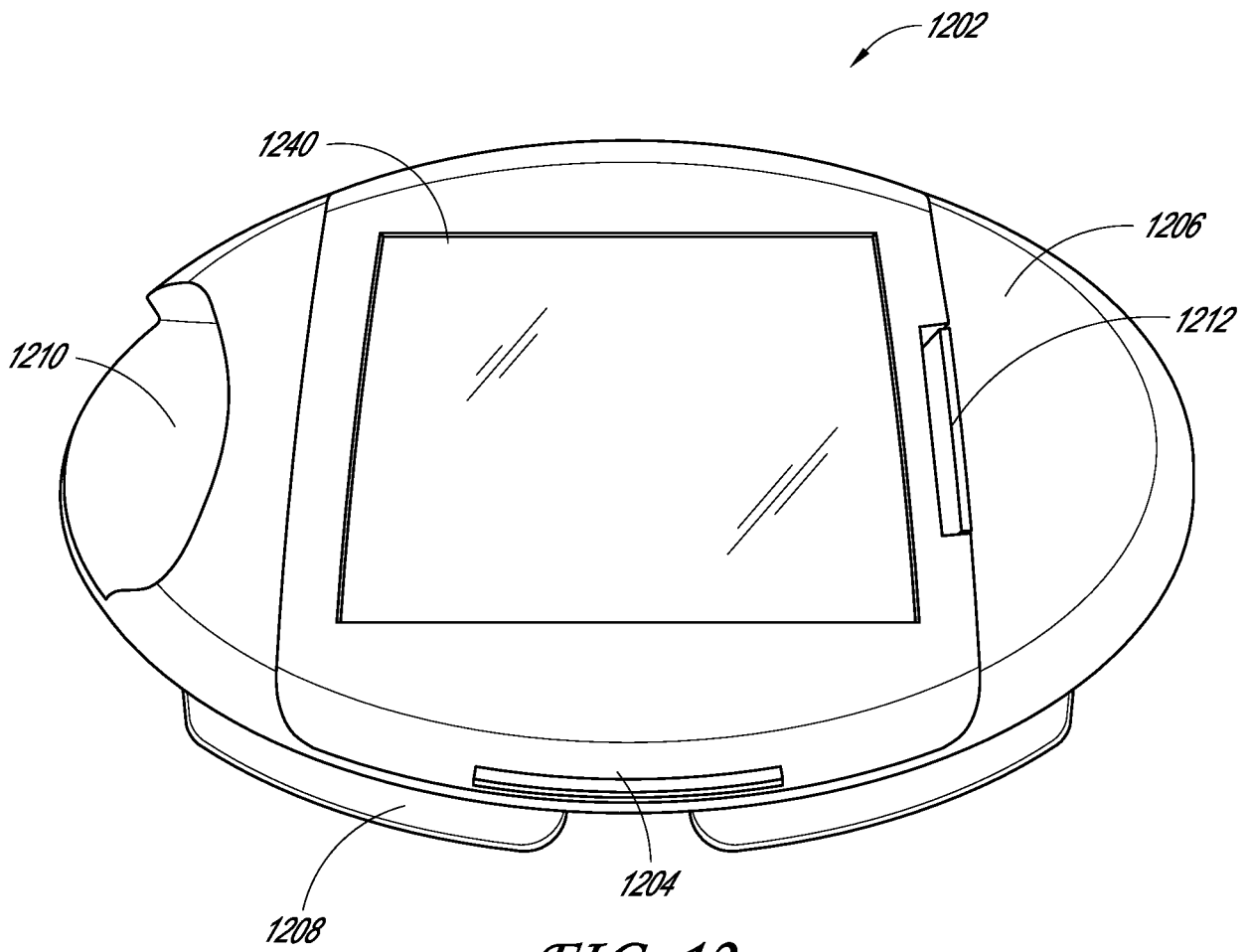


FIG. 12

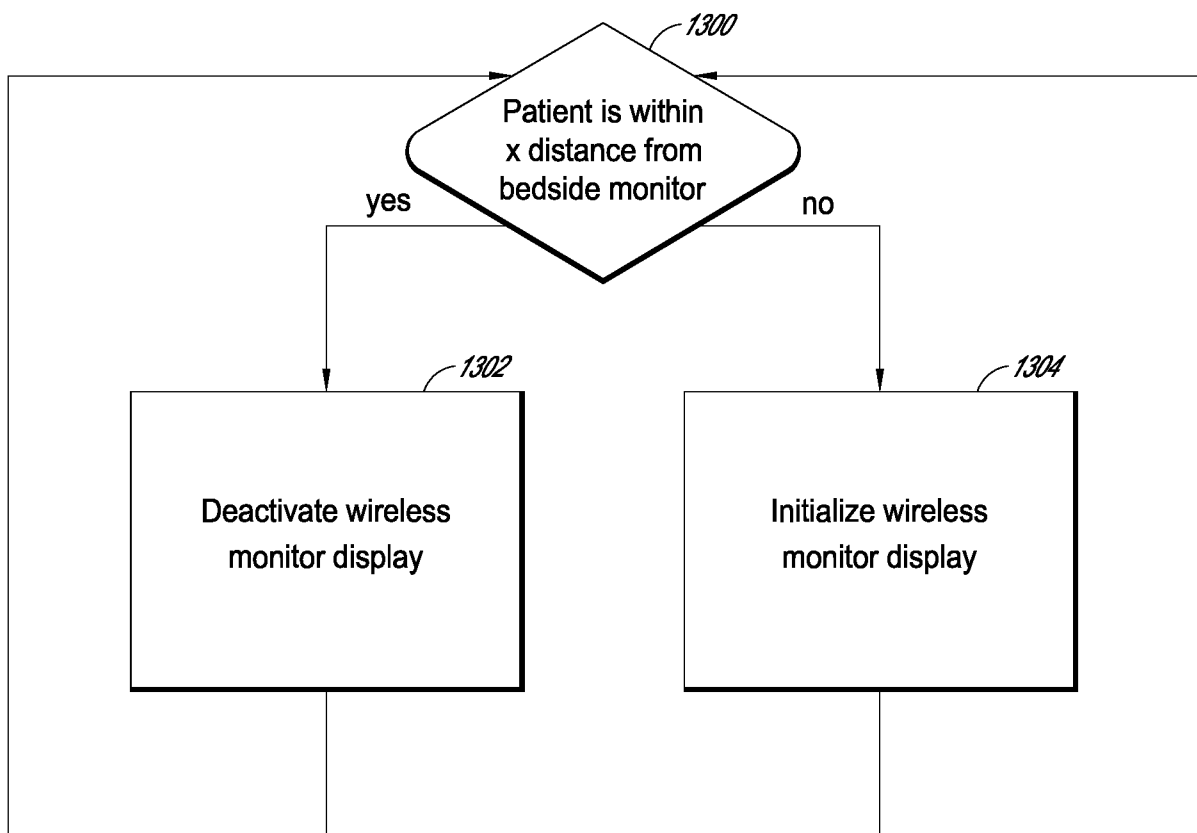


FIG. 13

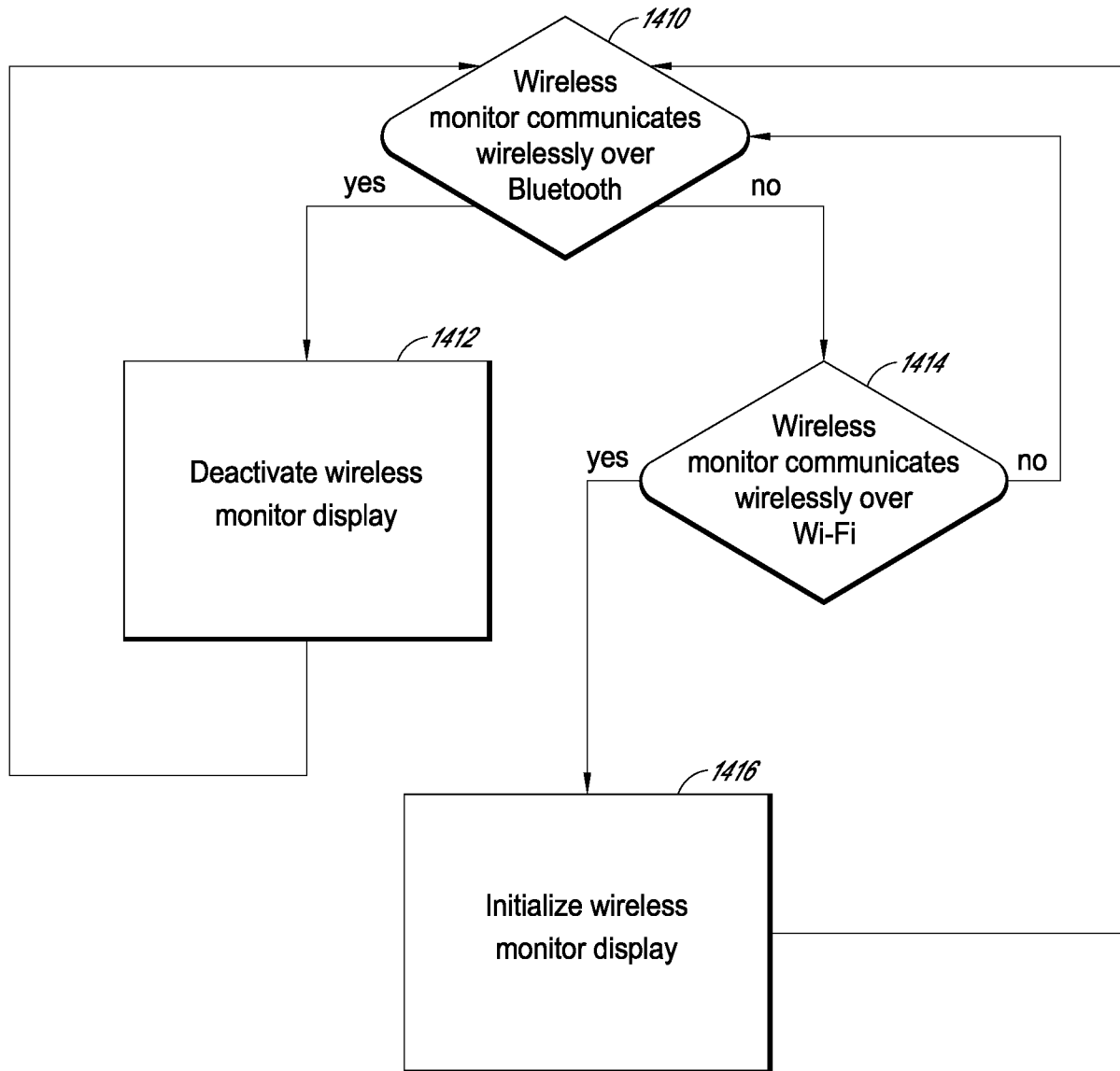


FIG. 14

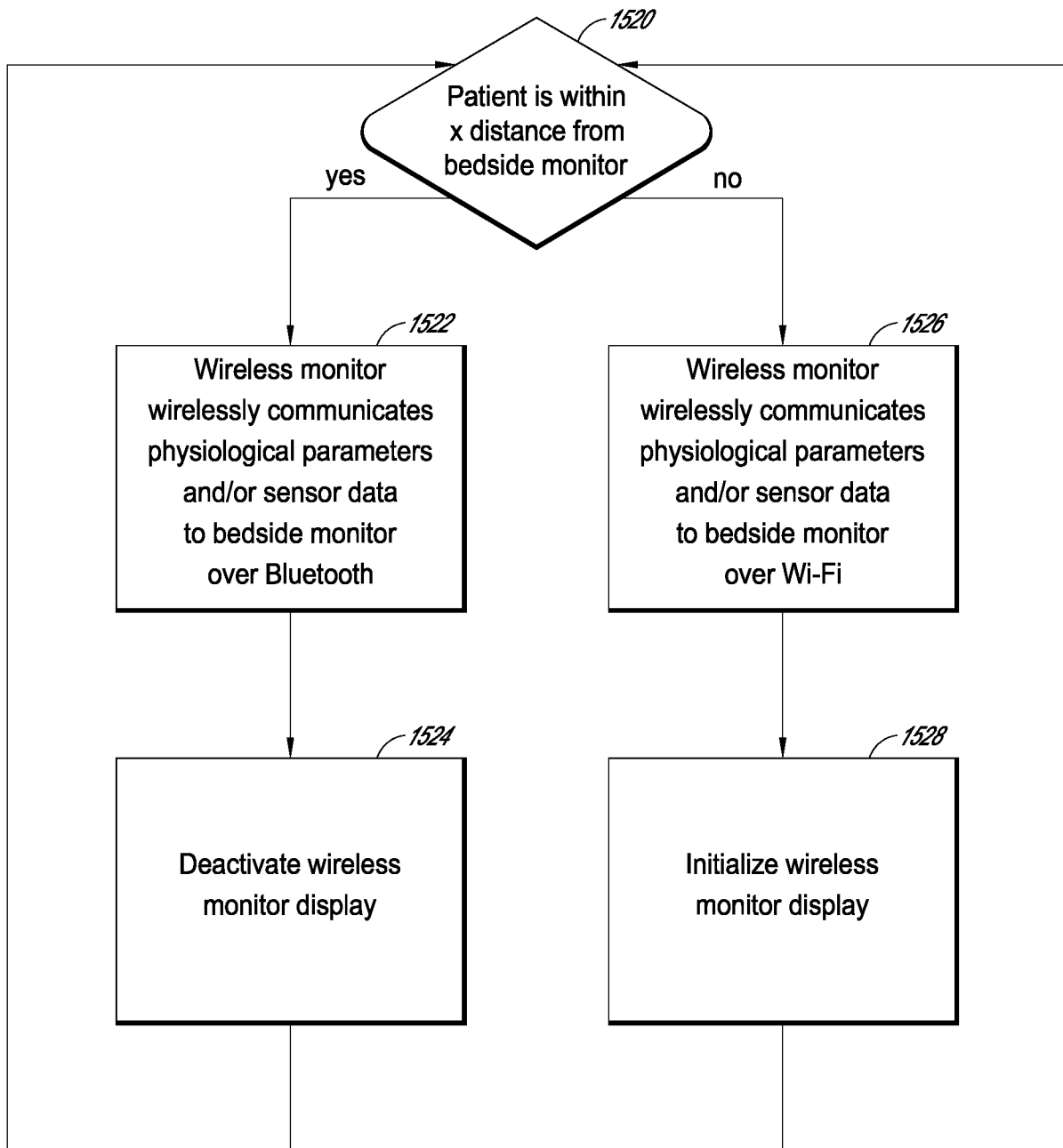


FIG. 15

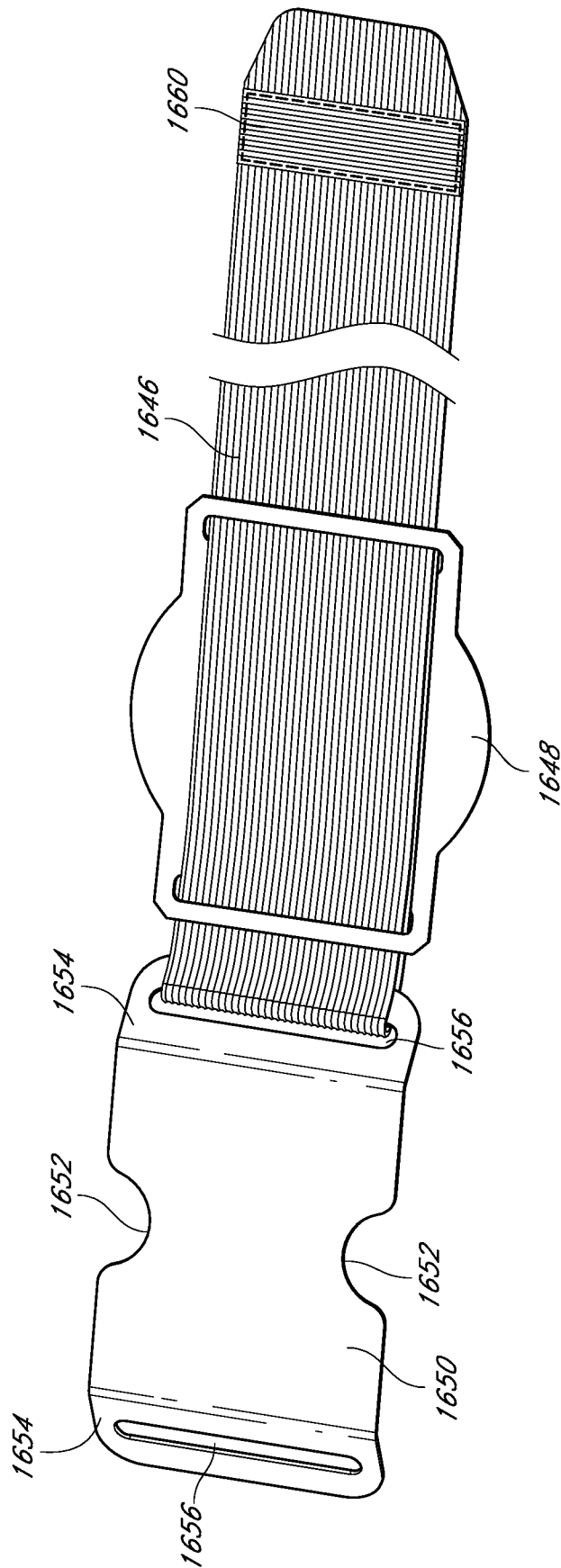


FIG. 16B

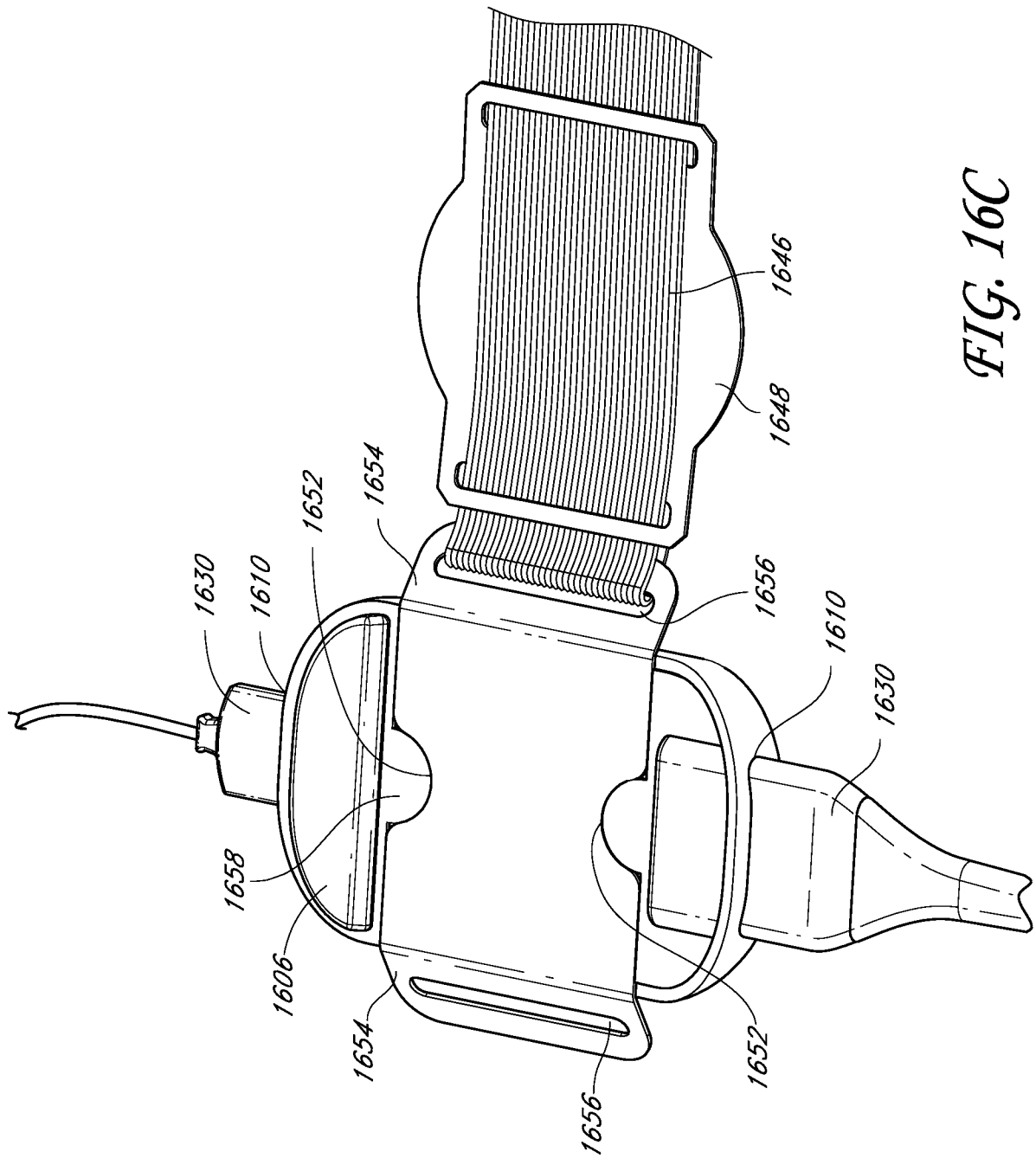


FIG. 16C

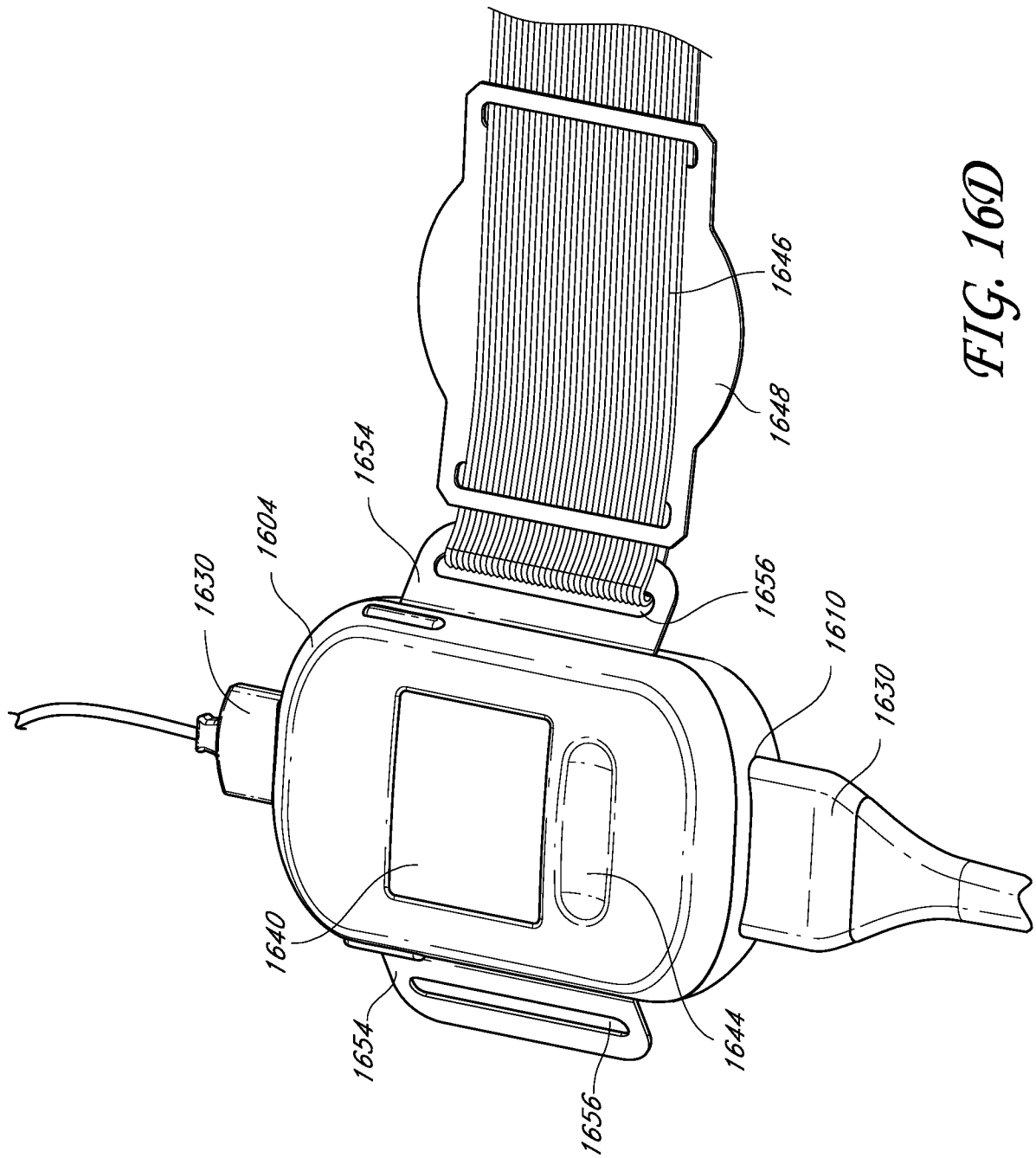


FIG. 16D

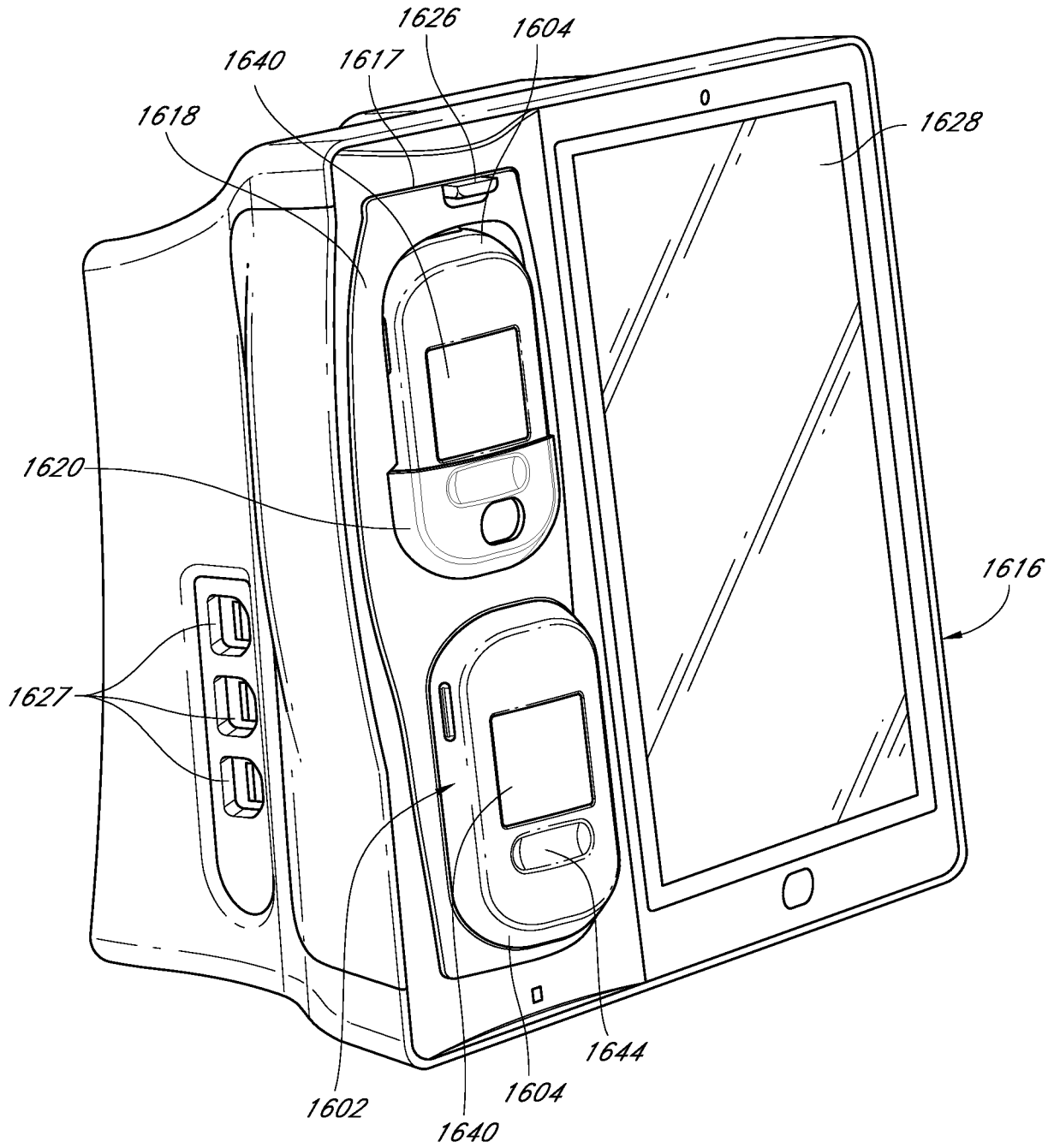


FIG. 16F

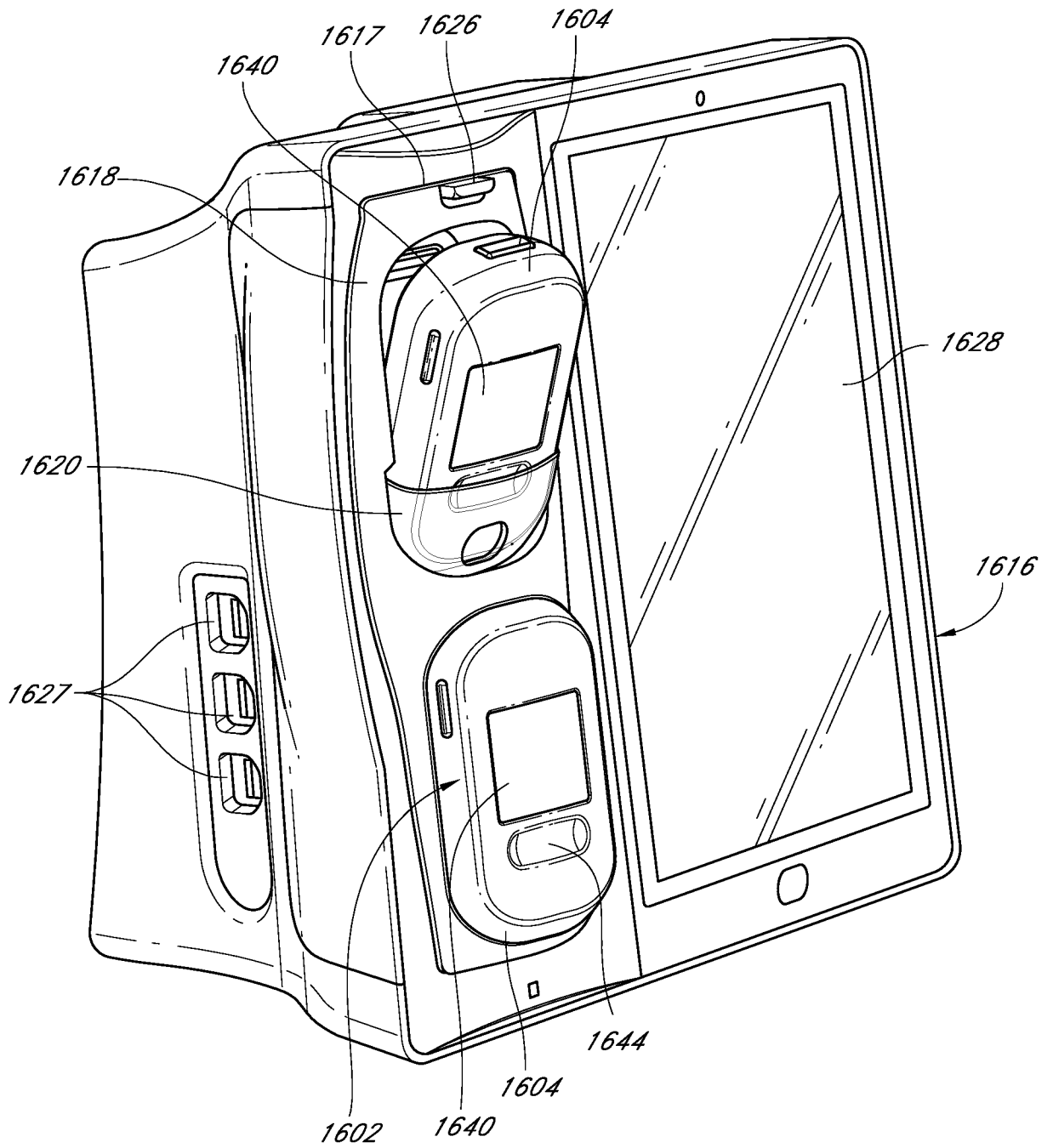


FIG. 16G

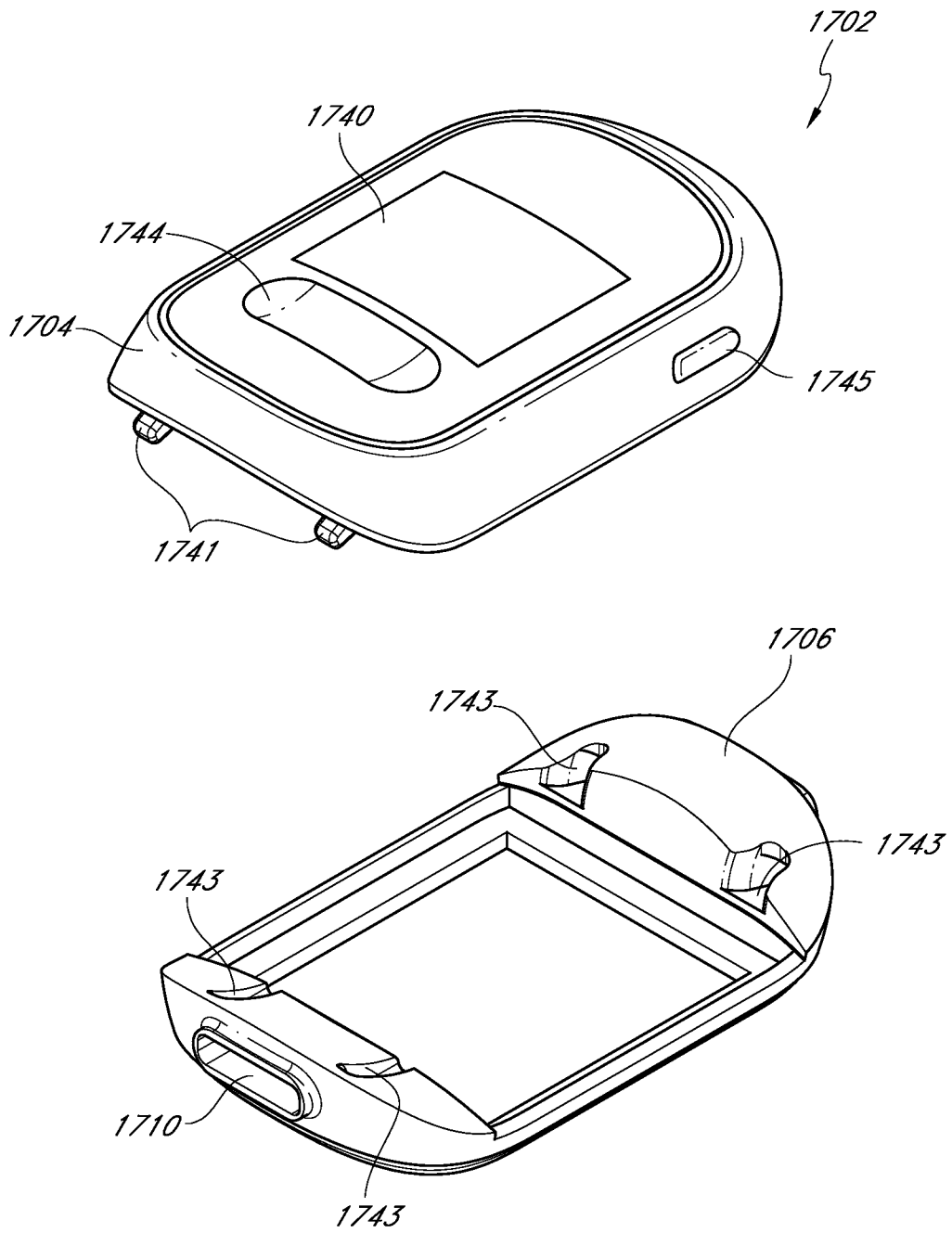


FIG. 17A

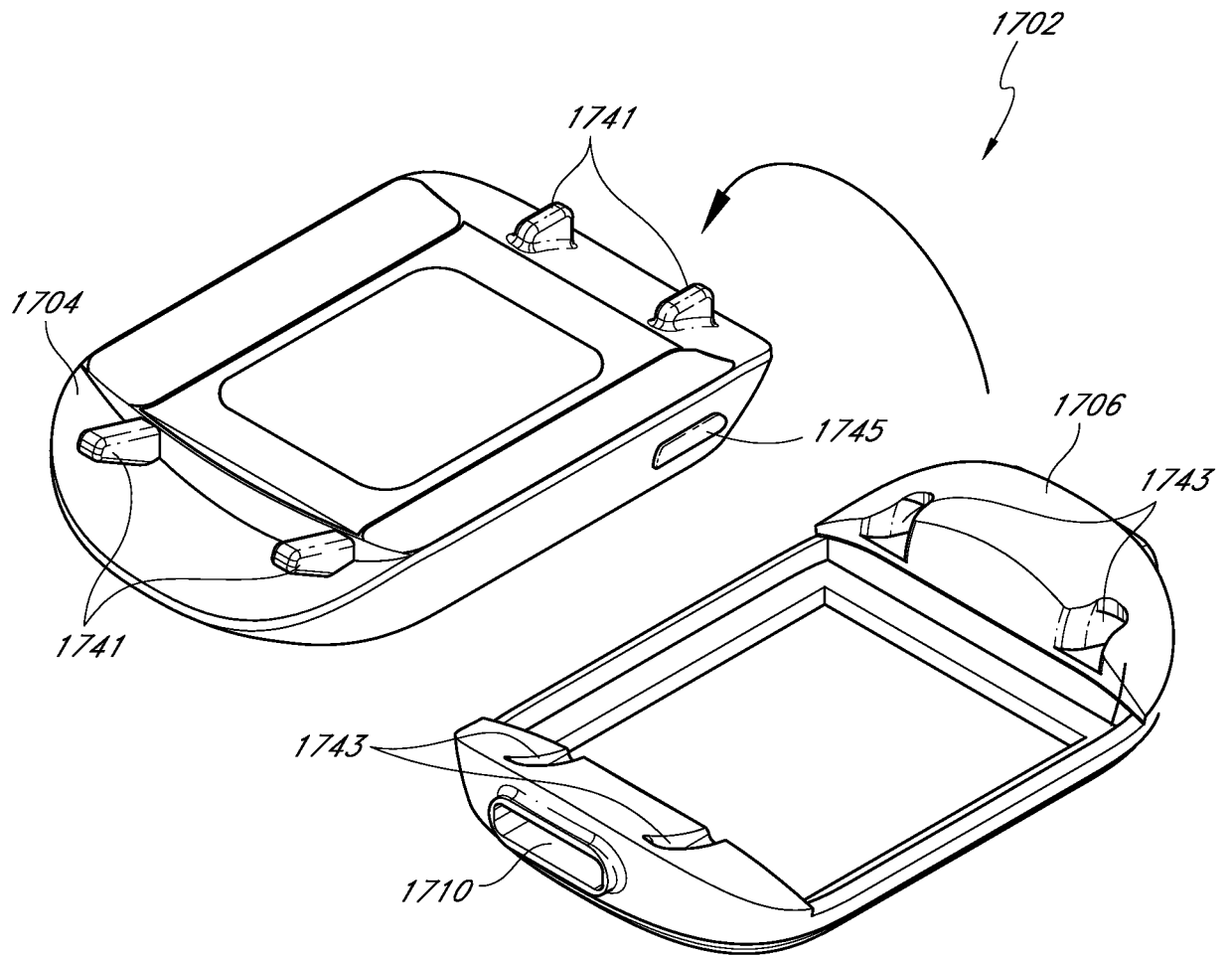


FIG. 17B

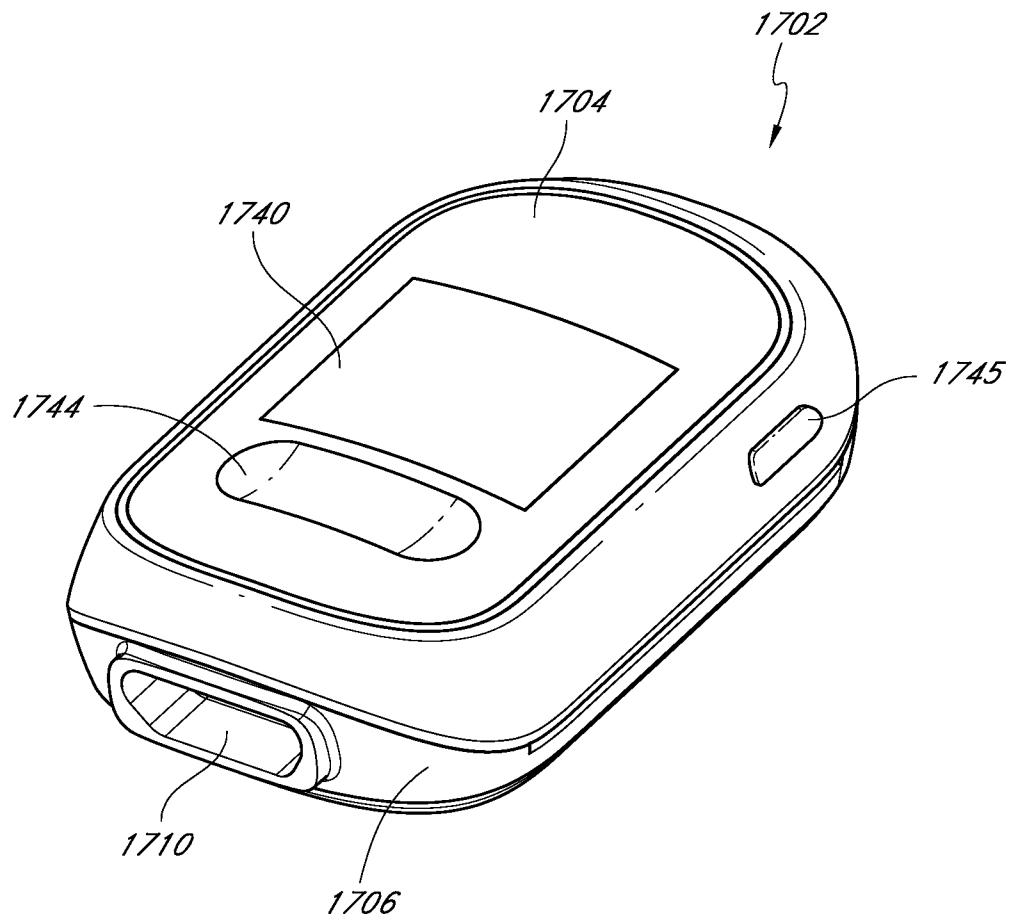


FIG. 17C

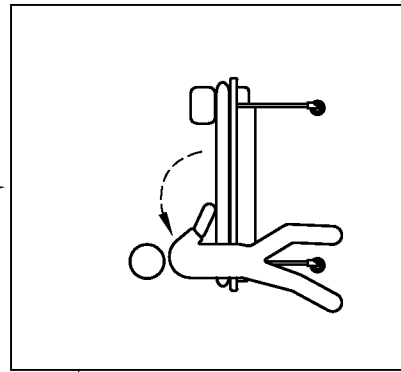
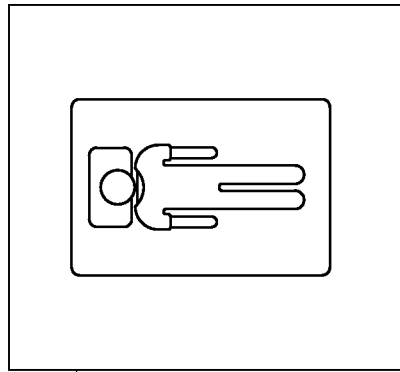


FIG. 18A

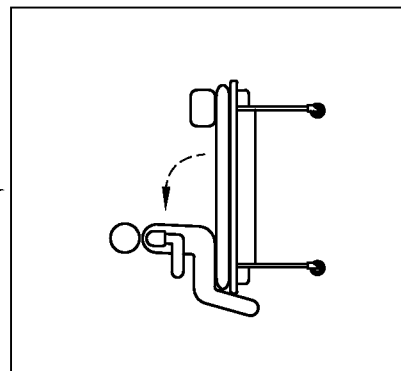
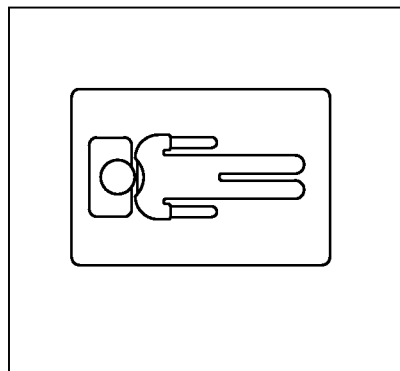


FIG. 18B

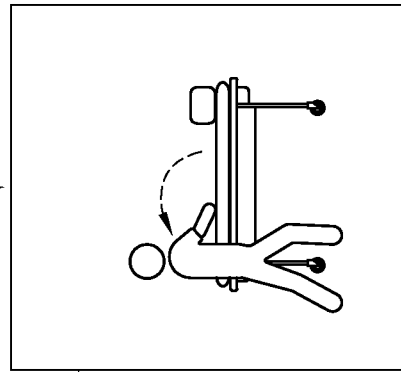
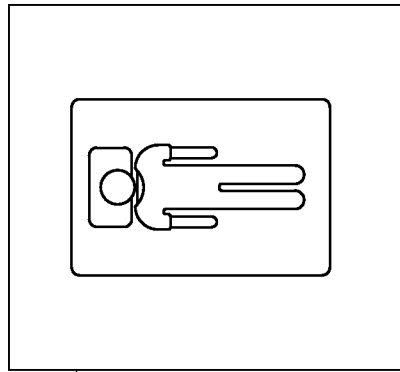


FIG. 18C

专利名称(译)	无线患者监护设备		
公开(公告)号	EP2811894A2	公开(公告)日	2014-12-17
申请号	EP2013705892	申请日	2013-02-08
[标]申请(专利权)人(译)	梅西莫股份有限公司		
申请(专利权)人(译)	Masimo公司		
当前申请(专利权)人(译)	Masimo公司		
[标]发明人	MUHSIN BILAL KIANI MASSI JOE E AL ALI AMMAR DEJONG CHAD A BARKER NICHOLAS EVAN KINAST ERIC KARL		
发明人	MUHSIN, BILAL KIANI, MASSI JOE, E. AL-ALI, AMMAR DEJONG, CHAD, A. BARKER, NICHOLAS, EVAN KINAST, ERIC, KARL		
IPC分类号	A61B5/00 A61B5/024 A61B5/1455		
CPC分类号	A61B5/002 A61B5/0024 A61B5/02416 A61B5/14551 A61B2560/0266 A61B2560/0475 G16H10/60 G16H40/20 G16H40/63 A61B5/0022 A61B5/0059 A61B5/0261 A61B5/0295 A61B5/14552 A61B5/6826 A61B5/6831 A61B5/6833 A61B5/725 A61B5/7405 A61B5/7425 A61B5/7445 A61B5/746 A61B2560 /0214		
代理机构(译)	法思博事务所		
优先权	61/597126 2012-02-09 US 61/625584 2012-04-17 US 61/703713 2012-09-20 US		
外部链接	Espacenet		

摘要(译)

一种用于获得医疗患者的生理信息并将获得的生理信息无线发送到无线接收器的设备。