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(54) **WIRELESS MEDICAL MONITORING SYSTEM**

DRAHTLOSES MEDIZINISCHES ÜBERWACHUNGSSYSTEM

SYSTÈME DE SURVEILLANCE MÉDICALE SANS FIL

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates to medical monitoring systems, particularly to wireless medical monitoring systems.

### BACKGROUND OF THE INVENTION

**[0002]** The following publications are believed to represent the current state of the art: U.S. Patent Nos.: 5,036,869; 5,394,882; 6,093,146; 6,544,173; 6,705,990; 6,544,174; 6,749,566; 6,801,137; 6,817,979; 6,852,084; 6,840,904 and 6,139,503; and U.S. published Patent Application Nos.: 2004/0203434 and 2007/0112274. U.S. Patent No. 6,594,174 discloses a system and a method according to the preamble of claims 1 and 11, respectively.

### SUMMARY OF THE INVENTION

**[0003]** The present invention seeks to provide a wireless medical monitoring system as defined in claim 1.

**[0004]** There is thus provided in accordance with a preferred embodiment of the present invention an operator-controllable medical monitoring system including at least one medical sensor that is adapted to monitor at least one patient characteristic, a plurality of medical monitors, each including a monitor wireless transceiver and a medical information display and a patient companion assembly including a patient companion assembly wireless transceiver and a medical monitor selector wirelessly operative to initially select one of the plurality of medical monitors and to provide a monitor selection indication which is visually sensible to the operator.

**[0005]** In accordance with a preferred embodiment of the present invention the patient companion assembly is operative automatically to establish communication between the at least one medical sensor and the initially selected one of the plurality of medical monitors absent operator intervention. Preferably, the patient companion assembly is responsive to the operator intervention to automatically select another one of the plurality of medical monitors. Additionally or alternatively, the at least one medical sensor also includes a sensor wireless transmitter which is adapted to communicate with the patient companion assembly wireless transceiver.

**[0006]** In accordance with another preferred embodiment of the present invention the patient companion assembly also includes sensing circuitry operative to sense changes in electrical characteristics of the operator-controllable medical monitoring system which are indicative of the activation of the at least one medical sensor, and to power up the patient companion assembly upon sensing the changes. Preferably, the changes in electrical characteristics include changes in impedance.

**[0007]** In accordance with yet another preferred em-

bodiment of the present invention the patient companion assembly also includes at least one medical sensor interface subunit. Preferably, the at least one medical sensor interface subunit includes at least one of a pressure sensor interface subunit, an ECG sensor interface subunit, an SPO2 sensor interface subunit, a temperature sensor interface subunit, a blood chemistry sensor interface subunit and a respiratory parameter sensor interface subunit.

**[0008]** In accordance with still another preferred embodiment of the present invention the pressure sensor interface subunit includes a plurality of pressure sensor connectors, each operative to be coupled to a medical pressure sensor, a plurality of pressure input channel interfaces, each coupled to one of the plurality of pressure sensor connectors and each including an amplifier and a filter, at least one A/D converter which is operative to convert analog pressure sensor signals received from the plurality of pressure input channel interfaces to digital pressure sensor signals and a pressure sensor input processor operative to adapt the digital pressure sensor signals for digital wireless communication, and to supply the digital pressure sensor signals to the patient companion assembly wireless transceiver.

**[0009]** Preferably, the ECG sensor interface subunit includes a multi-channel ECG sensor connector including a plurality of channels, each of the plurality of channels being operative to be coupled to an ECG electrode, an ECG input channel interface coupled to the multi-channel ECG sensor connector and including an amplifier and a filter, at least one A/D converter which is operative to convert analog ECG signals received from the ECG input channel interface to digital ECG signals and an ECG input processor operative to adapt the digital ECG signals for digital wireless communication, and to supply the digital ECG signals to the patient companion assembly wireless transceiver.

**[0010]** In accordance with a further preferred embodiment of the present invention the SPO2 sensor interface subunit includes an SPO2 sensor connector operative to be coupled to an SPO2 sensor, an SPO2 input channel interface coupled to the SPO2 sensor connector and including an amplifier and a filter, an A/D converter which is operative to convert analog SPO2 sensor signals received from the SPO2 input channel interface to digital SPO2 sensor signals and an SPO2 input processor operative to adapt the digital SPO2 sensor signals for digital wireless communication, and to supply the digital SPO2 sensor signals to the patient companion assembly wireless transceiver.

**[0011]** In accordance with yet a further preferred embodiment of the present invention temperature sensor interface subunit includes a temperature sensor connector operative to be coupled to a temperature sensor, a temperature input channel interface coupled to the temperature sensor connector and including an amplifier and a filter and an A/D converter which is operative to convert analog temperature sensor signals received from the

temperature input channel interface to digital temperature sensor signals, and to supply the digital temperature sensor signals to the patient companion assembly wireless transceiver via the SPO2 input processor.

**[0012]** Preferably, the blood chemistry sensor interface subunit includes at least one blood chemistry sensor connector operative to be coupled to at least one blood chemistry sensor, at least one blood chemistry input channel interface coupled to the at least one blood chemistry sensor connector and including an amplifier and a filter, an A/D converter which is operative to convert analog blood chemistry sensor signals received from the at least one blood chemistry input channel interface to digital blood chemistry sensor signals and a blood chemistry input processor operative to adapt the digital blood chemistry sensor signals for digital wireless communication, and to supply the digital blood chemistry sensor signals to the patient companion assembly wireless transceiver.

**[0013]** In accordance with a still further preferred embodiment of the present invention the respiratory parameter sensor interface subunit includes at least one respiratory parameter sensor connector operative to be coupled to at least one respiratory parameter sensor, at least one respiratory parameter input channel interface coupled to the at least one respiratory parameter sensor connector and including an amplifier and a filter, an A/D converter which is operative to convert analog respiratory parameter sensor signals received from the at least one respiratory parameter input channel interface to digital respiratory parameter sensor signals and a respiratory parameter input processor operative to adapt the digital respiratory parameter sensor signals for digital wireless communication, and to supply the digital respiratory parameter sensor signals to the patient companion assembly wireless transceiver.

**[0014]** In accordance with an additional preferred embodiment of the present invention the patient companion assembly also includes a controller operative to govern operation of the at least one medical sensor interface subunit and a man-machine interface adapted to be operated by an operator to provide inputs useful in controlling operation of the controller. Preferably, the patient companion assembly also includes at least one socket adapted to receive at least one corresponding sensor connector associated with the at least one medical sensor and power management functionality, operative, upon insertion of the at least one sensor connector to the at least one socket, to power-up the patient companion assembly. Additionally, the power management functionality is operative to shut-down the patient companion assembly if no sensor connector is connected to the at least one socket for a predetermined time duration.

**[0015]** In accordance with another preferred embodiment of the present invention the medical monitor selector includes a remote control device which is responsive to the operator intervention to direct an operator intervention monitor selection signal generally toward an operator selected one of the plurality of medical monitors.

Preferably, the patient companion assembly also includes a patient companion assembly monitor which is one of the plurality of medical monitors. Additionally or alternatively, the at least one medical sensor includes at least one of a pressure sensor, a temperature sensor, an ECG sensor, an SPO2 sensor, a blood chemistry sensor and a respiratory parameter sensor. Preferably, the pressure sensor includes at least one of an intracranial pressure sensor, an arterial pressure sensor and a venous pressure sensor.

**[0016]** In accordance with still another preferred embodiment of the present invention the plurality of medical monitors each includes at least one sensor socket operative to provide electrical power obtained from the medical monitor to at least one of the monitor wireless transceiver and electrical circuitry coupled to other sensor sockets.

**[0017]** There is also provided in accordance with another preferred embodiment of the present invention a patient companion assembly useful in an operator-controllable medical monitoring system including at least one medical sensor that is adapted to monitor at least one patient characteristic and a plurality of medical monitors, each including a monitor wireless transceiver and a medical information display, the patient companion assembly including a patient companion assembly wireless transceiver and a medical monitor selector wirelessly operative to initially select one of the plurality of medical monitors and to provide a monitor selection indication which is visually sensible to the operator.

**[0018]** In accordance with a preferred embodiment of the present invention the patient companion assembly is operative automatically to establish communication between the at least one medical sensor and the initially selected one of the plurality of medical monitors absent operator intervention. Preferably, the patient companion assembly is responsive to the operator intervention to automatically select another one of the plurality of medical monitors. Additionally or alternatively, the patient companion assembly also includes sensing circuitry operative to sense changes in electrical characteristics of the operator-controllable medical monitoring system which are indicative of the activation of the at least one medical sensor, and to power up the patient companion assembly upon sensing the changes.

**[0019]** In accordance with another preferred embodiment of the present invention the patient companion assembly also includes at least one medical sensor interface subunit including at least one of a pressure sensor interface subunit, an ECG sensor interface subunit, an SPO2 sensor interface subunit, a temperature sensor interface subunit, a blood chemistry sensor interface subunit and a respiratory parameter sensor interface subunit. Preferably, the patient companion assembly also includes a controller operative to govern operation of the at least one medical sensor interface subunit and a man-machine interface adapted to be operated by an operator to provide inputs useful in controlling operation

of the controller.

**[0020]** In accordance with yet another preferred embodiment of the present invention the patient companion assembly includes at least one socket adapted to receive at least one corresponding sensor connector associated with the at least one medical sensor and power management functionality, operative, upon insertion of the at least one sensor connector to the at least one socket, to power-up the patient companion assembly. Preferably, the power management functionality is operative to shut-down the patient companion assembly if no sensor connector is connected to the at least one socket for a predetermined time duration.

**[0021]** In accordance with still another preferred embodiment of the present invention the medical monitor selector includes a remote control device which is responsive to the operator intervention to direct an operator intervention monitor selection signal generally toward an operator selected one of the plurality of medical monitors. Preferably, the patient companion assembly also includes a patient companion assembly monitor which is one of the plurality of medical monitors.

**[0022]** There is further provided in accordance with a further preferred embodiment of the present invention an operator-controllable medical monitoring system including at least one medical sensor that is adapted to monitor at least one patient characteristic, a patient companion assembly including a patient companion assembly wireless transceiver and a plurality of medical monitors, each including a monitor wireless transceiver and a medical information display, the monitor wireless transceiver being powered by a source of electrical power which is also operative to power the medical information display.

**[0023]** In accordance with a preferred embodiment of the present invention the plurality of medical monitors each includes at least one sensor socket operative to provide the electrical power to at least one of the monitor wireless transceiver and electrical circuitry coupled to other sensor sockets.

**[0024]** There is additionally provided in accordance with another preferred embodiment of the present invention a method for operator-controllable medical monitoring of a patient as defined in claim 11 employing at least one medical sensor that is adapted to monitor at least one patient characteristic and a plurality of medical monitors, each including a monitor wireless transceiver and a medical information display, the method including employing a patient companion assembly, including a patient companion assembly wireless transceiver and a medical monitor selector, wirelessly to initially select one of the plurality of medical monitors and to provide a monitor selection indication which is visually sensible to the operator.

**[0025]** In accordance with a preferred embodiment of the present invention the method also includes employing the patient companion assembly automatically to establish communication between the at least one medical sensor and the initially selected one of the plurality of

medical monitors absent operator intervention. Preferably, the method also includes employing the patient companion assembly, responsive to the operator intervention, automatically to select another one of the plurality of medical monitors. Additionally or alternatively, the method also includes employing sensing circuitry forming part of the patient companion assembly to sense changes in electrical characteristics which are indicative of the activation of the at least one medical sensor, and to power up the patient companion assembly upon sensing the changes.

**[0026]** In accordance with another preferred embodiment of the present invention the employing a patient companion assembly includes employing power management functionality, operative, upon insertion of at least one sensor connector to at least one socket of a monitor, to power-up the patient companion assembly. Preferably, the method also includes employing the power management functionality to shut-down the patient companion assembly if a sensor connector is not connected to the at least one socket for a predetermined time duration.

**[0027]** In accordance with still another preferred embodiment of the present invention the employing the patient companion assembly includes employing a remote control device which is responsive to the operator intervention to direct an operator intervention monitor selection signal generally toward an operator selected one of the plurality of medical monitors. Preferably, the method also includes providing electrical power obtained from the medical monitor to the monitor wireless transceiver.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0028]** The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which: Figs. 1A and 1B, taken together, are a simplified pictorial illustration of the operation of an operator controlled medical monitoring system constructed and operative in accordance with a preferred embodiment of the present invention; Figs. 2A, 2B and 2C, taken together, form a simplified block diagram illustration of a patient companion assembly useful in the operator controlled medical monitoring system of Figs. 1A and 1B;

**[0029]** Figs. 3A and 3B, taken together, form a simplified block diagram illustration of a monitor interface assembly useful in the operator controlled medical monitoring system of Figs. 1A and 1B;

**[0030]** Fig. 4 is a simplified pictorial illustration of the patient companion assembly of Figs. 1A - 2C;

**[0031]** Fig. 5 is a simplified flow chart illustration of the operation of the system of Figs. 1A - 4;

**[0032]** Figs. 6A and 6B, taken together, are a simplified pictorial illustration of the operation of a operator controlled medical monitoring system constructed and operative in accordance with another preferred embodiment of the present invention Figs. 7A, 7B and 7C, taken together,

form a simplified block diagram illustration of a patient companion assembly useful in the operator controlled medical monitoring system of Figs. 6A and 6B;

**[0033]** Figs. 8A and 8B, taken together, form a simplified block diagram illustration of a monitor interface assembly useful in the operator controlled medical monitoring system of Figs. 6A and 6B;

**[0034]** Fig. 9 is a simplified pictorial illustration of the patient companion assembly of Figs. 6A - 7C;

**[0035]** Fig. 10 is a simplified flow chart illustration of the operation of the system of Figs. 6A - 9;

**[0036]** Figs. 11A and 11B, taken together, are a simplified pictorial illustration of the operation of a operator controlled medical monitoring system constructed and operative in accordance with yet another preferred embodiment of the present invention;

**[0037]** Figs. 12A, 12B and 12C, taken together, form a simplified block diagram illustration of a patient companion assembly useful in the operator controlled medical monitoring system of Figs. 11A and 11B;

**[0038]** Figs. 13A and 13B, taken together, form a simplified block diagram illustration of a monitor interface assembly useful in the operator controlled medical monitoring system of Figs. 11A and 11B;

**[0039]** Fig. 14 is a simplified pictorial illustration of the patient companion assembly of Figs. 11A - 12C; and

**[0040]** Fig. 15 is a simplified flow chart illustration of the operation of the system of Figs. 11A - 14.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0041]** Reference is now made to Figs. 1A and 1B, which, taken together, are a simplified pictorial illustration of the operation of a operator controlled medical monitoring system constructed and operative in accordance with a preferred embodiment of the present invention. As seen in Figs. 1A and 1B, there is provided an operator controlled medical monitoring system including a medical sensor that is adapted to monitor a patient characteristic; a plurality of medical monitors, each including a wireless receiver and a medical information output device; and a patient companion assembly, including a medical monitor selector employed by an operator to select one of the plurality of medical monitors and to establish communication between the medical sensor and a selected one of the plurality of medical monitors.

**[0042]** Turning to Fig. 1A, at stage A, there is seen a patient, typically in an operating room environment. In accordance with a preferred embodiment of the present invention, the patient is coupled to a patient companion assembly 100, which includes a medical monitor selector which can be employed by an operator to select one of a plurality of medical monitors, such as a conventional medical monitor 102, and to establish communication between medical sensing devices, such as a blood pressure sensor 104, attached to the patient and the selected medical monitor, preferably via a wireless receiver 106 asso-

ciated with the medical monitor 102. It is noted that in the embodiment shown in Fig. 1A, a wired connection is provided between the sensor 104 and the patient companion assembly 100, it being appreciated that alternatively a wireless connection may be provided. Preferably, the connection between the patient companion assembly 100 and the medical monitor 102 is wireless and employs a transmitter 108, preferably forming part of the patient companion assembly 100, which communicates with wireless receiver 106.

**[0043]** It is also appreciated that the medical sensor may be mounted on the patient, as shown in Fig. 1A, or otherwise coupled to the patient. Examples of medical sensor devices that may be coupled to the patient and mounted on the patient companion assembly 100 include physiological pressure sensors. Fig. 1A shows the operator in the process of connecting the sensor 104 to one of a plurality of connection sockets 110 of the patient companion assembly 100. Preferably, connection of a medical sensing device initiates powering up of the patient companion assembly 100.

**[0044]** At stage B, the patient is being operated on in the same location as that shown at stage A. It is seen that monitor 102 is displaying various patient parameters received from medical sensing devices, such as sensor 104, via the patient companion assembly 100, transmitter 108 and receiver 106.

**[0045]** At stage C, following the operation in Stage B, the patient is being prepared for transfer to another location and a conventional portable monitor 112, preferably having associated therewith a wireless receiver 114, is introduced. The operator is shown initializing communication between the patient companion assembly 100 and the portable monitor 112, typically by pressing a NEXT button 116 on the patient companion assembly 100. The initializing typically enables the patient parameters to appear on the portable monitor 112, as shown, and preferably simultaneously terminates display of the patient parameters on the monitor 102, also as shown.

**[0046]** As seen in Fig. 1B, stage D illustrates the patient following his transfer to an ICU or other recovery room, still coupled to portable monitor 112, which continues to display the patient parameters.

**[0047]** At stage E, initial selection of one of a plurality of wall-mounted monitors is shown. The selection is typically carried out by an operator pressing the NEXT button 116 on the patient companion assembly 100. The selection typically enables the patient parameters to appear on the selected wall-mounted monitor, here designated 118, and preferably simultaneously terminates display of the patient parameters on the portable monitor 112, also as shown.

**[0048]** In situations where there are plural wall-mounted monitors available for communication with the patient companion assembly 100, the selection of a wall-mounted monitor preferably is based on the strongest wireless signal sensed by the patient companion assembly 100. In the illustration at stage E, wall-mounted monitor 118

is not the wall-mounted monitor that the operator desires to employ. Accordingly, in accordance with a preferred embodiment of the present invention, and as shown at stage F, the operator can select an alternative wall-mounted monitor preferably by pressing the NEXT button 116 on the patient companion assembly 100, as shown. This preferably causes the patient parameters to appear on the wall-mounted monitor having the next strongest signal strength, here designated by reference numeral 120, and preferably simultaneously terminates display of the patient parameters on the monitor 118, also as shown. The operator may then press an OK button 122 to confirm the monitor selection. Alternatively, the operator may leave the buttons of the patient companion assembly 100 untouched and after a predetermined time duration elapses the monitor selection is automatically confirmed.

**[0049]** It is appreciated that if the originally selected wall monitor 118, shown in stage E, is the wall monitor the operator desired to employ, the operator may press the OK button 122 to confirm the monitor selection.

**[0050]** Reference is now made to Figs. 2A, 2B and 2C, which, taken together, form a simplified block diagram illustration of patient companion assembly 100 useful in the operator controlled medical monitoring system of Figs. 1A and 1B. As seen in Figs. 2A-2C, the patient companion assembly comprises a plurality of medical sensor interface subunits. A first medical sensor interface subunit, designated by reference numeral 150, preferably processes inputs from pressure sensors, such as intracranial pressure sensors, arterial pressure sensors and venous pressure sensors. Typically, interface subunit 150 includes five pressure sensor connectors 152, such as connectors 110 (Figs. 1A and 1B), each adapted to be coupled to a separate pressure sensor and each connected to a pressure input channel interface 154, typically including an amplifier and a filter. The outputs of pressure input channel interfaces 154 are preferably supplied via an A/D converter 156 and a multiplexer 158 to a pressure sensor input processor 160, which adapts the signals for digital wireless communication and supplies them to a digital wireless communications subsystem 162 including a wireless transceiver 164.

**[0051]** Turning to Fig. 2B, it is seen that patient companion assembly 100 additionally includes a second medical sensor interface subunit, designated by reference numeral 170, which preferably processes inputs from a plurality of ECG electrodes. Typically, interface subunit 170 includes a single multi-channel ECG connector 172 having plural channels, each connected to an ECG input channel interface 174, typically including an amplifier and a filter. The output signals from ECG input channel interfaces 174 are preferably supplied via an A/D converter 176 and a multiplexer 178 to an ECG input processor 180, which adapts the signals for digital wireless communication and supplies them to digital wireless communications subsystem 162.

**[0052]** A third medical sensor interface subunit, desig-

nated by reference numeral 190, preferably processes inputs from a SPO2 sensor. Typically, interface subunit 190 includes a single SPO2 connector 192 connected to an SPO2 input channel interface 194, typically including an amplifier and a filter. The output signal from SPO2 input channel interface 194 is preferably supplied via an A/D converter 196 to an SPO2 input processor 198, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 162.

**[0053]** A fourth medical sensor interface subunit, designated by reference numeral 200, preferably processes inputs from a temperature sensor. Typically, interface subunit 200 includes a single temperature connector 202 connected to a temperature input channel interface 204, typically including an amplifier and a filter. The output signal from temperature input channel interface 204 is preferably supplied via an A/D converter 206 to SPO2 input processor 198, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 162.

**[0054]** As seen in Fig. 2C, patient companion assembly 100 also includes a fifth medical sensor interface subunit, designated by reference numeral 210, which preferably processes inputs from a blood chemistry sensor. Typically, interface subunit 210 includes at least one blood chemistry connector 212, connected to at least one blood chemistry input channel interface 214, typically including an amplifier and a filter. The output signal from each blood chemistry input channel interface 214 is preferably supplied via an A/D converter 216 to a blood chemistry input processor 218, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 162.

**[0055]** A sixth medical sensor interface subunit, designated by reference numeral 220, preferably processes inputs from a respiratory parameter sensor. Typically, interface subunit 220 includes at least one respiratory parameter connector 222, connected to at least one respiratory parameter input channel interface 224, typically including an amplifier and a filter. The output signal from each respiratory parameter input channel interface 224 is preferably supplied via an A/D converter 226 to a respiratory parameter input processor 228, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 162.

**[0056]** It is appreciated that any suitable medical sensor may be coupled to a selectable monitor using the patient companion assembly 100 when equipped with a suitable medical sensor interface unit.

**[0057]** A suitable man-machine interface 230, which typically includes NEXT button 116 and OK button 122, governs the operation of a controller 232, which governs operation of the various elements of the patient companion assembly 100.

**[0058]** Reference is now made to Figs. 3A and 3B, which, taken together, form a simplified block diagram illustration of a monitor interface assembly useful in the

operator controlled medical monitoring system of Figs. 1A and 1B. As seen in Figs. 3A and 3B, the monitor interface assembly comprises a plurality of monitor interface subunits. A first pressure monitor interface subunit, designated by reference numeral 250, is preferably adapted to be connected to a pressure sensor socket of a conventional monitor, which typically provides low voltage power.

**[0059]** Monitor interface subunit 250 preferably comprises a digital wireless communications subsystem 252, which includes a wireless transceiver 254 which is operative to receive wireless transmissions from wireless transceiver 164 of patient companion assembly 100, to process the received transmissions and to direct them to corresponding monitor interface subunits.

**[0060]** Monitor interface subunit 250 and typically up to four additional pressure monitor interface subunits, here designated by reference numerals 262, 264, 266 and 268, are preferably provided with plug connectors (not shown) each adapted to be coupled to a separate pressure sensor socket of a monitor. Each of monitor interface subunits 250, 262, 264, 266 and 268 typically includes an amplifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions that are directed thereto by digital wireless communications subsystem 252. The outputs of monitor interface subunits 250, 262, 264, 266 and 268 are preferably supplied to corresponding pressure sensor sockets of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0061]** It is a particular feature of the present invention that digital wireless communications subsystem 252 is powered by electrical power which is received in part from multiple ones of the pressure sensor sockets of the monitor. It is a further particular feature of the present invention that each of monitor interface subunits 250, 262, 264, 266 and 268 provides power to the various other monitor interface subunits, some of which are connected to sockets of the monitor which do not provide electrical power.

**[0062]** Turning to Fig. 3B, it is seen that the monitor interface assembly additionally includes an ECG monitor interface subunit 270, which is preferably provided with a multi-channel plug connector (not shown) adapted to be coupled to an ECG socket of the monitor. Monitor interface subunit 270 typically includes multiple amplifiers, filters and D/A converters, which receive, via at least one processor, those parts of the received transmissions related to ECG sensing that are directed thereto by digital wireless communications subsystem 252. The outputs of monitor interface subunit 270 are preferably supplied to a corresponding ECG socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0063]** An SPO2 monitor interface subunit 272 is preferably provided with a plug connector (not shown) adapted to be coupled to an SPO2 sensor socket of the monitor. Monitor interface subunit 272 typically includes an am-

plifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions related to SPO2 sensing that are directed thereto by digital wireless communications subsystem 252. The output of monitor interface subunit 272 is preferably supplied to a corresponding SPO2 sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0064]** A temperature monitor interface subunit 274 is preferably provided with a plug connector (not shown) adapted to be coupled to a temperature sensor socket of the monitor. Monitor interface subunit 274 typically includes an amplifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions related to temperature sensing that are directed thereto by digital wireless communications subsystem 252. The output of monitor interface subunit 274 is preferably supplied to a corresponding temperature sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0065]** A blood chemistry monitor interface subunit 276 is preferably provided with at least one plug connector (not shown) adapted to be coupled to a blood chemistry sensor socket of the monitor. Monitor interface subunit 276 typically includes at least one amplifier, at least one filter and at least one D/A converter, which receive, via a processor, those parts of the received transmissions related to blood chemistry sensing that are directed thereto by digital wireless communications subsystem 252. The output of monitor interface subunit 276 is preferably supplied to a corresponding blood chemistry sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0066]** A respiratory parameter monitor interface subunit 278 is preferably provided with at least one plug connector (not shown) adapted to be coupled to a respiratory parameter socket of the monitor. Monitor interface subunit 278 typically includes at least one amplifier, at least one filter and at least one D/A converter, which receives, via at least one processor, those parts of the received transmissions related to respiratory parameter sensing that are directed thereto by digital wireless communications subsystem 252. The outputs of monitor interface subunit 278 are preferably supplied to a corresponding respiratory parameter sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0067]** A suitable man-machine interface 290 governs the operation of a controller 292, which governs operation of the various elements of the monitor interface assembly. It is appreciated that controller 292 may form part of the monitor interface subunit 250.

**[0068]** Reference is now made to Fig. 4, which is a simplified pictorial illustration of the patient companion assembly of Figs. 1A - 2C. As seen in Fig. 4, the patient companion assembly 100 comprises a housing 300, preferably composed of a forward portion 302 and a rear portion 304, which preferably encloses the apparatus of

Figs. 2A-2C. Mounted on a bottom edge of housing 300 are a plurality of pressure transducer connector sockets 110, preferably five sockets 110, such as an RJ11 female modular jack, commercially available from Bel-Fuse of Glen Rock, Pennsylvania, USA. Each socket 110 preferably includes a suitable pressure sensor connector (not shown) which is coupled to pressure input channel interface 154 (Figs. 2A-2C). A front panel 308 preferably defines mounting attachment protrusions arranged to define a plurality of pressure transducer mounting sockets 310, preferably five sockets 310, which are adapted to removably support conventional blood pressure transducer assemblies 312, each including a connector 313, such as Transpac IT, commercially available from Elcam Medical A.C.A.L. of Kibbutz Baram, Israel, under catalog designation "fully integrated disposable blood pressure transducer".

**[0069]** Mounted in a recess 314 at a side edge 316 of housing 300 there is preferably provided an SPO2 connector socket 320, such as a D-Type 9S connector socket commercially available from Molex of Illinois, USA, which preferably includes a suitable SPO2 sensor connector (not shown) which is coupled to SPO2 input channel interface 194 (Figs. 2A-2C). At recess 314 there is additionally provided an ECG sensor socket 322, such as a conventional female D-Type 15S connector socket commercially available from Molex of Illinois, USA, which preferably includes a suitable ECG sensor connector (not shown) which is coupled to ECG input channel interface 174 (Figs. 2A-2C). Further provided at recess 314 is a temperature sensor socket 324, such as a conventional female RS Phone jack 1/4" socket commercially available from Switchcraft Inc. of Chicago, Illinois, USA, which preferably includes a suitable temperature sensor connector (not shown) which is coupled to temperature input channel interface 204 (Figs. 2A-2C).

**[0070]** Located alongside front panel 308 is a control panel 326 including a plurality of pressure channel control buttons 328, preferably five buttons 328, which control operation of the blood pressure transducer assemblies 312. Also preferably included in the control panel 326 is a battery charge status indicator 330, a NEXT button 116, described hereinabove with reference to Figs. 1A-2C, an OK button 122, described hereinabove with reference to Figs. 1A-2C, a power on/off button 332 and an audio/visual alarm indicator 334.

**[0071]** Reference is now made to Fig. 5, which is a simplified flow chart illustration of the operation of the system of Figs. 1A - 4. As seen in Fig. 5, when the power on/off button 332 (Fig. 4) is in a power-off state, operation of the patient companion assembly 100 (Figs. 1A-1B) is initiated either by an operator pressing the power on/off button 332 or by an operator inserting connector 313 of the blood pressure transducer 312 into a socket 110 (Fig. 4). Various system checks are carried out automatically by the controller 232 of Figs. 2A-2C. If a problem is encountered, an alarm is preferably indicated by audio/visual indicator 334 (Fig. 4) and the patient companion as-

sembly power is shut down.

**[0072]** If no problem is encountered during the system checks, an attempt is made to establish wireless communication with digital wireless communication subsystem 252 (Figs. 3A and 3B) of a monitor such as monitor 102 (Figs. 1A-1B). The wireless transceiver 164 of the patient companion assembly 100 (Figs. 2A-2C) ranks receivers in its vicinity according to the strength of a signal emitted therefrom. Typically, a predetermined number of receivers, preferably 3, are ranked.

**[0073]** Thereafter, an attempt is made by the digital wireless communication subsystem 162 of the patient companion assembly 100 to establish communication with digital wireless communication subsystem 252 of the monitor having the highest ranking. The monitor that is being communicated with indicates the communication thereof by providing an audio/visual indication, such as a triangular waveform, for a predetermined time duration, typically 10 seconds.

**[0074]** If the NEXT button 116 (Fig. 4) is pressed during the predetermined time duration, an attempt is made by the digital wireless communication subsystem 162 of the patient companion assembly 100 to establish communication with digital wireless communication subsystem 252 of the monitor having the next ranking.

**[0075]** If the OK button 122 (Fig. 4) is pressed during the predetermined time duration, or if none of the buttons of control panel 326 (Fig. 4) of the patient companion assembly 100 were pressed during the predetermined time duration, the patient companion assembly confirms the establishing of communication with the selected monitor.

**[0076]** Following confirmation, and if a sensor is connected to a socket of the patient companion assembly 100 the selected monitor displays the sensor signals transmitted by the transmitter 164 of the patient companion assembly 100. If no sensor is connected to a socket of the patient companion assembly, the patient companion assembly continues in an idle state for a predetermined time duration, and if no sensor is connected during that time, the patient companion assembly power is shut down. Alternatively, the patient companion assembly 100 may attempt establishing communication with one of the monitors only when a sensor is connected to a suitable socket of the patient companion assembly.

**[0077]** Reference is now made to Figs. 6A and 6B, which, taken together, are a simplified pictorial illustration of the operation of a operator controlled medical monitoring system constructed and operative in accordance with another preferred embodiment of the present invention. As seen in Figs. 6A and 6B, there is provided an operator controlled medical monitoring system including a medical sensor that is adapted to monitor a patient characteristic; a plurality of medical monitors, each including a wireless receiver and a medical information output device; and a patient companion assembly, including a medical monitor selector employed by an operator to select one of the plurality of medical monitors and to es-

establish communication between the medical sensor and a selected one of the plurality of medical monitors.

**[0078]** Turning to Fig. 6A, at stage A, there is seen a patient, typically in an operating room environment. In accordance with a preferred embodiment of the present invention, the patient is coupled to a patient companion assembly 500 which includes a medical monitor selector which can be employed by an operator to select one of a plurality of medical monitors, such as a conventional medical monitor 502, and to establish communication between medical sensing devices, such as a blood pressure sensor 504, attached to the patient and the selected medical monitor, preferably via a wireless receiver 506 associated with the medical monitor 502. It is noted that in the embodiment shown in Fig. 6A, a wireless connection is provided between the sensor 504 and the patient companion assembly 500. Preferably, the connection between the patient companion assembly 500 and the medical monitor 502 is wireless and employs a transmitter 508, preferably forming part of the patient companion assembly 500, which communicates with wireless receiver 506. As seen in Fig. 6A, the patient companion assembly 500 additionally includes a monitor 509. It is also appreciated that the medical sensor may be mounted on the patient, as shown in Fig. 6A, or otherwise coupled to the patient. Examples of medical sensor devices that may be coupled to the patient and mounted on the patient companion assembly 500 include physiological pressure sensors.

**[0079]** Fig. 6A shows the sensor 504 transmitting patient information to one or more sensor input receivers 510 of the patient companion assembly 500. Preferably, the patient companion assembly senses changes in the electrical characteristics in the connection circuitry, such as changes of impedance, which are a result of the wireless connection of the medical sensing device. The change in the electrical characteristics is preferably sensed by secondary circuitry 511 formed in the patient companion assembly 500, which is constantly or routinely operational. The wireless connection of the medical sensing device, sensed by circuitry 511, initiates powering up of the patient companion assembly 500.

**[0080]** At stage B, the patient is being operated on in the same location as that shown at stage A. It is seen that monitor 502 is displaying various patient parameters received from medical sensing devices, such as sensor 504, via the patient companion assembly 500, transmitter 508 and receiver 506. As seen at stage B, monitor 509 of patient companion assembly also displays the patient parameters received by sensor input receiver 510.

**[0081]** At stage C, following the operation in Stage B, the patient is being prepared for transfer to another location and the operator is shown terminating communication between the patient companion assembly 500 and the medical monitor 502, typically by pressing a NEXT button 516 on the patient companion assembly 500. This typically results in the patient parameters appearing on the monitor 509, as shown, and preferably simultaneous-

ly the patient parameters no longer appear on the monitor 502, also as shown. Moreover, whenever communication between the patient companion assembly 500 and an external medical monitor, such as medical monitor 502, is terminated, the patient parameters are displayed on monitor 509 of the patient companion assembly.

**[0082]** It is appreciated that in any case in which the communication between the patient companion assembly 500 and an external monitor, such as monitor 502, is terminated, the patient parameters are automatically displayed on monitor 509. It is also appreciated that during the time in which the patient companion assembly 500 is in communication with an external monitor, such as monitor 502, the patient parameters are not displayed on monitor 509 in order to conserve energy.

**[0083]** As seen in Fig. 6B, stage D illustrates the patient following his transfer to an ICU or other recovery room, still coupled to patient companion assembly 500 including monitor 509, which continues to display the patient parameters.

**[0084]** At stage E, initial selection of one of a plurality of wall-mounted monitors is shown. The selection is typically carried out by an operator pressing the NEXT button 516 on the patient companion assembly 500. The selection typically enables the patient parameters to appear on the selected wall-mounted monitor, here designated 518, and display of the patient parameters on monitor 509 of patient companion assembly 500, is terminated.

**[0085]** In situations where there are plural wall-mounted monitors available for communication with the patient companion assembly 500, the selection of a wall-mounted monitor preferably is based on the strongest wireless signal sensed by the patient companion assembly 500. In the illustration at stage E, wall-mounted monitor 518 is not the wall-mounted monitor that the operator desires to employ. Accordingly, in accordance with a preferred embodiment of the present invention, and as shown at stage F, the operator can select an alternative wall-mounted monitor preferably by pressing the NEXT button 516 on the patient companion assembly 500, as shown. This preferably causes the patient parameters to appear on the wall-mounted monitor having the next strongest signal strength, here designated by reference numeral 520, and preferably simultaneously terminates display of the patient parameters on the monitor 518, also as shown. The operator may then press an OK button 522 to confirm the monitor selection. Alternatively, the operator may leave the buttons of the patient companion assembly 500 untouched and after a predetermined time duration elapses the monitor selection is automatically confirmed.

**[0086]** Reference is now made to Figs. 7A, 7B and 7C, which, taken together, form a simplified block diagram illustration of patient companion assembly 500 useful in the operator controlled medical monitoring system of Figs. 6A and 6B. As seen in Figs. 7A-7C, the patient companion assembly 500 comprises a plurality of medical sensor interface subunits. A first medical sensor in-

terface subunit, designated by reference numeral 550, preferably processes inputs from pressure sensors, such as intracranial pressure sensors, arterial pressure sensors and venous pressure sensors. Typically, interface subunit 550 includes five pressure sensor input receivers 552, such as input receivers 510, each adapted to receive input from a separate pressure sensor via a wireless connection, and each connected to a pressure input channel interface 554, typically including an amplifier and a filter. The outputs of pressure input channel interfaces 554 are preferably supplied via an A/D converter 556 and a multiplexer 558 to a pressure sensor input processor 560, which adapts the signals for digital wireless communication and supplies them to a digital wireless communications subsystem 562 including a wireless transceiver 564.

**[0087]** Turning to Fig. 7B, it is seen that patient companion assembly 500 additionally includes a second medical sensor interface subunit, designated by reference numeral 570, which preferably processes inputs from a plurality of ECG electrodes. Typically, interface subunit 570 includes a single multi-channel ECG input receiver 572 having plural channels, each adapted to receive ECG inputs from one ECG electrode via a wireless connection and each connected to an ECG input channel interface 574, typically including an amplifier and a filter. The output signals from ECG input channel interfaces 574 are preferably supplied via an A/D converter 576 and a multiplexer 578 to an ECG input processor 580, which adapts the signals for digital wireless communication and supplies them to digital wireless communications subsystem 562.

**[0088]** A third medical sensor interface subunit, designated by reference numeral 590, preferably processes inputs from a SPO2 sensor. Typically, interface subunit 590 includes a single SPO2 input receiver 592 which is adapted to receive inputs from a SPO2 sensor via a wireless connection and which is connected to an SPO2 input channel interface 594, typically including an amplifier and a filter. The output signal from SPO2 input channel interface 594 is preferably supplied via an A/D converter 596 to an SPO2 input processor 598, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 562.

**[0089]** A fourth medical sensor interface subunit, designated by reference numeral 600, preferably processes inputs from a temperature sensor. Typically, interface subunit 600 includes a single temperature input receiver 602 which is adapted to receive inputs from a temperature sensor via a wireless connection and which is connected to a temperature input channel interface 604, typically including an amplifier and a filter. The output signal from temperature input channel interface 604 is preferably supplied via an A/D converter 606 to SPO2 input processor 598, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 562.

**[0090]** As seen in Fig. 7C, patient companion assembly

500 also includes a fifth medical sensor interface subunit, designated by reference numeral 610, which preferably processes inputs from a blood chemistry sensor. Typically, interface subunit 610 includes at least one blood chemistry input receiver 612, which is adapted to receive inputs from at least one blood chemistry sensor via a wireless connection and which is connected to at least one blood chemistry input channel interface 614, typically including an amplifier and a filter. The output signal from each blood chemistry input channel interface 614 is preferably supplied via an A/D converter 616 to a blood chemistry input processor 618, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 562.

**[0091]** A sixth medical sensor interface subunit, designated by reference numeral 620, preferably processes inputs from a respiratory parameter sensor. Typically, interface subunit 620 includes at least one respiratory parameter input receiver 622, which is adapted to receive inputs from at least one respiratory sensor via a wireless connection and which is connected to at least one respiratory parameter input channel interface 624, typically including an amplifier and a filter. The output signal from each respiratory parameter input channel interface 624 is preferably supplied via an A/D converter 626 to a respiratory parameter input processor 628, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 562.

**[0092]** It is appreciated that any suitable medical sensor may be coupled to a selectable monitor using the patient companion assembly 500 when equipped with a suitable medical sensor interface unit.

**[0093]** A suitable man-machine interface 630, which typically includes NEXT button 516 and OK button 522, governs the operation of a controller 632, which governs operation of the various elements of the patient companion assembly 500. Controller 632 preferably includes secondary circuitry 511, which senses changes in the electrical characteristics when a sensor wirelessly communicates with the patient companion assembly 500, and thereafter the secondary circuitry powers up the patient companion assembly. Controller 632 additionally controls the display of patient parameters, which are provided by one or more of input processors 560, 580, 598, 618 and 628, on monitor 509.

**[0094]** Reference is now made to Figs. 8A and 8B, which, taken together, form a simplified block diagram illustration of a monitor interface assembly useful in the operator controlled medical monitoring system of Figs. 6A and 6B. As seen in Figs. 8A and 8B, the monitor interface assembly comprises a plurality of monitor interface subunits. A first pressure monitor interface subunit, designated by reference numeral 650, is preferably adapted to be connected to a pressure sensor socket of a conventional monitor, which typically provides low voltage power.

**[0095]** Monitor interface subunit 650 preferably comprises a digital wireless communications subsystem 652,

which includes a wireless transceiver 654 which is operative to receive wireless transmissions from wireless transceiver 564 of patient companion assembly 500, to process the received transmissions and to direct them to corresponding monitor interface subunits.

**[0096]** Monitor interface subunit 650 and typically up to four additional pressure monitor interface subunits, here designated by reference numerals 662, 664, 666 and 668, are preferably provided with plug connectors (not shown) each adapted to be coupled to a separate pressure sensor socket of a monitor. Each of monitor interface subunits 650, 662, 664, 666 and 668 typically includes an amplifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions that are directed thereto by digital wireless communications subsystem 652. The outputs of monitor interface subunits 650, 662, 664, 666 and 668 are preferably supplied to corresponding pressure sensor sockets of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0097]** It is a particular feature of the present invention that digital wireless communications subsystem 652 is powered by electrical power which is received in part from multiple ones of the pressure sensor sockets of the monitor. It is a further particular feature of the present invention that each of monitor interface subunits 650, 662, 664, 666 and 668 provides power to the various other monitor interface subunits, some of which are connected to sockets of the monitor which do not provide electrical power.

**[0098]** Turning to Fig. 8B, it is seen that the monitor interface assembly additionally includes an ECG monitor interface subunit 670, which is preferably provided with a multi-channel plug connector (not shown) adapted to be coupled to an ECG socket of the monitor. Monitor interface subunit 670 typically includes multiple amplifiers, filters and D/A converters, which receive, via at least one processor, those parts of the received transmissions related to ECG sensing that are directed thereto by digital wireless communications subsystem 652. The outputs of monitor interface subunit 670 are preferably supplied to a corresponding ECG socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0099]** An SPO2 monitor interface subunit 672 is preferably provided with a plug connector (not shown) adapted to be coupled to an SPO2 sensor socket of the monitor. Monitor interface subunit 672 typically includes an amplifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions related to SPO2 sensing that are directed thereto by digital wireless communications subsystem 652. The output of monitor interface subunit 672 is preferably supplied to a corresponding SPO2 sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0100]** A temperature monitor interface subunit 674 is preferably provided with a plug connector (not shown)

adapted to be coupled to a temperature sensor socket of the monitor. Monitor interface subunit 674 typically includes an amplifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions related to temperature sensing that are directed thereto by digital wireless communications subsystem 652. The output of monitor interface subunit 674 is preferably supplied to a corresponding temperature sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0101]** A blood chemistry monitor interface subunit 676 is preferably provided with at least one plug connector (not shown) adapted to be coupled to a blood chemistry sensor socket of the monitor. Monitor interface subunit 676 typically includes at least one amplifier, at least one filter and at least one D/A converter, which receive, via a processor, those parts of the received transmissions related to blood chemistry sensing that are directed thereto by digital wireless communications subsystem 652. The output of monitor interface subunit 676 is preferably supplied to a corresponding blood chemistry sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0102]** A respiratory parameter monitor interface subunit 678 is preferably provided with at least one plug connector (not shown) adapted to be coupled to a respiratory parameter socket of the monitor. Monitor interface subunit 678 typically includes at least one amplifier, at least one filter and at least one D/A converter, which receives, via at least one processor, those parts of the received transmissions related to respiratory parameter sensing that are directed thereto by digital wireless communications subsystem 652. The outputs of monitor interface subunit 678 are preferably supplied to a corresponding respiratory parameter sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0103]** A suitable man-machine interface 690 governs the operation of a controller 692, which governs operation of the various elements of the monitor interface assembly. It is appreciated that controller 692 may form part of the monitor interface subunit 650.

**[0104]** Reference is now made to Fig. 9, which is a simplified pictorial illustration of the patient companion assembly of Figs. 6A - 7C. As seen in Fig. 9, the patient companion assembly 500 comprises a housing 700, preferably composed of a forward portion 702 and a rear portion 704, which preferably encloses the apparatus of Figs. 7A-7C. Mounted on a bottom edge of housing 700 are a plurality of blood pressure sensor input receivers 510, preferably five input receivers 510. Each input receiver 510 is preferably coupled to pressure input channel interface 554 (Figs. 7A-7C).

**[0105]** A front panel 708 preferably defines mounting attachment protrusions arranged to define a plurality of pressure transducer mounting sockets 710, preferably five sockets 710, which are adapted to removably support conventional blood pressure transducer assemblies 712,

such as Transpac IT, commercially available from Elcam Medical A.C.A.L. of Kibbutz Baram, Israel, under catalog designation "fully integrated disposable blood pressure transducer". Also included in front panel 708 is medical monitor 509, described hereinabove with reference to Figs. 6A - 7C.

**[0106]** Mounted in a recess 714 at a side edge 716 of housing 700 there is preferably provided an SPO2 sensor input receiver 720, which preferably is coupled to SPO2 input channel interface 594 (Figs. 7A-7C). At recess 714 there is additionally provided an ECG sensor input receiver 722, which preferably is coupled to ECG input channel interface 574 (Figs. 7A-7C). Further provided at recess 714 is a temperature sensor input receiver 724, which preferably is coupled to temperature input channel interface 604 (Figs. 7A-7C).

**[0107]** Located alongside front panel 708 is a control panel 726 including a plurality of pressure channel control buttons 728, preferably five buttons 728, which control operation of the blood pressure transducer assemblies 712. Also preferably included in the control panel 726 is a battery charge status indicator 730, a NEXT button 516, described hereinabove with reference to Figs. 6A-7C, an OK button 522, described hereinabove with reference to Figs. 6A-7C, a power on/off button 732 and an audio/visual alarm indicator 734.

**[0108]** Reference is now made to Fig. 10, which is a simplified flow chart illustration of the operation of the system of Figs. 6A - 9. As seen in Fig. 10, when the power on/off button 732 (Fig. 9) is in a power-off state, operation of the patient companion assembly 500 (Figs. 6A-6B) is initiated either by an operator pressing the power on/off button 732 or by receipt of an output signal from a blood pressure transducer 312 by blood pressure sensor input receiver 510 (Fig. 9). Various system checks are carried out automatically by the controller 632 of Figs. 7A-7C. If a problem is encountered, an alarm is preferably indicated by audio/visual indicator 734 (Fig. 9) and the patient companion assembly power is shut down.

**[0109]** If no problem is encountered during the system checks, an attempt is made to establish wireless communication with digital wireless communication subsystem 652 (Figs. 8A and 8B) of a monitor such as monitor 502 (Figs. 6A-6B). The wireless transceiver 564 of the patient companion assembly 500 (Figs. 7A-7C) ranks receivers in its vicinity according to the strength of a signal emitted therefrom. Typically, a predetermined number of receivers, preferably 3, are ranked.

**[0110]** Thereafter, an attempt is made by the digital wireless communication subsystem 562 of the patient companion assembly 500 to establish communication with digital wireless communication subsystem 652 of the monitor having the highest ranking. The monitor that is being communicated indicates the communication thereof by providing an audio/visual indication, such as a triangular waveform, for a predetermined time duration, typically 10 seconds.

**[0111]** If the NEXT button 516 (Fig. 9) is pressed during

the predetermined time duration, an attempt is made by the digital wireless communication subsystem 562 of the patient companion assembly 500 to establish communication with digital wireless communication subsystem 652 of the monitor having the next ranking.

**[0112]** If the OK button 522 (Fig. 9) is pressed during the predetermined time duration, or if none of the buttons of control panel 726 (Fig. 9) of the patient companion assembly 500 were pressed during the predetermined time duration, the patient companion assembly confirms the establishing of communication with the selected monitor.

**[0113]** Following confirmation, and if a signal is received from a sensor by a sensor input receiver of patient companion assembly 500, the selected monitor displays the sensor signals transmitted by the transmitter 564 of the patient companion assembly 500.

**[0114]** If no signal is received from a sensor by a sensor input receiver, such as sensor input receivers 510, the patient companion assembly continues in an idle state for a predetermined amount of time and if no signal is received during that time, the patient companion assembly power is shut down.

**[0115]** Alternatively, the patient companion assembly 100 may attempt establishing communication with one of the monitors only when a sensor is connected to a suitable socket of the patient companion assembly.

**[0116]** It is appreciated that the patient companion assembly may initially establish communication with monitor 509 thereof, prior to attempting establishing communication with other monitors. Additionally, the sensor signal is preferably displayed only on a single monitor at any given time. Therefore, when a monitor other than monitor 509 is selected and the sensor signal is displayed on the selected monitor, the sensor signal is no longer displayed on monitor 509. Similarly, when the display of the sensor signal on an external monitor, such as monitor 502, is terminated, the signal may automatically be displayed on monitor 509.

**[0117]** Reference is now made to Figs. 11A and 11B, which, taken together, are a simplified pictorial illustration of the operation of a operator controlled medical monitoring system constructed and operative in accordance with yet another preferred embodiment of the present invention. As seen in Figs. 11A and 11B, there is provided an operator controlled medical monitoring system including a medical sensor that is adapted to monitor a patient characteristic; a plurality of medical monitors, each including a wireless receiver and a medical information output device; and a patient companion assembly, including a medical monitor selector employed by an operator to select one of the plurality of medical monitors and to establish communication between the medical sensor and a selected one of the plurality of medical monitors.

**[0118]** Turning to Fig. 11A, at stage A, there is seen a patient, typically in an operating room environment. In accordance with a preferred embodiment of the present invention, the patient is coupled to a patient companion

assembly 1100 which includes a medical monitor selector 1101 which can be employed by an operator to select one of a plurality of medical monitors, such as a conventional medical monitor 1102, and to establish communication between medical sensing devices, such as a blood pressure sensor 1104, attached to the patient and the selected medical monitor, preferably via a wireless receiver 1106 associated with the medical monitor 1102. It is noted that in the embodiment shown in Fig. 11A, a wired connection is provided between the sensor 1104 and the patient companion assembly 1100, it being appreciated that alternatively a wireless connection may be provided. Preferably, the connection between the patient companion assembly 1100 and the medical monitor 1102 is wireless and employs a transmitter 1108, preferably forming part of the patient companion assembly 1100, which communicates with wireless receiver 1106.

**[0119]** It is also appreciated that the medical sensor may be mounted on the patient, as shown in Fig. 1A, or otherwise coupled to the patient. Examples of medical sensor devices that may be coupled to the patient and mounted on the patient companion assembly 1100 include physiological pressure sensors. Fig. 11A shows the operator in the process of connecting the sensor 1104 to one of a plurality of connection sockets 1110 of the patient companion assembly 1100. Preferably, connection of a medical sensing device initiates powering up of the patient companion assembly 1100.

**[0120]** At stage B, the patient is being operated on in the same location as that shown at stage A. It is seen that monitor 1102 is displaying various patient parameters received from medical sensing devices, such as sensor 1104, via the patient companion assembly 1100, transmitter 1108 and receiver 1106.

**[0121]** At stage C, following the operation in Stage B, the patient is being prepared for transfer to another location and a conventional portable monitor 1113, preferably having associated therewith a wireless receiver 1114, is introduced. The operator is shown initializing communication between the patient companion assembly 1100 and the portable monitor 1113, typically by directing the monitor selector 1101 toward the portable monitor 1113 and pressing a SELECT button 1115 on the monitor selector 1101 of patient companion assembly 1100. The initializing typically enables the patient parameters to appear on the portable monitor 1113, as shown, and preferably simultaneously terminates display of the patient parameters on the monitor 1102, also as shown. Alternatively, the operator may terminate the display of the patient parameters on the monitor 1102 by directing the monitor selector thereto and pressing a CANCEL button 1116 on the monitor selector 1101. An identification of the selected, active monitor is provided on a display 1117 of monitor selector 1101.

**[0122]** As seen in Fig. 11B, stage D illustrates the patient following his transfer to an ICU or other recovery room, still coupled to portable monitor 1113, which continues to display the patient parameters.

**[0123]** At stage E, initial selection of one of a plurality of wall-mounted monitors is shown. The selection is typically carried out by an operator directing the monitor selector 1101 toward a selected monitor and pressing the SELECT button 1115 on the monitor selector 1101 of the patient companion assembly 1100. The selection typically enables the patient parameters to appear on the selected wall-mounted monitor, here designated 1118, and preferably simultaneously terminates display of the patient parameters on the portable monitor 1113, also as shown. Alternatively, the operator may terminate the display of the patient parameters on the monitor 1113 by directing the monitor selector thereto and pressing CANCEL button 1116 on the monitor selector 1101. An identification of the selected, active monitor is provided on display 1117 of monitor selector 1101.

**[0124]** In situations where there are plural wall-mounted monitors available for communication with the patient companion assembly 1100, the selection of a wall-mounted monitor preferably is based on the direction at which the monitor selector 1101 is pointed during the selection.

**[0125]** In the illustration at stage E, wall-mounted monitor 1118 is not the wall-mounted monitor that the operator desires to employ. Accordingly, in accordance with a preferred embodiment of the present invention, and as shown at stage F, the operator can select an alternative wall-mounted monitor preferably by directing the monitor selector 1101 toward the correct monitor and pressing the SELECT button 1115 on the monitor selector 1101 of patient companion assembly 1100, as shown. This preferably causes the patient parameters to appear on the wall-mounted monitor toward which the monitor selector 1101 was directed, here designated by reference numeral 1120, and preferably simultaneously terminates display of the patient parameters on the monitor 1118, also as shown. Alternatively, the operator may terminate the display of the patient parameters on the monitor 1118 by directing the monitor selector thereto and pressing CANCEL button 1116 on the monitor selector 1101. An identification of the selected, active monitor is provided on display 1117 of monitor selector 1101.

**[0126]** Reference is now made to Figs. 12A, 12B and 12C, which, taken together, form a simplified block diagram illustration of patient companion assembly 1100 useful in the operator controlled medical monitoring system of Figs. 11A and 11B. As seen in Figs. 12A-12C, the patient companion assembly comprises a plurality of medical sensor interface subunits. A first medical sensor interface subunit, designated by reference numeral 1150, preferably processes inputs from pressure sensors, such as intracranial pressure sensors, arterial pressure sensors and venous pressure sensors. Typically, interface subunit 1150 includes five pressure sensor connectors 1152, such as connectors 1110, each adapted to be coupled to a separate pressure sensor and each connected to a pressure input channel interface 1154, typically including an amplifier and a filter. The outputs

of pressure input channel interfaces 1154 are preferably supplied via an A/D converter 1156 and a multiplexer 1158 to a pressure sensor input processor 1160, which adapts the signals for digital wireless communication and supplies them to a digital wireless communications subsystem 1162 including a wireless transceiver 1164.

**[0127]** Turning to Fig. 12B, it is seen that patient companion assembly 1100 additionally includes a second medical sensor interface subunit, designated by reference numeral 1170, which preferably processes inputs from a plurality of ECG electrodes. Typically, interface subunit 1170 includes a single multi-channel ECG connector 1172 having plural channels, each connected to an ECG input channel interface 1174, typically including an amplifier and a filter. The output signals from ECG input channel interfaces 1174 are preferably supplied via an A/D converter 1176 and a multiplexer 1178 to an ECG input processor 1180, which adapts the signals for digital wireless communication and supplies them to digital wireless communications subsystem 1162.

**[0128]** A third medical sensor interface subunit, designated by reference numeral 1190, preferably processes inputs from a SPO2 sensor. Typically, interface subunit 1190 includes a single SPO2 connector 1192 connected to an SPO2 input channel interface 1194, typically including an amplifier and a filter. The output signal from SPO2 input channel interface 1194 is preferably supplied via an A/D converter 1196 to an SPO2 input processor 1198, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 1162.

**[0129]** A fourth medical sensor interface subunit, designated by reference numeral 1200, preferably processes inputs from a temperature sensor. Typically, interface subunit 1200 includes a single temperature connector 1202 connected to a temperature input channel interface 1204, typically including an amplifier and a filter. The output signal from temperature input channel interface 1204 is preferably supplied via an A/D converter 1206 to SPO2 input processor 1198, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 1162.

**[0130]** As seen in Fig. 12C, patient companion assembly 1100 also includes a fifth medical sensor interface subunit, designated by reference numeral 1210, which preferably processes inputs from a blood chemistry sensor. Typically, interface subunit 1210 includes at least one blood chemistry connector 1212, connected to at least one blood chemistry input channel interface 1214, typically including an amplifier and a filter. The output signal from each blood chemistry input channel interface 1214 is preferably supplied via an A/D converter 1216 to a blood chemistry input processor 1218, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 1162.

**[0131]** A sixth medical sensor interface subunit, designated by reference numeral 1220, preferably processes inputs from a respiratory parameter sensor. Typically,

interface subunit 1220 includes at least one respiratory parameter connector 1222, connected to at least one respiratory parameter input channel interface 1224, typically including an amplifier and a filter. The output signal from each respiratory parameter input channel interface 1224 is preferably supplied via an A/D converter 1226 to a respiratory parameter input processor 1228, which adapts the signal for digital wireless communication and supplies it to digital wireless communications subsystem 1162.

**[0132]** It is appreciated that any suitable medical sensor may be coupled to a selectable monitor using the patient companion assembly 1100 when equipped with a suitable medical sensor interface unit.

**[0133]** A suitable man-machine interface 1230, which typically includes the monitor selector 1101 which includes SELECT button 1115, display 1117 and CANCEL button 1116, governs the operation of a controller 1232, which governs operation of the various elements of the patient companion assembly 1100.

**[0134]** Reference is now made to Figs. 13A and 13B, which, taken together, form a simplified block diagram illustration of a monitor interface assembly useful in the operator controlled medical monitoring system of Figs. 11A and 11B. As seen in Figs. 13A and 13B, the monitor interface assembly comprises a plurality of monitor interface subunits. A first pressure monitor interface subunit, designated by reference numeral 1250, is preferably adapted to be connected to a pressure sensor socket of a conventional monitor, which typically provides low voltage power.

**[0135]** Monitor interface subunit 1250 preferably comprises a digital wireless communications subsystem 1252, which includes a wireless transceiver 1254 which is operative to receive wireless transmissions from wireless transceiver 1164 of patient companion assembly 1100, to process the received transmissions and to direct them to corresponding monitor interface subunits.

**[0136]** Monitor interface subunit 1250 and typically up to four additional pressure monitor interface subunits, here designated by reference numerals 1262, 1264, 1266 and 1268, are preferably provided with plug connectors (not shown) each adapted to be coupled to a separate pressure sensor socket of a monitor. Each of monitor interface subunits 1250, 1262, 1264, 1266 and 1268 typically includes an amplifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions that are directed thereto by digital wireless communications subsystem 1252. The outputs of monitor interface subunits 1250, 1262, 1264, 1266 and 1268 are preferably supplied to corresponding pressure sensor sockets of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0137]** It is a particular feature of the present invention that digital wireless communications subsystem 1252 is powered by electrical power which is received in part from multiple ones of the pressure sensor sockets of the

monitor. It is a further particular feature of the present invention that monitor interface subunits 1250, 1262, 1264, 1266 and 1268 each provides power to the various other monitor interface subunits, some of which are connected to sockets of the monitor which do not provide electrical power.

**[0138]** Turning to Fig. 13B, it is seen that the monitor interface assembly additionally includes an ECG monitor interface subunit 1270, which is preferably provided with a multi-channel plug connector (not shown) adapted to be coupled to an ECG socket of the monitor. Monitor interface subunit 1270 typically includes multiple amplifiers, filters and D/A converters, which receive, via at least one processor, those parts of the received transmissions related to ECG sensing that are directed thereto by digital wireless communications subsystem 1252. The outputs of monitor interface subunit 1270 are preferably supplied to a corresponding ECG socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0139]** An SPO2 monitor interface subunit 1272 is preferably provided with a plug connector (not shown) adapted to be coupled to an SPO2 sensor socket of the monitor. Monitor interface subunit 1272 typically includes an amplifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions related to SPO2 sensing that are directed thereto by digital wireless communications subsystem 1252. The output of monitor interface subunit 1272 is preferably supplied to a corresponding SPO2 sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0140]** A temperature monitor interface subunit 1274 is preferably provided with a plug connector (not shown) adapted to be coupled to a temperature sensor socket of the monitor. Monitor interface subunit 1274 typically includes an amplifier, a filter and a D/A converter, which receives, via a processor, those parts of the received transmissions related to temperature sensing that are directed thereto by digital wireless communications subsystem 1252. The output of monitor interface subunit 1274 is preferably supplied to a corresponding temperature sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0141]** A blood chemistry monitor interface subunit 1276 is preferably provided with at least one plug connector (not shown) adapted to be coupled to a blood chemistry sensor socket of the monitor. Monitor interface subunit 1276 typically includes at least one amplifier, at least one filter and at least one D/A converter, which receive, via a processor, those parts of the received transmissions related to blood chemistry sensing that are directed thereto by digital wireless communications subsystem 1252. The output of monitor interface subunit 1276 is preferably supplied to a corresponding blood chemistry sensor socket of the monitor in a conventional form which is suitable for conventional operation of the

monitor.

**[0142]** A respiratory parameter monitor interface subunit 1278 is preferably provided with at least one plug connector (not shown) adapted to be coupled to a respiratory parameter socket of the monitor. Monitor interface subunit 1278 typically includes at least one amplifier, at least one filter and at least one D/A converter, which receives, via at least one processor, those parts of the received transmissions related to respiratory parameter sensing that are directed thereto by digital wireless communications subsystem 1252. The outputs of monitor interface subunit 1278 are preferably supplied to a corresponding respiratory parameter sensor socket of the monitor in a conventional form which is suitable for conventional operation of the monitor.

**[0143]** A suitable man-machine interface 1290 governs the operation of a controller 1292, which governs operation of the various elements of the monitor interface assembly, and which is operative to receive communications commands from monitor selector 1101. It is appreciated that controller 1292 may form part of the monitor interface subunit 1250.

**[0144]** Reference is now made to Fig. 14, which is a simplified pictorial illustration of the patient companion assembly of Figs. 11A - 12C. As seen in Fig. 14, the patient companion assembly 1100 comprises a housing 1300, preferably composed of a forward portion 1302 and a rear portion 1304, which preferably encloses the apparatus of Figs. 12A-12C. Mounted on a bottom edge of housing 1300 are a plurality of pressure transducer connector sockets 1110, preferably five sockets 1110, such as an RJ11 female modular jack, commercially available from Bel-Fuse of Glen Rock, Pennsylvania, USA. Each socket 1110 preferably includes a suitable pressure sensor connector (not shown) which is coupled to pressure input channel interface 1154 (Figs. 12A-12C). A front panel 1308 preferably defines mounting attachment protrusions arranged to define a plurality of pressure transducer mounting sockets 1310, preferably five sockets 1310, which are adapted to removably support conventional blood pressure transducer assemblies 1312 each including a connector 1313, such as Transpac IT, commercially available from Elcam Medical A.C.A.L. of Kibbutz Baram, Israel, under catalog designation "fully integrated disposable blood pressure transducer".

**[0145]** Mounted in a recess 1314 at a side edge 1316 of housing 1300 there is preferably provided an SPO2 connector socket 1320, such as a D-Type 9S connector socket commercially available from Molex of Illinois, USA, which preferably includes a suitable SPO2 sensor connector (not shown) which is coupled to SPO2 input channel interface 1194 (Figs. 12A-12C). At recess 1314 there is additionally provided an ECG sensor socket 1322, such as a conventional female D-Type 15S connector socket commercially available from Molex of Illinois, USA, which preferably includes a suitable ECG sensor connector (not shown) which is coupled to ECG input channel interface 1174 (Figs. 12A-12C). Further provid-

ed at recess 1314 is a temperature sensor socket 1324, such as a conventional female RS Phone jack 1/4" socket commercially available from Switchcraft Inc. of Chicago, Illinois, USA, which preferably includes a suitable temperature sensor connector (not shown) which is coupled to temperature input channel interface 1204 (Figs. 12A-12C).

**[0146]** Located alongside front panel 1308 is a control panel 1326 including a plurality of pressure channel control buttons 1328, preferably five buttons 1328, which control operation of the blood pressure transducer assemblies 1312. Also, preferably included in the control panel 1326 is a battery charge status indicator 1330, a power on/off button 1332 and an audio/visual alarm indicator 1334.

**[0147]** On side edge 1336 of the housing 1300, opposite side edge 1316, is a selector support element 1338, which seats monitor selector 1101. Monitor selector 1101 is preferably connected to the housing 1300 of patient companion assembly 1100, typically by a cable 1340. As seen in the enlarged portion of Fig. 14, the SELECT button 1115, the display 1117 and the CANCEL button 1116 are preferably provided on a front surface 1342 of monitor selector 1101.

**[0148]** Reference is now made to Fig. 15, which is a simplified flow chart illustration of the operation of the system of Figs. 11A - 14. As seen in Fig. 15, when the power on/off button 1332 (Fig. 14) is in a power-off state, operation of the patient companion assembly 1100 (Figs. 11A-11B) is initiated either by an operator pressing the power on/off button 1332 or by an operator inserting the connector 1313 of a blood pressure transducer 1312 into a socket 1110 (Fig. 14). Various system checks are carried out automatically by the controller 1232 of Figs. 12A-12C. If a problem is encountered, an alarm is preferably indicated by audio/visual indicator 1334 (Fig. 14) and the patient companion assembly power is shut down.

**[0149]** If no problem is encountered during the system checks, an attempt is made to establish wireless communication with digital wireless communication subsystem 1252 (Figs. 13A and 13B) of a monitor such as monitor 1102 (Figs. 11A-11B). The wireless transceiver 1164 of the patient companion assembly 1100 (Figs. 12A-12C) ranks receivers in its vicinity according to the strength of a signal emitted therefrom. Typically, a predetermined number of receivers, preferably 3, are ranked.

**[0150]** Thereafter, an attempt is made by the digital wireless communication subsystem 1162 of the patient companion assembly 1100 to establish communication with digital wireless communication subsystem 1252 of the monitor having the highest ranking. The monitor that is being communicated with indicates the communication thereof by providing an audio/visual indication, such as a triangular waveform, for a predetermined time duration, typically 10 seconds.

**[0151]** If the monitor selector 1101 is directed at another monitor and the SELECT button 1115 (Fig. 14) is pressed during the predetermined time duration, an at-

tempt is made by the digital wireless communication subsystem 1162 of the patient companion assembly 1100 to establish communication with digital wireless communication subsystem 252 of the monitor at which the monitor selector 1101 is directed.

**[0152]** If none of the buttons of control panel 1326 (Fig. 14) of the patient companion assembly 1100 or of monitor selector 1101 were pressed during the predetermined time duration, the patient companion assembly confirms the establishing of communication with the selected monitor.

**[0153]** Following confirmation, and if a sensor is connected to a socket of the patient companion assembly 1100 the selected monitor displays the sensor signals transmitted by the transmitter 1164 of the patient companion assembly 1100. If no sensor is connected to a socket of the patient companion assembly, the patient companion assembly continues in an idle state for a predetermined time duration, and if no sensor is connected during that time, the patient companion assembly power is shut down.

**[0154]** Alternatively, the patient companion assembly 1100 may attempt establishing communication with one of the monitors only when a sensor is connected to a suitable socket of the patient companion assembly.

**[0155]** If the CANCEL button 1116 is pressed, the display of sensor signals on the monitor currently displaying them is terminated, and the patient companion assembly continues in an idle state for a predetermined time duration. If an operator selects another monitor by pressing the SELECT button 1115 during the predetermined time duration an attempt is made to establish communication between the patient companion assembly and the selected monitor as described above, and if the predetermined time duration elapses and no monitor is selected the patient companion assembly power is shut down.

**[0156]** It is appreciated that a monitor selector of the type shown in the embodiment of Figs. 11A - 15 may be employed in the embodiments of Figs. 1A - 10. Additionally, a monitor of the type of monitor 509 shown in the embodiment of Figs. 6A - 10 may be employed in the embodiment of Figs. 11A - 15.

**[0157]** It is appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of various features described hereinabove as well as variations and modifications thereto which would occur to a person of skill in the art upon reading the above description and which are not in the prior art.

**Claims**

1. An operator-controllable medical monitoring system comprising:

at least one medical sensor (104) that is adapted to monitor at least one patient characteristic; a plurality of medical monitors (118,120), each including a monitor wireless transceiver and a medical information display; and  
 5 a patient companion assembly (100) including:

a patient companion assembly wireless transceiver (164);  
 an operator controllable button (116); and  
 10 a medical monitor selector,

said patient companion assembly further comprises at least one medical sensor interface subunit operative to process inputs from said at least one medical sensor, and  
 15 said medical monitor selector is wirelessly operative, in response to an operator pressing said operator controllable button, to initially select one of said plurality of medical monitors for display of said inputs and to provide a monitor selection indication which is visually sensible to said operator, **characterized in that**

said medical monitor selector is wirelessly operative, in response to an operator pressing said operator controllable button, to automatically select another one of said plurality of medical monitors and to establish communication between said at least one  
 20 medical sensor and said another one of said plurality of medical monitors, said another one of said plurality of medical monitors being selected based on the strength of a wireless signal sensed by said patient companion assembly.

2. An operator-controllable medical monitoring system according to claim 1 and wherein said at least one medical sensor also comprises a sensor wireless transmitter which is adapted to communicate with said patient companion assembly wireless transceiver.
3. An operator-controllable medical monitoring system according to claim 1 or claim 2 and wherein said at least one medical sensor interface subunit comprises at least one of a pressure sensor interface subunit, an ECG sensor interface subunit, an SP02 sensor interface subunit, a temperature sensor interface subunit, a blood chemistry sensor interface subunit and a respiratory parameter sensor interface subunit.
4. An operator-controllable medical monitoring system according to any of claims 1 - 3 and wherein said at least one medical sensor interface subunit comprises:

a plurality of medical sensor connectors, each operative to be coupled to a medical sensor; a plurality of medical sensor input channel interfaces, each coupled to one of said plurality of medical sensor connectors and each including  
 5 an amplifier and a filter;

at least one A/D converter which is operative to convert analog medical sensor signals received from said plurality of medical input channel interfaces to digital medical sensor signals; and a medical sensor input processor operative to adapt said digital medical sensor signals for digital wireless communication, and to supply said digital medical sensor signals to said patient companion assembly wireless transceiver.

5. An operator-controllable medical monitoring system according to any of the preceding claims and wherein said patient companion assembly comprises:

at least one socket adapted to receive at least one corresponding sensor connector associated with said at least one medical sensor; and power management functionality, operative, upon insertion of said at least one sensor connector to said at least one socket, to power-up said patient companion assembly.

6. An operator-controllable medical monitoring system according to claim 5 and wherein said power management functionality is operative to shut-down said patient companion assembly if no sensor connector is connected to said at least one socket for a predetermined time duration.

7. An operator-controllable medical monitoring system according to any of the preceding claims and wherein said plurality of medical monitors each comprises at least one sensor socket operative to provide electrical power obtained from said medical monitor to at least one of said monitor wireless transceiver and electrical circuitry coupled to other sensor sockets.

8. An operator-controllable medical monitoring system according to any of the preceding claims and wherein said patient companion assembly also comprises sensing circuitry operative to sense changes in electrical characteristics of said operator-controllable medical monitoring system which are indicative of the activation of said at least one medical sensor, and to power up said patient companion assembly upon sensing said changes.

9. An operator-controllable medical monitoring system according to any claim 1 and wherein said monitor wireless transceiver is powered by a source of electrical power which is also operative to power said medical information display.

10. An operator-controllable medical monitoring system according to claim 9 and wherein said plurality of medical monitors each comprises at least one sensor socket operative to provide said electrical power to at least one of said monitor wireless transceiver and electrical circuitry coupled to other sensor sockets.
11. A method for operator-controllable medical monitoring of a patient, employing at least one medical sensor (104) that is adapted to monitor at least one patient characteristic and a plurality of medical monitors (118,120), each including a monitor wireless transceiver and a medical information display, the method comprising:
- providing a patient companion assembly (100)/ including a patient companion assembly wireless transceiver (164), an operator controllable button (116), at least one medical sensor interface subunit operative to process inputs from said at least one medical sensor and a medical monitor selector,
- and employing said medical monitor selector wirelessly, in response to an operator pressing said operator controllable button, to initially select one of said plurality of medical monitors for display of said inputs and to provide a monitor selection indication which is visually sensible to said operator, **characterized in**
- employing said medical monitor selector, in response to an operator pressing said operator controllable button, to automatically select another one of said plurality of medical monitors for display of said inputs and to establish communication between said at least one medical sensor and said another one of said plurality of medical monitors, said another one of said plurality of medical monitors being selected based on the strength of a wireless signal sensed by said patient companion assembly.
12. A method according to claim 11 and also comprising employing sensing circuitry forming part of said patient companion assembly to sense changes in electrical characteristics which are indicative of the activation of said at least one medical sensor, and to power up said patient companion assembly upon sensing said changes.
13. A method according to any of claims 11-12 comprising employing said patient companion assembly wirelessly by employing power management functionality, operative, upon insertion of at least one sensor connector to at least one socket of a monitor, to power-up said patient companion assembly.

14. A method according to claim 13 and also comprising employing said power management functionality to shut-down said patient companion assembly if a sensor connector is not connected to said at least one socket for a predetermined time duration.

#### Patentansprüche

1. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem, aufweisend:
- mindestens einen Medizinsensor (104), der dafür ausgelegt ist, mindestens einen Kennwert eines Patienten zu überwachen;
- eine Mehrzahl von medizinischen Monitoren (118, 120), die jeweils einen drahtlosen Monitor-Transceiver und eine Anzeige für medizinische Informationen aufweisen; und
- eine Patientenbegleitanordnung (100), die aufweist:
- einen drahtlosen Patientenbegleitanordnungs-Transceiver (164);
- eine von einem Bediener zu betätigende Taste (116); und
- einen Wähler für einen medizinischen Monitor,
- wobei:
- die Patientenbegleitanordnung ferner mindestens eine Medizinsensor-Schnittstellenuntereinheit aufweist, die dazu dient, Eingaben von dem mindestens einen Medizinsensor zu verarbeiten, und
- der Wähler für den medizinischen Monitor auf drahtlose Weise dazu dient, als Reaktion darauf, dass ein Bediener die vom Bediener zu steuernde Taste drückt, zu Anfang einen von der Mehrzahl von medizinischen Monitoren auszuwählen, der die Eingaben anzeigt und einen Monitorwahlhinweis ausgibt, der für den Bediener visuell erkennbar ist,
- dadurch gekennzeichnet, dass**
- der Wähler für den medizinischen Monitor auf drahtlose Weise dazu dient, als Reaktion darauf, dass ein Bediener die von einem Bediener zu steuernde Taste drückt, automatisch einen anderen von der Mehrzahl von medizinischen Monitoren auszuwählen und eine Kommunikation zwischen dem mindestens einen Medizinsensor und dem anderen von der Mehrzahl von medizinischen Monitoren einzurichten, wobei der andere von der Mehrzahl von medizinischen Monitoren auf Basis der Stärke eines

- drahtlosen Signals, das durch die Patientenbegleitordnung erfasst wird, ausgewählt wird.
2. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach Anspruch 1, wobei außerdem der mindestens eine Medizinsensor auch einen drahtlosen Sensorsender aufweist, der dafür ausgewählt ist, mit dem drahtlosen Transceiver der Patientenbegleitordnung zu kommunizieren. 5
  3. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach Anspruch 1 oder Anspruch 2, wobei außerdem die mindestens eine Medizinsensor-Schnittstellenuntereinheit mindestens eine von einer Drucksensor-Schnittstellenuntereinheit, einer ECG-Sensor-Schnittstellenuntereinheit, einer SpO<sub>2</sub>-Sensor-Schnittstellenuntereinheit, einer Temperatursensor-Schnittstellenuntereinheit, einer Blutchemiesensor-Schnittstellenuntereinheit und einer Respirationsparametersensor-Schnittstellenuntereinheit aufweist. 10
  4. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach einem der Ansprüche 1-3, wobei die mindestens eine Medizinsensor-Schnittstellenuntereinheit aufweist:
    - eine Mehrzahl von Medizinsensorsteckern, die jeweils dazu da sind, mit einem Medizinsensor verbunden zu werden; 30
    - eine Mehrzahl von Schnittstellen für Medizinsensor-Eingangskanäle, die jeweils mit einem von der Mehrzahl von Medizinsensorsteckern verbunden sind und jeweils einen Verstärker und einen Filter aufweisen; 35
    - mindestens einen A/D-Wandler, der dazu dient, analoge Medizinsensorsignale, die von der Mehrzahl von Schnittstellen für medizinische Eingangskanäle empfangen werden, in digitale Medizinsensorsignale umzuwandeln; und 40
    - einen Medizinsensoreingabe-Prozessor, der dazu dient, die digitalen Medizinsensorsignale für eine digitale Drahtloskommunikation aufzubereiten und die digitalen Medizinsensorsignale an den drahtlosen Patientenbegleitordnungs-Transceiver zu liefern. 45
  5. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach einem der vorangehenden Ansprüche, wobei außerdem die Patientenbegleitordnung aufweist:
    - mindestens eine Steckdose, die dafür ausgelegt ist, mindestens einen entsprechenden Sensorstecker, der mit dem mindestens einen Medizinsensor assoziiert ist, aufzunehmen; und 50
    - eine Leistungsverwaltungsfunktion, die dazu dient, nach Einstecken des mindestens einen Sensorsteckers in die mindestens eine Steckdose die Patientenbegleitordnung mit Leistung zu versorgen. 55
  6. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach Anspruch 5, wobei außerdem die Leistungsverwaltungsfunktion dazu dient, die Patientenbegleitordnung auszuschalten, wenn über eine vorgegebene Zeitspanne kein Sensorstecker mit der mindestens einen Steckdose verbunden ist.
  7. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach einem der vorangehenden Ansprüche, wobei außerdem die Mehrzahl medizinischer Monitore jeweils mindestens eine Sensorsteckdose aufweist, die dazu dient, elektrische Leistung, die vom medizinischen Monitor erhalten wird, an den drahtlosen Monitor-Transceiver und/oder eine elektrische Schaltung, die mit anderen Sensorsteckdosen verbunden ist, zu liefern.
  8. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach einem der vorangehenden Ansprüche, wobei außerdem die Patientenbegleitordnung auch eine Sensorschaltung aufweist, die dazu dient, Änderungen von elektrischen Kennwerten des von einem Bediener zu steuernden medizinischen Überwachungssystems, die auf die Aktivierung des mindestens einen Medizinsensors hinweisen, zu erfassen und die Patientenbegleitordnung einzuschalten, sobald diese Änderungen erfasst werden.
  9. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach einem der vorangehenden Ansprüche, wobei außerdem der drahtlose Monitor-Transceiver von einer Stromquelle mit Leistung versorgt wird, die auch dazu dient, die Anzeige für medizinische Informationen mit Leistung zu versorgen.
  10. Durch einen Bediener zu steuerndes medizinisches Überwachungssystem nach Anspruch 9, wobei außerdem die Mehrzahl von medizinischen Monitoren jeweils mindestens eine Sensorsteckdose aufweist, die dazu dient, den mindestens einen drahtlosen Monitor-Transceiver und eine elektrische Schaltung, die mit anderen Sensorsteckdosen verbunden ist, mit Leistung zu versorgen.
  11. Verfahren zur von einem Bediener zu steuernden medizinischen Überwachung eines Patienten, für das mindestens ein Medizinsensor (104), der dafür ausgelegt ist, mindestens einen Kennwert eines Patienten zu überwachen, und eine Mehrzahl von medizinischen Monitoren (118, 120), die jeweils einen

drahtlosen Monitor-Transceiver und eine Anzeige für medizinische Informationen aufweisen, verwendet werden, wobei das Verfahren umfasst:

Bereitstellen einer Patientenbegleitanordnung (100), die aufweist: einen drahtlosen Patientenbegleitanordnungs-Transceiver (164); eine von einem Bediener zu betätigende Taste (116); mindestens eine Medizinsensor-Schnittstellenuntereinheit, die dazu dient, Eingaben von dem mindestens einen Medizinsensor und einem Wähler für einen medizinischen Monitor zu verarbeiten, und für das der Wähler für den medizinischen Monitor auf drahtlose Weise dafür verwendet wird, als Reaktion darauf, dass ein Bediener die vom Bediener zu steuernde Taste drückt, zu Anfang einen von der Mehrzahl von medizinischen Monitoren auszuwählen, der die Eingaben anzeigt und um einen Monitorwahlhinweis ausgibt, welcher für den Bediener visuell erkennbar ist, **dadurch gekennzeichnet, dass** der Wähler für den medizinischen Monitor dazu verwendet wird, als Reaktion darauf, dass ein Bediener die von einem Bediener zu steuernde Taste drückt, automatisch einen anderen von der Mehrzahl von medizinischen Monitoren auszuwählen, der die Eingaben anzeigt, und eine Kommunikation zwischen dem mindestens einen Medizinsensor und dem anderen von der Mehrzahl von medizinischen Monitoren einzurichten, wobei der andere von der Mehrzahl von medizinischen Monitoren auf Basis der Stärke eines drahtlosen Signals, das von der Patientenbegleitanordnung erfasst wird, ausgewählt wird.

12. Verfahren nach Anspruch 11, für das außerdem eine Sensorschaltung verwendet wird, die Teil der Patientenbegleitanordnung ist, um Änderungen von elektrischen Kennwerten, die auf die Aktivierung des mindestens einen Medizinsensors hinweisen, zu erfassen und die Patientenbegleitanordnung einzuschalten, sobald diese Änderungen erfasst werden.
13. Verfahren nach einem der Ansprüche 11-12, die drahtlose Verwendung der Patientenbegleitanordnung umfassend durch Verwenden einer Leistungsverwaltungsfunktion, die dazu dient, nach Einstecken des mindestens einen Sensorsteckers in mindestens eine Steckdose eines Monitors die Patientenbegleitanordnung mit Leistung zu versorgen.
14. Verfahren nach Anspruch 13, außerdem die Verwendung der Leistungsverwaltungsfunktion zum Abschalten der Patientenbegleitanordnung, wenn

ein Sensorstecker für eine vorgegebene Zeitspanne nicht mit der mindestens einen Steckdose verbunden ist, umfassend.

## Revendications

1. Un système de surveillance médical pouvant être commandé par un opérateur comprenant :

au moins un capteur médical (104) qui est adapté de façon à surveiller au moins une caractéristique de patient,  
une pluralité de dispositifs de surveillance médicale (118, 120), chacun d'eux comprenant un émetteur-récepteur sans fil de dispositif de surveillance et un dispositif d'affichage d'informations médicales, et  
un bloc d'accompagnement de patient (100) comprenant :

un émetteur-récepteur sans fil de bloc d'accompagnement de patient (164),  
un bouton pouvant être commandé par un opérateur (116), et  
un sélecteur de dispositif de surveillance médicale,  
où :

ledit bloc d'accompagnement de patient comprend en outre au moins une sous-unité d'interface de capteur médical destinée à traiter des entrées provenant dudit au moins un capteur médical, et  
ledit sélecteur de dispositif de surveillance médicale est destiné, de manière non filaire, en réponse à une pression par un opérateur sur ledit bouton pouvant être commandé par un opérateur, à sélectionner initialement un dispositif de ladite pluralité de dispositifs de surveillance médicale pour un affichage desdites entrées et à fournir une indication de sélection de dispositif de surveillance qui est visuellement perceptible par ledit opérateur, **caractérisé en ce que**  
ledit sélecteur de dispositif de surveillance médicale est destiné, de manière non filaire, en réponse à une pression par un opérateur sur ledit bouton pouvant être commandé par un opérateur, à sélectionner automatiquement un autre dispositif de ladite pluralité de dispositifs de surveillance médicale et à établir communication entre ledit au moins un capteur médical et ledit un

- autre dispositif de ladite pluralité de dispositifs de surveillance médicale, ledit un autre dispositif de ladite pluralité de dispositifs de surveillance médicale étant sélectionné en fonction de la puissance d'un signal sans fil détecté par ledit bloc d'accompagnement de patient.
2. Un système de surveillance médical pouvant être commandé par un opérateur selon la Revendication 1 et où ledit au moins un capteur médical comprend également un émetteur sans fil de capteur qui est adapté de façon à communiquer avec ledit émetteur-récepteur sans fil de bloc d'accompagnement de patient.
  3. Un système de surveillance médical pouvant être commandé par un opérateur selon la Revendication 1 ou 2 et où ladite au moins une sous-unité d'interface de capteur médical comprend au moins un dispositif parmi une sous-unité d'interface de capteur de pression, une sous-unité d'interface de capteur ECG, une sous-unité d'interface de capteur SP02, une sous-unité d'interface de capteur de température, une sous-unité d'interface de capteur de chimie du sang et une sous-unité d'interface de capteur de paramètres respiratoires.
  4. Un système de surveillance médical pouvant être commandé par un opérateur selon l'une quelconque des Revendications 1 à 3 et où ladite au moins une sous-unité d'interface de capteur médical comprend :
    - une pluralité de connecteurs de capteur médical, chacun d'eux étant destiné à être couplé à un capteur médical,
    - une pluralité d'interfaces de canal d'entrée de capteur médical, chacune d'elles étant couplée à un connecteur de ladite pluralité de connecteurs de capteur médical et chacune d'elles comprenant un amplificateur et un filtre, au moins un convertisseur analogique/numérique qui est destiné à convertir des signaux analogiques de capteur médical reçus de ladite pluralité d'interfaces de canal d'entrée médicale en signaux numériques de capteur médical, et un processeur d'entrée de capteur médical destiné à adapter lesdits signaux numériques de capteur médical à une communication sans fil numérique, et à fournir lesdits signaux numériques de capteur médical audit émetteur-récepteur sans fil de bloc d'accompagnement de patient.
  5. Un système de surveillance médical pouvant être commandé par un opérateur selon l'une quelconque des Revendications précédentes et où ledit bloc d'accompagnement de patient comprend :
    - au moins une prise adaptée de façon à recevoir au moins un connecteur de capteur correspondant associé audit au moins un capteur médical, et
    - une fonctionnalité de gestion de l'alimentation électrique, destinée, après insertion dudit au moins un connecteur de capteur dans ladite au moins une prise, à mettre sous tension ledit bloc d'accompagnement de patient.
  6. Un système de surveillance médical pouvant être commandé par un opérateur selon la Revendication 5 et où ladite fonctionnalité de gestion de l'alimentation électrique est destinée à mettre hors tension ledit bloc d'accompagnement de patient si aucun connecteur de capteur n'est raccordé à ladite au moins une prise pendant une durée prédéterminée.
  7. Un système de surveillance médical pouvant être commandé par un opérateur selon l'une quelconque des Revendications précédentes et où ladite pluralité de dispositifs de surveillance médicale comprend au moins une prise de capteur destinée à fournir une alimentation électrique obtenue à partir dudit dispositif de surveillance médicale à au moins un dispositif parmi ledit émetteur-récepteur sans fil de dispositif de surveillance et un circuit électrique couplé à d'autres prises de capteur.
  8. Un système de surveillance médical pouvant être commandé par un opérateur selon l'une quelconque des Revendications précédentes et où ledit bloc d'accompagnement de patient comprend également un circuit de détection destiné à détecter des modifications dans les caractéristiques électriques dudit système de surveillance médical pouvant être commandé par un opérateur qui sont indicatives de l'activation dudit au moins un capteur médical, et à mettre sous tension ledit bloc d'accompagnement de patient après détection desdites modifications.
  9. Un système de surveillance médical pouvant être commandé par un opérateur selon la Revendication 1 et où ledit émetteur-récepteur sans fil de dispositif de surveillance est alimenté par une source d'alimentation électrique qui est également destinée à alimenter ledit dispositif d'affichage d'informations médicales.
  10. Un système de surveillance médical pouvant être commandé par un opérateur selon la Revendication 9 et où ladite pluralité de dispositifs de surveillance médicale comprend au moins une prise de capteur destinée à fournir ladite alimentation électrique à au moins un dispositif parmi ledit émetteur-récepteur

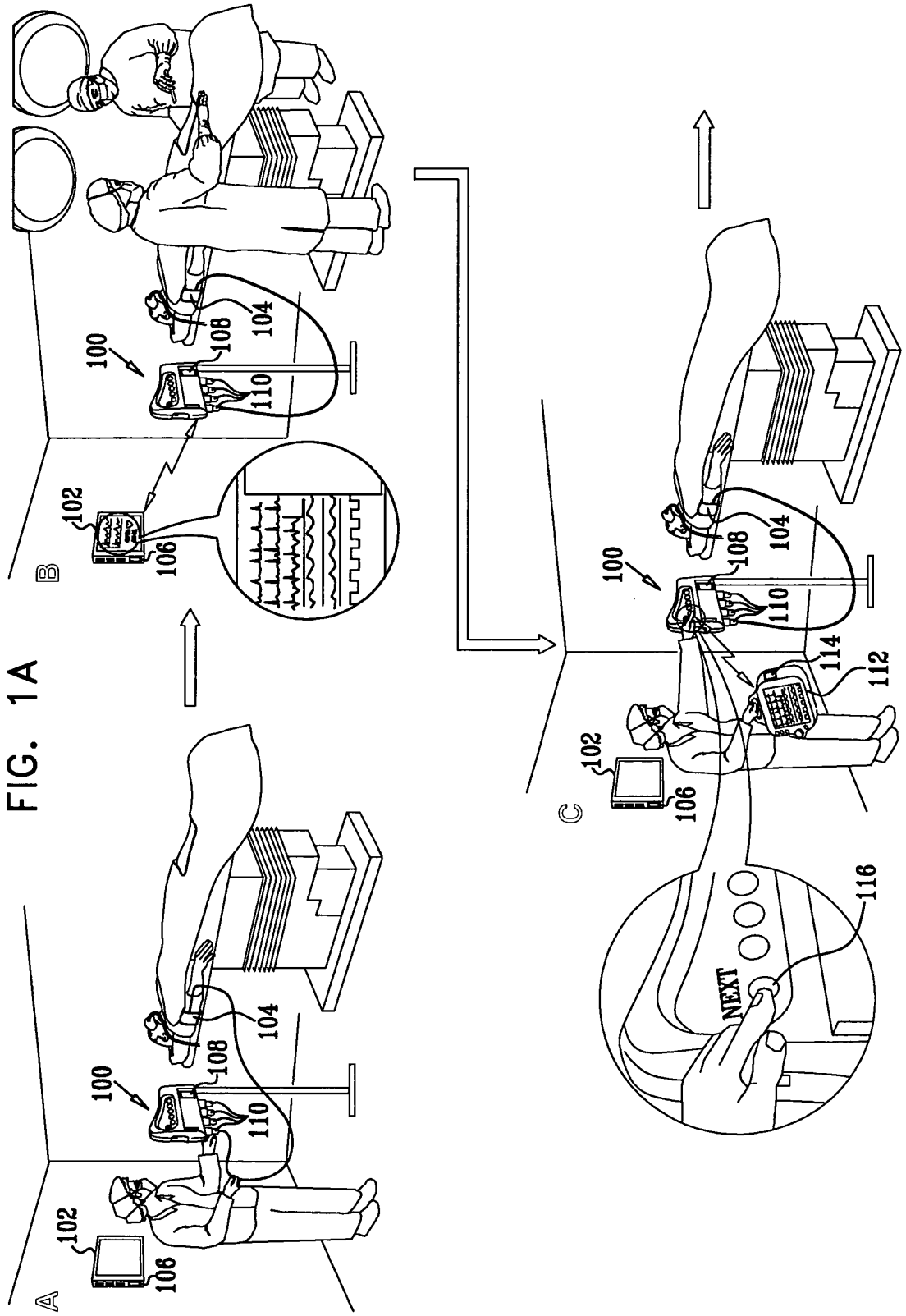
sans fil de dispositif de surveillance et un circuit électrique couplé à d'autres prises de capteur.

11. Un procédé de surveillance médicale d'un patient pouvant être commandé par un opérateur, utilisant au moins un capteur médical (104) qui est adapté de façon à surveiller au moins une caractéristique de patient et une pluralité de dispositifs de surveillance médicale (118, 120), chacun d'eux comprenant un émetteur-récepteur sans fil de dispositif de surveillance et un dispositif d'affichage d'informations médicales, le procédé comprenant :

la fourniture d'un bloc d'accompagnement de patient (100) comprenant un émetteur-récepteur sans fil de bloc d'accompagnement de patient (164), un bouton pouvant être commandé par un opérateur (116), au moins une sous-unité d'interface de capteur médical destinée à traiter des entrées provenant dudit au moins un capteur médical et un sélecteur de dispositif de surveillance médicale, et l'utilisation dudit sélecteur de dispositif de surveillance médicale, de manière non filaire, en réponse à une pression par un opérateur sur ledit bouton pouvant être commandé par un opérateur, de façon à sélectionner initialement un dispositif de ladite pluralité de dispositifs de surveillance médicale pour un affichage desdites entrées et de façon à fournir une indication de sélection de dispositif de surveillance qui est visuellement perceptible par ledit opérateur, l'utilisation dudit sélecteur de dispositif de surveillance médicale, en réponse à une pression par un opérateur sur ledit bouton pouvant être commandé par un opérateur, de façon à sélectionner automatiquement un autre dispositif de ladite pluralité de dispositifs de surveillance médicale pour un affichage desdites entrées et de façon à établir une communication entre ledit au moins un capteur médical et ledit un autre dispositif de ladite pluralité de dispositifs de surveillance médicale, ledit un autre dispositif de ladite pluralité de dispositifs de surveillance médicale étant sélectionné en fonction de la puissance d'un signal sans fil détecté par ledit bloc d'accompagnement de patient.

12. Un procédé selon la Revendication 11 et comprenant également l'utilisation d'un circuit de détection formant partie dudit bloc d'accompagnement de patient de façon à détecter des modifications dans des caractéristiques électriques qui sont indicatives de l'activation dudit au moins un capteur médical, et de façon à mettre sous tension ledit bloc d'accompagnement de patient après détection desdites modifications.

13. Un procédé selon l'une quelconque des Revendications 11 à 12 comprenant l'utilisation dudit bloc d'accompagnement de patient de manière non filaire par l'utilisation d'une fonctionnalité de gestion de l'alimentation électrique, destinée, après insertion d'au moins un connecteur de capteur dans au moins une prise d'un dispositif de surveillance, à mettre sous tension ledit bloc d'accompagnement de patient.
14. Un procédé selon la Revendication 13 et comprenant également l'utilisation de ladite fonctionnalité de gestion de l'alimentation électrique de façon à mettre hors tension ledit bloc d'accompagnement de patient si un connecteur de capteur n'est pas raccordé à ladite au moins une prise pendant une durée prédéterminée.



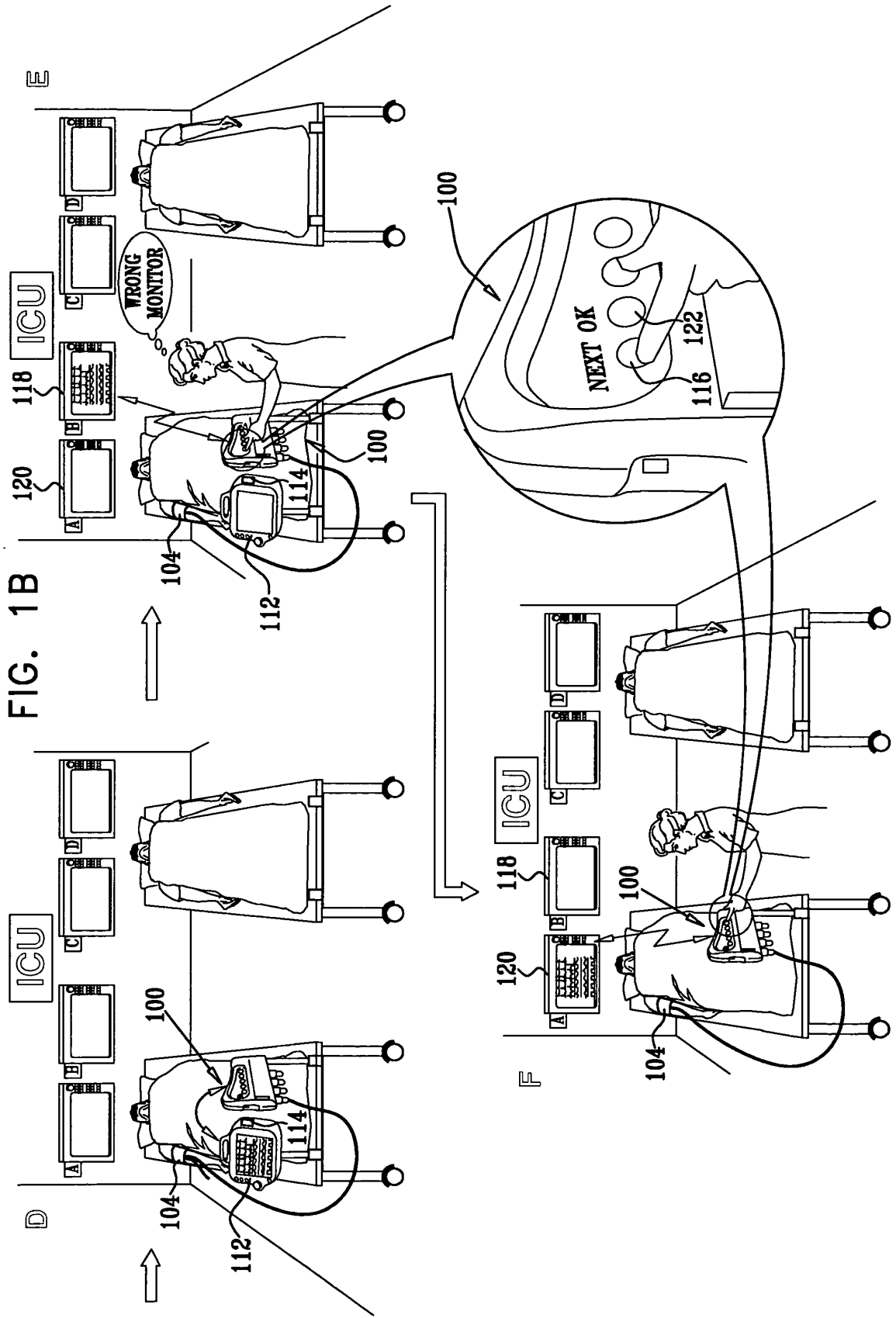
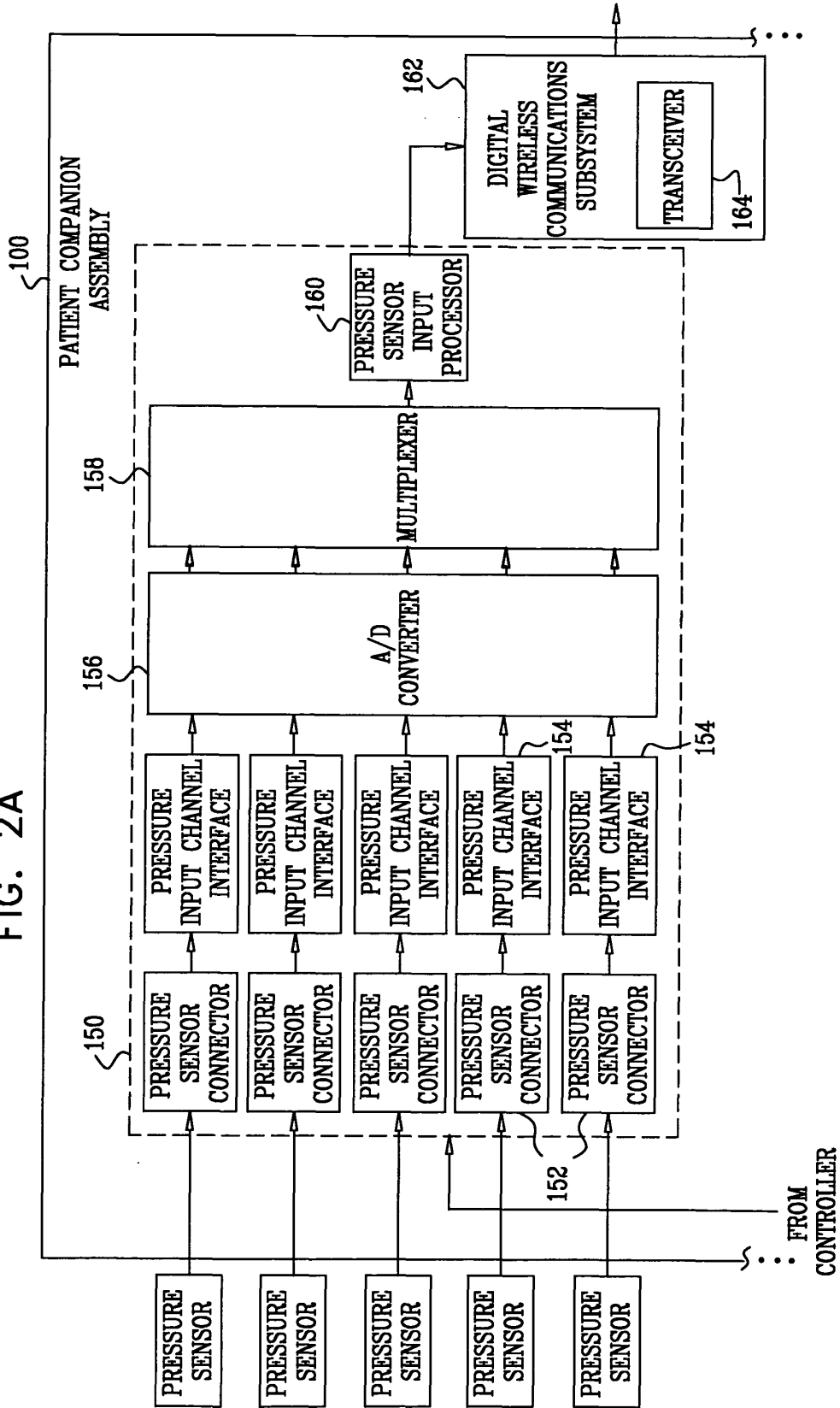
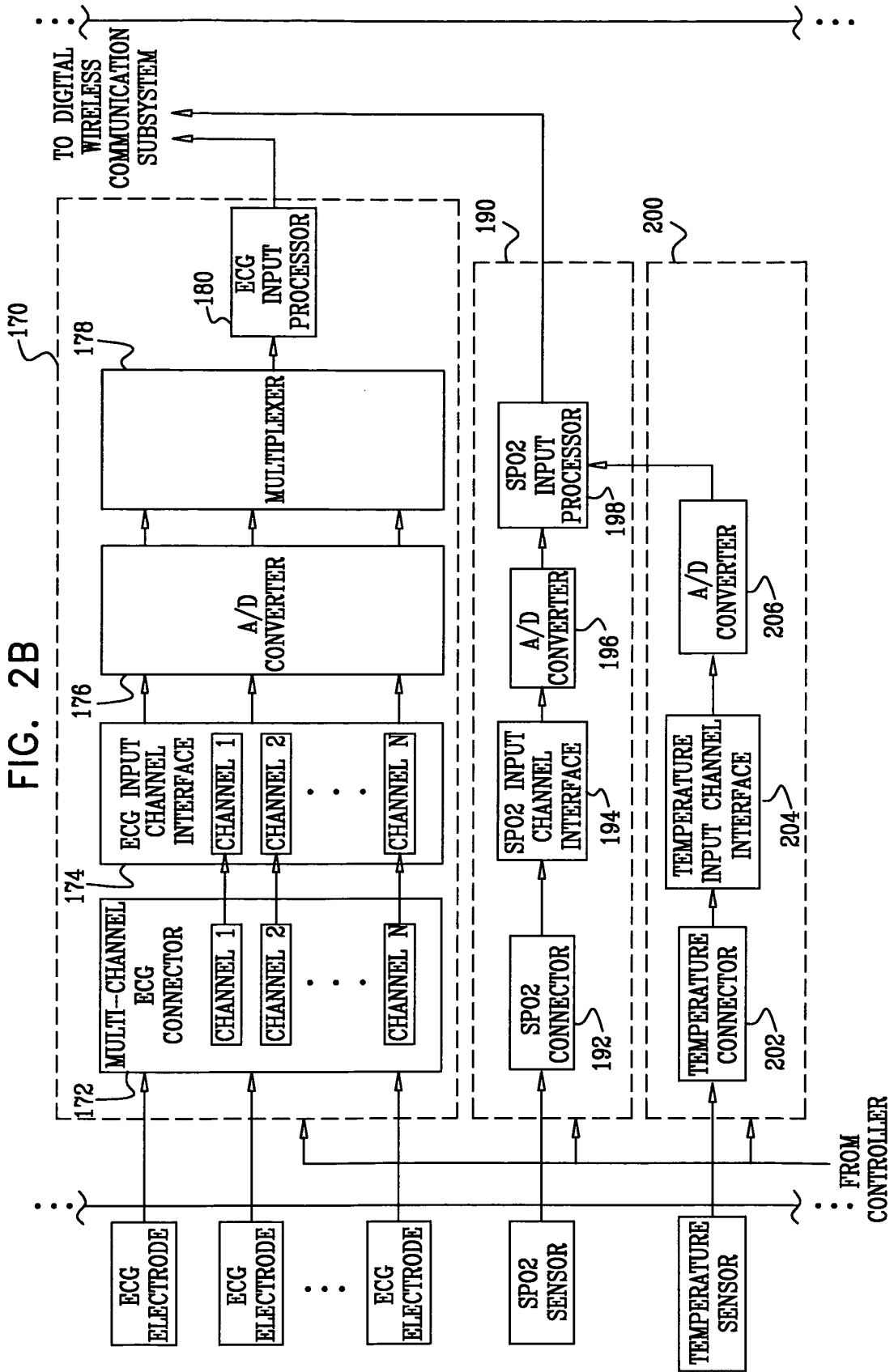


FIG. 2A





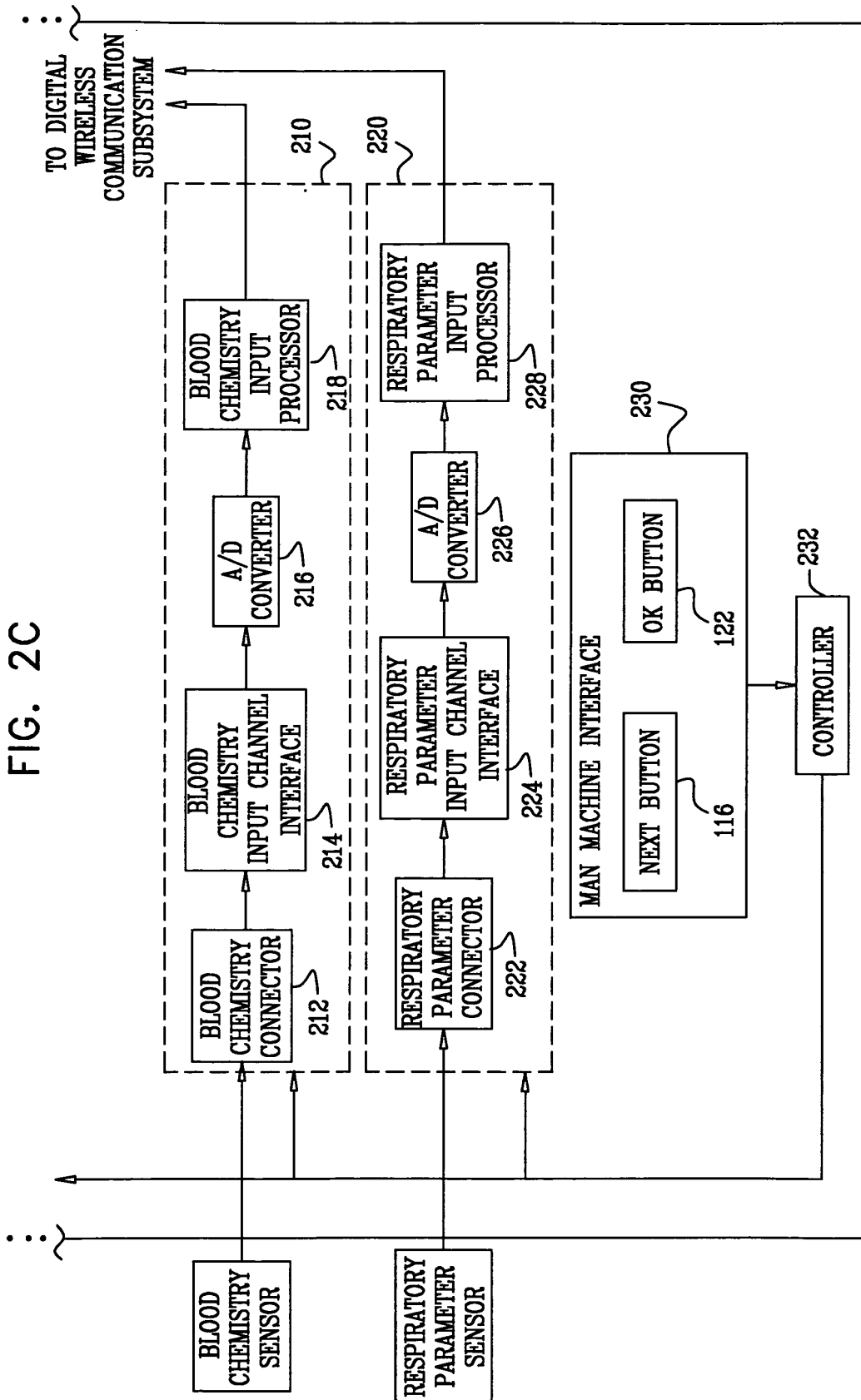


FIG. 2C

FIG. 3A

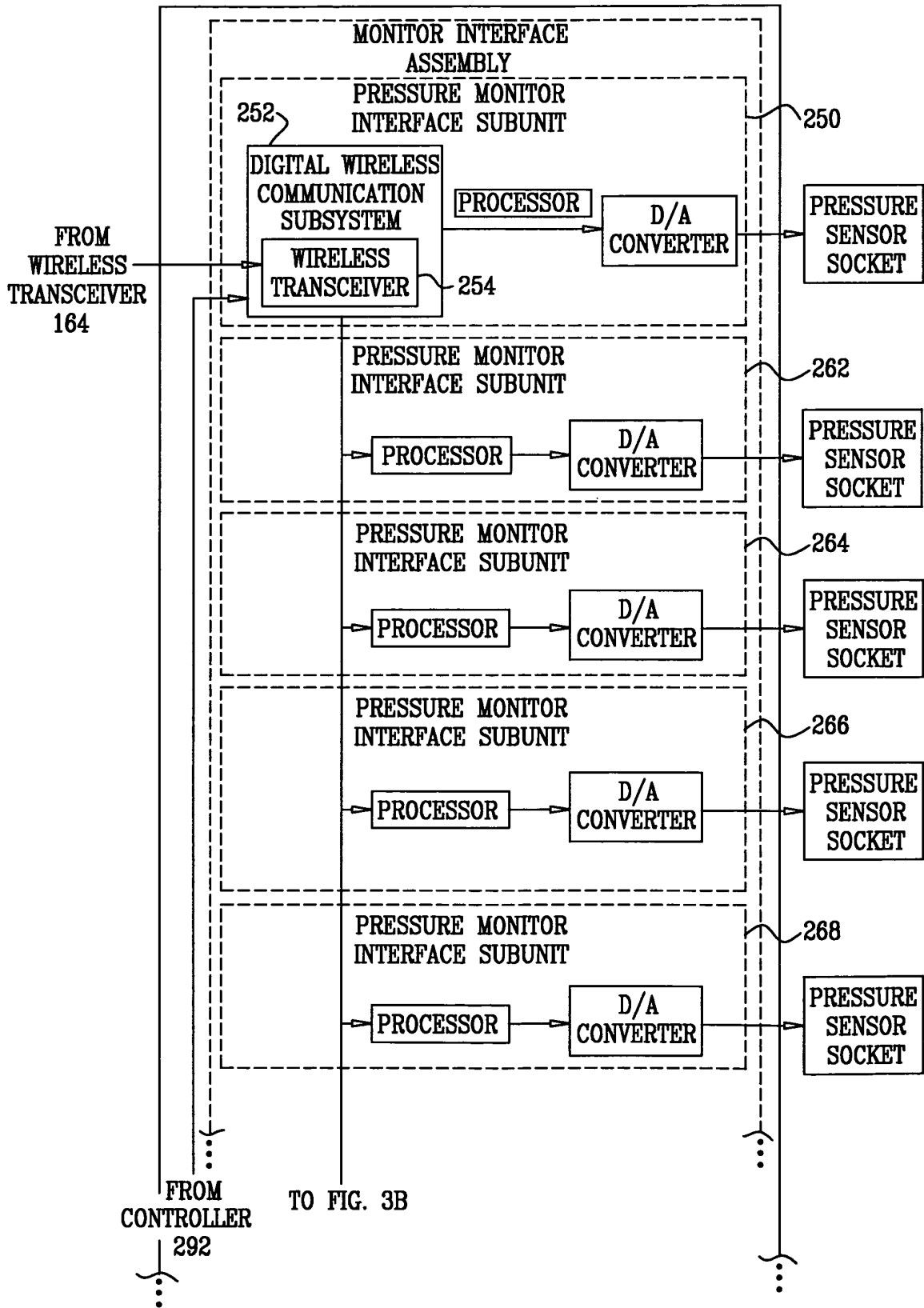
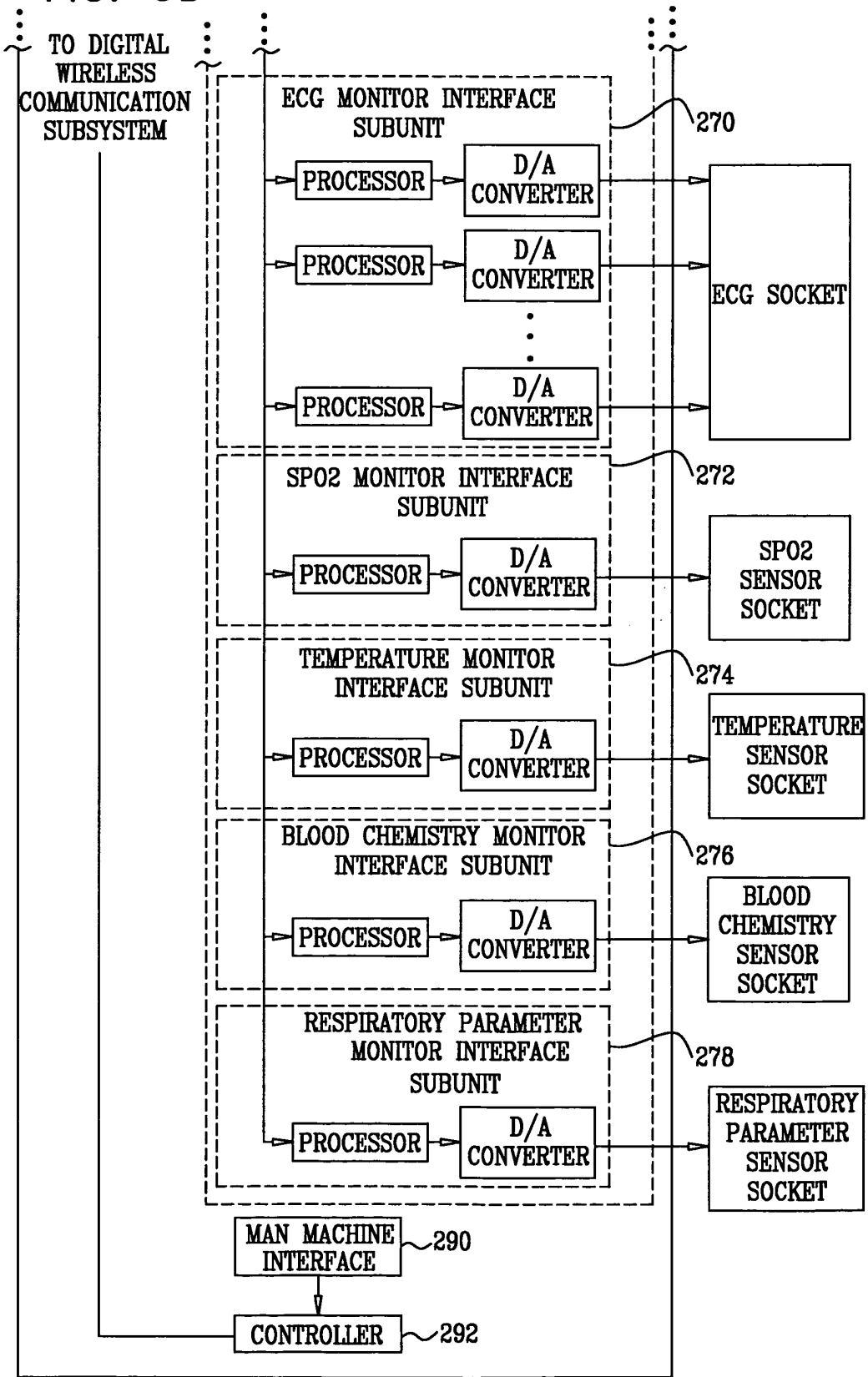


FIG. 3B



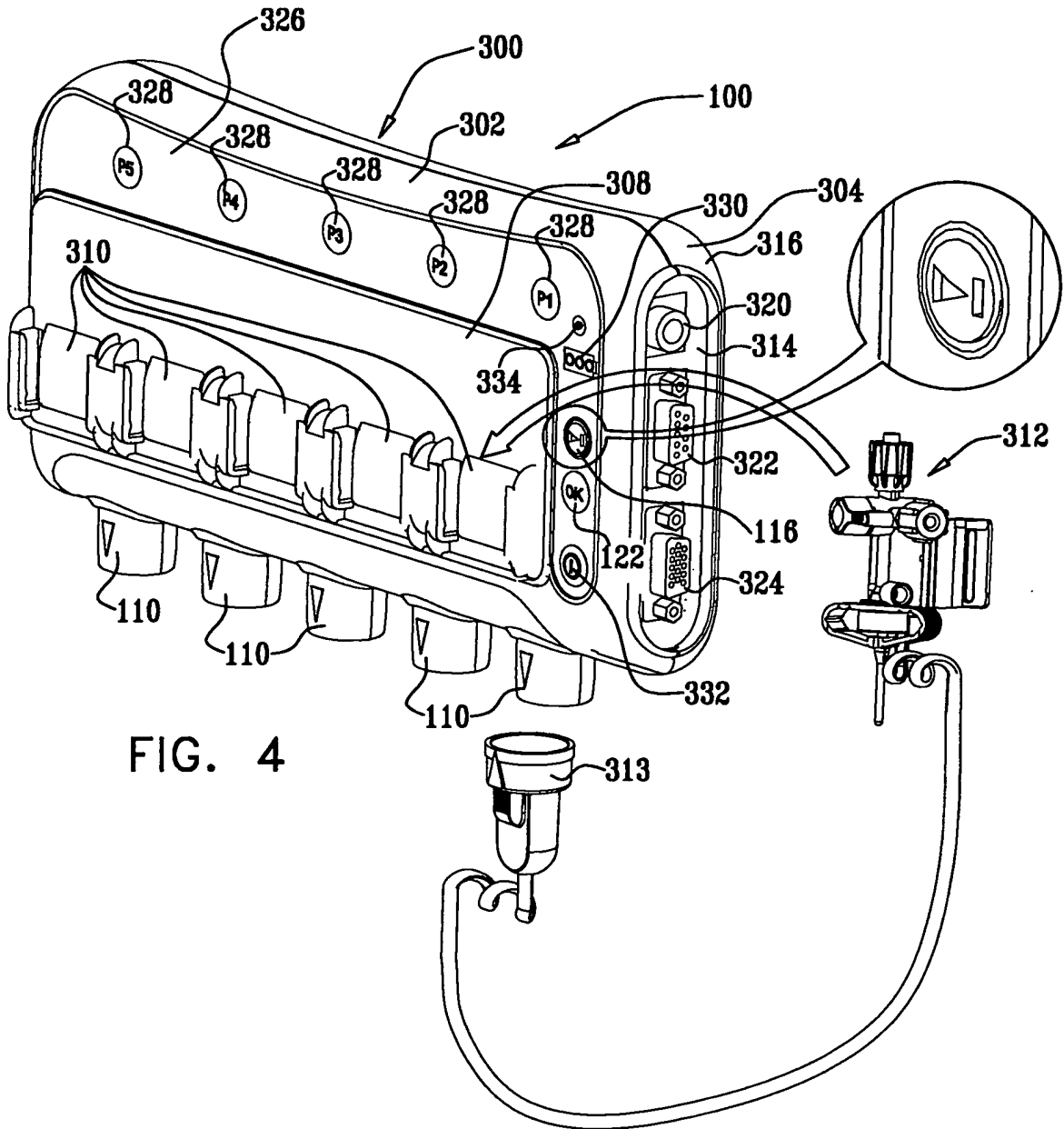
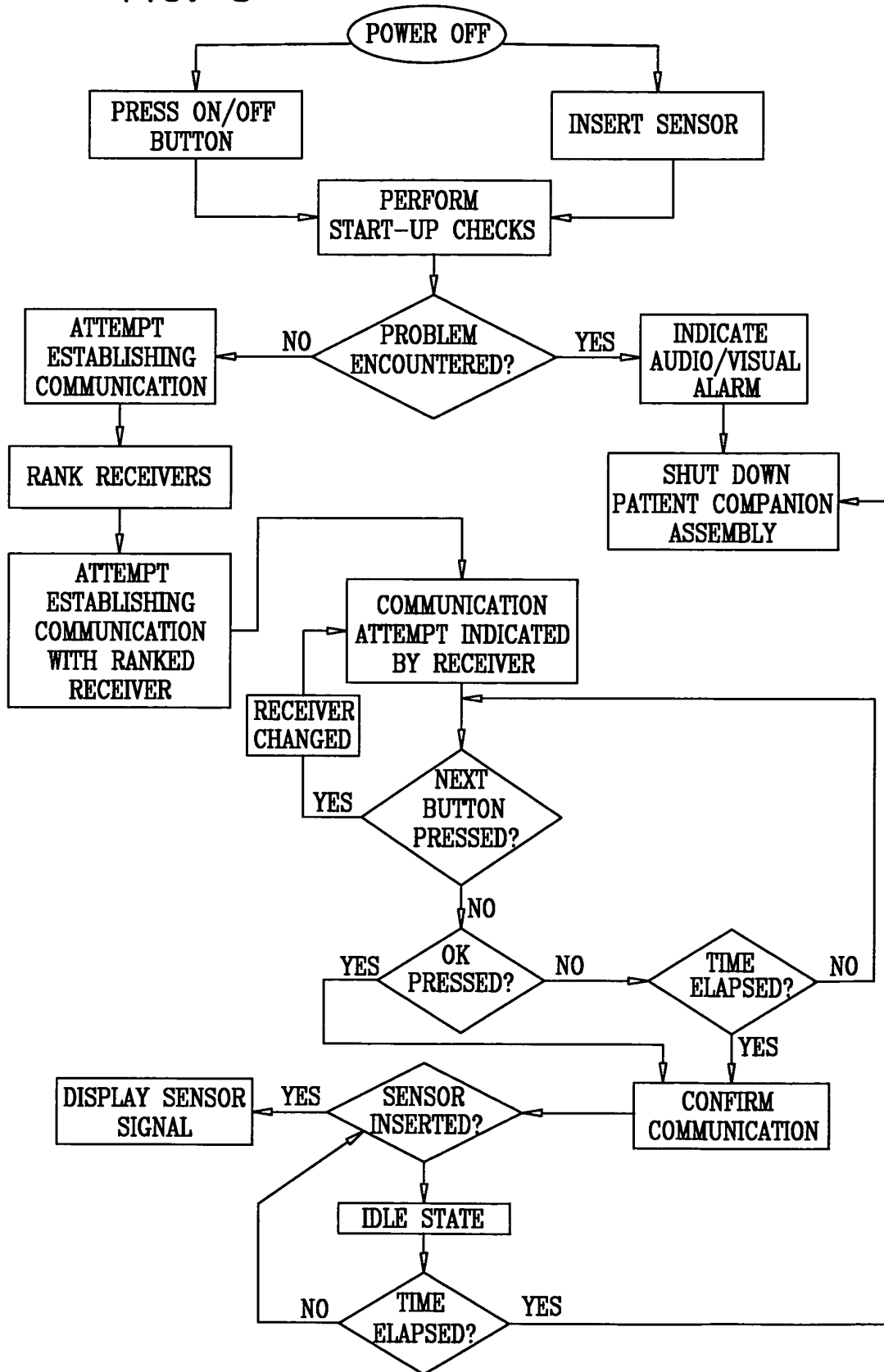
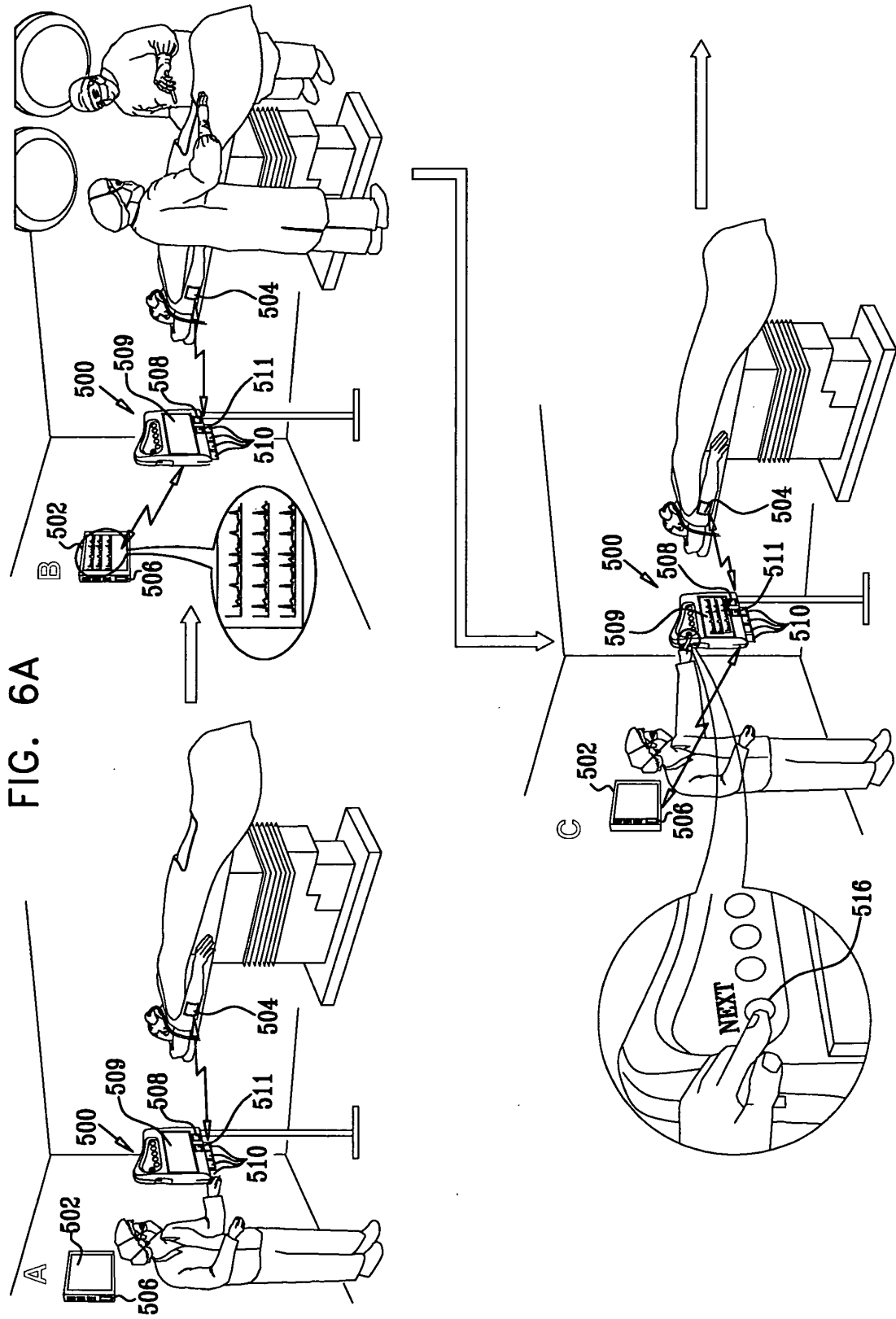


FIG. 4

FIG. 5





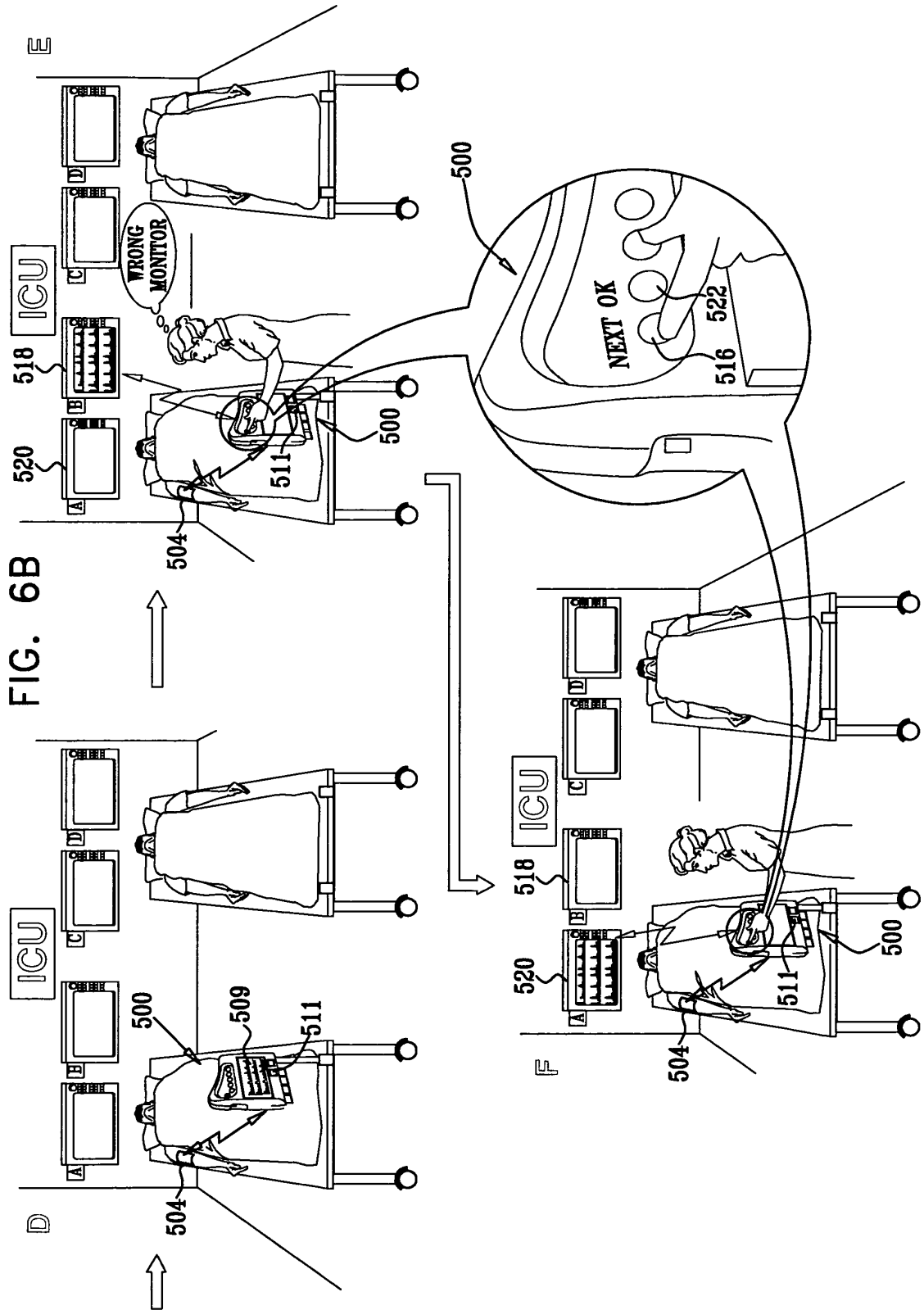
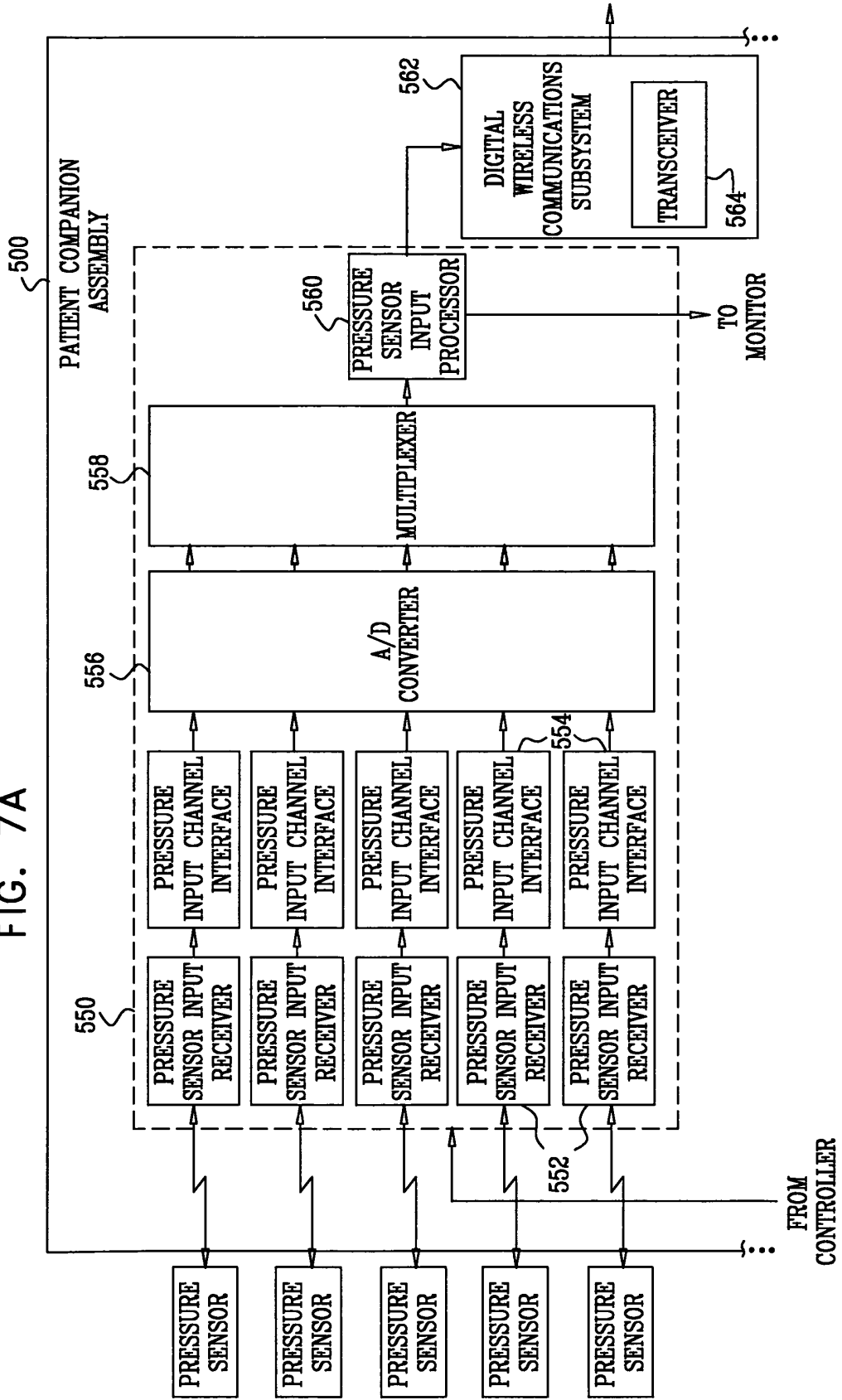
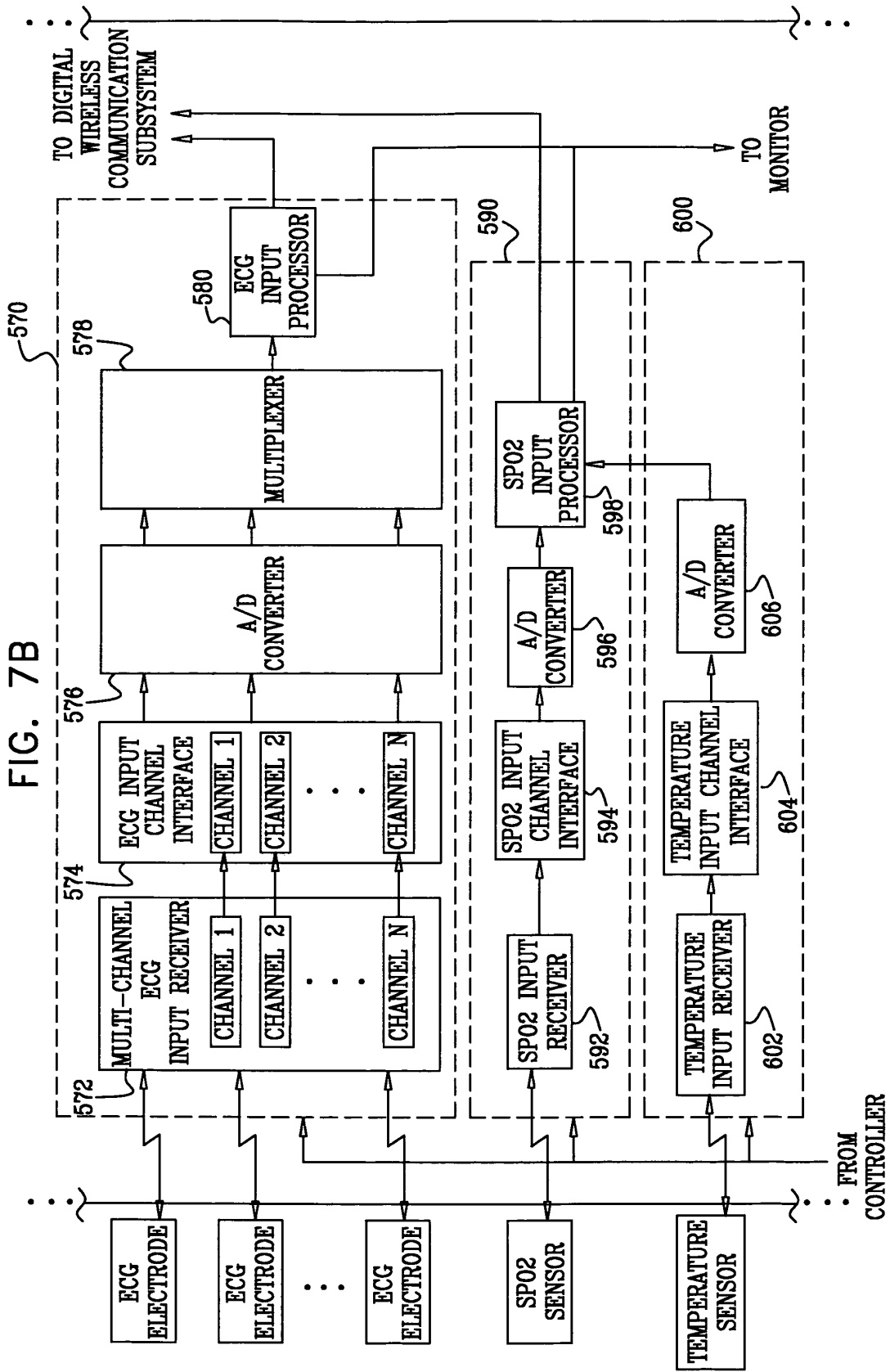


FIG. 7A





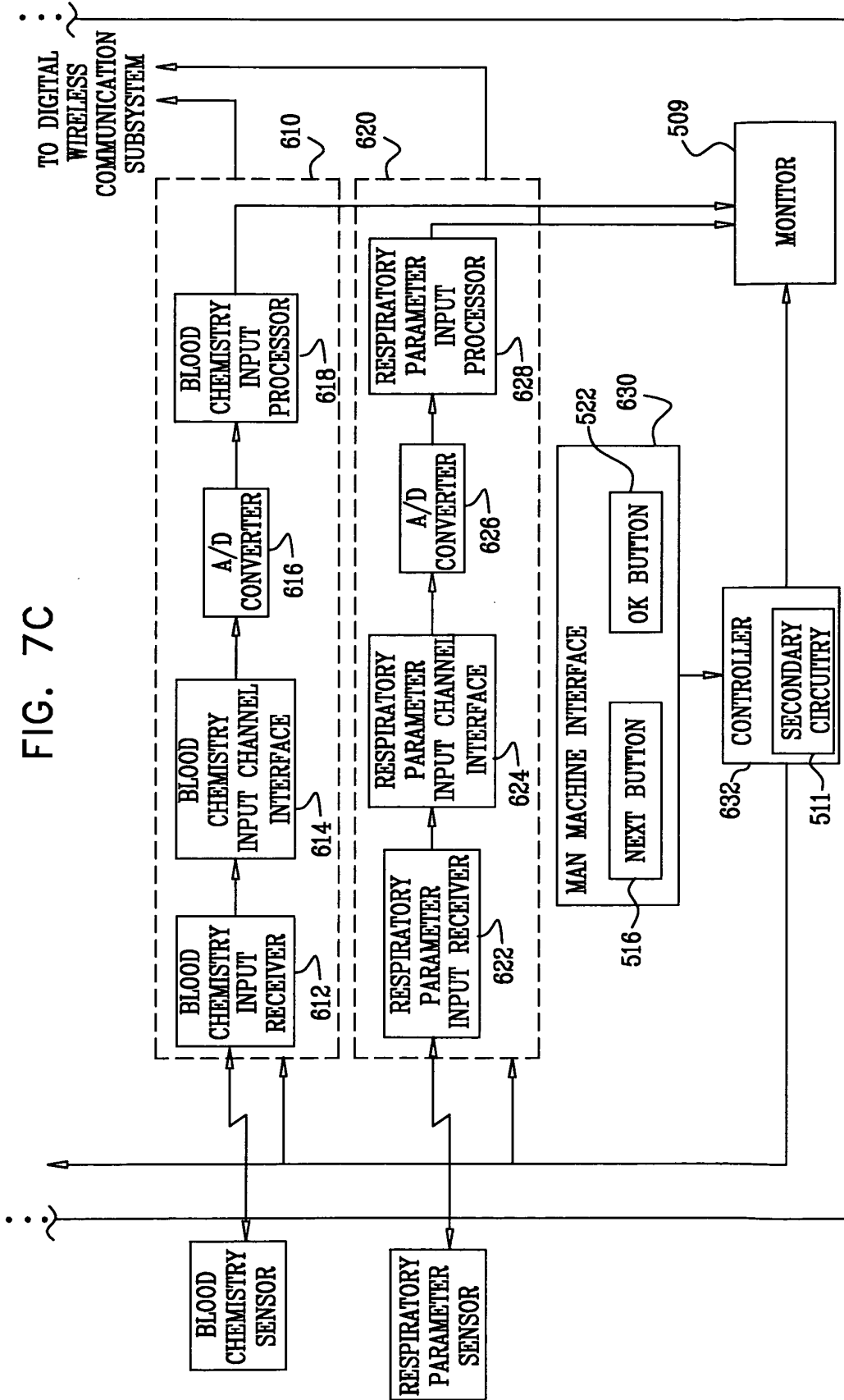


FIG. 7C

FIG. 8A

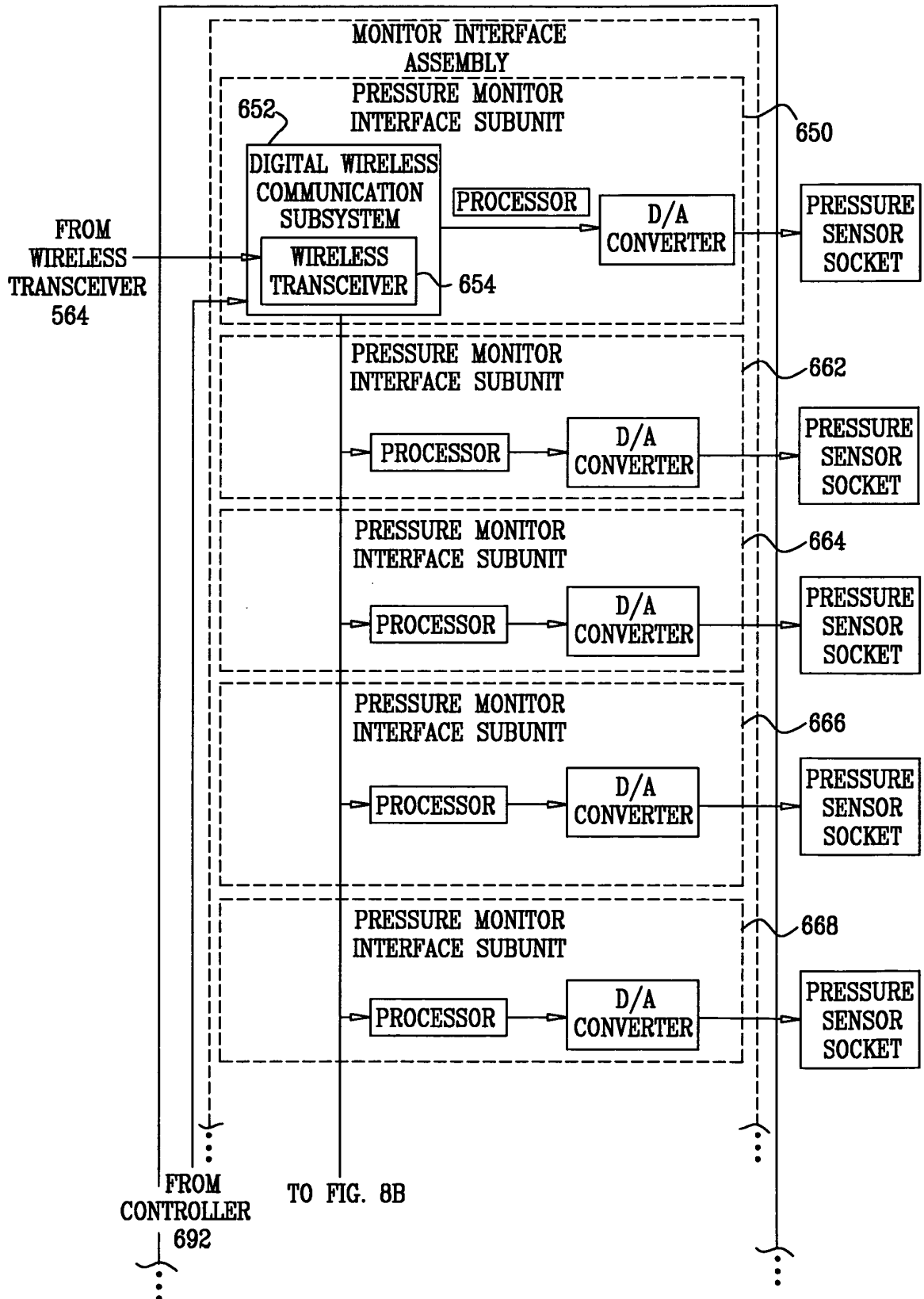


FIG. 8B

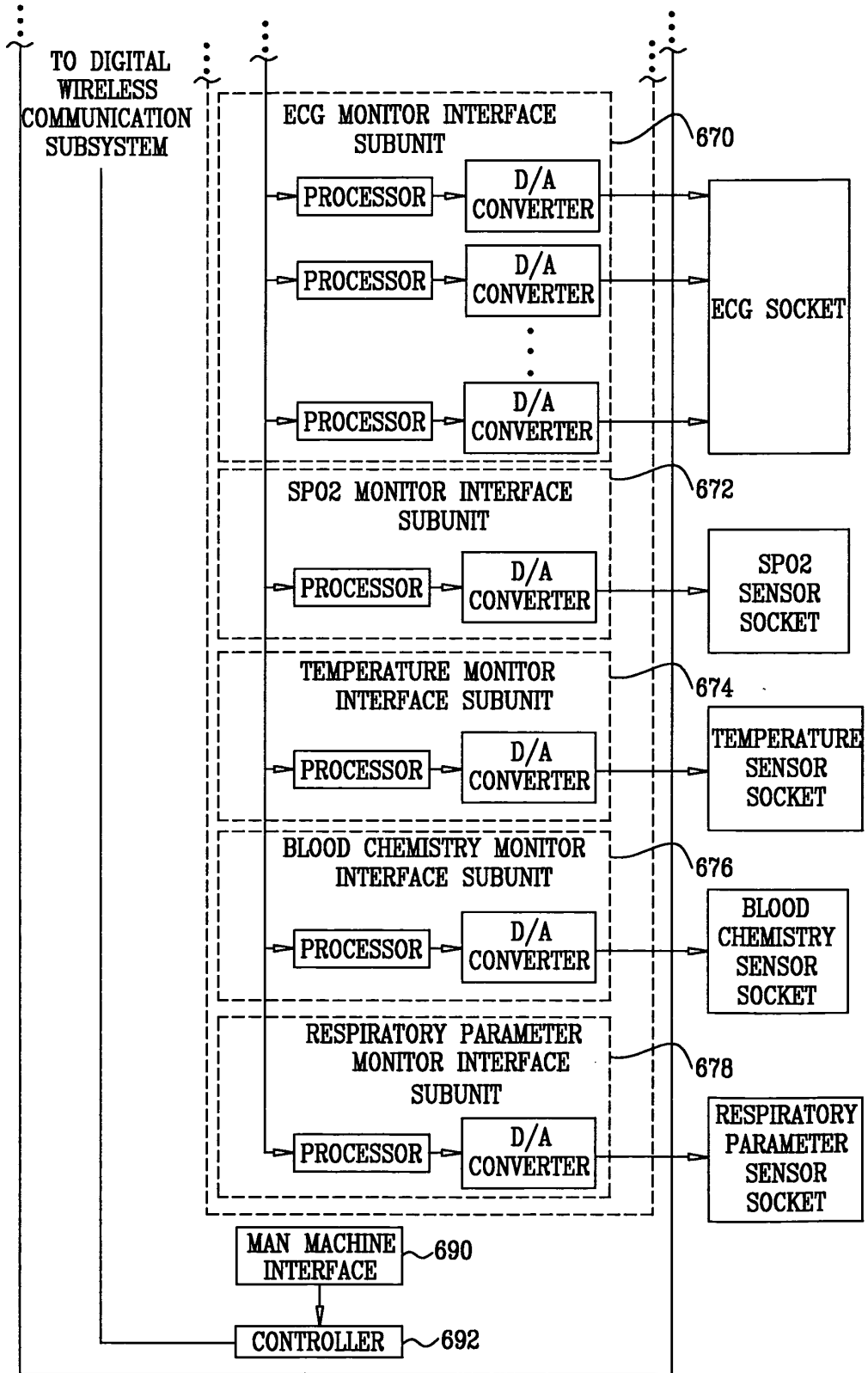
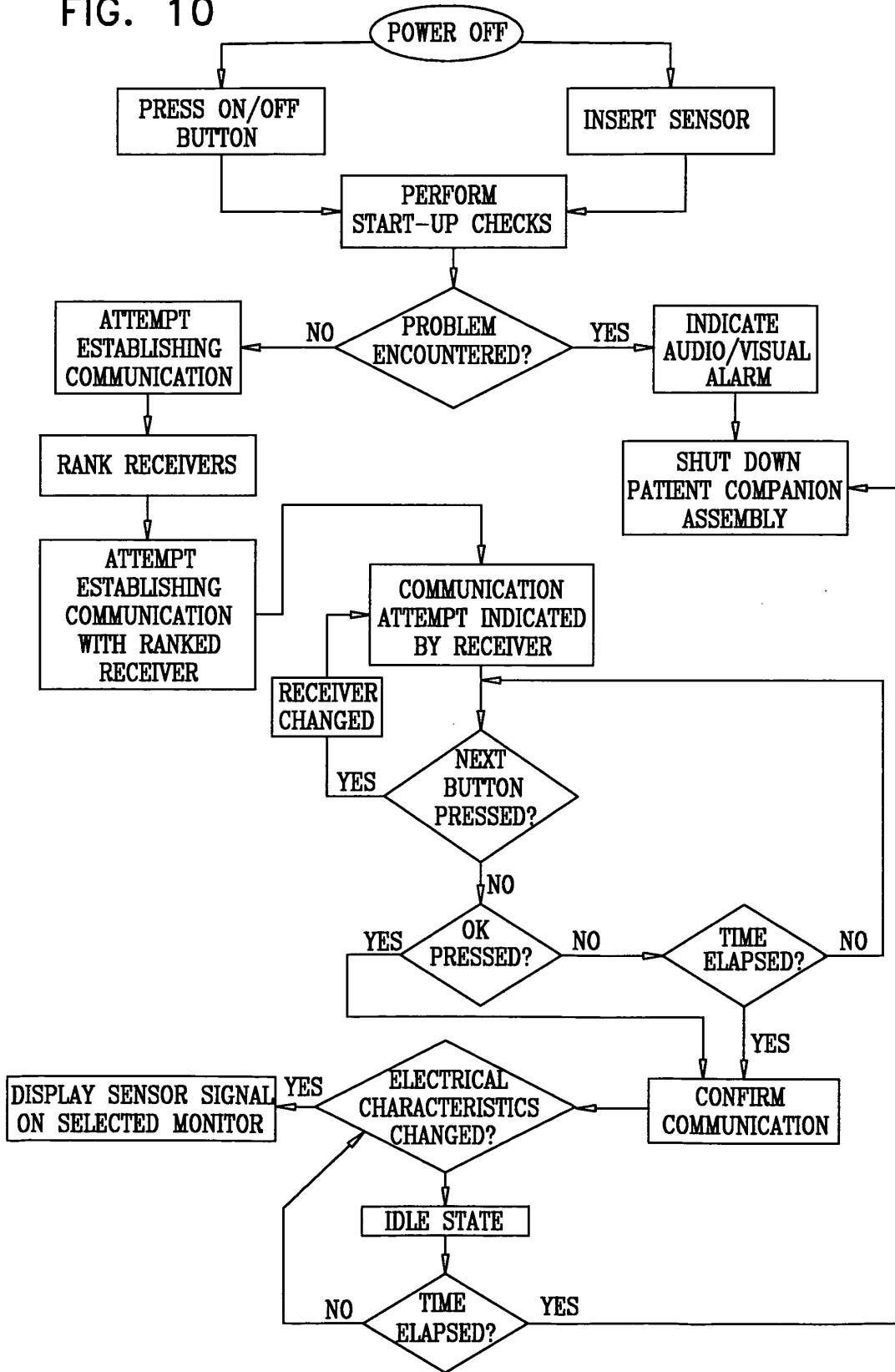
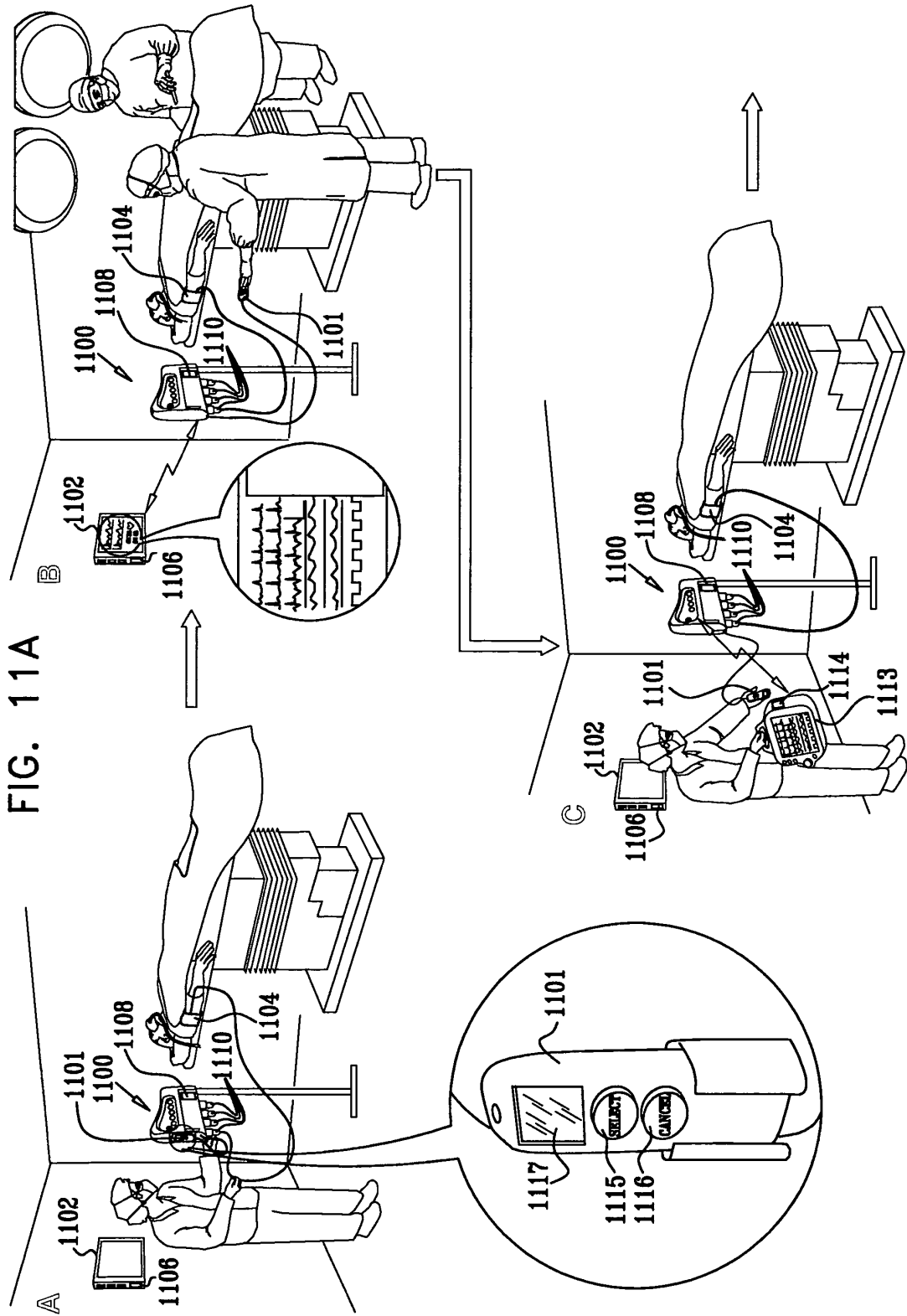




FIG. 10





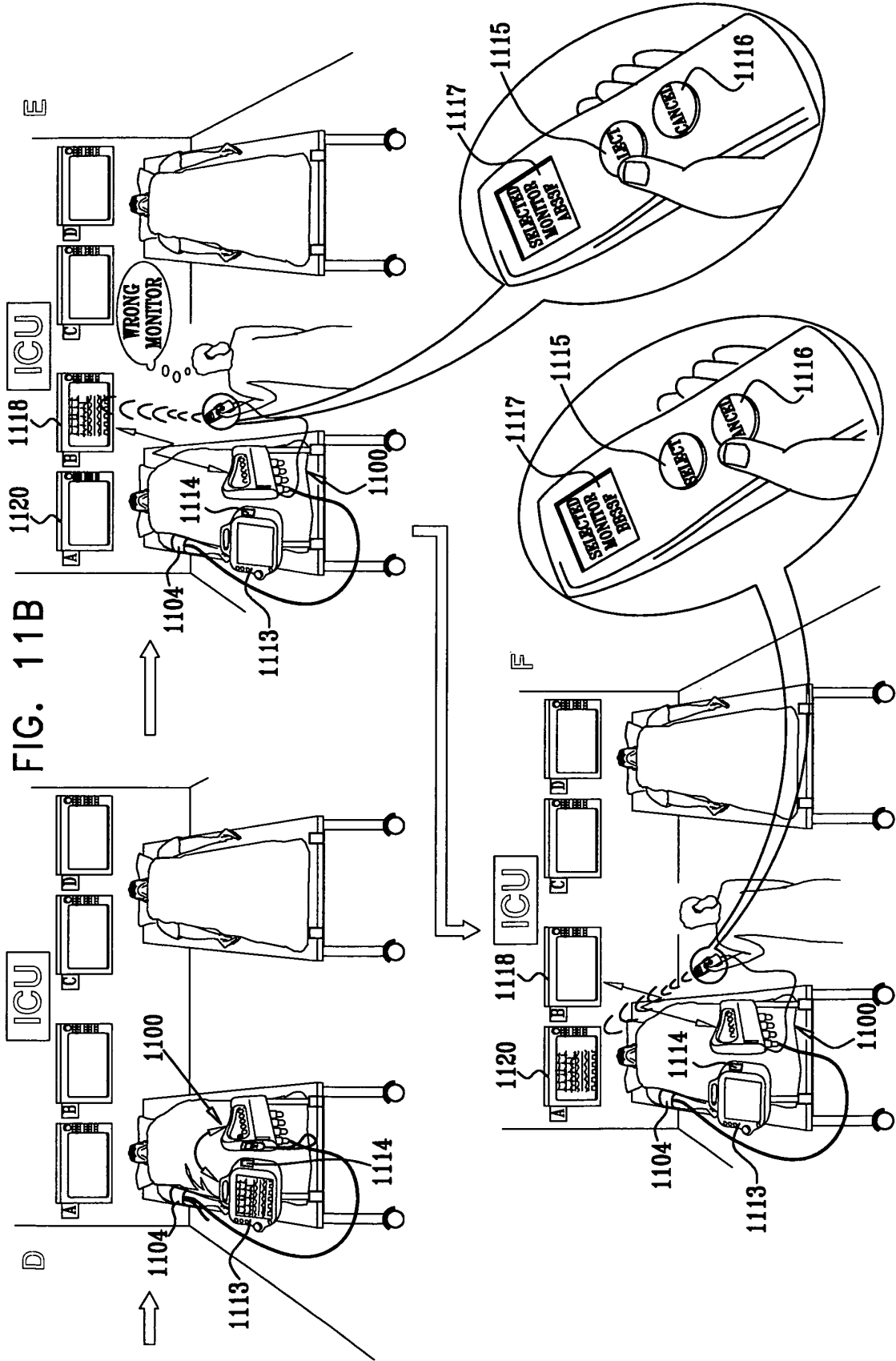
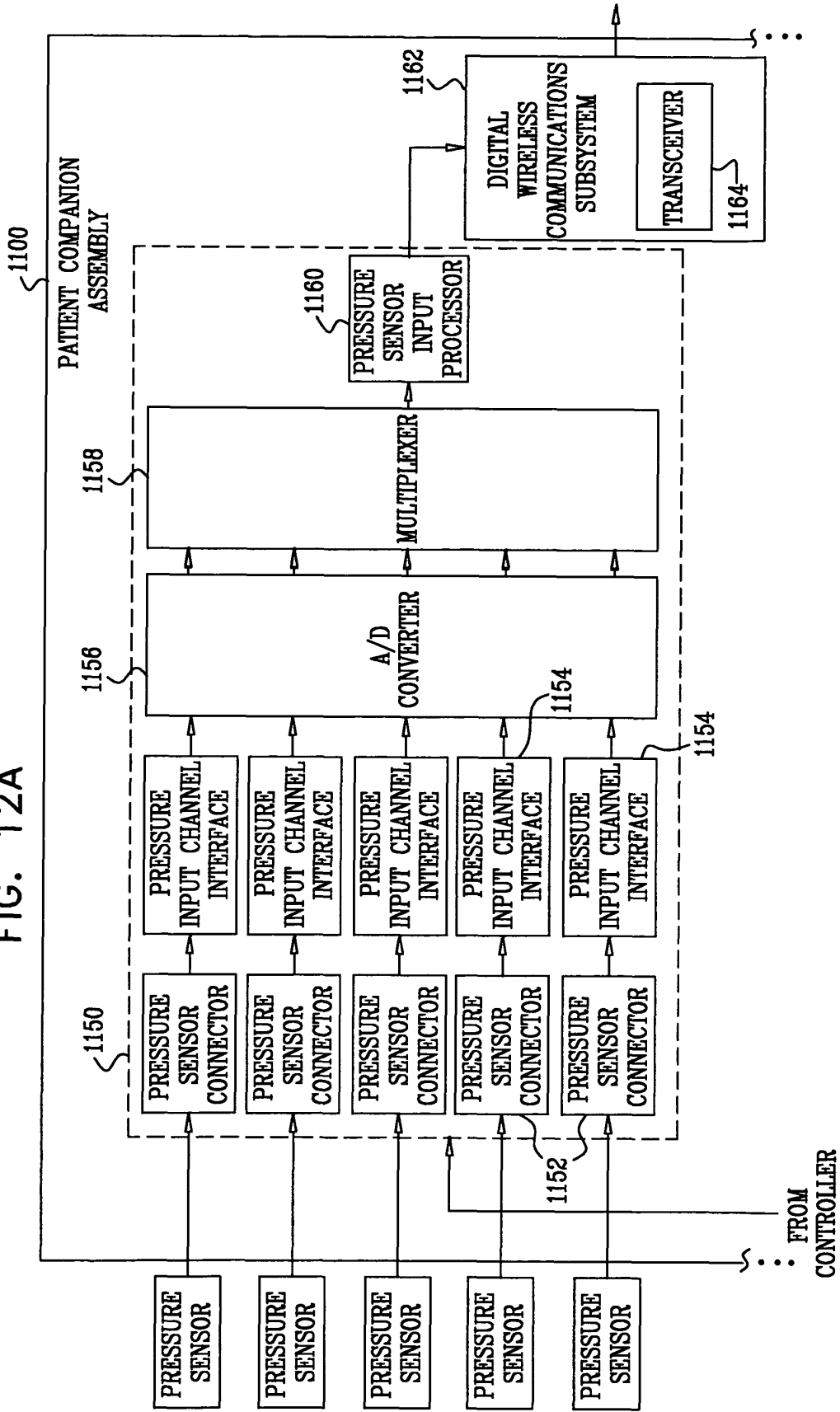
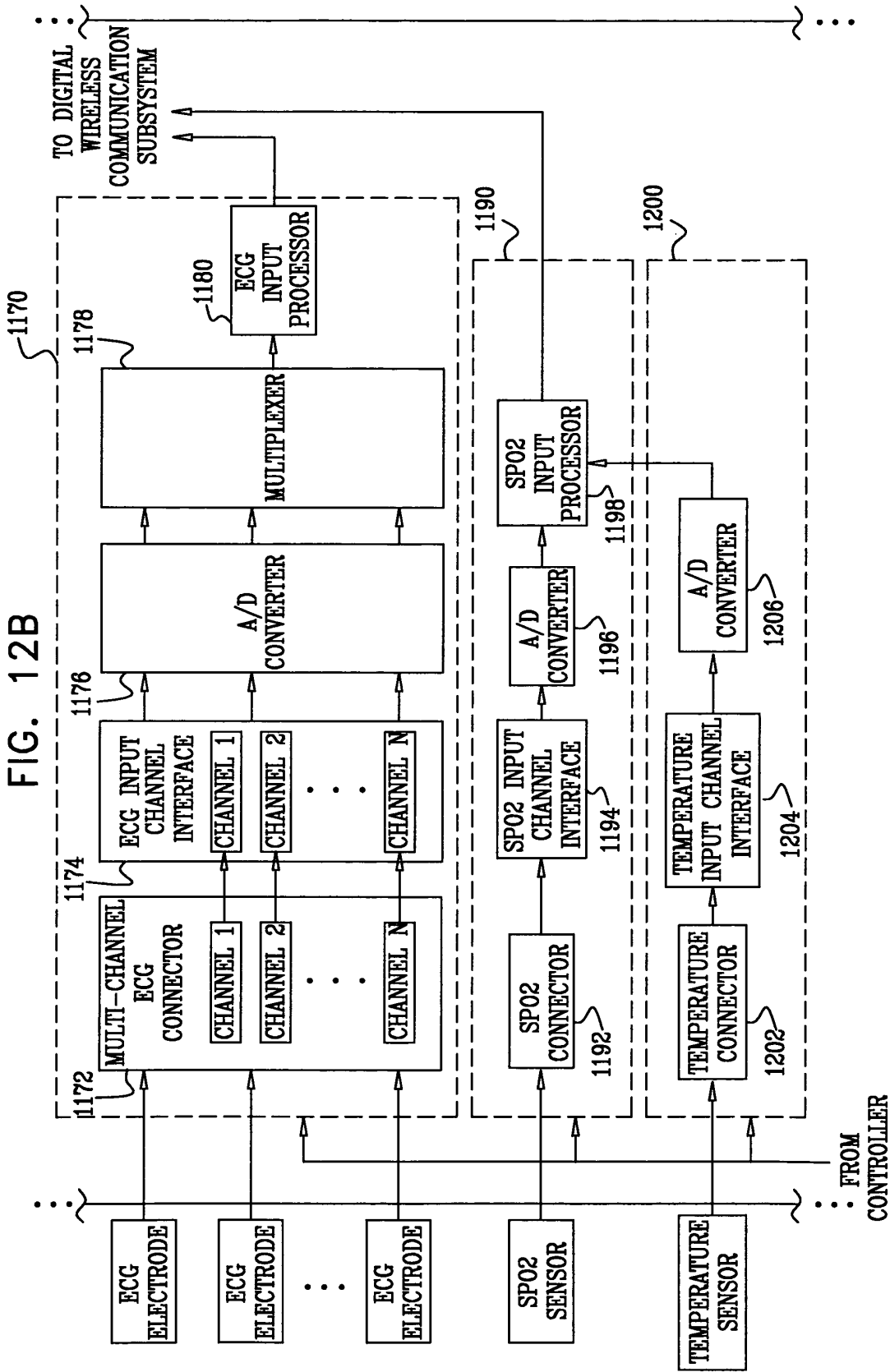


FIG. 12A





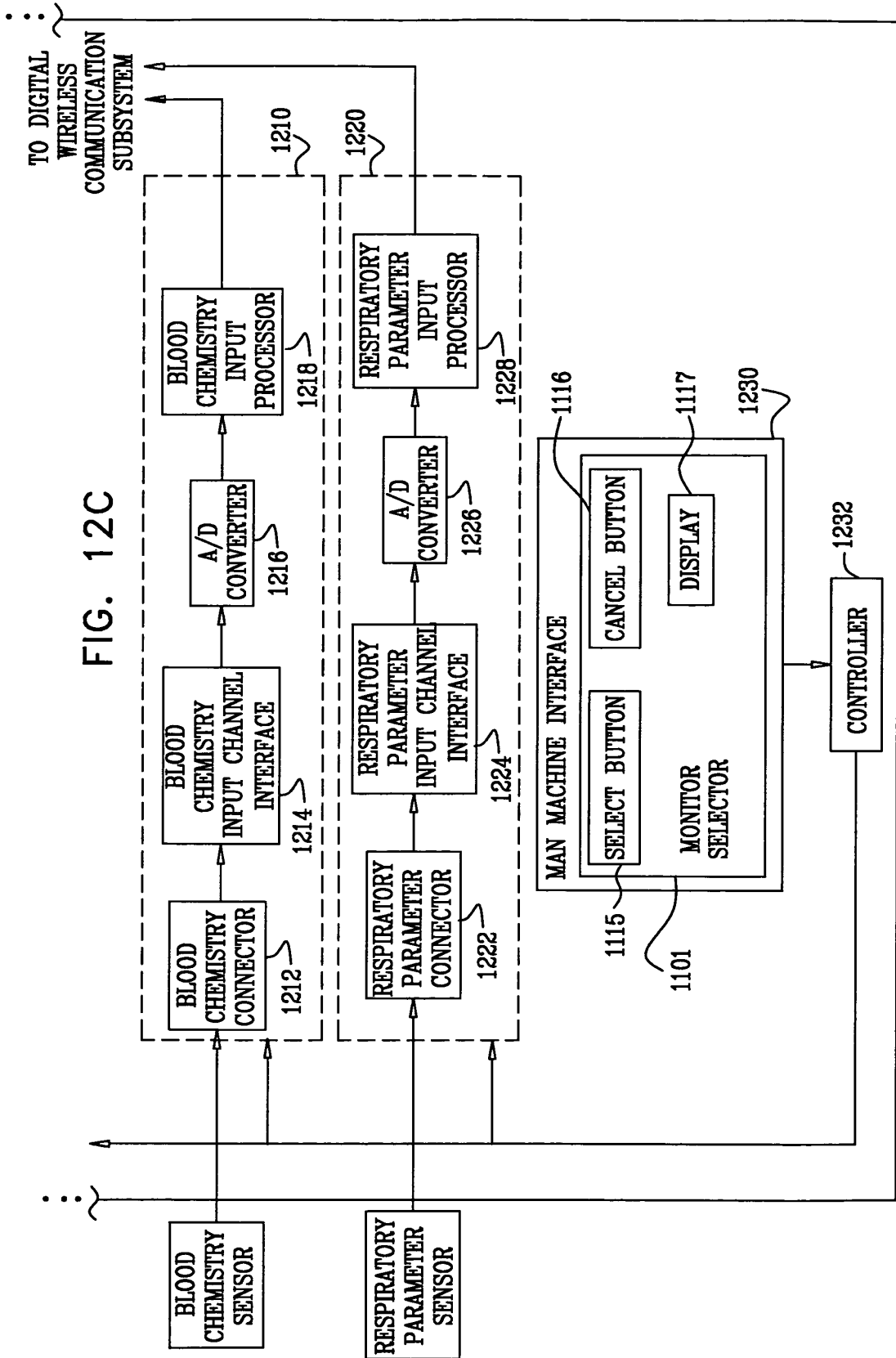


FIG. 13A

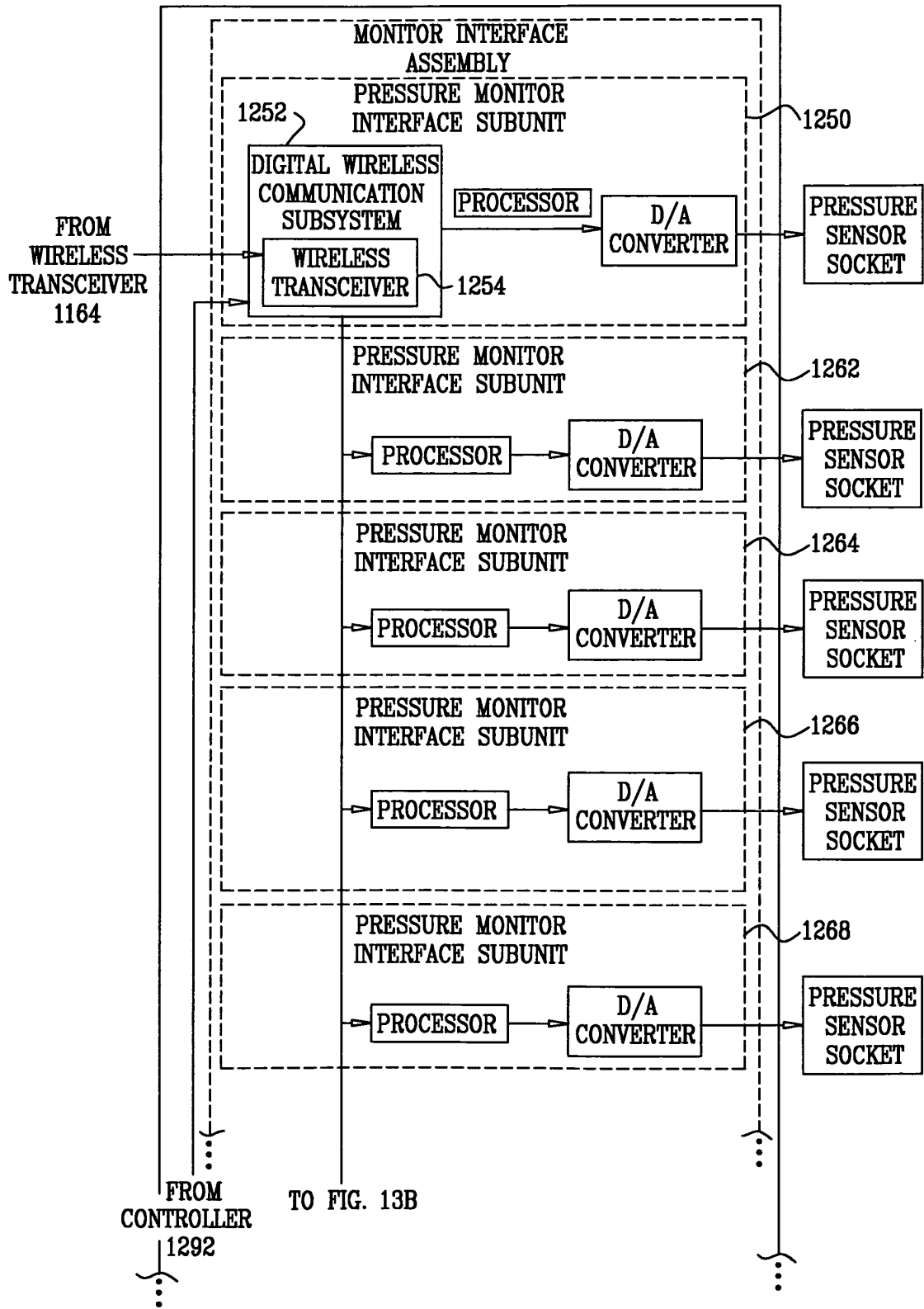


FIG. 13B

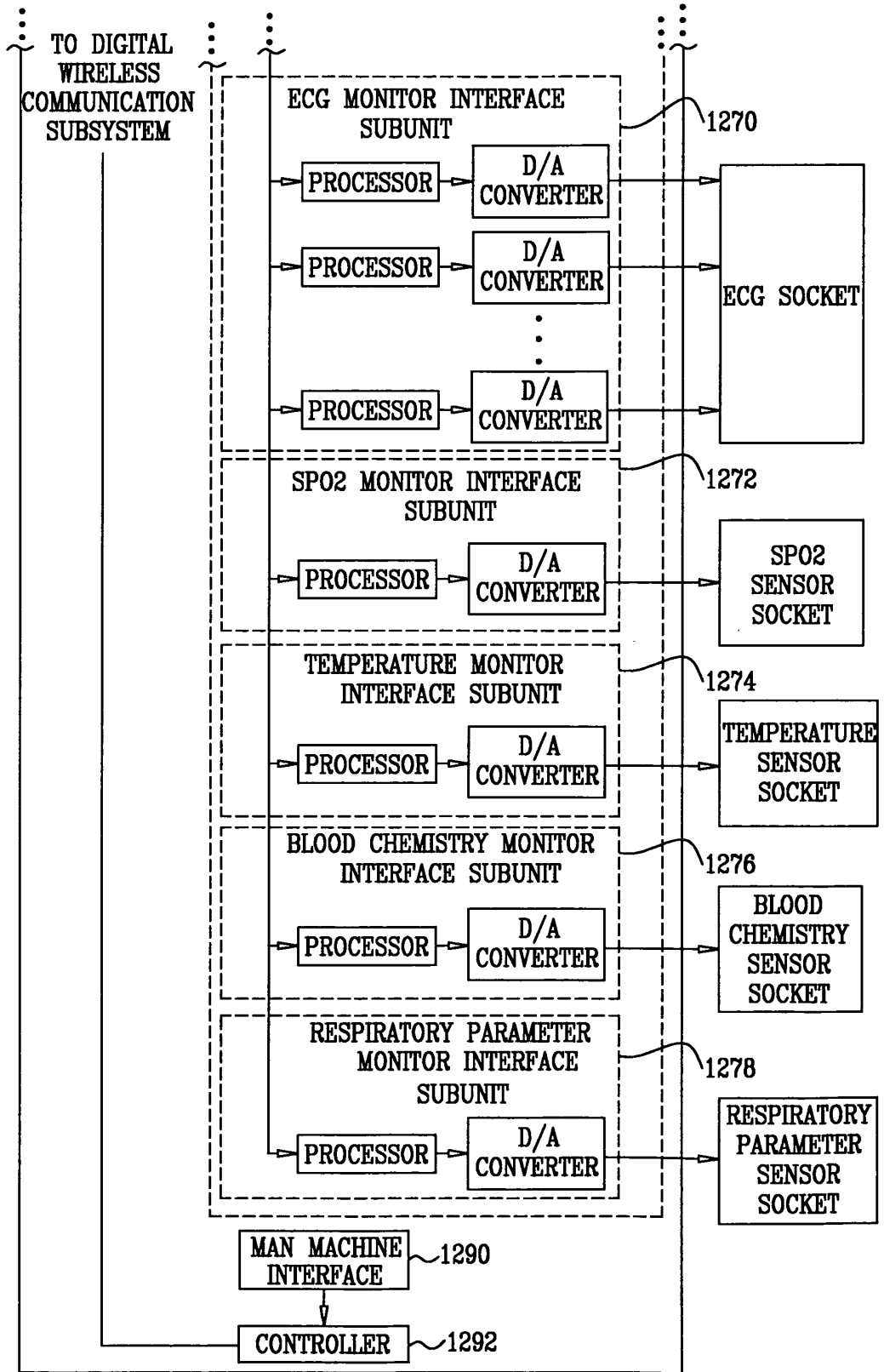
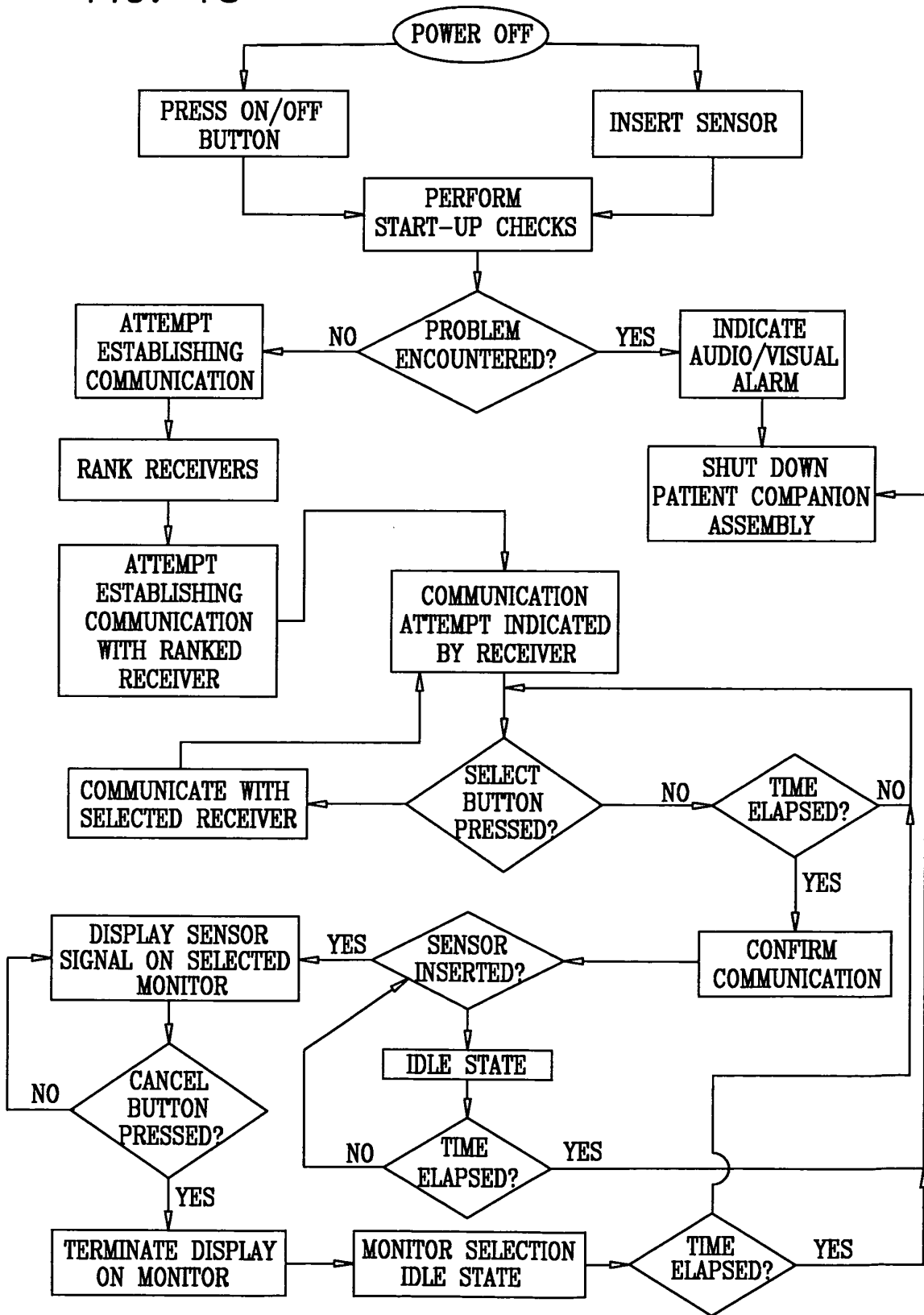




FIG. 15



**REFERENCES CITED IN THE DESCRIPTION**

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专利名称(译)	无线医疗监控系统		
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[标]申请(专利权)人(译)	爱康医学农业合作协会有限公司		
申请(专利权)人(译)	爱康医疗农业合作协会有限公司.		
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代理机构(译)	MESSULAM , ALEC MOSES		
其他公开文献	EP2043503A4 EP2043503A1		
外部链接	<a href="#">Espacenet</a>		

摘要(译)

一种操作者可控的医疗监测系统，包括至少一个适于监测至少一个患者特征的医疗传感器，多个医疗监测器，每个包括监测器无线收发器和医疗信息显示器以及包括患者伴侣的患者伴侣组件无线收发器和医疗监视器选择器无线操作以初始选择多个医疗监视器中的一个并提供对操作者视觉上敏感的监视器选择指示。

