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Thede

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(54) DOCKING STATION FOR PORTABLE MEDICAL DEVICES

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(52) **U.S. Cl.** **600/300**; 600/485; 124/920; 124/897

(58) **Field of Search** 600/300, 301, 600/481, 485, 486; 128/897, 920, 903, 904

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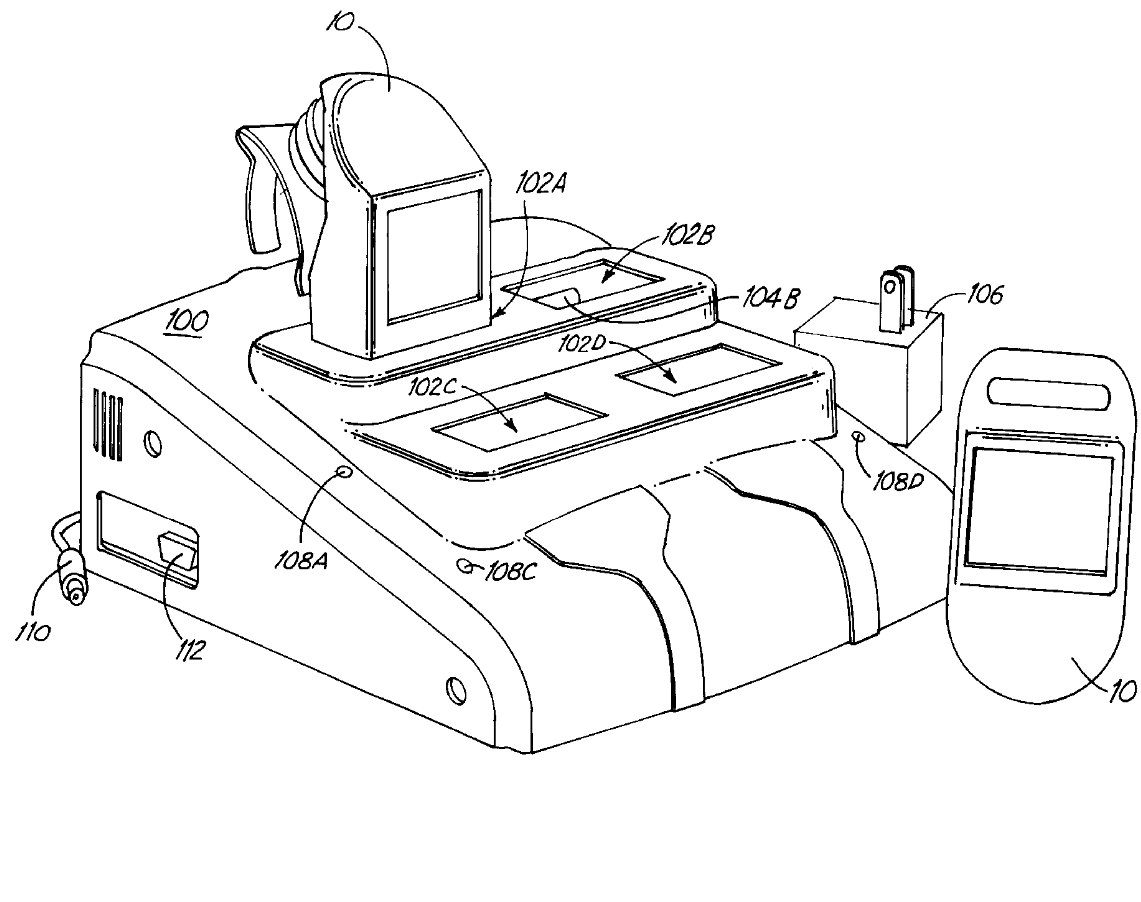
(57) **ABSTRACT**

A storage device for storing a plurality of portable medical devices includes a plurality of bays for receiving and storing the plurality of portable medical devices. Each portable medical device includes an electrical connector. Each bay includes a first electrical connector. The first electrical connector of each bay is configured to interface with the electrical connector of one of the portable medical devices. A second electrical connector is configured to be coupled to a computer. A battery charger is coupled to at least one of the first electrical connectors of a bay for charging a battery of one of the portable medical devices. A switch is coupled to the first electrical connector of each bay and coupled to the second electrical connector for selectively coupling each bay to the computer for data transfer between the bay and the computer.

21 Claims, 9 Drawing Sheets



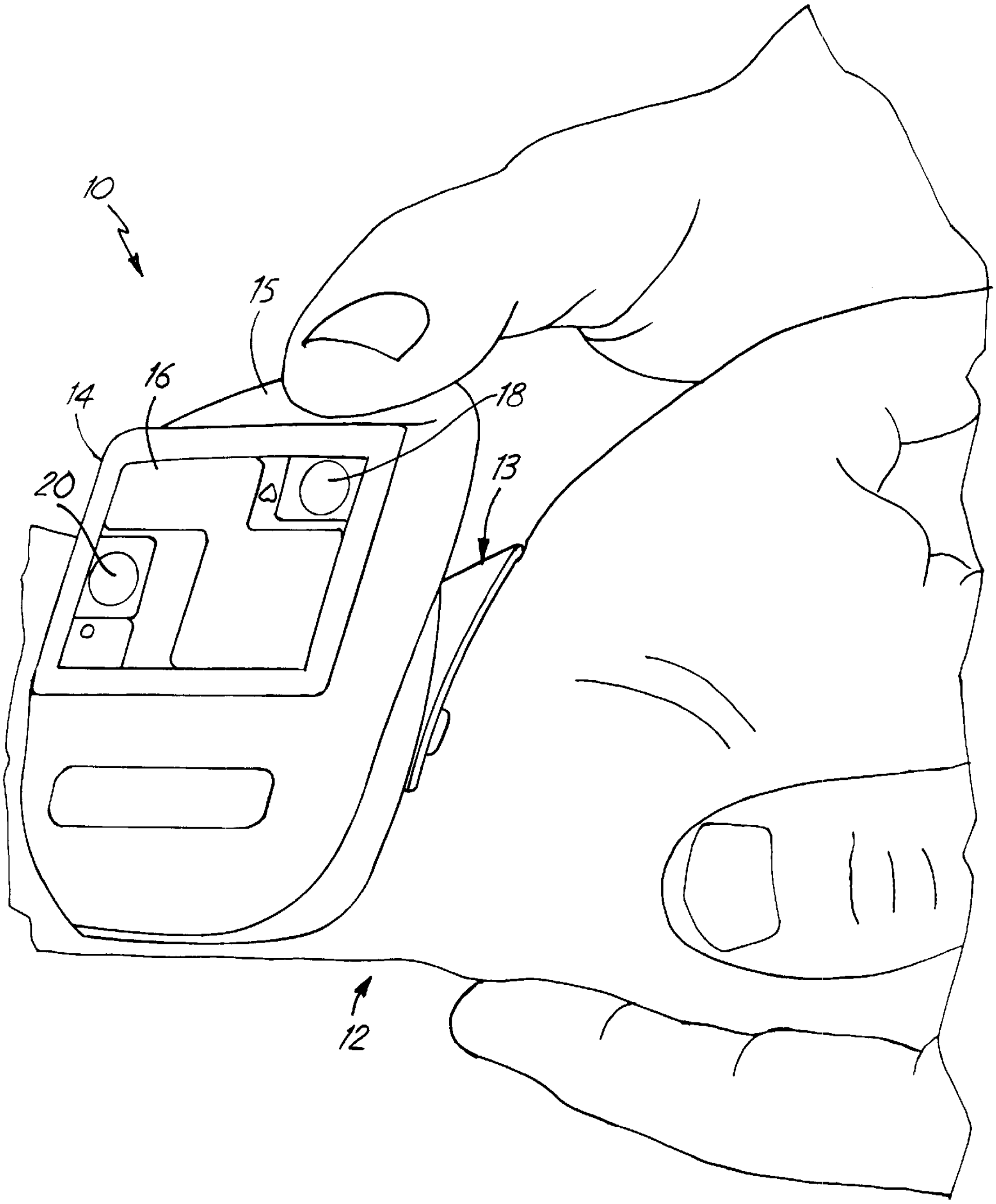


FIG. 1

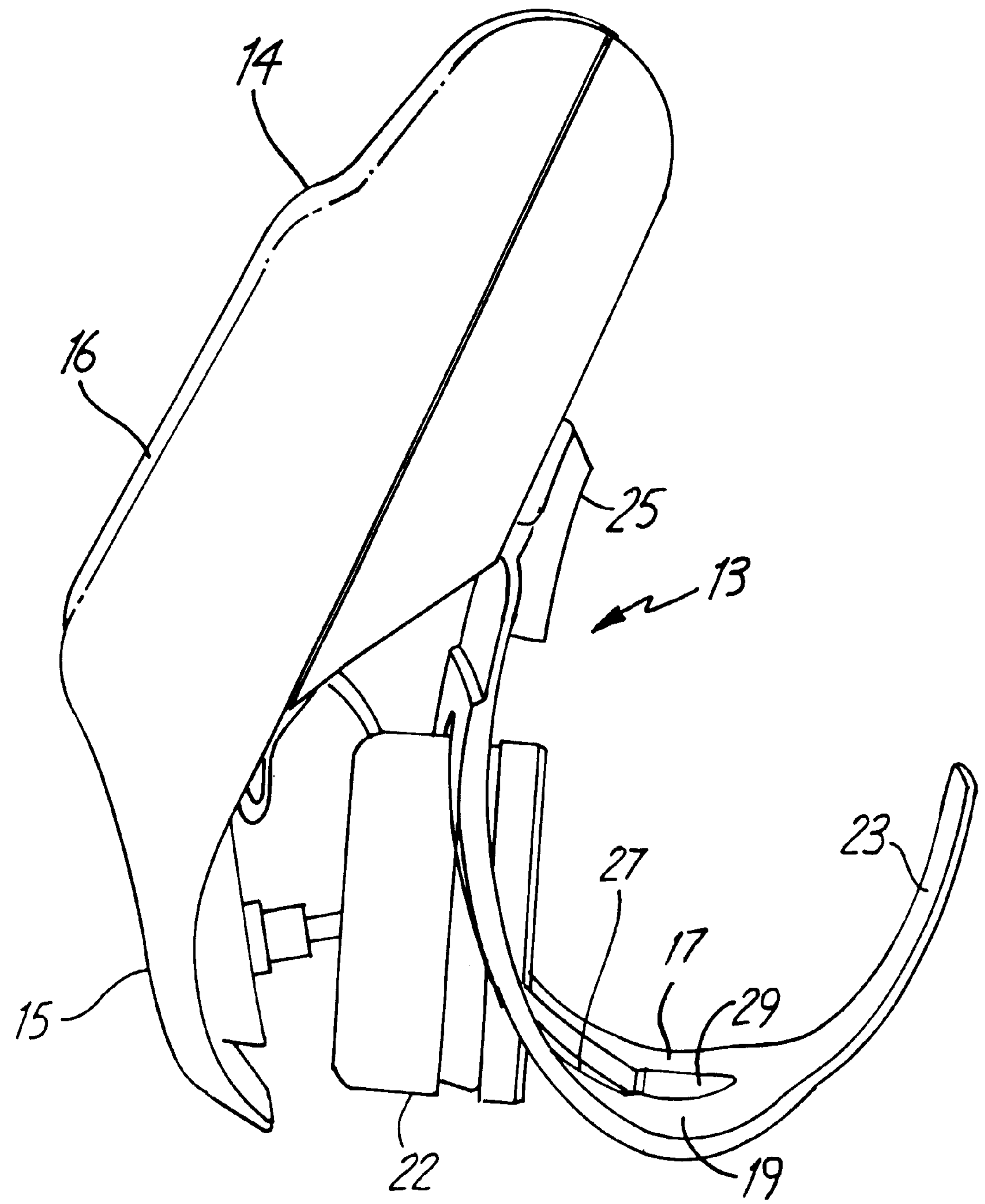


FIG. 2A

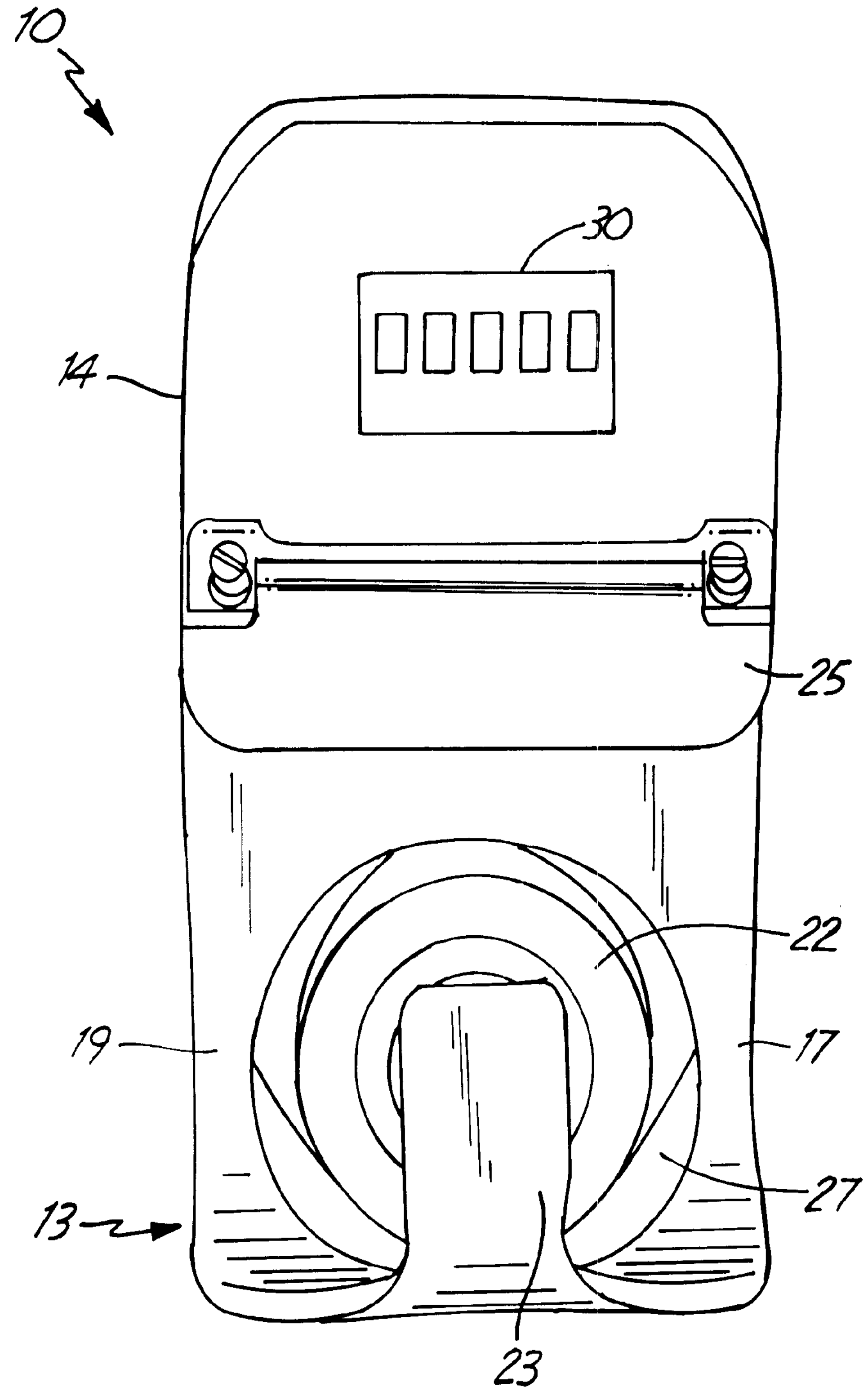


FIG. 2B

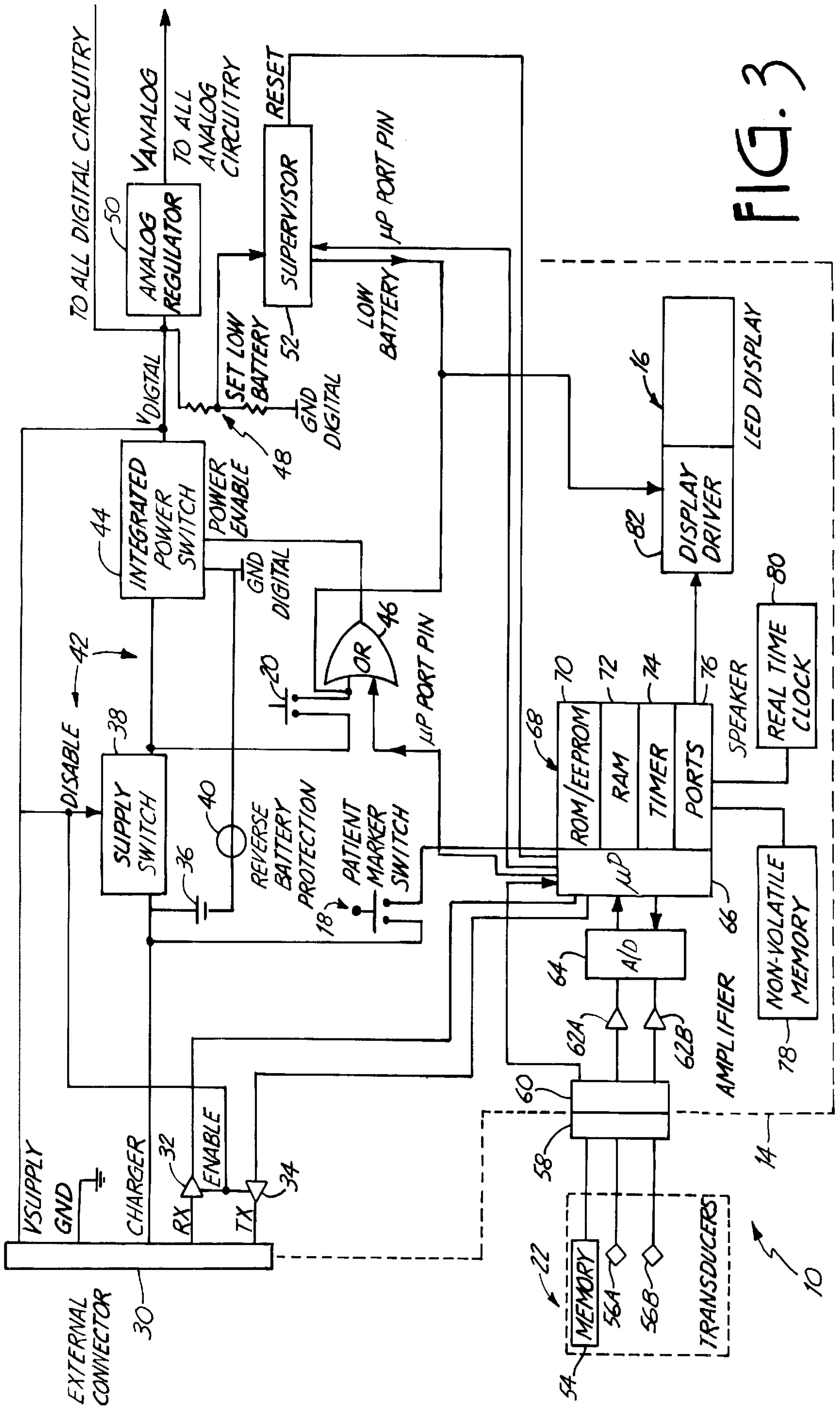

TO ALL DIGITAL CIRCUITRY
VANALOG
TO ALL ANALOG CIRCUITRY
RESET
50
ANALOG REGULATOR
SUPERVISOR
μP PORT PIN
52
SET LOW BATTERY
LOW BATTERY
VDIGITAL
GND DIGITAL
48
16
LED DISPLAY
44
INTEGRATED POWER SWITCH
POWER ENABLE
GND DIGITAL
82
DISPLAY DRIVER
80
REAL TIME CLOCK
42
46
OR
μP PORT PIN
20
70
72
74
76
68
ROM/EEPROM
RAM
TIMER
PORTS
SPEAKER
DISABLE
38
SUPPLY SWITCH
40
36
REVERSE BATTERY PROTECTION
PATIENT MARKER SWITCH
18
μP
66
64
A/D
NON-VOLATILE MEMORY
78
62A
62B
AMPLIFIER
60
58
14
VSUPPLY
GND
CHARGER
32
RX
ENABLE
TX
34
22
MEMORY
56A
56B
TRANSDUCERS
54
10
EXTERNAL CONNECTOR
30

FIG. 3

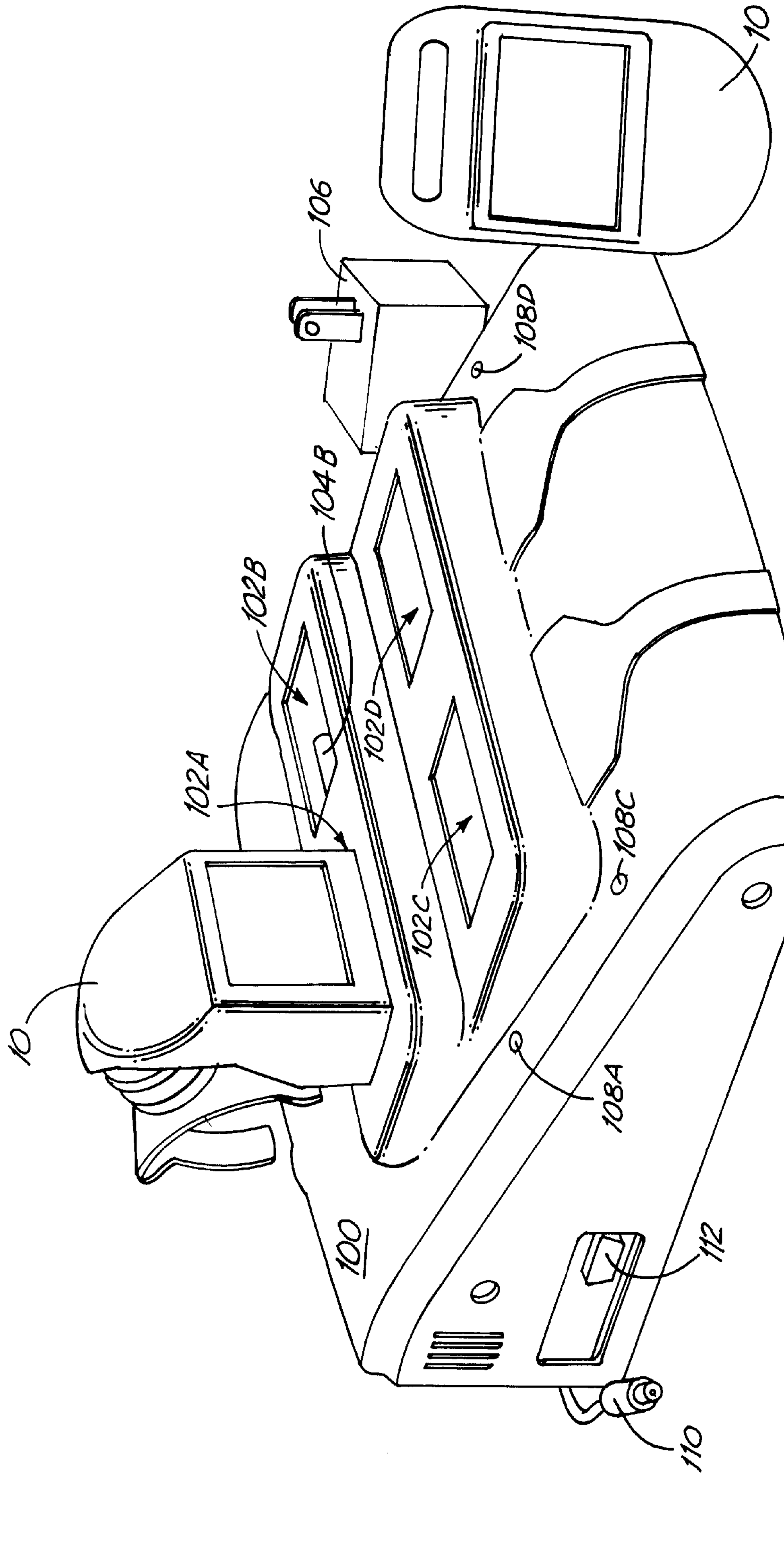
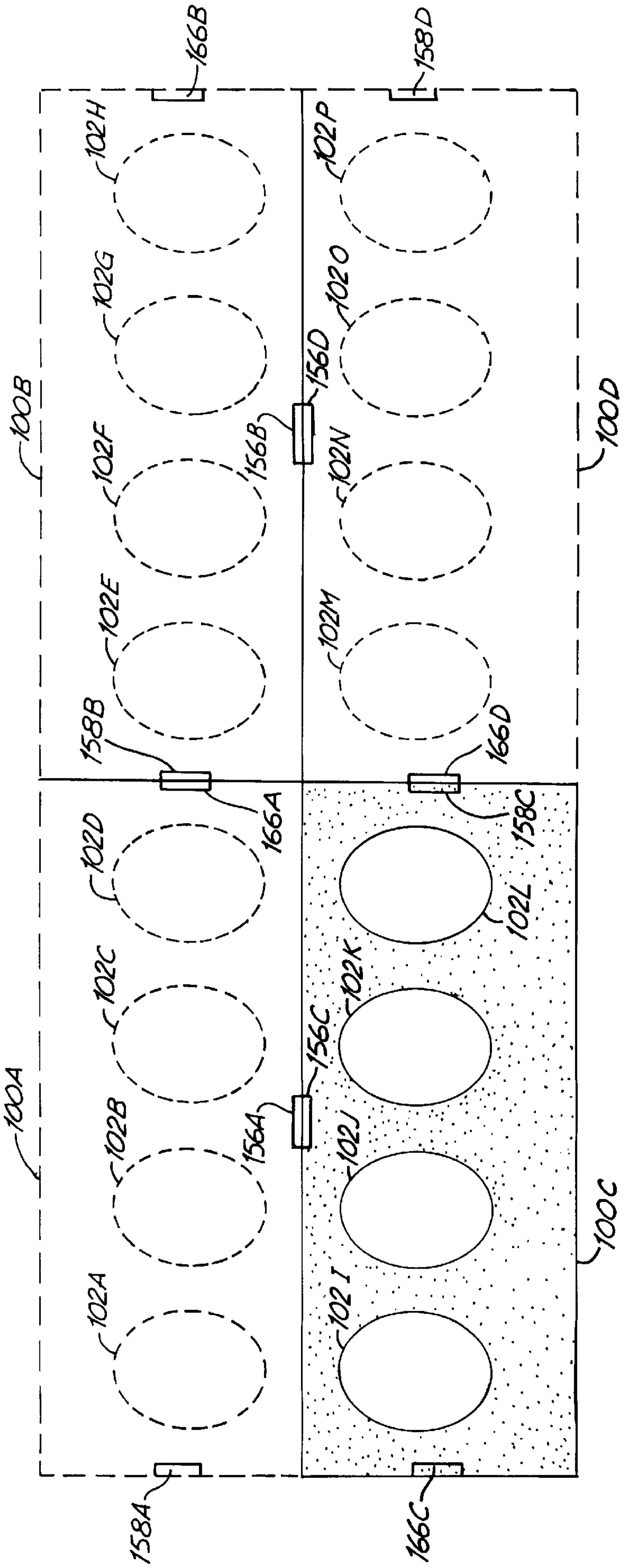


FIG. 4


166B
158D
102H
102P
102G
102O
156D
100B
156B
100D
102F
102N
102E
102M
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166A
158C
102D
102L
102C
102K
156C
100A
102B
156A
102J
100C
102A
102I
158A
166C

FIG. 5

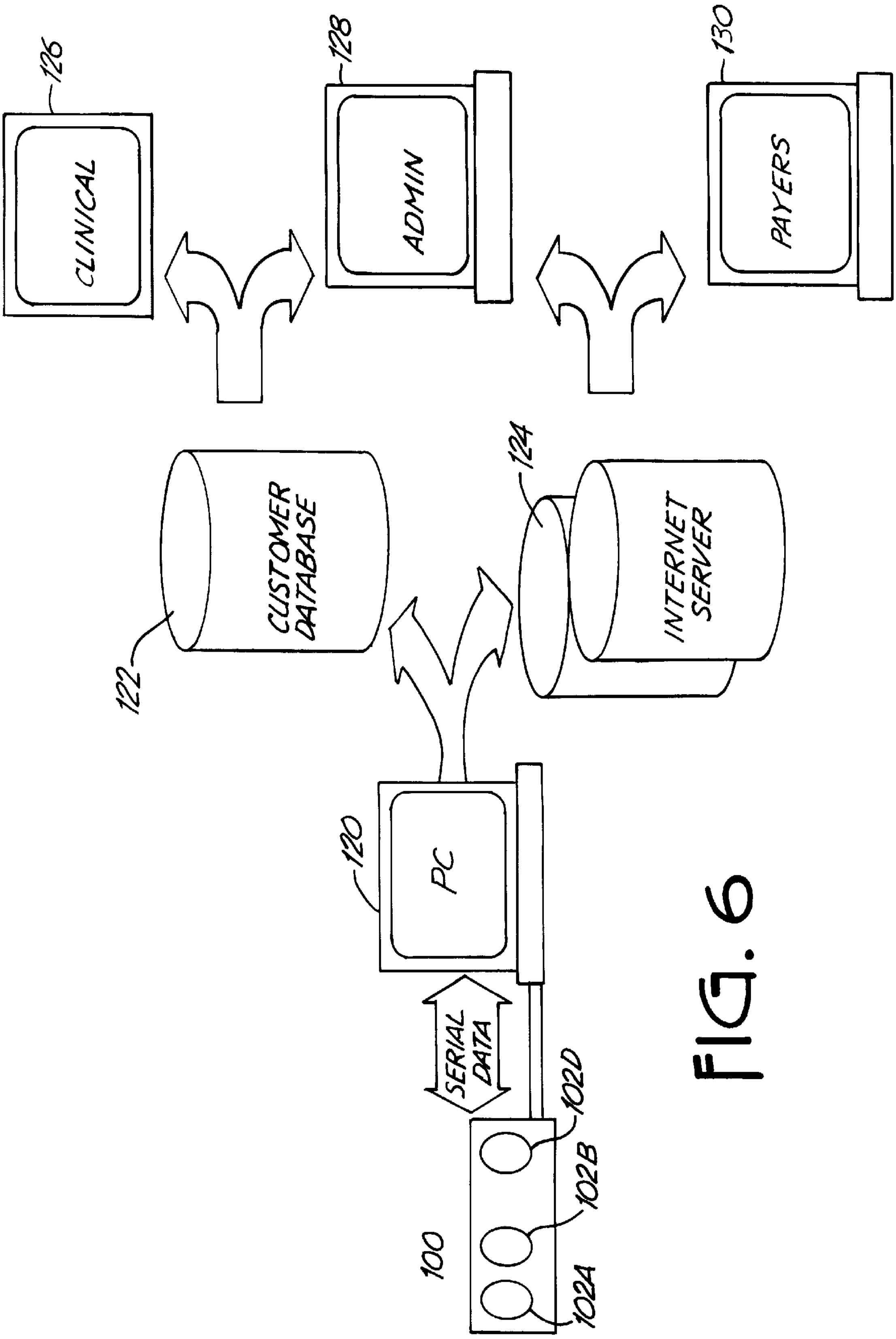
126
CLINICAL
128
ADMIN
130
PAYERS
CUSTOMER DATABASE
122
124
INTERNET SERVER
120
PC
SERIAL DATA
100
102A
102B
102D

FIG. 6

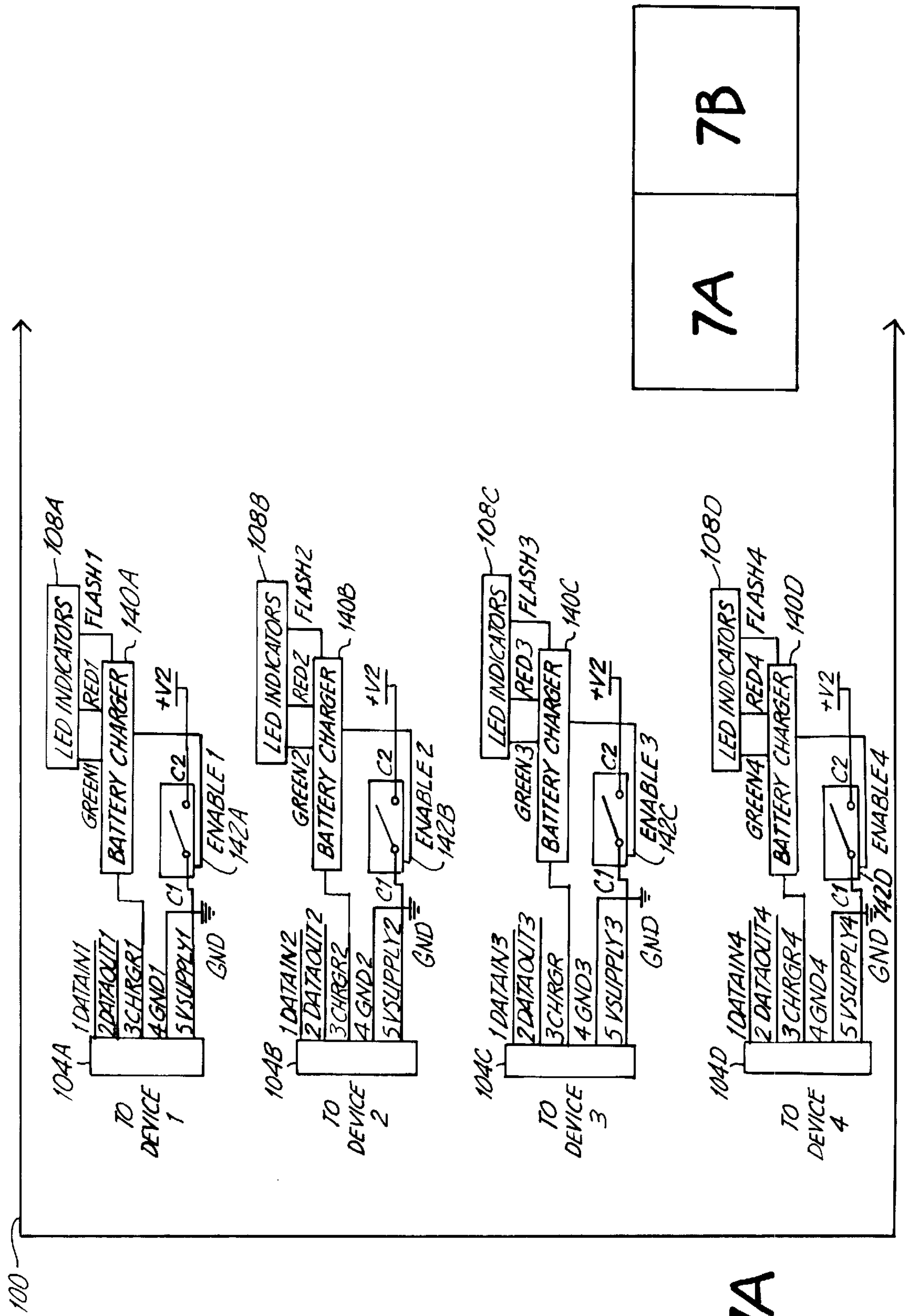
7A
7B
100
LED INDICATORS
108A
108B
108C
108D
GREEN1
RED1
FLASH1
GREEN2
RED2
FLASH2
GREEN3
RED3
FLASH3
GREEN4
RED4
FLASH4
BATTERY CHARGER
140A
140B
140C
140D
+V2
C1
C2
ENABLE1
ENABLE 2
ENABLE 3
ENABLE4
142A
142B
142C
142D
1 DATAIN1
2 DATAOUT1
3CHRGR1
4GND1
5 VSUPPLY1
1 DATAIN2
2 DATAOUT2
3CHRGR2
4 GND2
5 VSUPPLY2
1 DATAIN3
2DATAOUT3
3CHRGR
4 GND3
5 VSUPPLY3
1DATAIN4
2 DATAOUT4
3 CHRGR4
4GND4
5 VSUPPLY4
GND
104A
104B
104C
104D
TO DEVICE 1
TO DEVICE 2
TO DEVICE 3
TO DEVICE 4

FIG. 7A

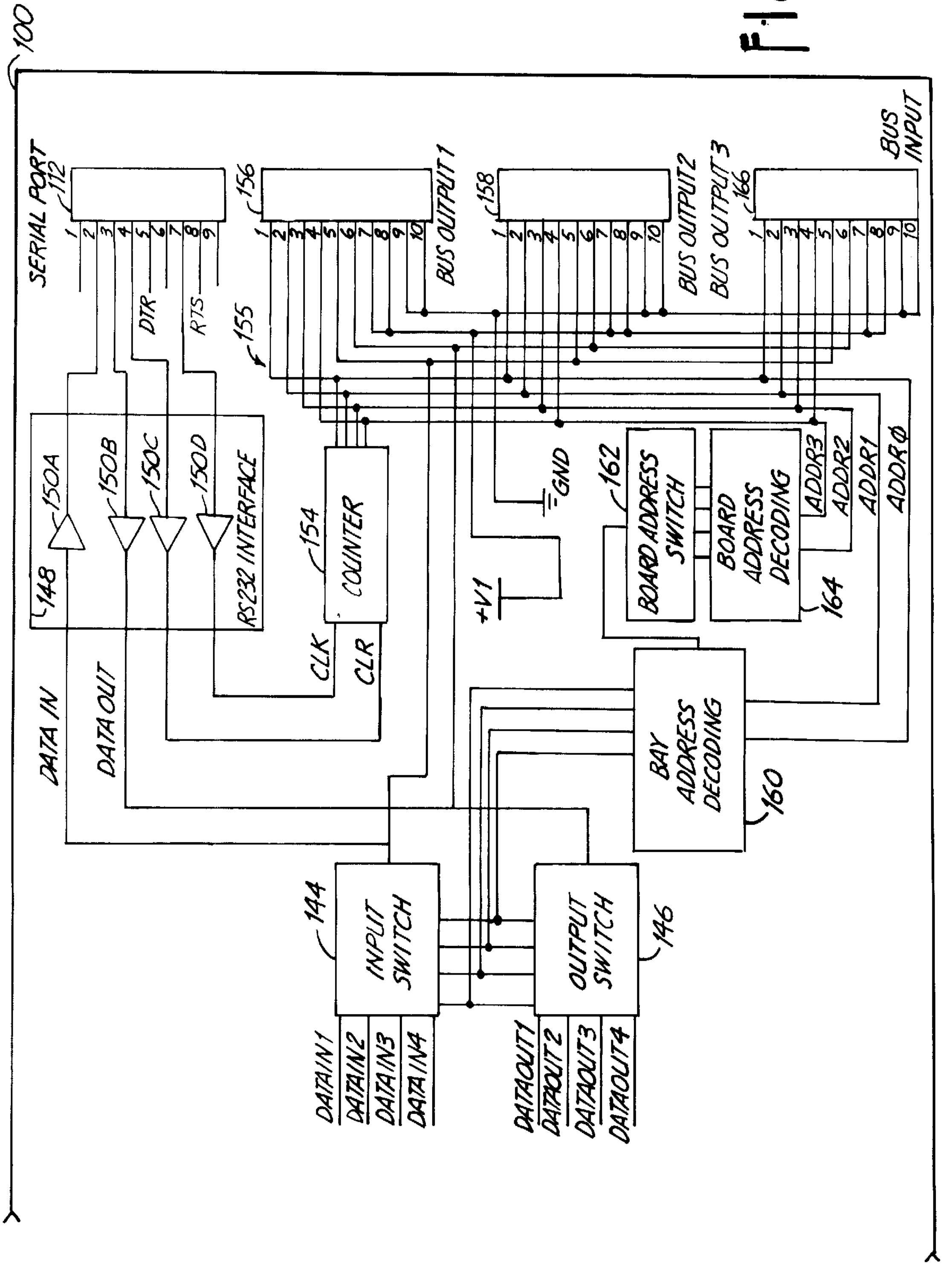
100
SERIAL PORT
112
156
BUS OUTPUT 1
158
BUS OUTPUT 2
BUS OUTPUT 3
166
BUS INPUT
DTR
RTS
155
150A
150B
150C
150D
148
RS232 INTERFACE
154
COUNTER
CLK
CLR
GND
+V1
162
BOARD ADDRESS SWITCH
BOARD ADDRESS DECODING
164
ADDR3
ADDR2
ADDR1
ADDRØ
DATA IN
DATA OUT
BAY ADDRESS DECODING
160
144
INPUT SWITCH
146
OUTPUT SWITCH
DATAIN1
DATAIN2
DATAIN3
DATAIN4
DATAOUT1
DATAOUT2
DATAOUT3
DATAOUT4

FIG. 7B

DOCKING STATION FOR PORTABLE MEDICAL DEVICES

CROSS-REFERENCE TO RELATED APPLICATION(S)

None.

BACKGROUND OF THE INVENTION

The present invention relates to a system and method for storage of, and interfacing with, portable medical devices. In particular, the invention relates to a docking system and method for storing, charging, and transmitting data to and from portable medical devices, including non-invasive blood pressure measurement devices.

There has been a continuing need for devices which will measure blood pressure non-invasively, with accuracy comparable to invasive methods. Medwave, Inc. the assignee of the present invention, has developed non-invasive blood pressure measurement methods and devices which are described in the following United States patents, hereby incorporated by reference: U.S. Pat. No. 5,649,542 entitled CONTINUOUS NON-INVASIVE BLOOD PRESSURE MONITORING SYSTEM; U.S. Pat. No. 5,450,852 entitled CONTINUOUS NON-INVASIVE PRESSURE MONITORING SYSTEM; U.S. Pat. No. 5,640,964 entitled WRIST MOUNTED BLOOD PRESSURE SENSOR; U.S. Pat. No. 5,720,292 entitled BEAT ONSET DETECTOR; U.S. Pat. No. 5,738,103 entitled SEGMENTED ESTIMATION METHOD; U.S. Pat. No. 5,722,414 entitled CONTINUOUS NON-INVASIVE BLOOD PRESSURE MONITORING SYSTEM; U.S. Pat. No. 5,642,733 entitled BLOOD PRESSURE SENSOR LOCATOR; U.S. Pat. No. 5,797,850 entitled METHOD AND APPARATUS FOR CALCULATING BLOOD PRESSURE OF AN ARTERY; and U.S. Pat. No. 5,941,828 entitled HAND-HELD NON-INVASIVE BLOOD PRESSURE MEASUREMENT DEVICE.

As described in these patents, blood pressure is determined by sensing pressure waveform data derived from an artery. A pressure sensing device includes a sensing chamber with a diaphragm which is positioned over the artery. A transducer coupled to the sensing chamber senses pressure within the chamber. A flexible body conformable wall is located adjacent to (and preferably surrounding) the sensing chamber. The wall is isolated from the sensing chamber and applies force to the artery while preventing pressure in a direction generally parallel to the artery from being applied to the sensing chamber. As varying pressure is applied to the artery by the sensing chamber, pressure waveforms are sensed by the transducer to produce sensed pressure waveform data. The varying pressure may be applied automatically in a predetermined pattern, or may be applied manually.

The sensed pressure waveform data is analyzed to determine waveform parameters which relate to the shape of the sensed pressure waveforms. One or more blood pressure values are derived based upon the waveform parameters. The Medwave blood pressure measurement devices include both automated devices for continually monitoring blood pressure (such as in a hospital setting) and hand-held devices which can be used by a physician or nurse, or by a patient when desired.

When multiple hand-held or portable medical devices, such as the Medwave blood pressure measurement devices, are used in a common environment, such as a hospital, it would be convenient to provide a central storage medium for holding the devices, charging the batteries of the devices, as well as communicating with the devices to obtain stored information.

The information obtained from the devices through the docking station may be used in multiple ways. The information can be used by doctors and nurses for remote patient monitoring. The information can be used for billing purposes. Charts and graphs can be generated from the information, such as blood pressure or pulse rate historical data for a patient. The information can be used for sensor management (e.g., displaying sensor usage information, sensor test information and warnings, sensor expiration information and warnings, etc.).

BRIEF SUMMARY OF THE INVENTION

The present invention is a storage device and method for storing a plurality of portable medical devices and gathering and centrally storing a set of patient data gathered from the portable medical devices. In a preferred embodiment, the storage device includes a plurality of bays for receiving and storing the plurality of portable medical devices. Each portable medical device includes an electrical connector. Each bay includes a first electrical connector. The first electrical connector of each bay is configured to interface with the electrical connector of one of the portable medical devices. A second electrical connector is configured to be coupled to a computer. A battery charger is coupled to at least one of the first electrical connectors of a bay for charging a battery of one of the portable medical devices. A switch is coupled to the first electrical connector of each bay and coupled to the second electrical connector for selectively coupling each bay to the computer for data transfer between the bay and the computer.

A preferred method according to the present invention for gathering and centrally storing a set of patient data for each one of a plurality of patients includes applying a plurality of portable medical devices to a plurality of patients to obtain the patient data. The patient data is stored in the plurality of portable medical devices. The plurality of portable medical devices are placed in a docking station coupled to a computer. The stored patient data is transmitted from each portable medical device through the docking station to the computer and stored therein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a non-invasive blood pressure measurement device suitable for use with the present invention.

FIG. **2**A is a side view of the blood pressure measurement device of FIG. **1**.

FIG. **2**B is a bottom view of the blood pressure measurement device of FIG. **1**.

FIG. **3** is an electrical block diagram of the blood pressure measurement device.

FIG. **4** is a perspective view of a docking station according to the present invention.

FIG. **5** is a schematic diagram of multiple docking stations coupled together.

FIG. **6** is a high level flow diagram illustrating the flow of information in the present invention.

FIGS. **7**A and **7**B are electrical schematic diagrams of the docking station.

DETAILED DESCRIPTION

Prior to describing the docking system and method of the present invention, a description is provided of a blood pressure measurement device, which is suitable for use in conjunction with the docking system.

FIG. **1** illustrates a blood pressure measurement device being used to measure and display blood pressure within an underlying artery within wrist **12** of a patient. Blood pressure measurement device **10** includes placement guide **13**, main housing **14**, display panel **16**, patient identification toggle **18**, power switch **20**, and sensor interface assembly **22** (best shown in FIGS. **2**A and **2**B).

Using placement guide **13** of measurement device **10**, measurement device **10** is placed at the projection of the styloid process bone perpendicular to wrist **12**. With device **10**, a small amount of force is manually applied to the radial artery, which runs along the styloid process bone. As the force is manually applied, blood pressure waveforms are recorded and the corresponding hold down pressure which is being manually applied is also recorded. Using the shape of the blood pressure waveforms, waveform parameters are generated. These parameters, along with universal coefficients, are used to calculate pressure values which then can be displayed.

Placement guide **13** is connected to housing **14** at the base of housing **14**. Placement guide **13** straddles the styloid process bone, automatically placing sensor interface assembly **22** over the underlying artery. Housing **14** contains all of the electrical components of measurement device **10**. The shape and configuration of housing **14** allows it to hang on the patient's wrist, using placement guide **13** as a type of hook. Housing **14** includes pressure platform **15**, which is a flattened depression directly above sensor interface assembly **22**. In operation, the user (medical personnel) applies pressure on pressure platform **15** with a thumb or finger. The hold-down force from the user's thumb applies a force in an axial direction (i.e., an axial direction with respect to a central cylindrical axis of sensor interface assembly **22**) to wrist **12** of the patient. The axial force is transmitted from pressure platform **15** of housing **14** to sensor interface assembly **22**.

In a preferred embodiment, display panel **16** simultaneously displays the following values based upon blood pressure measurements: systolic pressure, diastolic pressure, pulse rate, and mean blood pressure. Display panel **16** also preferably provides visual prompting for manually applying a varying hold down pressure.

Power switch **20** is actuated to turn on power to the circuitry within housing **14**. Timing circuitry within housing **14** automatically turns power of f after a predetermined period of inactivity. Actuation of switch **20**, after the unit is turned on, causes display panel **16** to indicate previous readings of blood pressure and pulse rate.

Patient identification toggle **18** is used to organize the recorded blood pressure information with respect to a particular patient. After actuating power switch **20**, the user selects the specific patient for which blood pressure will be measured by pressing patient identification toggle **18**. In one embodiment, display panel **16** displays a patient identification number for the currently selected patient. The patient identification number changes as patient identification toggle **18** is pressed. In one embodiment the user can scroll through a list of **16** patient identification memory locations.

FIG. **2**A is a side view of blood pressure measurement device **10**, and FIG. **2**B is a bottom view of blood pressure measurement device **10**. As can be seen from FIGS. **2**A and **2**B, placement guide **13** is generally U-shaped. Placement guide **13** includes hook **23**, pad **25**, and opening **27**. Opening **27** is a generally circular aperture that has a notch **29** near hook **23**. Guide ribs **17** and **19** encircle opening **27** and notch **29**, and meet at the base of hook **23**.

When device **10** is placed on the patient, pad **25** contacts the palm side of the wrist of the patient, while hook **23** wraps around the backside of the wrist. Placement guide **13** is made of a flexible plastic so as to fit all patients, with the styloid process bone fitting into notch **29** of opening **27**. Opening **27** also allows sensor interface assembly **22** to come in contact with the patient's wrist. Pad **25** becomes a pivot point about which force is applied.

Relying on a cantilever type action, device **10** allows the user to apply a force at pressure platform **15** of housing **14**. Housing **14** pivots about pad **25**, and sensor interface assembly **22** applies an axial force to the underlying artery. Sensor interface assembly **22** is pivotally mounted to housing **14**. As pressure is manually applied by moving housing **14** toward the artery, that force is transferred from housing **14** to sensor interface assembly **22**.

Device **10**, with placement guide **13** and the cantilever type action, allows sensor interface assembly **22** to be consistently placed in the proper position, and the hold-down force to be consistently applied in the axial direction with respect to wrist **12**. This improvement greatly simplifies the procedure of applying pressure by the user, because the user no longer controls the direction and angle at which pressure is applied with respect to the patient's wrist.

Instead of having to palpate wrist **12** to identify the location of the radial artery, a user simply places device **10** adjacent wrist **12** so that placement guide **13** hooks onto the patient's wrist with guide ribs **17** and **19** straddling the projection of the styloid process bone. The measurement process is significantly simplified with the present invention.

The force applied to the artery is swept in an increasing fashion so the pressure waveform data from a series of pulses are obtained with different amounts of force being applied. To achieve the desired pattern of variable force, user feedback is preferably provided with device **10**.

In a preferred embodiment, feedback is in the form of a visual counter on display panel **16**. As the user begins to apply pressure, a number is displayed corresponding to the amount of pressure applied by the user. As the user increases the applied pressure, the displayed number proportionally increases. The user (medical personnel) is previously instructed to increase pressure smoothly so that the displayed counter increases one integer at a time, approximately one per second. If the user increases the hold-down pressure too quickly, the displayed counter will also jump quickly through the corresponding numbers to indicate the choppy applied pressure. The user applies greater pressure until device **10** shows the resulting blood pressure measurements on display panel **16**. Preferably, the user applies enough pressure to get the counter up to the number 15, but it could be as low as 4 or 5, or as high as 27 or 28, depending on the patient. If a patient has higher blood pressure, greater applied force will be necessary, and the corresponding ending counter number will be a higher integer.

After the measurement, the user can then view the blood pressure reading. In a preferred embodiment, display panel **16** provides a digital readout of systolic, diastolic, and mean blood pressure, as well as pulse rate. An indication of memory location (by number) corresponding to the patient is also displayed.

As soon as the reading is complete, device **10** is ready to take another reading. There is no need to clear display **16**. Device **10** stores a predetermined number of previous readings (such as the last 10 readings). To review prior readings, patient identification toggle **18** or power switch **20** is pressed. This causes a different reading from memory to be displayed on display **16**.

Alternatively, the feedback to the user can be audible tones and/or visual movable bars. The process of applying force in response to audible tones and/or visual movable bars on display **16** is fully described in U.S. Pat. No. 5,941,828, entitled "Non-Invasive Blood Pressure Sensor With Motion Artifact Reduction", which is incorporated herein.

As can be seen in FIG. **2**B, device **10** includes external connector **30**. External connector **30** is a five pin connector that is used to transmit and receive data, recharge battery **36** (see FIG. **3**) contained within housing **14** and provide an alternative power source to device **10**. External connector **30** allows device **10** to be connected to a docking station **100** (shown in FIG. **4**) so that its internal battery can be recharged, and the collected blood pressure information can be downloaded to a central system. Device **10** can be used by a nurse or other employee in a hospital setting to collect blood pressure and heart rate information from a series of patients. Docking station **100** is described below with reference to FIGS. **4**–**7**.

FIG. **3** is an electrical block diagram of device **10**. Device **10** includes patient marker switch **18**, power supply circuit **42**, sensor interface assembly **22**, connectors **58** and **60**, amplifiers **62**A and **62**B, analog-to-digital (A/D) converter **64**, microprocessor **68**, display driver and memory circuit **82**, display panel **16**, non-volatile memory **78** and real-time clock **80**. Power supply circuit **42** includes external connector **30**, amplifiers **32** and **34**, rechargeable battery **36**, supply switch **38**, reverse battery protection **40**, switch **20**, integrated power switch **44**, OR circuit **46**, voltage divider **48**, analog regulator **50** and supervisor circuit **52**.

Device **10** can be powered through an external power source, such as docking station **100**. An external power source couples to device **10** through external connector **30**. Power from external connector **30** on the VSUPPLY line causes supply switch **38** to disconnect rechargeable battery **36** from supplying power to supply circuit **42**. Instead, rechargeable battery **36** is recharged using the CHRGR line while the external power source supplies power to supply circuit **42** on the VSUPPLY line. External connector **30** also allows device **10** to receive and transmit data, such as blood pressure information and device serial number, to docking station **100** (see FIG. **4**) over the RX (receive) line and TX (transmit) line. The RX and TX lines are coupled to amplifiers **32** and **34**, respectively, which amplify the signals transmitted and received by microprocessor **68**. Amplifiers **32** and **34** are enabled when power is received through the VSUPPLY line, and are disabled when no power is received through the VSUPPLY line. External connector **30** also includes a GND line, which is connected to ground.

Switch **20** is partially a monitoring pushbutton switch. Pressing switch **20** causes OR circuit **46** to turn on integrated power switch **44**. Integrated power switch **44** supplies power to all digital circuits, including microprocessor **68**, display panel **16** and associated display driver and memory circuit **82**. Integrated power switch **44** supplies power to microprocessor **68**, which in turn latches on OR circuit **46**. The turn of f of the circuit is controlled by microprocessor **68** discontinuing a signal to OR circuit **46**. This occurs through a fixed time of no activity.

Analog regulator **50** outputs electrical power which is used to energize analog circuitry, including amplifiers **62**A and **62**B, and analog-to-digital (A/D) converter **64**.

Pressure transducers **56**A and **56**B and nonvolatile memory **54** within sensor interface assembly **22** are connected through connector **58** and connector **60** to circuitry within housing **14**. Transducers **56**A and **56**B sense pressure communicated within sensor interface assembly **22** and supply electrical signals to connector **58**. In a preferred embodiment, transducers **56**A and **56**B are piezoresistive pressure transducers. Nonvolatile memory **54** stores offsets of transducers **56**A and **56**B and other information such as a sensor serial number. Nonvolatile memory **54** is, in a preferred embodiment, an EEPROM.

The outputs of transducers **56**A and **56**B are analog electrical signals representative of sensed pressure. These signals are amplified by amplifiers **62**A and **62**B and applied to inputs of A/D converter **64**. The analog signals to A/D converter **64** are converted to digital data and supplied to the digital signal processing circuitry **66** of microprocessor **68**.

Microprocessor **68** includes digital signal processing circuitry **66**, read only memory (ROM) and electrically erasable programmable read only memory (EEPROM) **70**, random access memory (RAM) **72**, timer circuitry **74**, and input/output ports **76**. A/D converter **64** may be integrated with microprocessor **68**, while some of the memory may be external to microprocessor **68**.

Based upon the pressure data received, microprocessor **68** performs calculations to determine blood pressure values. As each pulse produces a cardiac waveform, microprocessor **68** determines a peak amplitude of the waveform. Microprocessor **68** controls display driver **82** to create the visual counter on display **16** that counts in correlation to the hold down pressure applied by the user. The visual counter guides the user in applying a variable force to the artery.

When a measurement cycle has been completed, microprocessor **68** reorders the cardiac waveforms in increasing order of their corresponding hold down pressure and performs calculations to determine systolic pressure, diastolic pressure, mean blood pressure, and pulse rate. The process of calculating pressure using shape, amplitude, and hold down is described in the previously mentioned Medwave patents, which are incorporated by reference. If patient identification toggle **18** is pressed, a signal is supplied to microprocessor **68**, causing it to toggle to a new pressure reading with a new memory location. In one embodiment, the memory location of that pressure reading is also displayed.

The blood pressure calculations, organized by patient, are preferably time-stamped at the time of calculation using real-time clock **80**, and stored in non-volatile memory **78**, so that the calculations are not lost when power to device **10** is turned off. Non-volatile memory is preferably an EEPROM.

A preferred docking station according to the present invention is illustrated in FIG. **4**. Docking station **100** includes four bays **102**A–**102**D (collectively referred to as bays **102**) for receiving and holding blood pressure devices **10**. Bays **102**A–**102**D include five-pin connectors **104**A–**104**D, respectively, for interfacing with external connector **30** of a device **10**. Only connector **104**B is visible in FIG. **4**, but connectors **104**A, **104**C and **104**D are the same as connector **104**B. Docking station **100** further includes AC adapter **106**, LED indicators **108**A–**108**D (collectively referred to as LED indicators **108**) and DB-9 connector **112**. LED indicator **108**B is not visible in FIG. **4**, but is positioned adjacent bay **102**B similar to the positioning of LED indicator **108**A adjacent bay **102**A. LED indicators **108** are preferably dual color (red-green) LEDs. AC adapter **106** plugs into a wall receptacle for AC power, and outputs a DC voltage through DC connector **110**. DC connector **110** plugs into docking station **100** and provides DC power for the circuitry therein. Alternatively, power for docking station **100** and for recharging devices **10** may be obtained from another source, such as from personal computer (PC) **120** (shown in FIG. **6**).

Docking station **100** preferably has a modular design, allowing multiple docking stations **100** to be connected together. FIG. **5** shows a diagram of four docking stations **100A–100D** (collectively referred to as docking stations **100**) connected together. When multiple docking stations **100** are coupled together, one docking station **10A** acts as a master, while the remaining docking stations **100B–100D** act as slaves. Docking stations **100** are electrically coupled together via bus input connectors **166A–166D** (collectively referred to as bus input connectors **166**), first bus output connectors **156A–156D** (collectively referred to as first bus output connectors **156**) and second bus output connectors **158A–158D** (collectively referred to as second bus output connectors **158**). Bus connectors **156**, **158** and **166** are preferably positioned on the back and both sides of a docking station **100**, allowing the docking stations to be connected side-to-side or back-to-back.

In a preferred embodiment, docking station **100** is connected to a personal computer (PC) **120** as shown in FIG. **6**. After blood pressure and heart rate data are obtained by a blood pressure measurement device **10**, the nurse places device **10** into a docking station **100**, and PC **120** transmits commands through docking station **100** to device **10** via external connector **30**. In response, device **10** outputs stored data through docking station **100** to PC **120**. Concurrently, the rechargeable battery **36** within device **10** is recharged, and power is supplied to device **10** from docking station **100** via external connector **30**, while device **10** is in docking station **100**.

Device **10** outputs pulse rate data and blood pressure data to PC **120**, including systolic blood pressure and diastolic blood pressure. Each set of pulse rate and blood pressure data includes a patient ID number, and a time stamp and a date stamp of the reading. As described above, the patient ID number is a number from 1–16 that is set using patient identification toggle **18**, and allows blood pressure and pulse rate data to be organized within device **10** with respect to particular patients. In a preferred embodiment, a sensor serial number is also output from device **10** to PC **120**, so that blood pressure and pulse rate information can be organized with respect to particular measurement devices **10**. Device **10** may also transmit to PC **120** any other information stored in the device **10**, including mean blood pressure information, usage history information and sensor test information.

PC **120** preferably includes database **122** for all of the patients in the hospital. PC **120** runs a custom software application that associates actual patients with patient ID numbers and serial numbers for devices **10**. Each time PC **120** obtains information from a device **10** stored in docking station **100**, PC **120** stores the information in database **122**. The information obtained from devices **10** may also be stored on an Internet server **124**. The information obtained from devices **10** and stored in database **122** or Internet server **124** may be accessed by other computers, such as computers **126** used by clinical personnel, computers **128** used by administrative personnel and computers **130** used by payers.

The information obtained from devices **10** through docking station **100** may be used in multiple ways. The information can be used by doctors and nurses for remote patient monitoring. The information can be used for billing purposes. Charts and graphs can be generated from the information, such as blood pressure or pulse rate historical data for a patient. The information can be used for sensor management (e.g., displaying sensor usage information, sensor test information and warnings, sensor expiration information and warnings, etc.).

FIGS. **7A** and **7B** show an electrical schematic diagram of docking station **100**. Docking station **100** includes five-pin connectors **104A–104D** (collectively referred to as connectors **104**), LED indicators **108A–108D** (collectively referred to as LED indicators **108**), battery chargers **140A–140D** (collectively referred to as battery chargers **140**), switches **142A–142D** (collectively referred to as switches **142**), input switch **144**, output switch **146**, serial interface **148**, DB-9 connector **112**, counter **154**, first bus output **156**, second bus output **158**, bay address decoder **160**, board address switch **162**, board address decoder **164**, bus input **166** and DC power supplies **+V1** and **+V2**. Power supplies **+V1** and **+V2** are provided power from DC connector **110** (shown in FIG. **4**).

Each connector **104** of docking station **100** may be connected to external connector **30** of a blood pressure measurement device **10**. Five lines are connected to each connector **104**—DATAIN, DATAOUT, CHRGR, GND and VSUPPLY. Each DATAIN line connects with the TX line of a device **10** (see FIG. **3**), and is used for transmitting data from device **10** to docking station **100**. The DATAIN line from each connector **104** is connected to input switch **144**. Each DATAOUT line connects with the RX line of a device **10**, and is used for transmitting data from docking station **100** to a device **10**. The DATAOUT line from each connector **104** is connected to output switch **146**. Each GND line within docking station **100** is connected to the GND line of a device **10**, and is coupled to ground.

Each CHRGR line of docking station **100** connects with the CHRGR line of a device **10**. Each CHRGR line of docking station **100** is also coupled to one of the battery chargers **140**. Battery chargers **140** provide a current source for recharging battery **36** within a device **10**. Battery chargers **140A–140D** are coupled to LED indicators **108A–108D**, respectively. When a device **10** is first plugged into a bay **102** of docking station **100**, for example bay **102A**, battery charger **140A** detects the presence of device **10**, begins charging device **10**, starts a timer, and uses the RED1 output line to cause LED indicator **108A** to display a red light. The display of the red light indicates that device **10** is charging. In a preferred embodiment, battery charger **140A** monitors the timer and uses the GREEN1 and FLASH1 output lines to cause LED indicator **108A** to display a flashing green light after 15 hours of charging. If device **10** is removed from bay **102A**, and then replaced back in bay **102A**, battery charger **140A** resets the timer. Other battery chargers with different charging times may be used. Battery chargers **140B–140D** operate in the same manner as battery charger **140A**.

Each VSUPPLY line of docking station **100** is connected to the VSUPPLY line of a device **10**, and is used to provide power to device **10**. Each VSUPPLY line of docking station **100** is connected to one of the switches **142**. Each switch **142** is controlled by one of the battery chargers **140**. When a device **10** is first plugged into a bay **102** of docking station **100**, for example bay **102A**, battery charger **140A** detects the presence of the device **10**, and closes switch **142A**. Power is then supplied to the device **10** from power supply **+V2**. Supplying power to device **10** from power supply **+V2** guarantees not only that the digital voltage levels are the same in device **10** and docking station **100** (optimizing noise margin and reducing likelihood of latch-up and/or damage), but that the saved pressure readings, pulse rates and other data in device **10** may be obtained even with a fully discharged battery **36**.

When multiple docking stations **100** are coupled together as shown in FIG. **5**, one docking station **100**A is a master unit, and the remaining docking stations **100**B–**100**D are slave units. The slave units **100**B–**100**D are similar to the master unit **100**A, with the deletion of counter **154**, serial interface **148** and DB-9 connector **112**. When multiple docking stations **100** are connected together, only the master docking station **100**A connects directly to PC **120**, while the remaining docking stations **100** share a common bus **155** for communicating with PC **120**.

Each docking station **100** includes a first bus output **156**, a second bus output **158** and a bus input **166**, which are each implemented with a 10-pin connector. Each bus line coupled to first bus output **156** is also coupled to a corresponding pin of second bus output **158** and bus input **166**. The bus lines are numbered from 1 to 10. Bus lines **1**–**4** are connected to lines ADDR**0**, ADDR**1**, ADDR**2** and ADDR**3**, respectively. Bus line **5** is connected to input switch **144**. Bus line **6** is connected to output switch **146**. Bus lines **7** and **8** are connected to +V**1**, which is a DC power supply. Bus lines **9** and **10** are connected to ground.

In a preferred embodiment, bus input connector **166** is positioned on the left side of docking station **100**, first bus output connector **156** is positioned on the back side of docking station **100**, and second bus output connector **158** is positioned on the right side of docking station **100**. Other configurations are possible.

Each docking station **100** includes a circuit board for holding and connecting the electronics in FIGS. **7**A and **7**B. When multiple docking stations **100** are coupled together, each circuit board (and correspondingly each docking station **100**) is assigned a board address. The board address for each docking station **100** is set with board address switch **162**. Similarly, each bay **102** within a docking station **100** is assigned a bay address. Each circuit board and each bay **102** is assigned one address in the set {**00**, **01**, **10**, **11**}. The lines ADDR**0** and ADDR**1** are used to cycle through the four bay addresses. The lines ADDR**2** and ADDR**3** are used to cycle through the four board addresses.

DB-9 connector **112** of docking station **100** is preferably connected to a serial port of PC **120**, although DB-9 connector **112** may alternatively be connected to any other device that is able to manipulate TX, RX, DTR (Data Terminal Ready), and RTS (Request to Send) lines. In order to access bays **102**, and therefore the blood pressure measurement devices **10**, PC **120** toggles the RTS line, which then toggles the CLK line of counter **154**. Counter **154** generates binary addresses in a sequence of 0 (i.e., 0000) to 15 (i.e., 1111). The first two digits of the four digit binary address represent a board address and are sent out on lines ADDR**2** and ADDR**3**. The last two digits of the four digit binary address represent a bay address and are sent out on lines ADDR**0** and ADDR**1**. The DTR line may toggled by PC **120** in order to reset counter **154** to 0. In this way, the data may be re-synchronized at any time to start from board **00**, bay **00**.

When counter **154** toggles to a new address, the new address goes out to bay address decoder **160** and board address decoder **164**. Board address decoder **164** includes four output lines, each output line corresponding to one of the four possible board addresses. Board address decoder **164** decodes the two digit board address portion of the four digit address and, based on the decoded address, sets one of its four output lines high. If the line set high by board address decoder **164** corresponds to the board address set at board address switch **162**, board address switch **162** sends an enable signal to bay address decoder **160**, allowing bay address decoder **160** to decode the bay address. If the line set high by board address decoder **164** does not correspond to the board address set at board address switch **162**, board address switch **162** maintains its output line low, thereby maintaining bay address decoder **160** in a disabled state.

Bay address decoder **160** includes four output lines, each output line corresponding to one of the four possible bay addresses. When bay address decoder **160** is enabled by board address switch **162** and receives a bay address, bay address decoder **160** decodes the bay address and, based on the decoded address, sets one of its four output lines high. The output lines of bay address decoder **160** are coupled to input switch **144** and output switch **146**. Based on the output of bay address decoder **160**, input switch **144** and output switch **146** couple the DATAIN and DATAOUT lines for the currently selected bay **102** to serial interface **148** and to bus lines **5** and **6**. Serial interface **148** includes amplifiers **150**A–**150**D, which amplify signals on the DATAIN, DATAOUT, DTR/CLR and RTS/CLK lines.

After toggling to a new address, PC **120** sends characters on the DATAOUT line and then waits for a response. If PC **120** does not receive a response within an allotted time, PC **120** assumes that no blood pressure measurement device **10** is present at the current board and bay address, moves on to the next board and bay address, and repeats the process. If a blood pressure measurement device **10** is present at the current board and bay address, the device **10** responds by sending characters to PC **120** on the DATAIN line. In this fashion, PC **120** is constantly scanning bays **102**, looking for blood pressure measurement devices **10** that may be present.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

What is claimed is:

1. A storage device for storing a plurality of portable medical devices, each portable medical device including an electrical connector, the storage device comprising:

a plurality of bays for receiving and storing the plurality of portable medical devices, each bay including a first electrical connector, the first electrical connector of each bay configured to interface with the electrical connector of one of the portable medical devices;

a second electrical connector configured to be coupled to a computer;

a battery charger coupled to at least one of the first electrical connectors of a bay for charging a battery of one of the portable medical devices; and

switch means coupled to the first electrical connector of each bay and coupled to the second electrical connector for selectively coupling each bay to the computer for data transfer between the portable medical devices and the computer.

2. The storage device of claim **1**, and further comprising means for supplying power to a portable medical device when the device is placed in one of the plurality of bays.

3. The storage device of claim **1**, wherein the plurality of portable medical devices are non-invasive blood pressure measurement devices.

4. The storage device of claim **1**, and further comprising a plurality of indicator lights, each indicator light positioned adjacent one of the bays, each indicator light indicating a charging status of one of the portable medical devices.

5. The storage device of claim **4**, wherein each indicator light is a dualcolor LED.

6. The storage device of claim **1**, and further comprising at least one third electrical connector configured to be connected to a second storage device for storing a plurality of portable medical devices.

7. The storage device of claim **1**, and further comprising at least three bus connectors, each bus connector configured to be connected to a storage device for storing a plurality of portable medical devices.

8. The storage device of claim **1**, wherein the storage device comprises a master unit and at least one slave unit, the master unit and the slave unit each including a plurality of bays for receiving and storing the plurality of portable medical devices, the master unit and the slave unit each including a bus connector for electrically coupling the master unit to the slave unit.

9. The storage device of claim **8**, wherein the master unit and the slave unit each include multiple bus connectors to connect the master unit and the slave unit together in multiple alternative configurations.

10. A method of gathering and centrally storing a set of patient data for each of a plurality of patients, the method comprising:

applying a plurality of non-invasive blood pressure measurement devices to a plurality of patients to obtain the patient data;

storing the patient data in the plurality of non-invasive blood pressure measurement devices;

placing the plurality of non-invasive blood pressure measurement devices in a docking station coupled to a computer; and

transmitting the stored data from each non-invasive blood pressure measurement device through the docking station to the computer and storing the patient data therein.

11. The method of claim **10**, and further comprising storing a patient identifier in each set of patient data.

12. The method of claim **11**, and further comprising storing a time and a date stamp in each set of patient data, the time and the date stamp indicating the time and the date that the set of patient data was obtained.

13. The method of claim **11**, and further comprising storing a device identifier in each non-invasive blood pressure measurement device and transmitting the device identifier from each non-invasive blood pressure measurement device through the docking station to the computer.

14. The method of claim **10**, and further comprising storing device usage history information in each non-invasive blood pressure measurement device, and transmitting the device usage history information from each non-invasive blood pressure measurement device through the docking station to the computer.

15. The method of claim **10**, and further comprising storing device test information in each non-invasive blood pressure measurement device, and transmitting the device test information from each non-invasive blood pressure measurement device through the docking station to the computer.

16. The method of claim **10**, and further comprising generating and displaying patient status information based on the patient data stored in the computer.

17. The method of claim **10**, and further comprising generating billing information based on patient data stored in the computer.

18. The method of claim **10**, wherein the portable medical devices are non-invasive blood pressure measurement devices.

19. The method of claim **10**, wherein the patient data includes systolic and diastolic blood pressure information.

20. The method of claim **10**, and further comprising supplying power to at least one of the non-invasive blood pressure measurement devices when the device is placed in the docking station.

21. The method of claim **10**, and further comprising recharging a battery of at least one of the non-invasive blood pressure measurement devices when the device is placed in the docking station.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,524,240 B1
DATED : February 25, 2003
INVENTOR(S) : Roger C. Thede

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

<u>Column 12,</u>
Lines 26-28, please delete claim 18 in its entirety.
Line 29, claim reference number “19” should read -- 18 --
Line 31, claim reference number “20” should read -- 19 --
Line 35, claim reference number “21” should read -- 20 --.

Signed and Sealed this

Thirteenth Day of April, 2004

JON W. DUDAS
Acting Director of the United States Patent and Trademark Office

专利名称(译)	便携式医疗设备的对接站		
公开(公告)号	US6524240	公开(公告)日	2003-02-25
申请号	US09/721218	申请日	2000-11-22
[标]申请(专利权)人(译)	麦迪威公司		
申请(专利权)人(译)	MEDWAVE INC.		
当前申请(专利权)人(译)	MEDWAVE INC.		
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发明人	THEDE, ROGER C.		
IPC分类号	A61B5/021 A61B5/00 A61B5/02		
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摘要(译)

一种用于存储多个便携式医疗设备的存储设备，包括多个用于接收和存储多个便携式医疗设备的机架。每个便携式医疗设备包括电连接器。每个托架包括第一电连接器。每个机架的第一电连接器配置成与便携式医疗设备之一的电连接器接口。第二电连接器配置为耦合到计算机。电池充电器耦合到机架的第一电连接器中的至少一个，用于为一个便携式医疗设备的电池充电。开关耦合到每个机架的第一电连接器并且耦合到第二电连接器，用于选择性地将每个机架耦合到计算机，以便在机架和计算机之间进行数据传输。