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- (54) **MODULAR PATIENT MONITOR** 4,231,354 A 11/1980 Kurtz et al.
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(57) **ABSTRACT**

A modular patient monitor has a docking station configured to accept a handheld monitor. The docking station has standalone patient monitoring functionality with respect to a first set of parameters. At least some of the first parameter set are displayed simultaneously on a full-sized screen integrated with the docking station. The handheld monitor also has standalone patient monitoring functionality with respect to a second set of parameters. At least some of the second set of parameters are displayed simultaneously on a handheld-sized screen integrated with the handheld monitor. The docking station has a port configured to accept the handheld monitor. While the handheld monitor is docketed in the port, the docking station functionally combines the first set of parameters and the second set of parameters, and at least some of the combined first and second sets of parameters are displayed simultaneously on the full-sized screen.

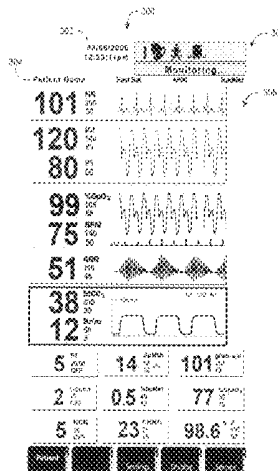
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(58) **Field of Classification Search**  
None  
See application file for complete search history.

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**15 Claims, 17 Drawing Sheets**



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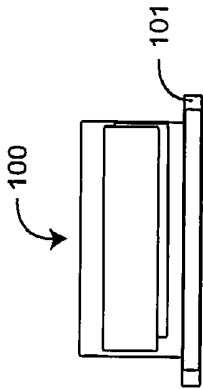


FIG. 1A

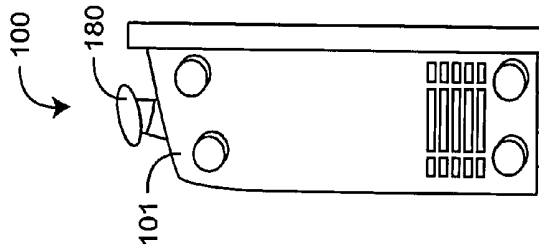


FIG. 1B

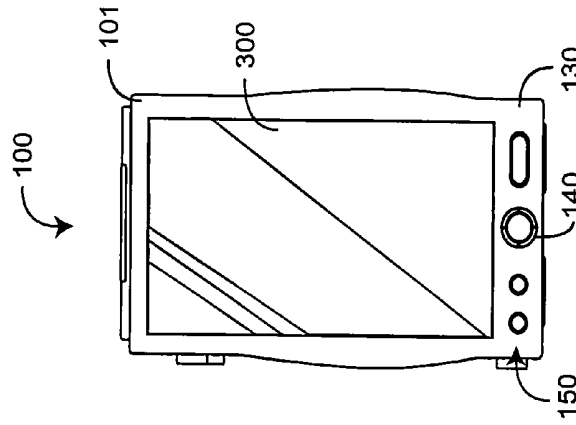


FIG. 1C

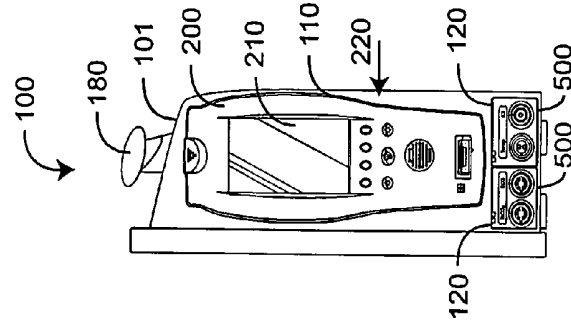


FIG. 1D

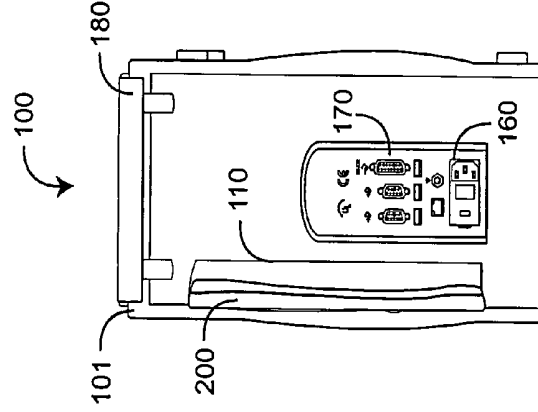


FIG. 1E

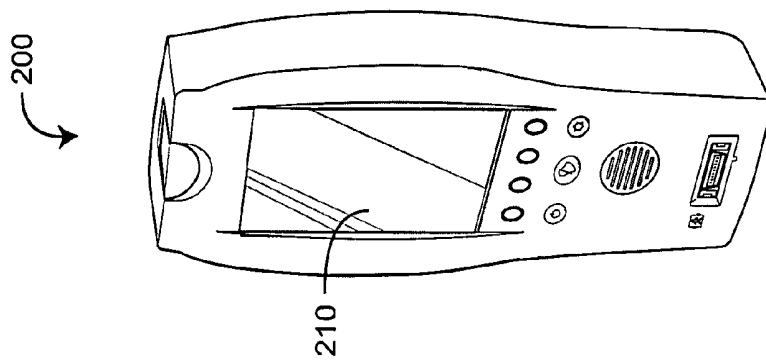


FIG. 2B

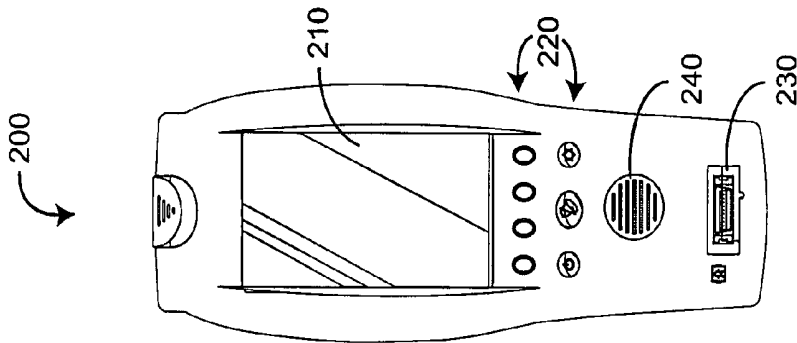


FIG. 2A

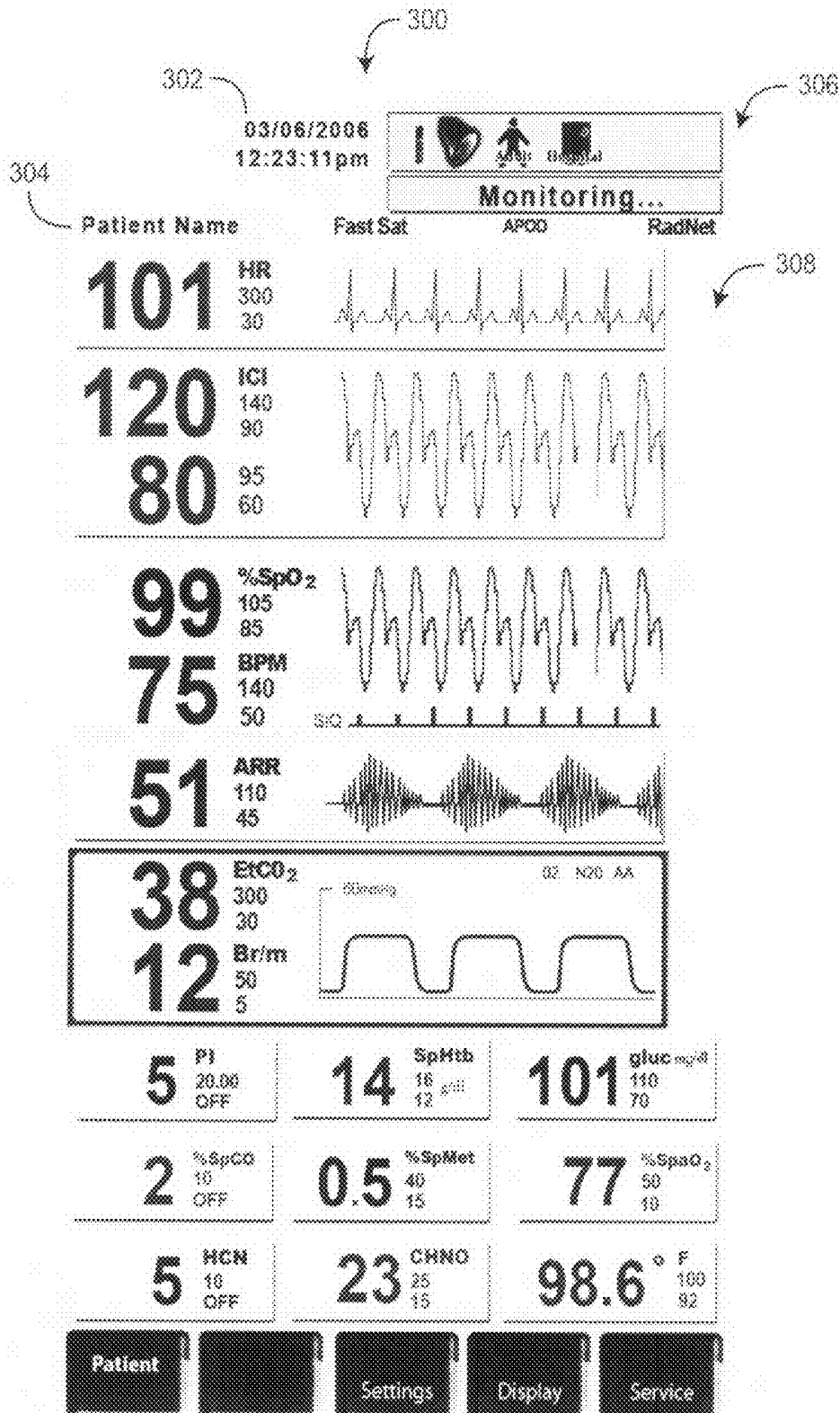


FIG. 3

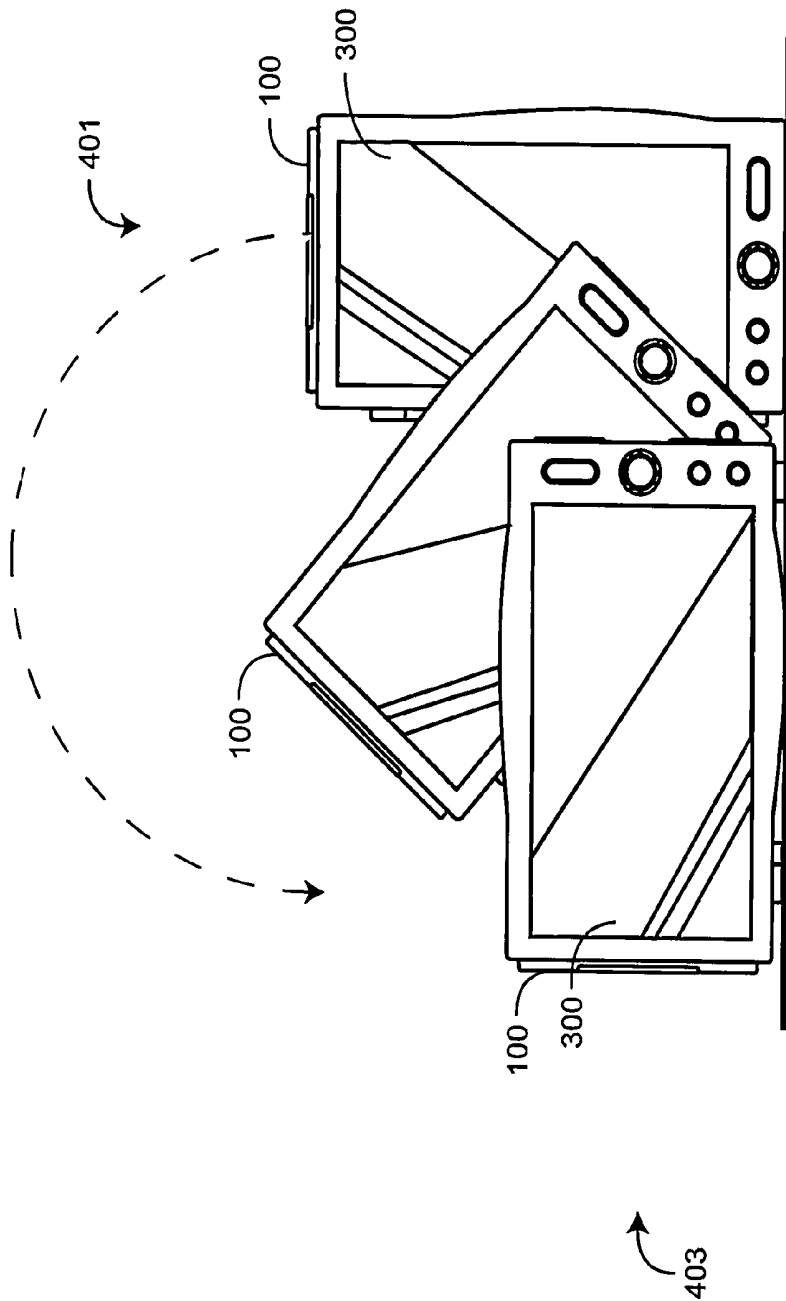


FIG. 4

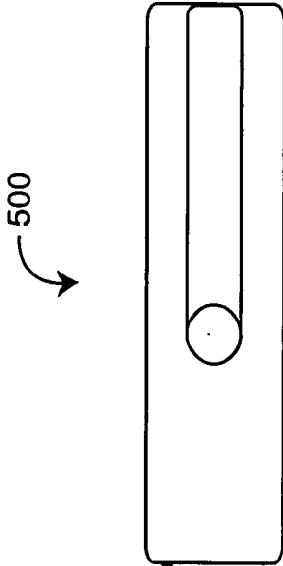


FIG. 5A

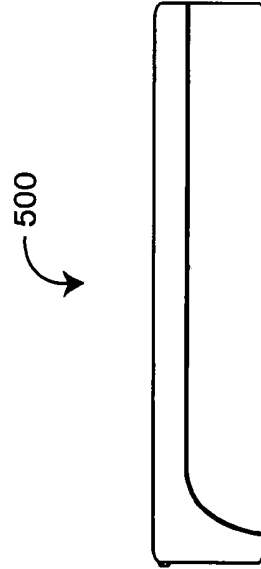


FIG. 5C

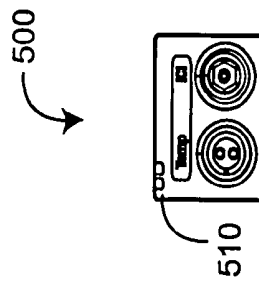


FIG. 5B

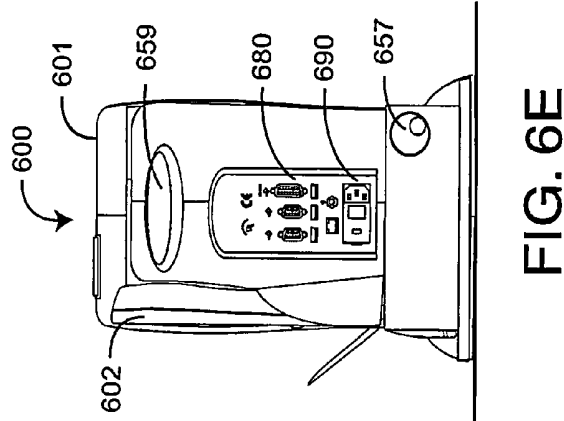
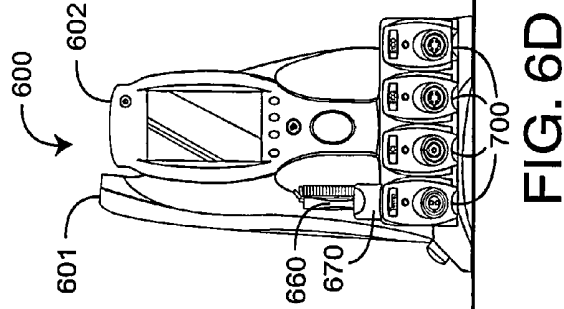
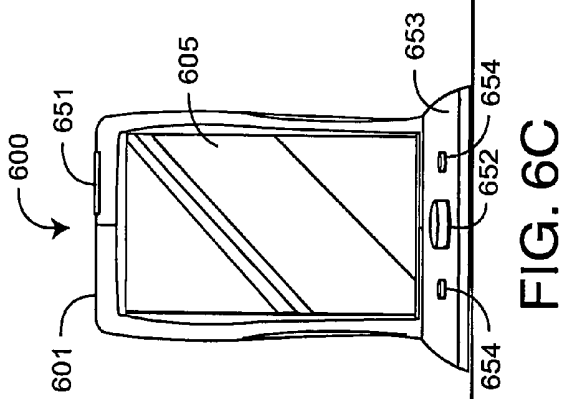
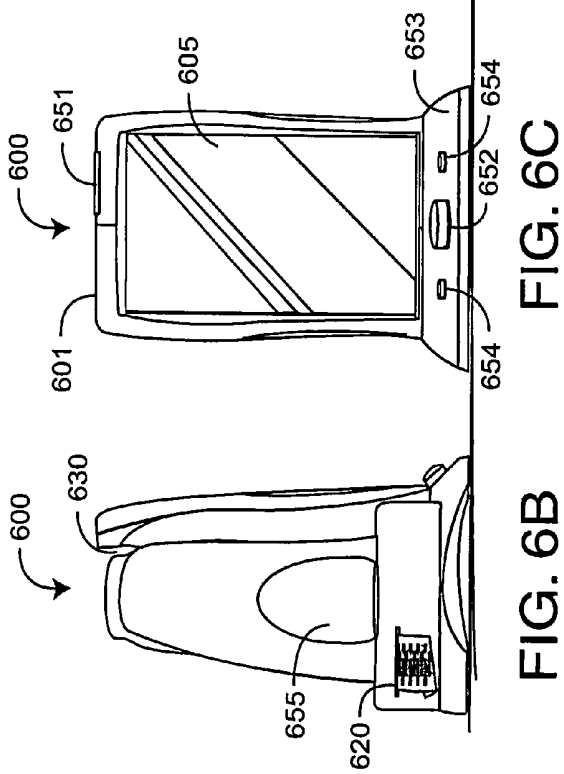
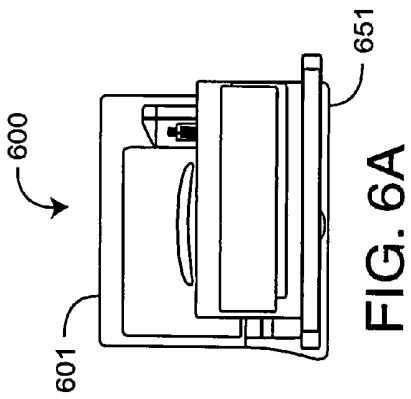


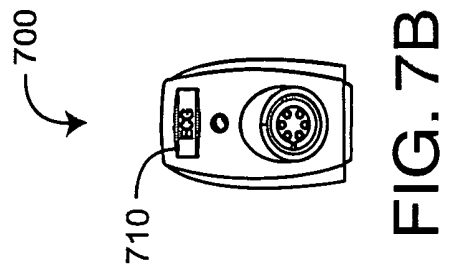
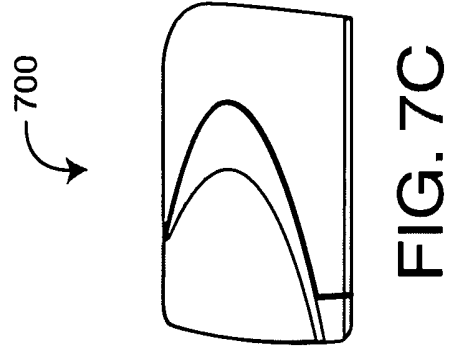
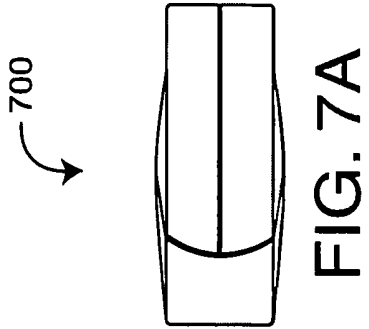
FIG. 6A

FIG. 6B

FIG. 6C

FIG. 6D

FIG. 6E



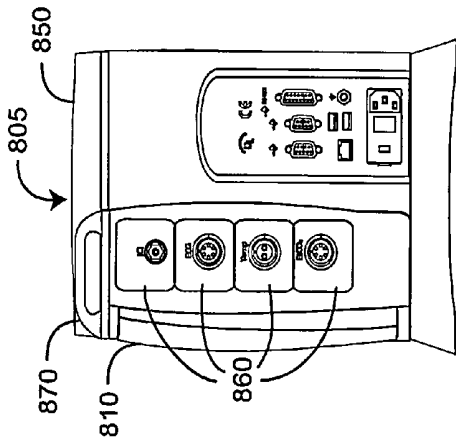


FIG. 8A

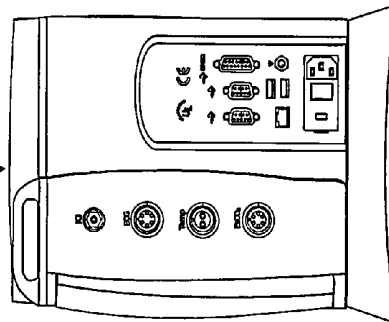


FIG. 8B

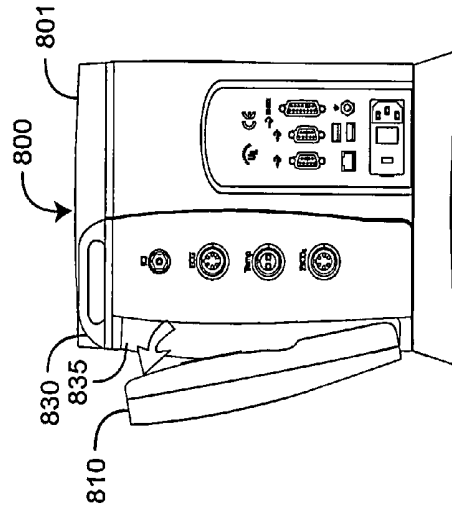


FIG. 8C

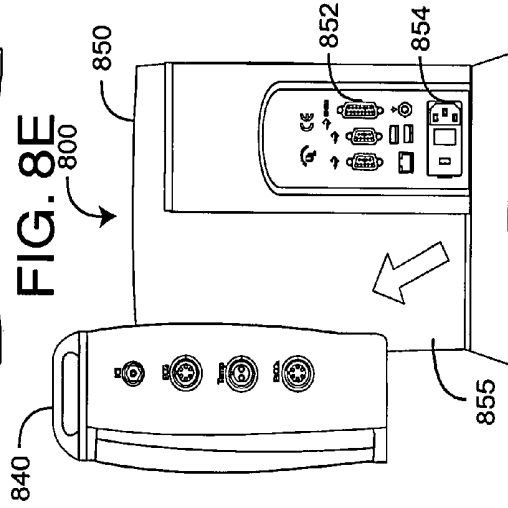


FIG. 8D

FIG. 8E

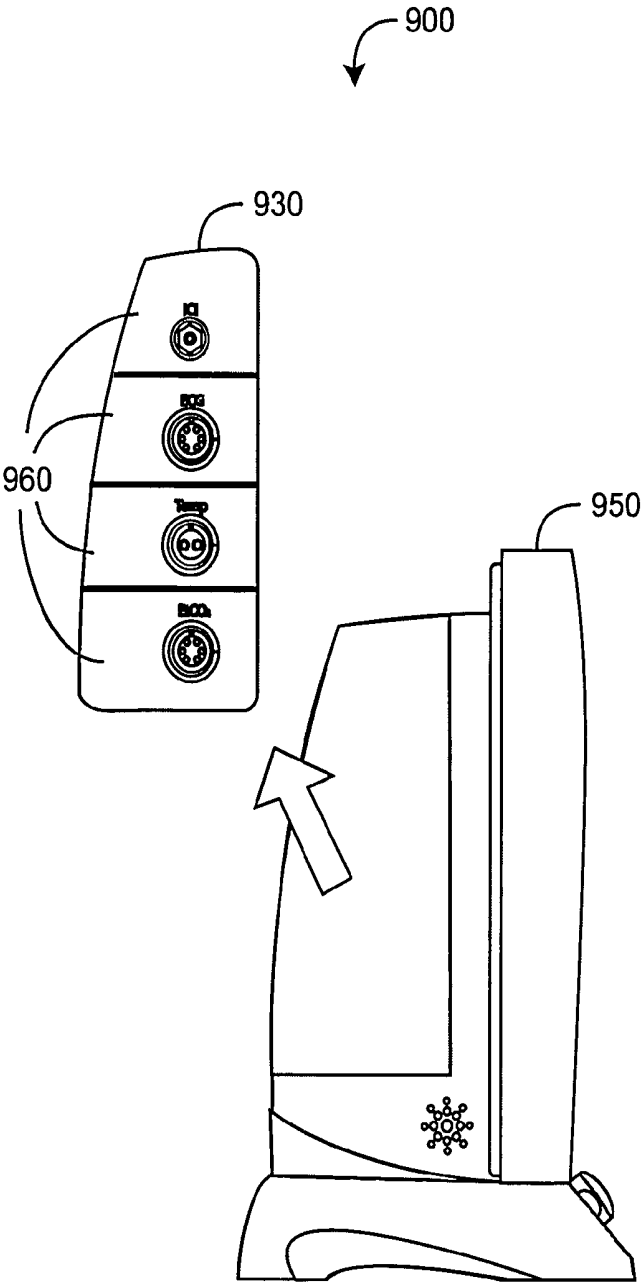


FIG. 9

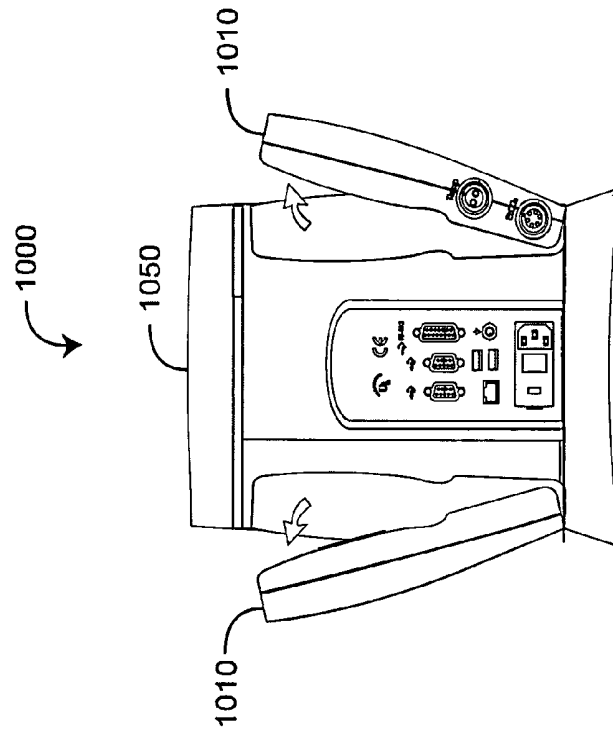


FIG. 10A

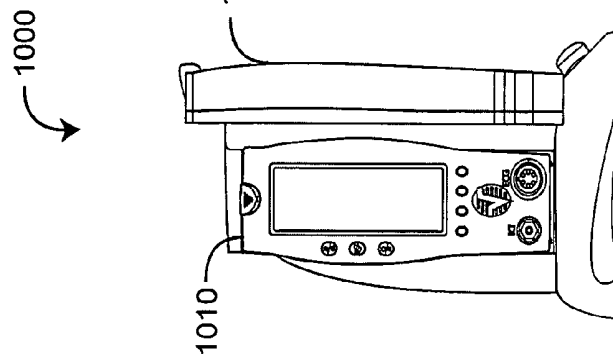


FIG. 10B

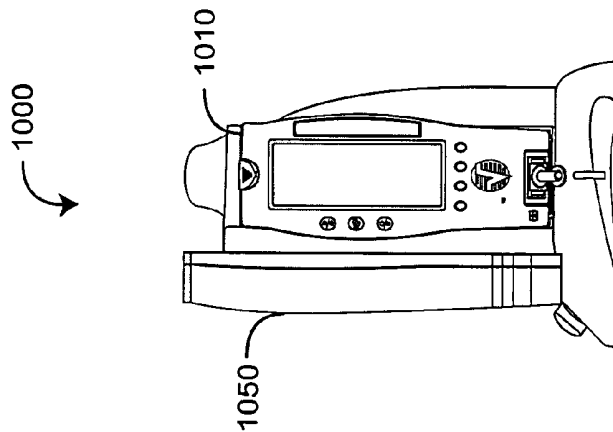


FIG. 10C

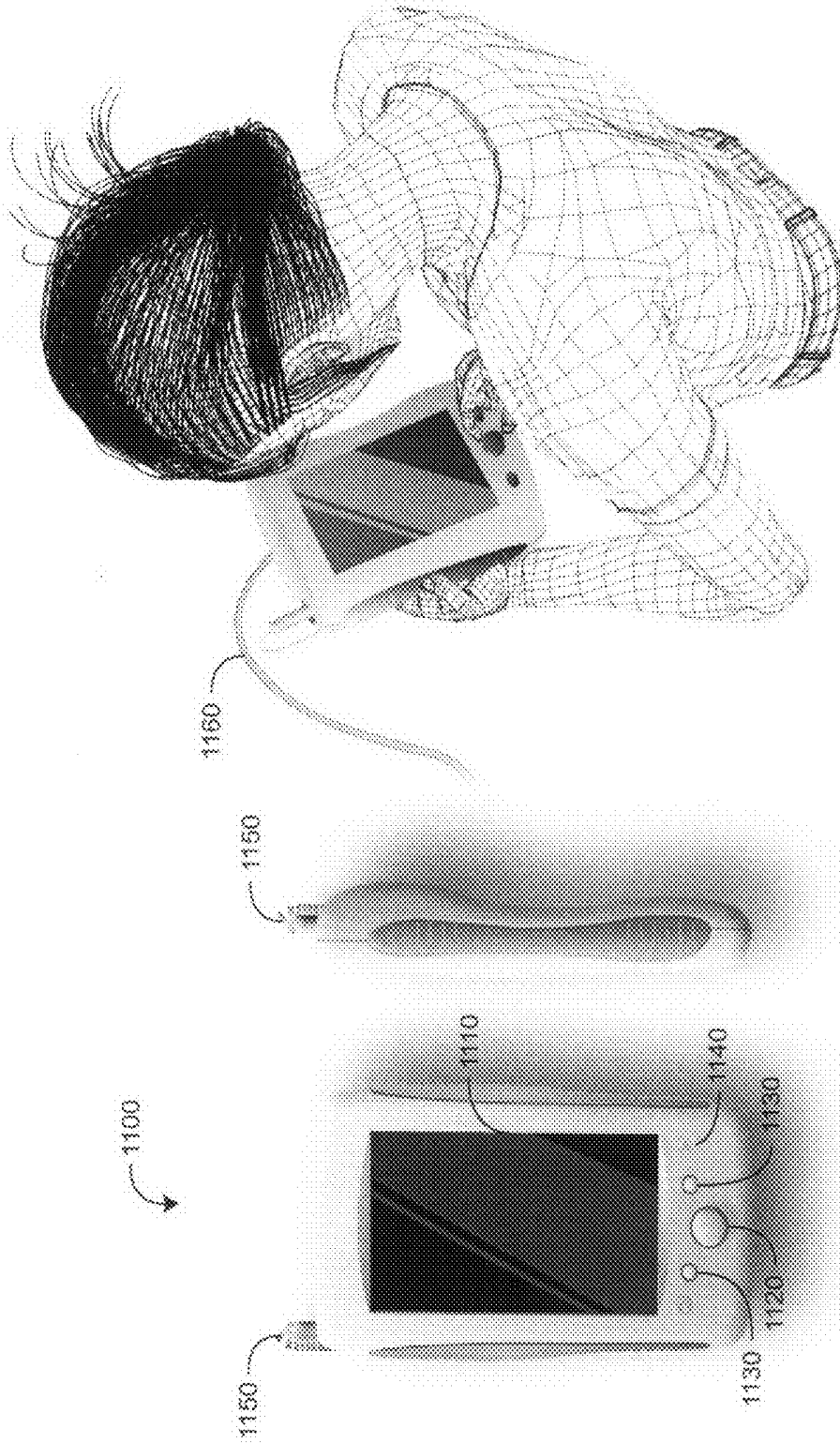


FIG. 11C

FIG. 11A FIG. 11B

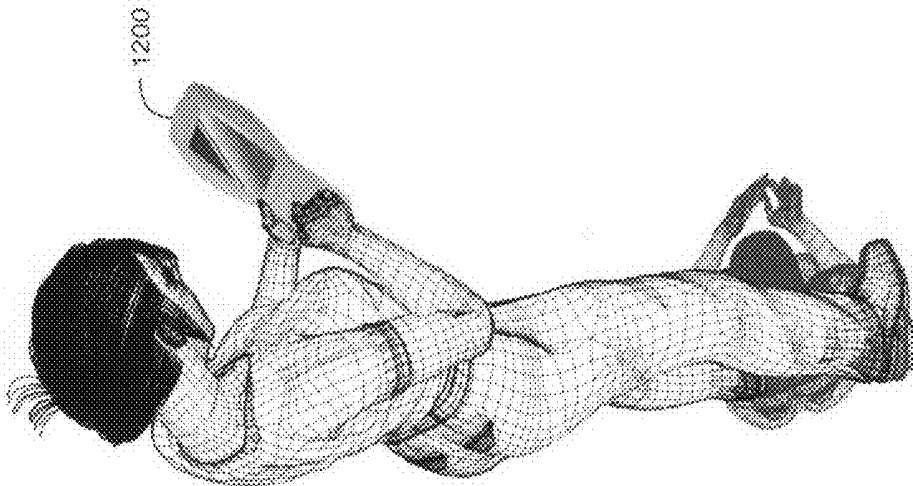


FIG. 12A

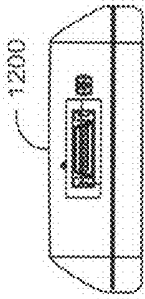


FIG. 12B

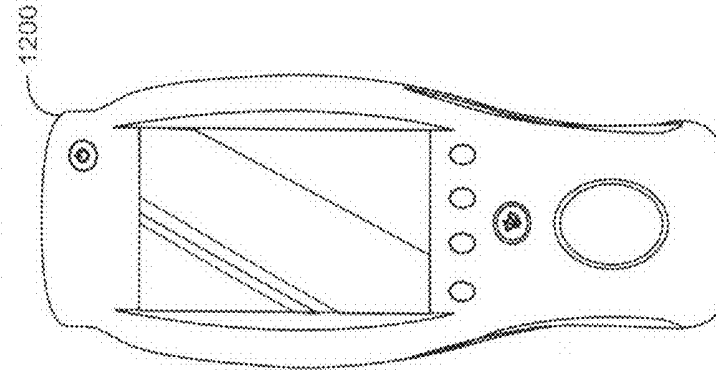


FIG. 12C

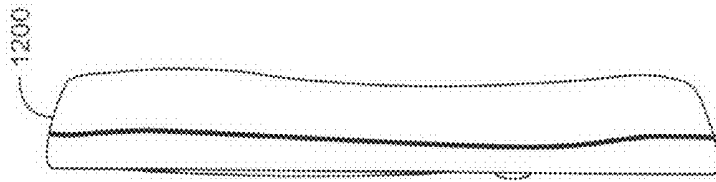


FIG. 12D

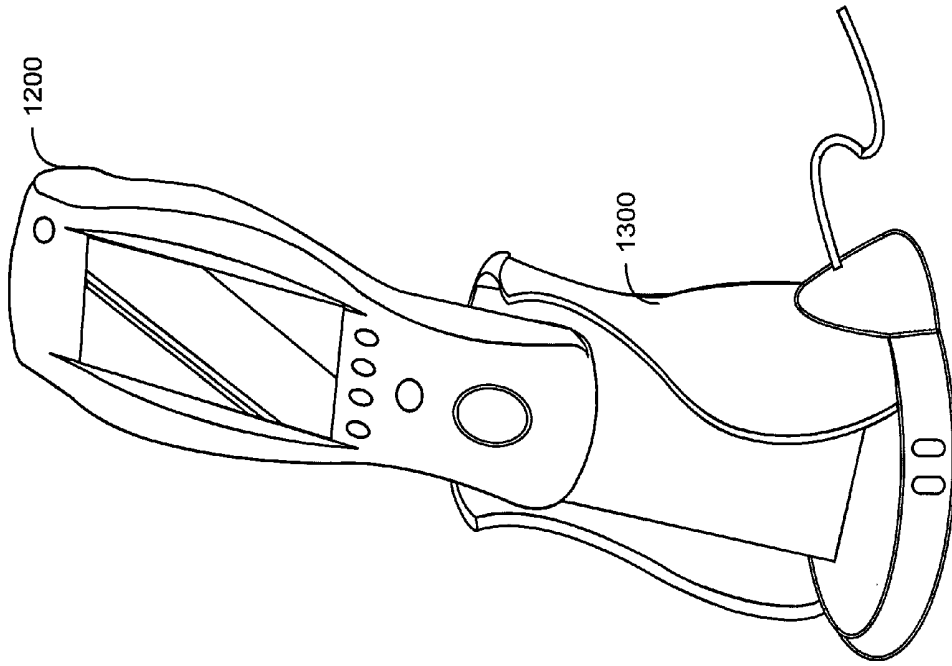


FIG. 13B

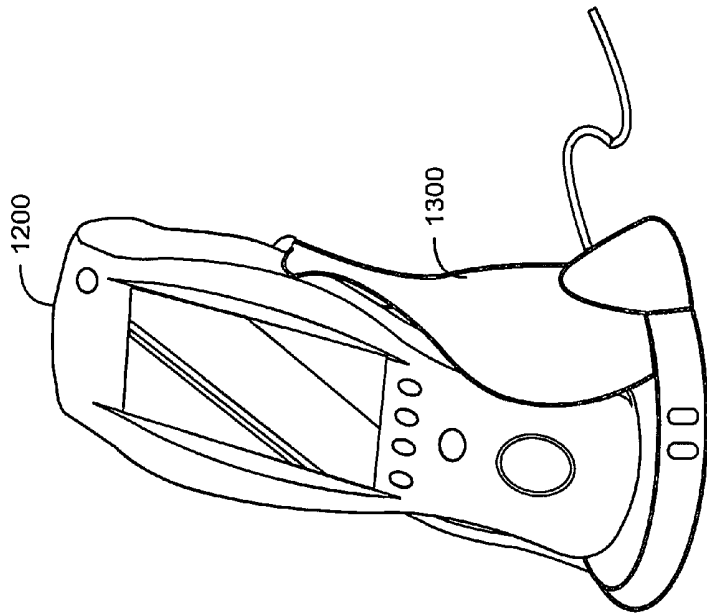


FIG. 13A

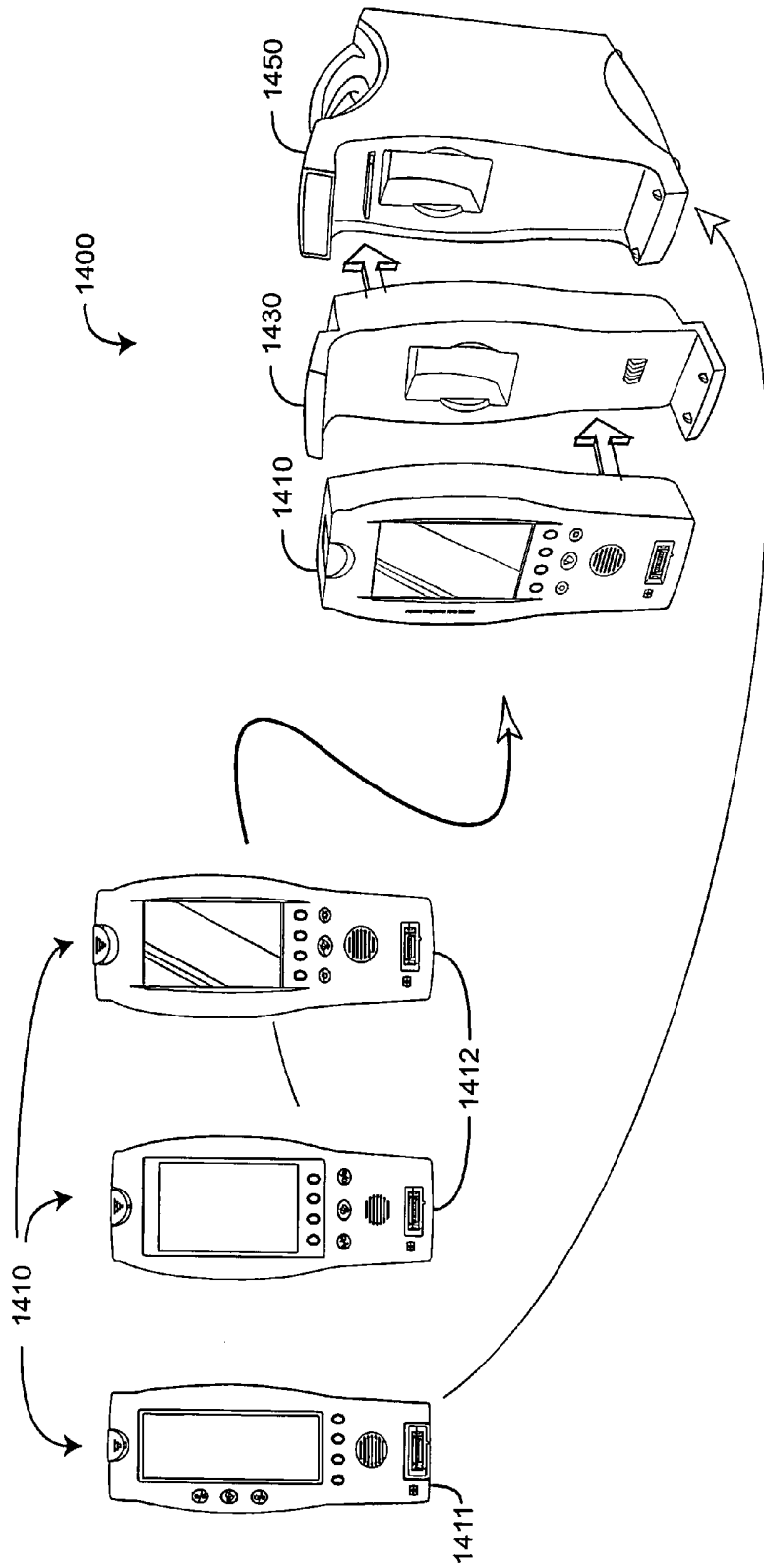


FIG. 14

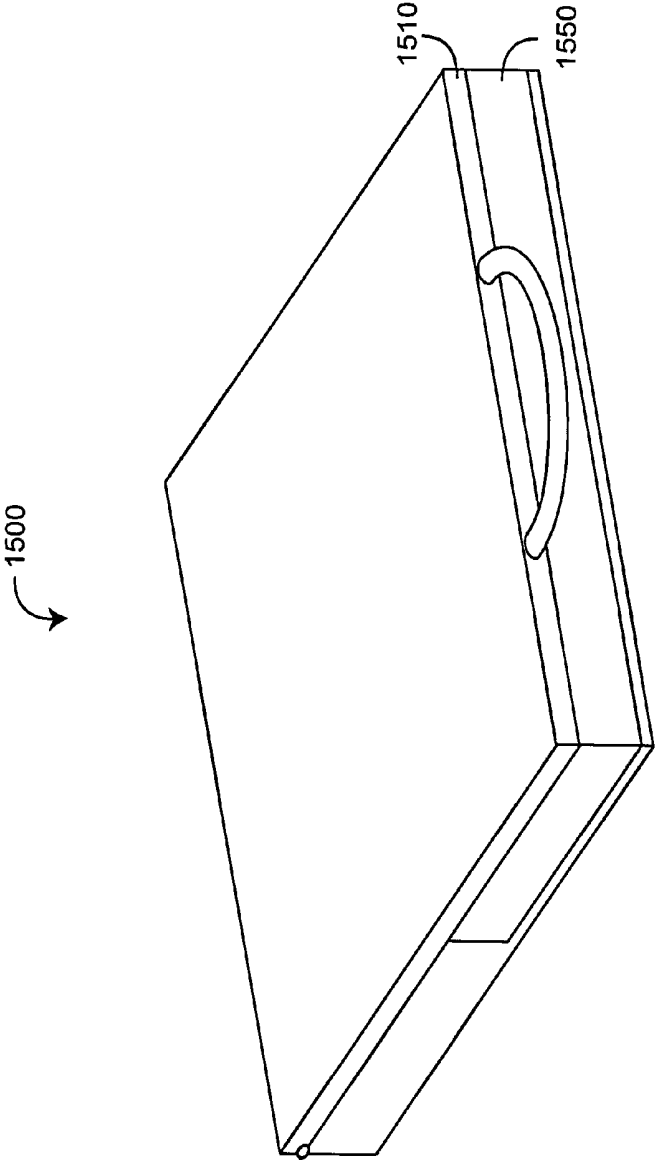


FIG. 15A

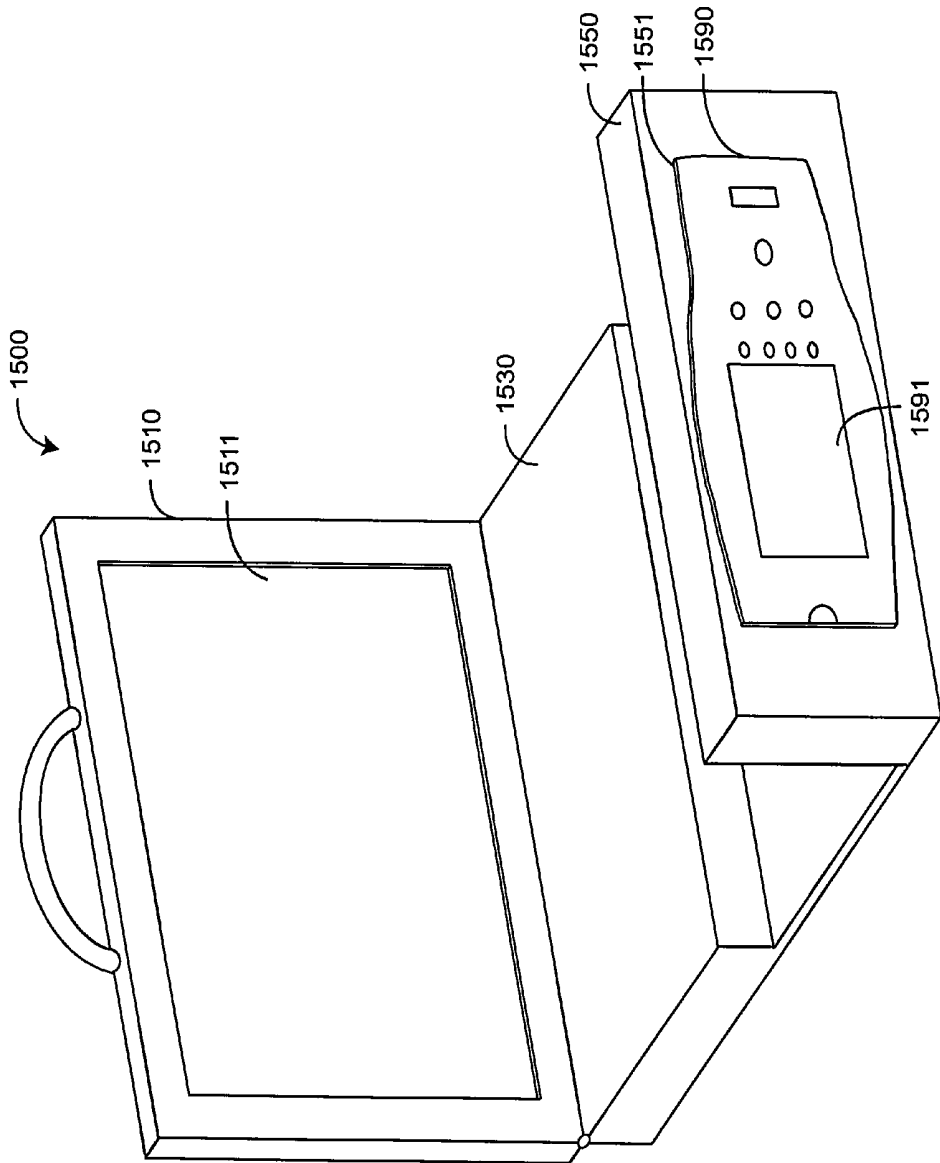


FIG. 15B

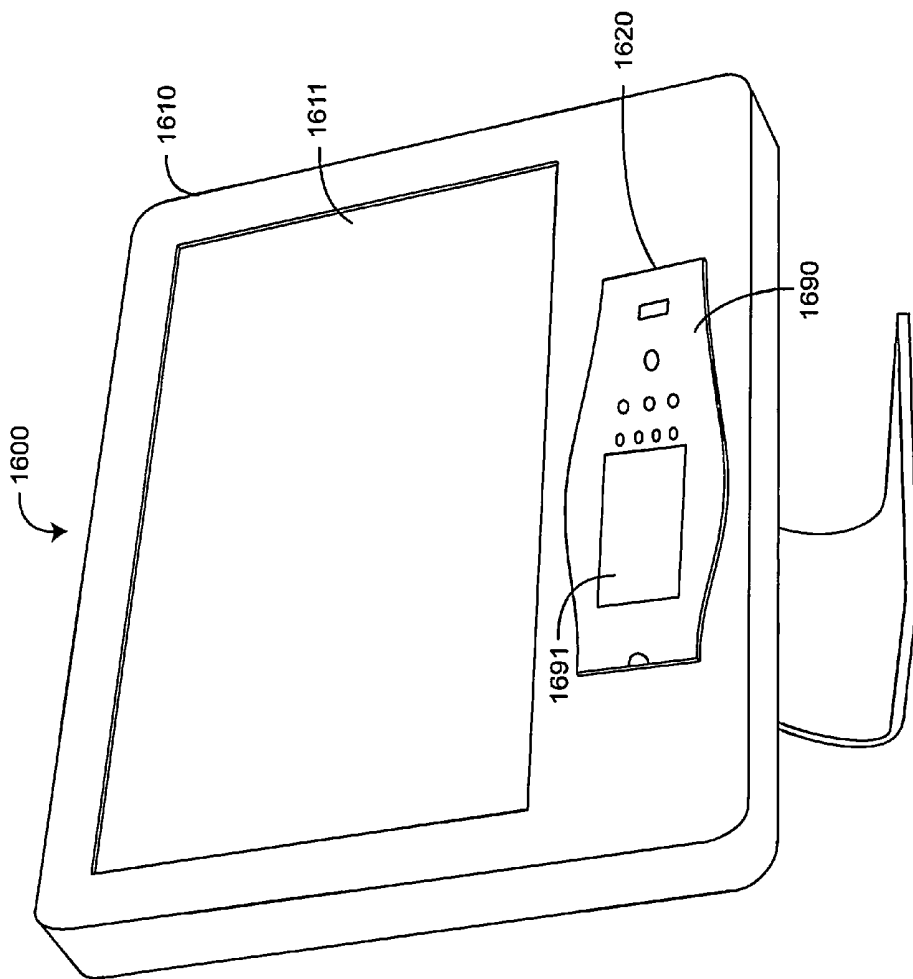


FIG. 16

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**MODULAR PATIENT MONITOR****CROSS-REFERENCE TO RELATED APPLICATIONS**

This application relates to and claims the benefit of prior U.S. Provisional Application No. 60/846,471, filed Sep. 22, 2006, entitled Modular Patient Monitor, incorporated by reference herein.

**BACKGROUND OF THE INVENTION**

Pulse oximetry is a widely accepted continuous and non-invasive method of measuring the level of arterial oxygen saturation in blood. A typical pulse oximetry system has a sensor, a patient monitor and a patient cable. The sensor is placed on a patient fleshy tissue site, usually on the fingertip for adults and the hand or foot for neonates and connected to the patient monitor via the patient cable. The sensor provides a sensor signal detected from the patient tissue site to the patient monitor. The patient monitor displays the calculated data as a percentage value for arterial oxygen saturation (SpO<sub>2</sub>), as a pulse rate (PR) and as a pulse waveform (plethysmograph or "pleth").

**SUMMARY OF THE INVENTION**

A modular patient monitor provides a multipurpose, scalable solution for various patient monitoring applications. In an embodiment, a modular patient monitor utilizes multiple wavelength optical sensor and acoustic sensor technologies to provide blood constituent monitoring and acoustic respiration monitoring (ARM) at its core, including pulse oximetry parameters and additional blood parameter measurements such as carboxyhemoglobin (HbCO) and methemoglobin (HbMet). Pulse oximetry monitors and sensors are described in U.S. Pat. No. 5,782,757 entitled Low Noise Optical Probes and U.S. Pat. No. 5,632,272 entitled Signal Processing Apparatus, both incorporated by reference herein. Advanced blood parameter monitors and sensors providing blood parameter measurements in addition to pulse oximetry are described in U.S. patent application Ser. No. 11/367,013, filed Mar. 1, 2006 entitled Multiple Wavelength Sensor Emitters and U.S. patent application Ser. No. 11/367,014, filed Mar. 1, 2006 entitled Non-Invasive Multi-Parameter Monitor, both incorporated by reference herein. Acoustic respiration sensors and monitors are described in U.S. Pat. No. 6,661,161 entitled Piezoelectric Biological Sound Monitor with Printed Circuit Board and U.S. patent application Ser. No. 11/547,570 filed Oct. 6, 2006 entitled Non-Invasive Monitoring of Respiration Rate, Heart Rate and Apnea, both incorporated by reference herein.

Expansion modules provide blood pressure BP, blood glucose, ECG, CO<sub>2</sub>, depth of sedation and cerebral oximetry to name a few. The modular patient monitor is advantageously scalable in features and cost from a base unit to a high-end unit with the ability to measure multiple parameters from a variety of sensors. In an embodiment, the modular patient monitor incorporates advanced communication features that allow interfacing with other patient monitors and medical devices.

The modular patient monitor is adapted for use in hospital, sub-acute and general floor standalone, multi-parameter measurement applications by physicians, respiratory therapists, registered nurses and other trained clinical caregivers. It can be used in the hospital to interface with central monitoring and remote alarm systems. It also can be used to obtain

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routine vital signs and advanced diagnostic clinical information and as an in-house transport system with flexibility and portability for patient ambulation. Further uses for the modular patient monitor are clinical research and other data collection.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIGS. 1A-E are top, side, front, right and back views of a modular patient monitor;

FIGS. 2A-B are front and perspective views of a handheld monitor;

FIG. 3 is a docking station multiple parameter display;

FIG. 4 is an illustration of a modular patient monitor having 90 degree rotation with corresponding display rotation;

FIGS. 5A-C are top, front and side views of a monitor cartridge;

FIGS. 6A-E are top, side, front, right and back views of another modular patient monitor embodiment having alternative cartridge embodiments;

FIGS. 7A-C are top, front and side views of an alternative cartridge embodiment;

FIGS. 8A-E are a front and various back views of yet another modular patient monitor embodiment having a shuttle, including a display and control; a docked shuttle; a docked shuttle with an undocked handheld; an undocked shuttle; and a shuttle having a handheld;

FIG. 9 is a modular patient monitor side view of a further modular patient monitor embodiment having a shuttle without a docking handheld;

FIGS. 10A-C are side views and a back view, respectively, of an additional modular patient monitor embodiment having dual dockable handhelds;

FIGS. 11A-C are illustrations of a tablet-configured handheld monitor;

FIGS. 12A-D are front perspective, top, front and side views of an alternative handheld embodiment;

FIGS. 13A-B are front perspective views of an alternative handheld embodiment plugged into, and removed from, a charger;

FIG. 14 is a perspective view of upgrade and legacy handhelds installable into a legacy docking station directly or via a docking station adapter;

FIGS. 15A-B are closed and opened views, respectively, of a notebook-style modular patient monitor embodiment having a foldable display; and

FIG. 16 is a perspective view of a flat panel display docking station.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

FIGS. 1A-E illustrate a modular patient monitor embodiment **100** having a two-piece modular configuration, a handheld **200** unit and a configurable docking station **101**. The handheld **200** docks into a handheld port **110** of the docking station **101**, providing the modular patient monitor **100** with two-in-one functionality. In particular, the handheld **200** provides a specific set of clinically relevant parameters. The docking station **101** supports various parameters that are configured to specific hospital environments and/or patient populations including general floor, OR, ICU, ER, NICU, to name a few. Further, the docking station **101** has module ports **120** that accept plug-in expansion modules **500** for additional parameters and technologies. The handheld **200** docked into the docking station **101** allows access to all available parameters providing maximum connectivity, functionality and a

larger color display **300**. The modular patient monitor **100** provides standalone multi-parameter applications, and the handheld **200** is detachable to provide portability for patient ambulation and in-house transport.

As shown in FIGS. 1A-E, the docking station **101** has a dashboard **130**, with a trim knob **140** and buttons **150** so as to support system navigation and data entry. The trim knob **140** is a primary means for system navigation and data entry with an option of a keyboard and mouse as a secondary means.

The docking station **101** also has a power supply module **160** and connectivity ports **170**. The handheld **200** mechanically attaches to and electrically connects to the docking station **101** when docked, such that the two devices function as one unit and both the handheld display **210** and the docking station display **300** provide user information. In an embodiment, the handheld **200** docks on a docking station side such that the handheld display **200** is visible from that side of the docking station **101** (FIG. 1D). In addition, the docking station **101** has one or more module slots **120** that accommodate external modules **400**, as described with respect to FIGS. 4A-C, below.

Also shown in FIGS. 1A-E, controls of the docking station **101** take precedence over those of the handheld **200** when docked. However, the handheld buttons **220** also work for back up purposes. In an embodiment, buttons **150**, **220** on the docking station dashboard **130** and on the handheld **200** provide for alarm suspend/silence and mode/enter. The trim knob **140** is the primary method to toggle thru screen menus on the dashboard **130**. The procedure includes next, up, down or across page navigation, parameter selection and entry, data entry, alarm limit selection and selection of probe-off detection sensitivity. As a secondary control method, the modular patient monitor **100** has a port for an external keyboard for patient context entry and to navigate the menu. In an embodiment, the docking station **150** has a touch screen. In an embodiment, the modular patient monitor **100** has a bar code scanner module adapted to automatically enter patient context data.

The modular patient monitor **100** includes an integral handle for ease of carrying and dead space for storage for items such as sensors, reusable cables, ICI cable and cuff, EtCO<sub>2</sub> hardware and tubing, temperature disposables, acoustic respiratory sensors, power cords and other accessories such as ECG leads, BP cuffs, temperature probes and respiration tapes to name a few. The monitor **100** can operate on AC power or battery power. The modular patient monitor **100** stands upright on a flat surface and allows for flexible mounting such as to an anesthesia machine, bedside table and computer on wheels.

FIGS. 2A-B illustrate a handheld monitor **200**, which provides pulse oximetry parameters including oxygen saturation (SpO<sub>2</sub>), pulse rate (PR), perfusion index (PI), signal quality (SiQ) and a pulse waveform (pleth), among others. In an embodiment, the handheld **200** also provides measurements of other blood constituent parameters that can be derived from a multiple wavelength optical sensor, such as carboxy-hemoglobin (HbCO) and methemoglobin (HbMet). The handheld **200** has a color display **210**, user interface buttons **220**, an optical sensor port **230** and speaker **240**. The handheld **200** also has external I/O such as a bar code reader and bedside printer connectivity. The handheld **200** also has a flexible architecture, power and memory headroom to display additional parameters, such as Sp<sub>2</sub>O<sub>2</sub>, blood glucose, lactate to name a few, derived from other noninvasive sensors such as acoustic, fetal oximetry, blood pressure and ECG sensors to name a few. In an embodiment, the handheld unit **200** has an active matrix (TFT) color display **210**, an optional wireless

module, an optional interactive touch-screen with on-screen keyboard and a high quality audio system. In another embodiment, the handheld **200** is a Radical or Radical-7™ available from Masimo Corporation, Irvine Calif., which provides Masimo SET® and Masimo Rainbow™ parameters. A color LCD screen handheld user interface is described in U.S. Provisional Patent Application No. 60/846,472 titled Patient Monitor User Interface, filed Sep. 22, 2006 and U.S. Pat. No. \_\_\_\_\_ titled Patient Monitor User Interface, filed Sep. 24, 2007, both applications incorporated by reference herein.

FIG. 3 illustrates a modular patient monitor color display **300**. The modular patient monitor display **300** auto-scales its presentation of parameter information based upon the parameters that are active. Fewer parameters result in the display **300** of larger digits and more waveform cycles. In an embodiment, the display **300** has a main menu screen showing date and time **302**, patient data **304**, battery life and alarm indicators **306** and all enabled parameters **308**. Date and time **302** can be enabled or disabled. The display **300** may also have dynamic bar graphs or indicators to show perfusion index and signal quality. Waveforms are displayed for SpO<sub>2</sub>, NIBP (non-invasive blood pressure), EtCO<sub>2</sub> (end-tidal carbon dioxide) and ECG (electrocardiogram) if enabled. Trend waveforms are displayed for parameters that are less dynamic, such as HbCO and HbMet. Further, the display **300** has individual text displays for alarms, alarm suspend, sensor off or no sensor, battery condition, sensitivity, trauma mode, AC power, printer function, recording function, connectivity messages and menus to name a few. Pulse search is indicated by blinking dashes in the pulse and parameter displays. In an embodiment, the color display **300** is an 11.1" LCD with allowance for the use of a 10.4" LCD within the standard mechanical design for the 11.1" display. The docking station **101** also supports any external VGA display.

An exemplar color print illustration of the color display **300** is disclosed in U.S. Provisional Application No. 60/846,471 entitled Modular Patient Monitor, cited above. In particular, each of the displayed parameters are variously presented in one of a off-white to white shade, lime green to green shade, crimson to red shade, generally turquoise shade, generally chartreuse shade, yellow to gold shade, generally blue and generally purple shade, to name a few.

FIG. 4 illustrates a modular patient monitor **100** having a vertical orientation **401** and a horizontal orientation **403**. In the vertical orientation **401**, the display **300** presents data in a vertical format, such as shown in FIG. 3, above. In the horizontal orientation **403**, the display **300** presents data in a horizontal format, so that the data appears upright with respect to the viewer. That is, the display **300** automatically switches format according to the patient monitor **100** orientation. A patient monitor having a rotatable display format is described in U.S. Pat. No. 6,770,028 entitled Dual Mode Pulse Oximeter and incorporated by reference herein.

FIGS. 5A-C illustrate an expansion module **500**, which the docking station **101** (FIGS. 1A-E) accepts for additional parameters and technologies, such as ICI-NIBP, glucose monitoring, ECG, EtCO<sub>2</sub>, conscious sedation monitoring, cerebral oximetry, anesthetic agent monitoring, lactate, patient body temperature and assay cartridges, to name a few. The expansion module **500** has an indicator **510** indicating parameters to be provided. In one embodiment, the expansion module **500** provides two parameters to the docking station, which is adapted to accept two modules **500** for four additional parameters. In an embodiment, an ECG module is used to provide an R-wave trigger for ICI-NIBP.

As shown in FIGS. 1A-E, the modular patient monitor **100** includes various connectivity ports **170** such as Ethernet,

USB, RS-232, RS-423, nurse call, external VGA and I/O ports for a keyboard and a bar code reader to name a few. As an option, the modular patient monitor **100** has on-board and bedside recorder capability. The modular patient monitor **100** also supports multiple wireless and hardwired communication platforms, web server technology that allows remote viewing of data as well as limited bi-directional control of module functionality and an optional wireless connectivity standards base technology, such as IEEE 802.11x. The wireless option is provided in the handheld **200** and the docking station **101**. A wireless module supports the downloading and temporary storage of upgrade software from a remote central server to a destination docking station or a specific module. In an embodiment, the modular patient monitor **100** supports patient context management, specifically the ability to upload or alternatively enter patient unique identification. The modular patient monitor **100** also connects both wired and wirelessly to other patient monitors.

The modular patient monitor **100** may be logged onto via the Internet so as to download raw waveforms and stored trending data for both customer service purposes and for data mining to enhance algorithms and so as to be uploaded with firmware updates. The modular patient monitor **100** may also incorporate removable storage media for the same purpose. In an embodiment, removable storage media functions as a black box, which is a diagnostic tool to retrieve device use information. In particular, the black box can record values displayed, raw waveforms including sounds, and buttons touched by the end user. A patient monitor with removable storage media is described in U.S. patent Ser. No. 10/983,048 entitled Pulse Oximetry Data Capture System filed Nov. 5, 2004 and incorporated by reference herein.

The modular patient monitor **100** may also have an audio module slot (not shown) accommodating an external audio system and wireless headphone module. In an embodiment, the docking station **101** audio system is configured to reproduce respiratory sounds from an ARR (acoustic respiratory rate) sensor.

In an embodiment, the modular patient monitor **100** has a redundant speaker system for alarms. The modular patient monitor **100** may also include alarms for all parameters and a parameter fusion alarm that involves analysis of multiple parameters in parallel. A user can select custom default alarm parameters for adult, pediatric and neonatal patients. A patient monitor having redundant alarm speakers is described in U.S. patent application Ser. No. 11/546,927 entitled Robust Alarm System, filed Oct. 12, 2006 and incorporated by reference herein.

An alarm condition exists for low battery, sensor-off patient, defective sensor, ambient light, parameter limit exceeded and defective speakers, as examples. Audible alarm volume is adjustable and when muted, a visual indicator is illuminated. In an embodiment, the volume is adjustable in at least of four discrete steps. The parameter display flashes to indicate which values are exceeding alarm limits, the parameter is enlarged automatically, and numerics are displayed in either RED or with a RED background. The audible alarm is silence-able with a default alarm silence period for up to two minutes. This delay can be user configurable. Separate from sleep mode, the audible alarms are permanently mutable via a password-protected sub-menu. The visual alarm indicator still flashes to indicate an alarm condition. A visual indicator on the dashboard indicates an alarm silence condition, such as blinking for temporary silence and solid for muted. An alarm speaker is mounted so as not to be susceptible to muffling

from a bed surface, attached external monitor surface or other type of flat resting surface. Redundant and smart alarm annunciation is also provided.

The user accesses the setup menu via a front dashboard knob **140** and mode/enter button **150**. TABLE 1 shows user settable parameters. The user can override default settings on a patient-by-patient basis via setup menus.

TABLE 1

PARAMETER SETTINGS	
SpO <sub>2</sub> high & low limit	
Pulse Rate high & low limit	
Pulse Tone volume	
MetHb high and low limit	
HbCO high & low limit	
ICI high and low limit	
tHb high and low limit	
EtCO <sub>2</sub> high and low limit	
ARR high and low limit	
Temp high and low limit	
Glucose high and low limit	
Audible alarm volume	

Default settings are stored in non-volatile memory (NVM). There is a factory, hospital and user default setting which may be automatically based on patient recognition. The user can choose any of the three at any time. The user may over-write hospital and user default settings with their own preferences via a password protected “save as default” setup menu function. All parameters return to hospital default settings after a power cycle.

In one embodiment, the default settings are as shown in TABLE 2, stored in NVM. These settings are also over-written into NVM as a result of a factory reset or return to factory defaults function from within the setup menus.

TABLE 2

PARAMETER	FACTORY DEFAULT
SpO <sub>2</sub> high limit	Off
SpO <sub>2</sub> low limit	90
Pulse Rate high limit	140
Pulse Rate low limit	40
Alarm Volume	2 (of 4)
Pulse tone volume	2 (of 4)
MetHb high limit	5%
MetHb low limit	Off
HbCO high limit	10%
HbCO low limit	Off
LCD brightness	3 (of 5)

FIGS. 6A-E illustrate another modular patient monitor **600** embodiment having a docking station **601**, a handheld monitor **602** and parameter cartridges **700**. Each cartridge **700** provides one parameter to the docking station **601**, which accepts four cartridges **700** for a total of four additional parameters. Further, the patient monitor **600** also has a cord management channel **630**, an oral temperature probe **660** and probe covers **670** located on the docking station **601**. The docking station **601** has a trim knob **652** and control buttons **654** on a front stand **653** so as to support system navigation and data entry. The docking station **601** also has a color display **605**, a thermal printer **620**, an alarm indicator light bar **651**, a thermal printer paper door **657** and a handle **659**, a sensor holder **655**, connectivity ports **680** and a power supply module **690**. FIGS. 7A-C illustrate a parameter cartridge **700** having an indicator **710** indicating the parameter or technology provided.

FIGS. 8A-D illustrate a three-piece modular patient monitor **800** including a handheld monitor **810**, a shuttle station **830** and a docking station **850**. The docking station **850** has a shuttle port **855** that allows the shuttle station **830** to dock. The shuttle station **830** has a handheld port **835** that allows the handheld monitor **810** to dock. Accordingly, the modular patient monitor **800** has three-in-one functionality including a handheld **810**, a handheld **810** docked into a shuttle station **830** as a handheld/shuttle **840** and a handheld/shuttle **840** docked into a docking station **850**. When docked, the three modules of handheld **810**, shuttle **830** and docking station **850** function as one unit.

As shown in FIGS. 8A-D, the handheld module **810** functions independently from the shuttle **830** and docking station **850** and is used as an ultra-light weight transport device with its own battery power. The handheld **810** docked into the shuttle module **830** functions independently of the docking station **850** and expands the handheld parameter capability to the ability to measure all parameters available. The docking station **850**, in turn, provides the shuttle **830** or handheld/shuttle **840** with connectivity ports **852**, a power supply module **854**, a large color display **856**, wireless and hardwired communications platforms, a web server and an optional printer. As such, the docking station **850** charges the handheld **810** and shuttle **830**, provides a larger screen and controls, such as a trim knob, allows wireless, hardwired and Internet communications and provides connectivity to various external devices. FIG. 8E illustrates another modular patient monitor embodiment **805** having a shuttle **870** with plug-in modules **860** for expanded parameter functionality.

In an embodiment, the handheld monitor **810** incorporates blood parameter measurement technologies including HbCO, HbMet, SpO<sub>2</sub> and Hbt, and the shuttle station **830** incorporates non-blood parameters, such as intelligent cuff inflation (ICI), end-tidal CO<sub>2</sub> (EtCO<sub>2</sub>), acoustic respiration rate (ARR), patient body temperature (Temp) and ECG, to name a few. In an alternative embodiment, parameters such as SpO<sub>2</sub>, ARR and ECG that clinicians need during in-house transports or patient ambulation are loaded into the handheld **810**.

FIG. 9 illustrates a two-piece modular patient monitor **900** having a shuttle **930** and a docking station **950** without a corresponding handheld. In an embodiment, the shuttle **930** has plug-in modules **960** for added parameter functions.

FIGS. 10A-C illustrate yet another modular patient monitor **1000** embodiment having dual removable handhelds **1010** and a docking station **1050** without a corresponding shuttle. For example, the handhelds **1010** may include one blood parameter monitor and one non-blood parameter monitor.

FIGS. 11A-C illustrate a handheld tablet monitor **1100** having a display **1110**, a trim knob **1120** and control buttons **1130**. An electroluminescent lamp **1140** on the front panel provides a thin uniform lighting with low power consumption. A temperature probe **1150** is attached to the monitor **1100**. The tablet monitor **1100** connects to a multiple parameter sensor through a patient cable **1160**. FIGS. 12-13 illustrate a handheld monitor **1200** configured to plug into a compact holder/battery charger **1300**. The handheld monitor **1200** is adapted to plug into the compact charger **1300**.

FIG. 14 illustrates a modular patient monitor **1400** embodiment having various handheld monitors **1410**, a docking station adapter **1430** and a legacy docking station **1450**. The handheld monitors **1410** can include legacy handhelds **1411** and upgrade handhelds **1412**. The docking station adapter **1430** is configured for the legacy docking station **1450** so that

both legacy handhelds **1411** and upgrade handhelds **1412** can dock into the legacy docking station **1450** directly or via the docking station adapter **1430**.

FIGS. 15A-B illustrate a “notebook” modular patient monitor **1500** embodiment having a foldable lid **1510**, a fixed body **1530** and a foldable docking station **1550**. The fixed body **1530** houses patient monitor electronics and provides external device connectivity at a back end (not visible). The lid **1510** has a notebook display **1551**, such as a color LCD. The docking station **1550** has a port **1551** that removably connects, both mechanically and electrically, a corresponding handheld monitor **1590**, such as the handheld embodiments described above. In a closed position (FIG. 15A), the notebook monitor **1500** can be carried via an optional handle or simply in hand or under an arm. In an open position (FIG. 15B), the notebook monitor is operational, connecting to patient sensors via the handheld **1590** or a sensor connector (not shown) on the back end of the notebook. In the open position, the docking station **1550** can stay in a stowed or folded position (not shown) so that the handheld screen **1591** faces upward. Alternatively, in the open position, the docking station **1550** is unfolded as shown (FIG. 15B) so that the handheld display **1591** can be easily viewed from the front of the notebook in conjunction with the notebook display **1511** in the lid **1510**. In an embodiment, the notebook **1500** can have a conventional keyboard and touch pad, have conventional monitor controls, incorporate a conventional computer and peripherals or a combination of the above. As shown, the notebook display **1511** faces inward, so that the display **1511** is protected in the folded position. In another embodiment, the display **1511** faces outward (not shown).

FIG. 16 illustrates a flat panel modular patient monitor embodiment **1600** having a flat panel body **1610** housing a flat panel display **1611** and a handheld port **1620**. The handheld port **1620** removably accepts a handheld monitor **1690** having a handheld display **1691**, such as the handheld monitors described above. The flat panel monitor **1600** can be free-standing on a table top, wall-mounted or mounted on or integrated within a patient bed, as a few examples. The flat panel monitor **1600** can be simply a docking and display device or can provide built-in patient monitoring functions and parameters not available to the handheld **1690**.

A modular patient monitor has been disclosed in detail in connection with various embodiments. These embodiments are disclosed by way of examples only and are not to limit the scope of the claims that follow. One of ordinary skill in art will appreciate many variations and modifications.

What is claimed is:

1. A modular patient monitor comprising:

a docking station including a first display integrated with said docking station, a docking port and a housing, said first display occupying substantially all of a display side of said housing, said docking station receives patient data, determines measurements for a first set of physiological parameters by processing said patient data, and displays at least some of said measurements on said first display; and

a handheld monitor including a second display integrated with said handheld monitor, said monitor receives patient data, determines measurements for a second set of physiological parameters by processing said patient data, and displays at least some of said measurements on said second display, at least some of the second set of parameters are the same as at least some of the first set of parameters, wherein said docking station accepts the handheld monitor, the docking station functionally combining the first set of parameters and the

second set of parameters whenever the handheld monitor is docked in the docking port, and at least a portion of the combined first and second sets of parameters are displayed on the first display integrated with the docking station including at least some of said same parameters from said first and second set of parameters.

2. The modular patient monitor according to claim 1 comprising

- an expansion module having computational functionality for at least one physiological parameter, wherein said docking station further comprises
- a module port, wherein when said expansion module is docked in said module port, the docking station adds the computational functionality for the at least one physiological parameter to the first set of parameters.

3. The modular patient monitor according to claim 2 wherein:

- the second set of parameters are blood constituent related; and
- the expansion module at least one physiological parameter is non-blood related.

4. The modular patient monitor according to claim 3 wherein the second display integrated with the handheld monitor is viewable simultaneously with the first display integrated with the docking station when the handheld monitor is docked in the docking station port.

5. The modular patient monitor according to claim 4 further comprising:

- a second handheld monitor including a third display integrated with said second handheld monitor, said monitor receives patient data, determines measurements for a third set of parameters by processing said patient data, and displays at least some of the measurements on said third display, wherein at least some of the third set of parameters are the same as at least some of the first and second sets of parameters; and
- a second docking station port on the docking station configured to accept the second handheld monitor.

6. A modular patient monitor comprising:

- a docking station having a first display integrated with said docking station and a docking station port, the docking station providing patient monitoring functionality with respect to a first set of physiological parameters including an indication of blood oxygen saturation of a patient being monitored; and

- a handheld monitor removably attachable mechanically and electrically to the docking station via the docking station port, the handheld having a second display, the handheld monitor providing patient monitoring functionality with respect to a second set of parameters including one or more of blood pressure, other blood parameters, ECG, and respiration, wherein the patient monitoring functionality of the docking station includes the first and second set of parameters when the handheld monitor is docked in the docking station port.

7. The modular patient monitor according to claim 6 wherein the first display and the docking station together comprise a flat panel display incorporating the docking station port.

8. The modular patient monitor according to claim 6 wherein a notebook device is said docking station, wherein said notebook device comprises a foldable display and a foldable docking portion.

9. The modular patient monitor according to claim 7 wherein first display and second display are visible simultaneously.

10. The modular patient monitor according to claim 1 wherein said first display autoscales its display of measurements based on at least the number measurements to be displayed.

11. The modular patient monitor according to claim 10 wherein said first display displays measurements larger when fewer measurements are displayed.

12. The modular patient monitor according to claim 1 wherein said first display is rotatable and orients said display of measurements vertically or horizontally according to the rotation.

13. The modular patient monitor according to claim 6 wherein said first display autoscales its display of measurements based on at least the number measurements to be displayed.

14. The modular patient monitor according to claim 13 wherein said first display displays measurements larger when fewer measurements are displayed.

15. The modular patient monitor according to claim 6 wherein said first display is rotatable and orients said display of measurements vertically or horizontally according to the rotation.

\* \* \* \* \*

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 8,840,549 B2  
APPLICATION NO. : 11/903746  
DATED : September 23, 2014  
INVENTOR(S) : Ammar Al-Ali

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On The Title Page

(Item 57, Abstract) at line 13, Change “docket” to --docked--.

In The Specification

In column 4 at line 3, Change “Radical” to --Radical®--.

In column 4 at line 8, Change “U.S. Pat. No. \_\_\_\_\_” to --U.S. App. No. 11/904,046--.

In The Claims

In column 8 at line 65, In Claim 1, after “docking” insert --port--.

Signed and Sealed this  
Twenty-second Day of September, 2015



Michelle K. Lee  
*Director of the United States Patent and Trademark Office*

专利名称(译)	模块化患者监护仪		
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摘要(译)

模块化患者监视器具有配置为接受手持式监视器的扩展坞。对接站具有关于第一组参数的独立患者监测功能。在与扩展坞集成的全尺寸屏幕上同时显示第一参数集中的至少一些。手持式监视器还具有关于第二组参数的独立患者监视功能。在与手持式监视器集成的手持式屏幕上同时显示第二组参数中的至少一些。扩展坞具有配置为接受手持式监视器的端口。虽然手持式监视器是端口中的文档，但是对接站在功能上组合了第一组参数和第二组参数，并且在全尺寸屏幕上同时显示组合的第一和第二组参数中的一些。

