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(54) **MODULAR DIGITAL ULTRASOUND IMAGING SYSTEM**

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Publication Classification

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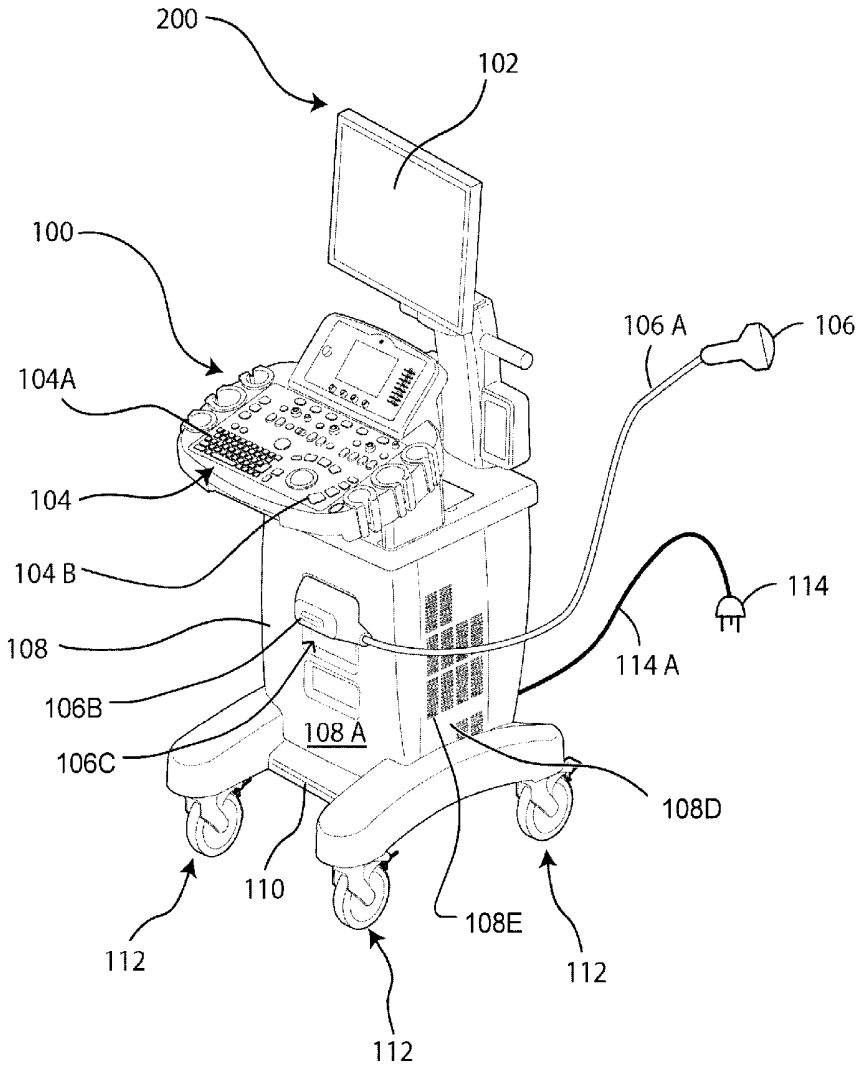
(57) **ABSTRACT**

A housing unit for an ultrasound system which comprises an ultrasound transducer, a video display, an input device and a removable PC computer. The removable PC may be housed within an enclosure defined by the housing unit. The removable PC may house all of the processor(s) required for control and operation of the ultrasound system. The removable PC may be coupled to and uncoupled from the ultrasound transducer, the video display and the input device using conventional connectors. Such connectors permit users to interchange the removable PC with an updated PC without having to send the ultrasound system to the manufacturer and without requiring the services of a technician.



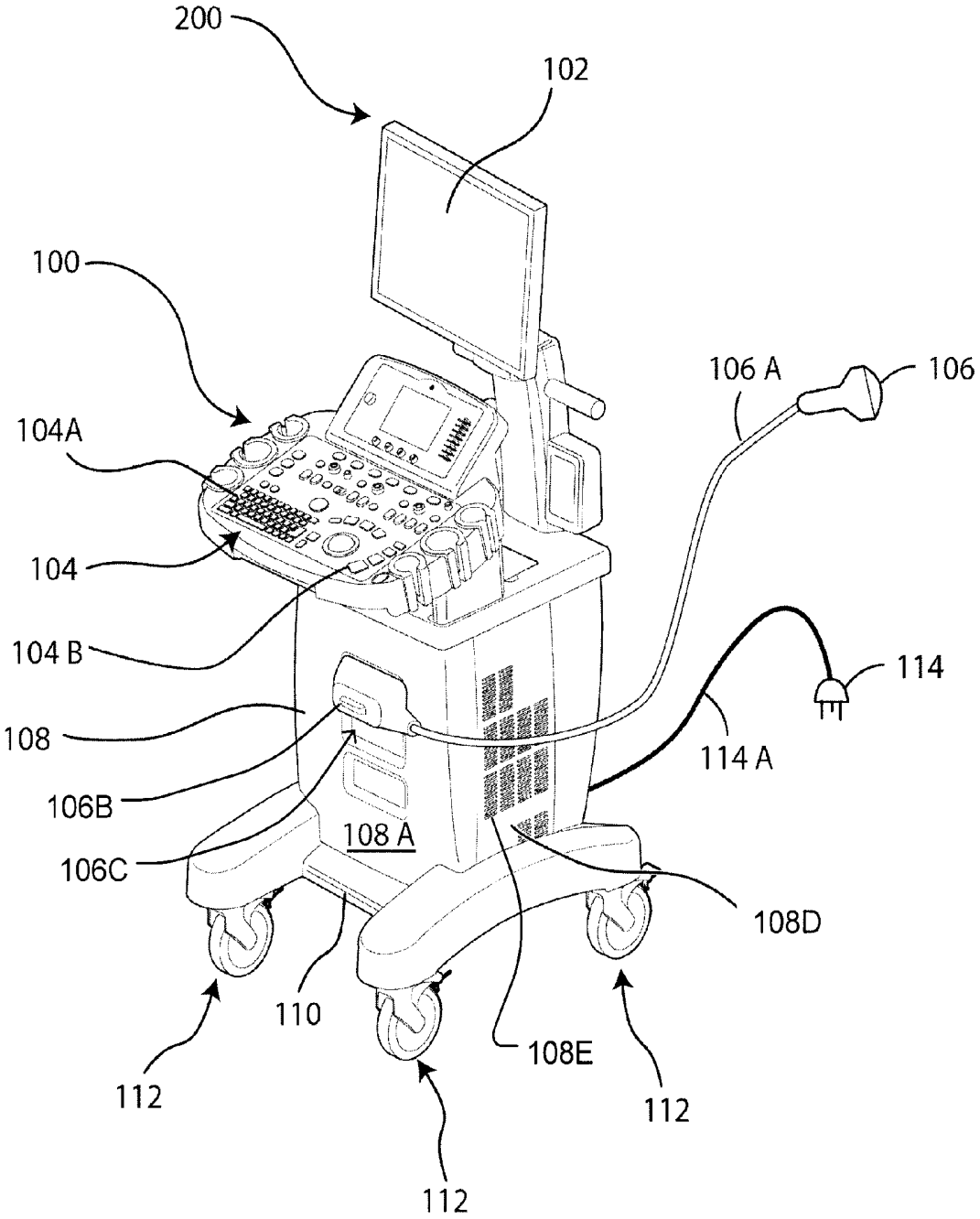

200
102
100
106 A
106
104A
104
104 B
114
108
114 A
106B
108 A
106C
108D
110
108E
112
112
112

FIGURE 1

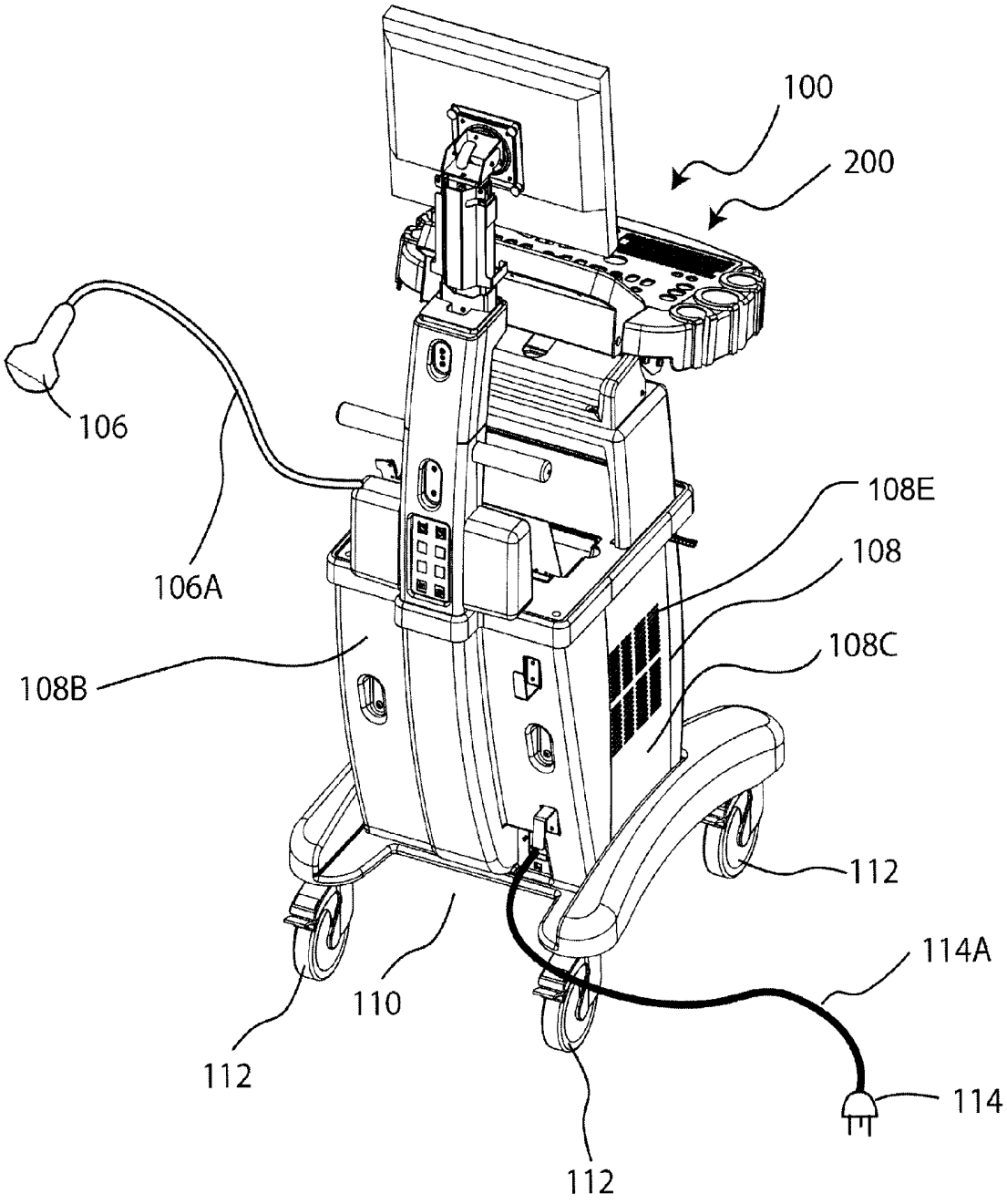


FIGURE 2A

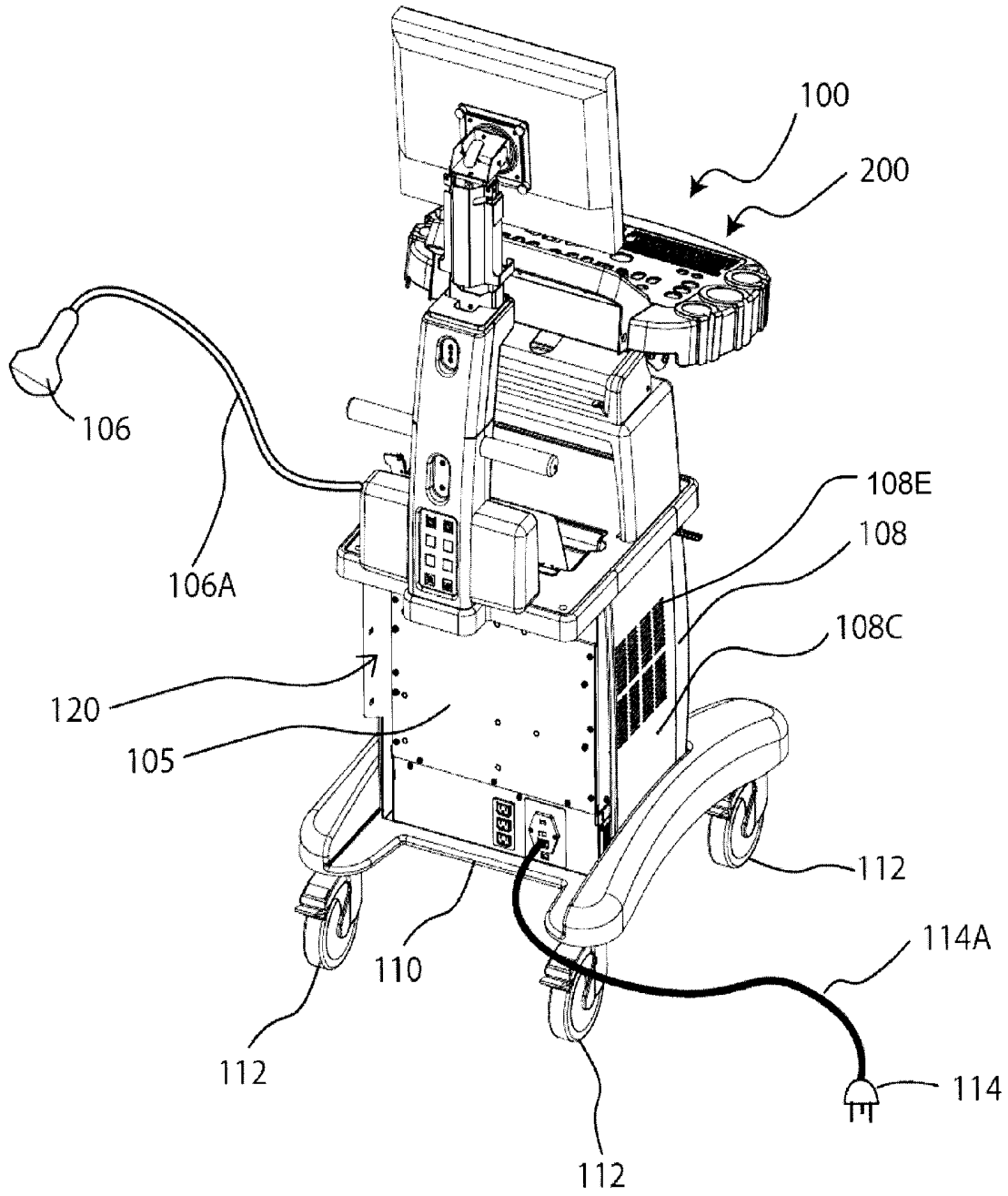


FIGURE 2B

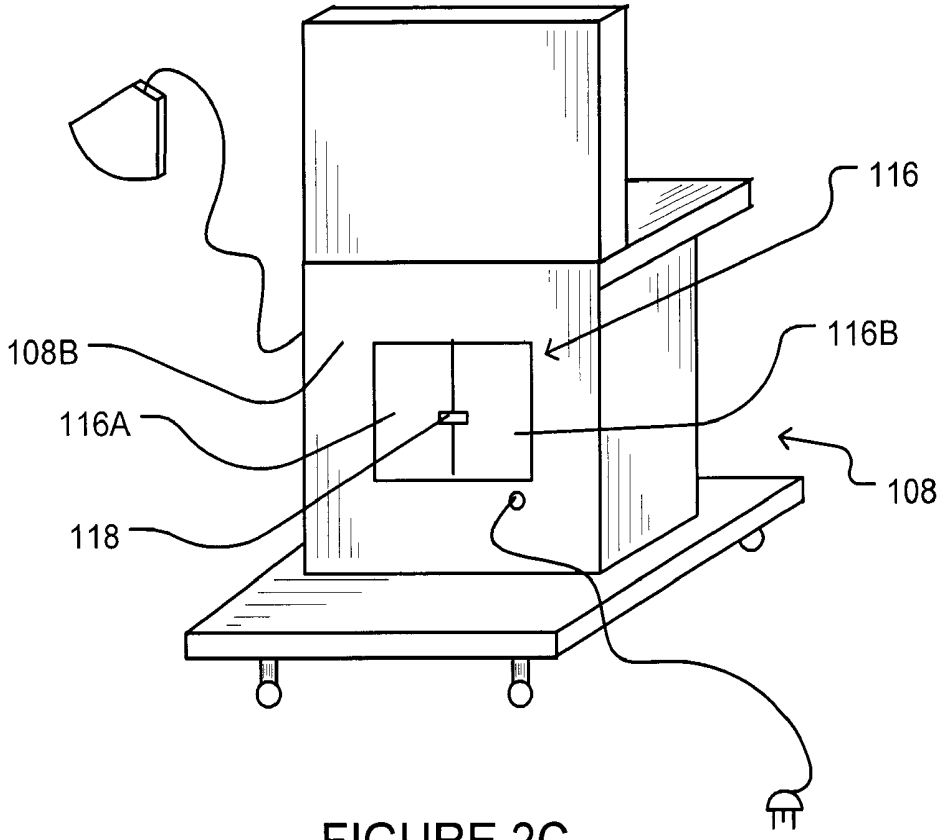


FIGURE 2C

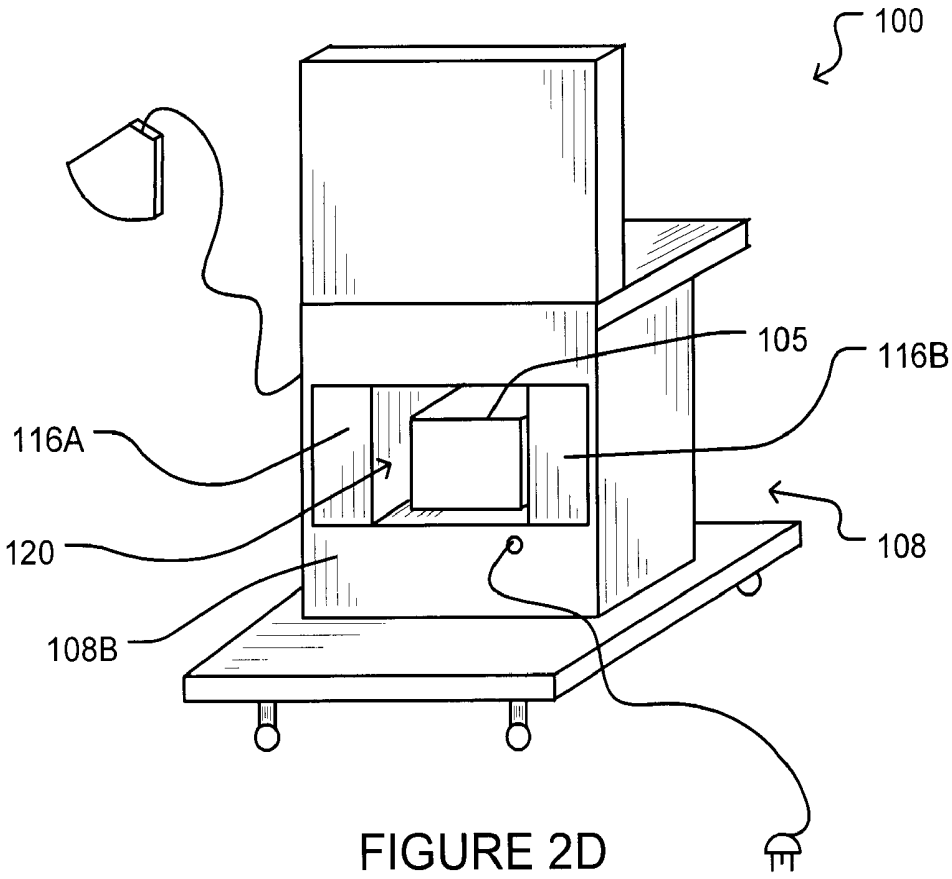


FIGURE 2D

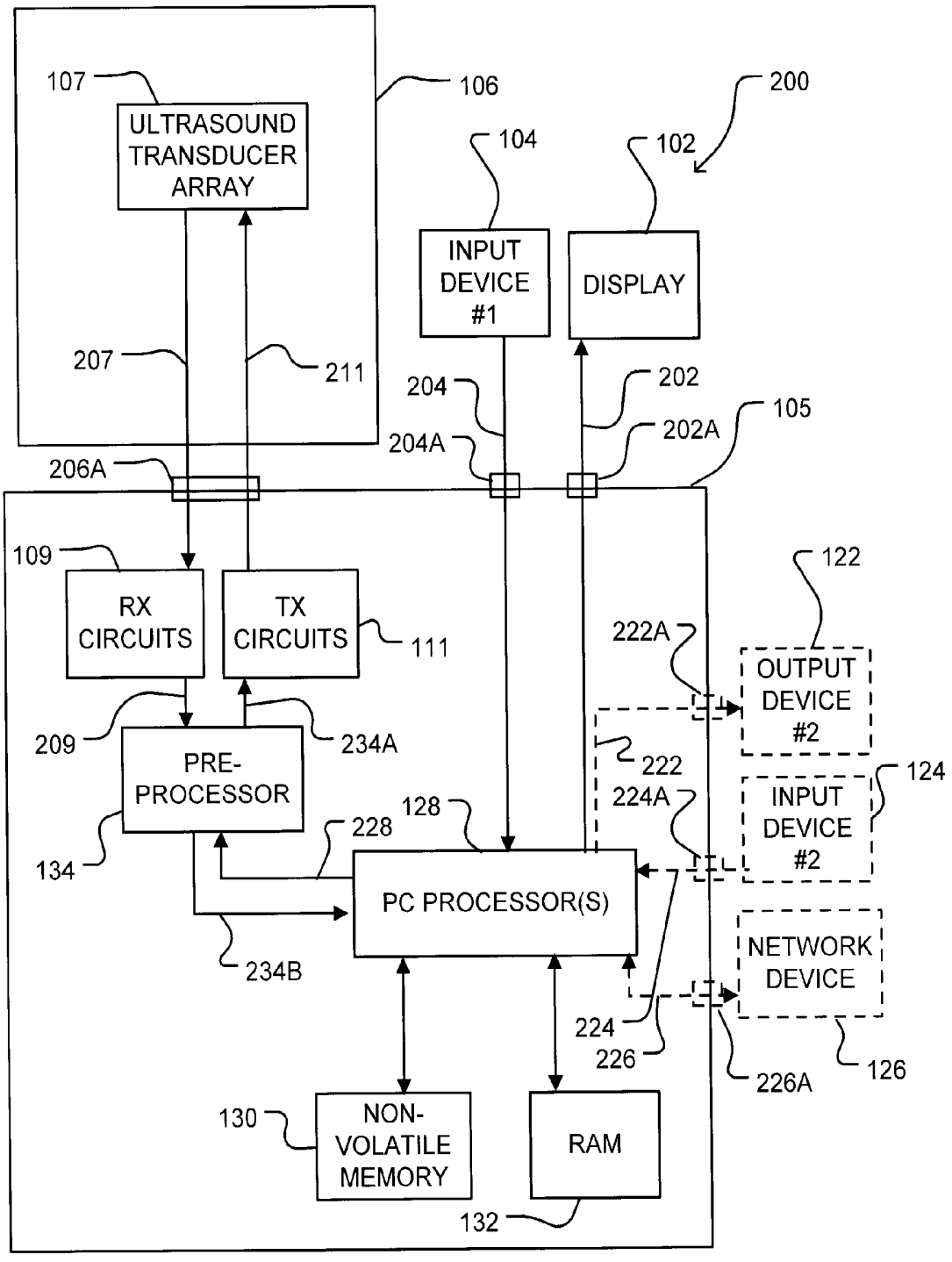

107
ULTRASOUND TRANSDUCER ARRAY
106
200
104
102
INPUT DEVICE #1
DISPLAY
207
211
204
202
204A
202A
105
206A
109
RX CIRCUITS
TX CIRCUITS
111
122
222A
OUTPUT DEVICE #2
209
234A
222
224A
124
INPUT DEVICE #2
PRE-PROCESSOR
128
228
134
PC PROCESSOR(S)
NETWORK DEVICE
234B
224
226
226A
126
130
NON-VOLATILE MEMORY
RAM
132

FIGURE 3A

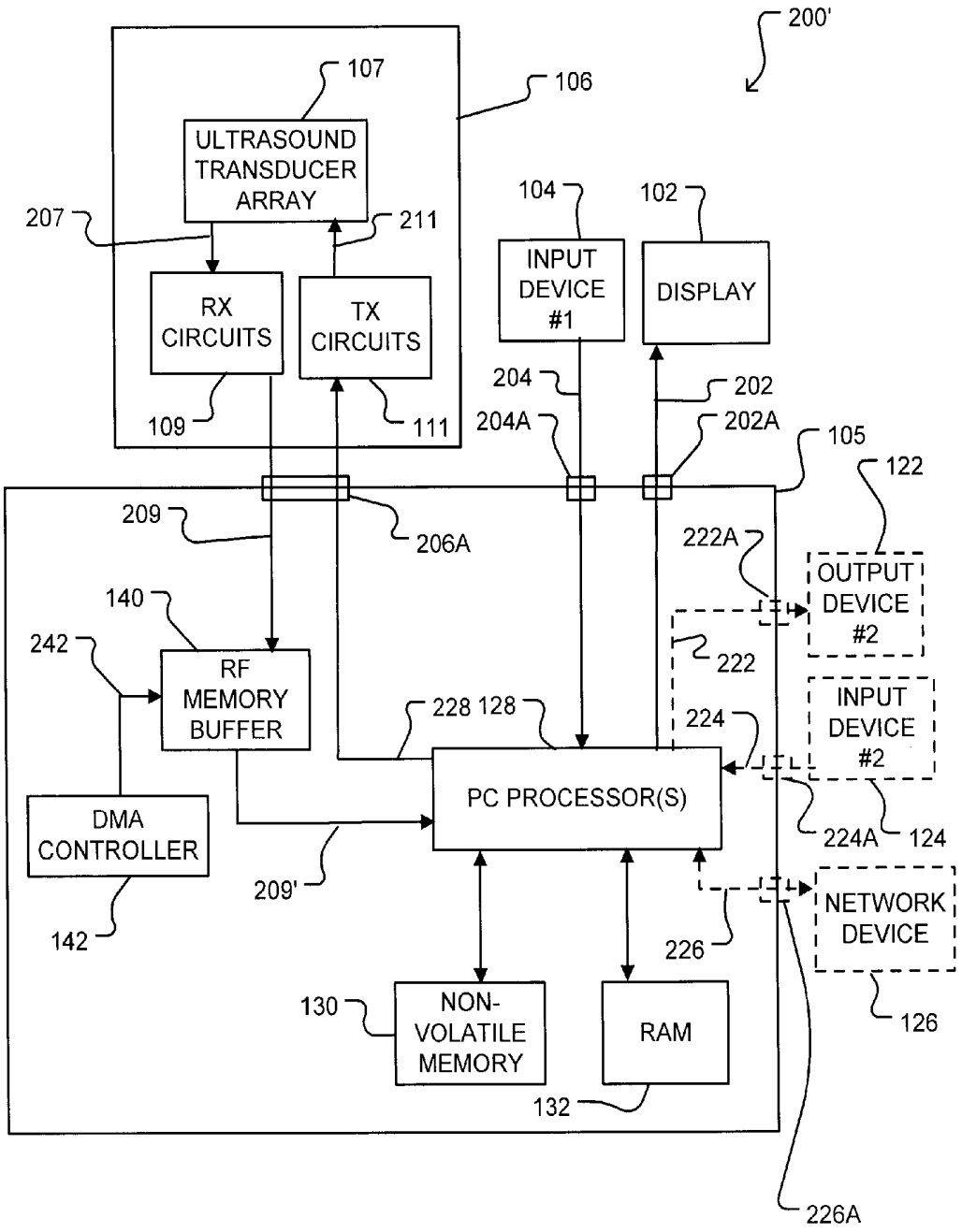

200'
107
106
ULTRASOUND TRANSDUCER ARRAY
207
211
104
102
INPUT DEVICE #1
DISPLAY
RX CIRCUITS
TX CIRCUITS
204
202
109
111
204A
202A
105
122
209
206A
222A
OUTPUT DEVICE #2
140
242
RF MEMORY BUFFER
222
228 128
224
INPUT DEVICE #2
PC PROCESSOR(S)
DMA CONTROLLER
224A
124
209'
NETWORK DEVICE
142
226
130
NON-VOLATILE MEMORY
RAM
126
132
226A

FIGURE 3B

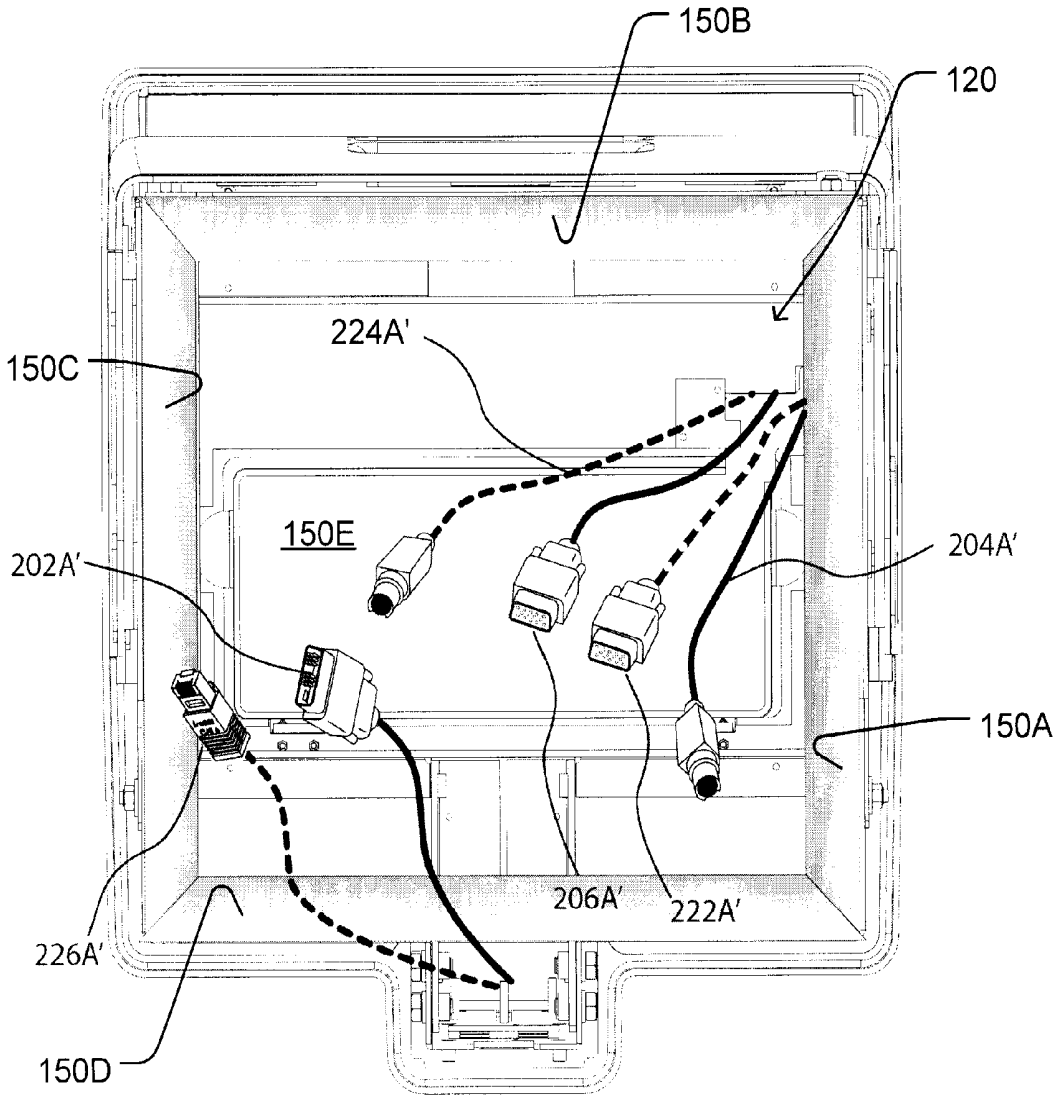


FIGURE 4A

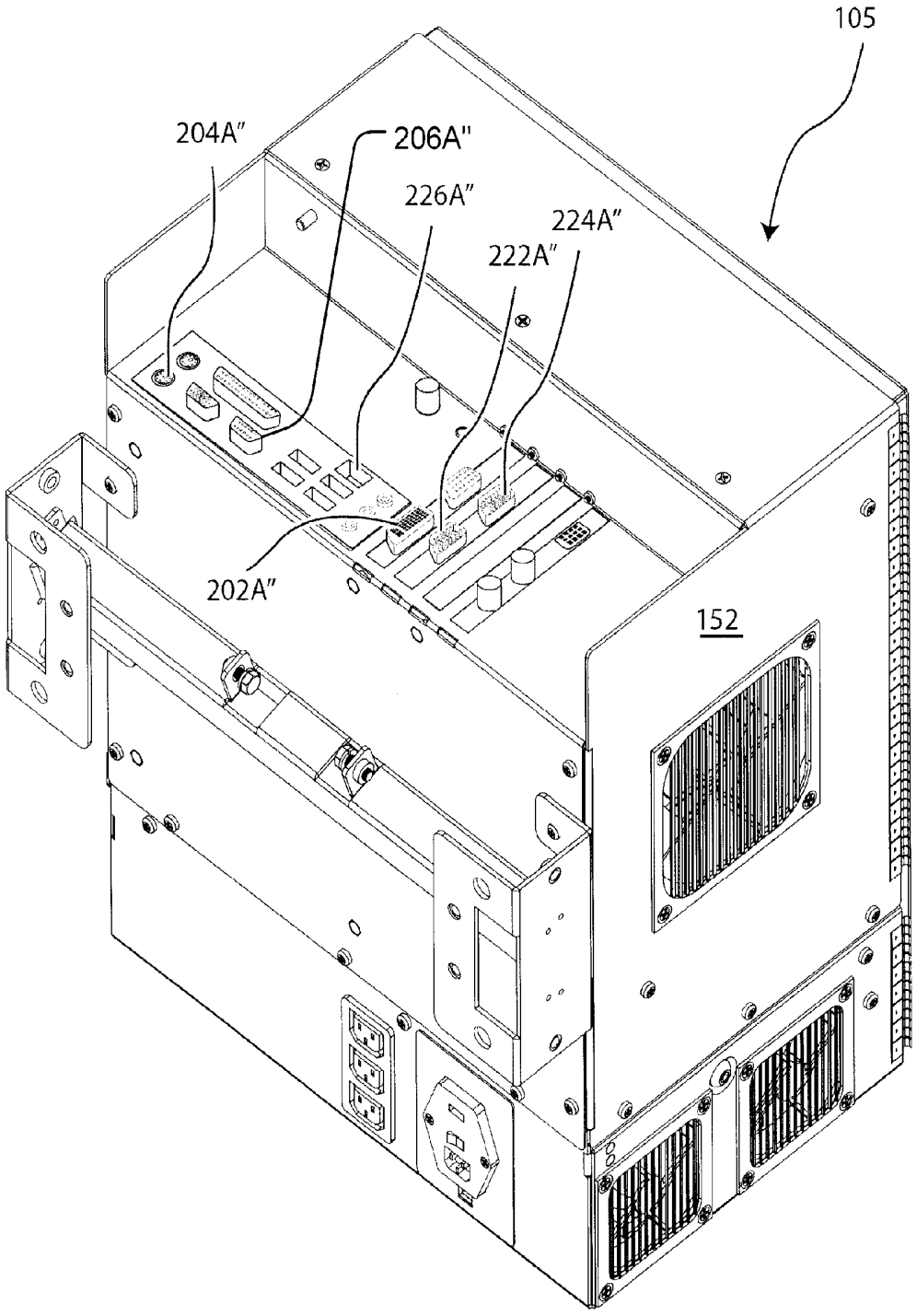


FIGURE 4B

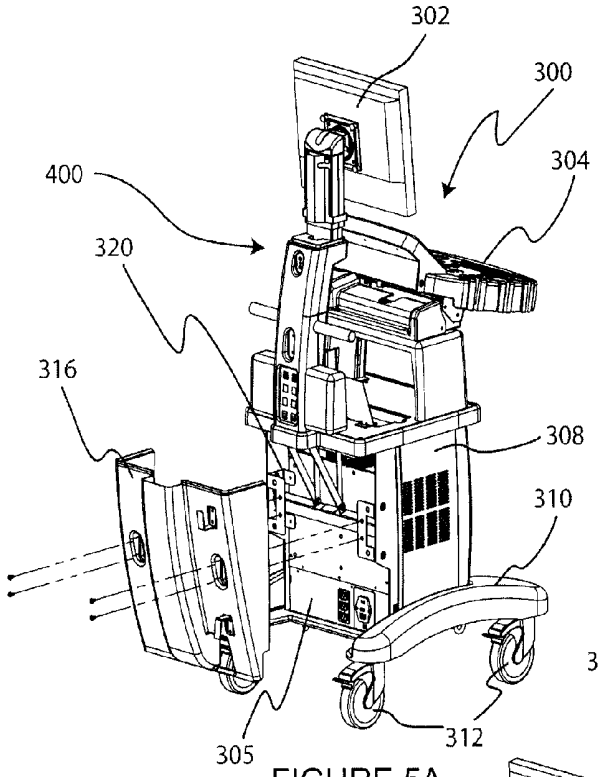


FIGURE 5A

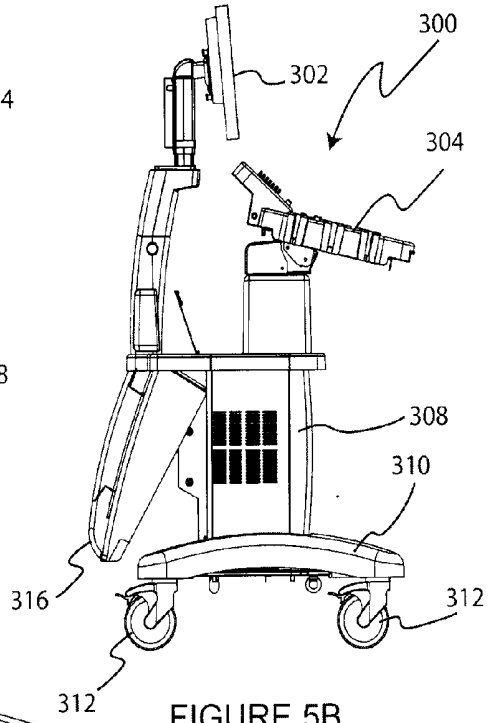


FIGURE 5B

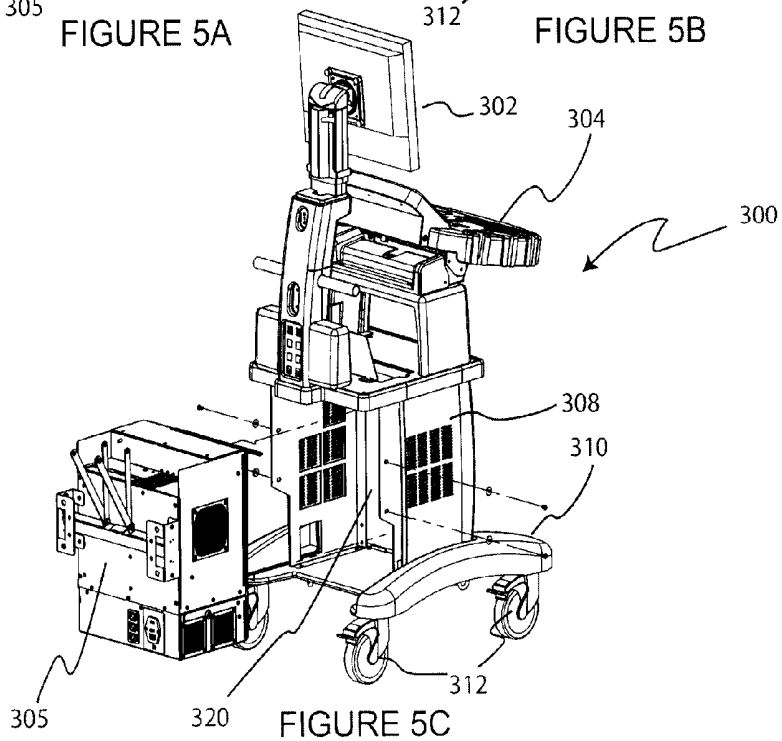


FIGURE 5C

MODULAR DIGITAL ULTRASOUND IMAGING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. provisional patent application No. 60/744,194 entitled MODULAR DIGITAL ULTRASOUND IMAGING SYSTEM filed 3 Apr. 2006. This application is related to the following co-owned U.S. patent applications:

[0002] (i) application No. 60/744,192 entitled METHODS AND SYSTEMS FOR TRANSFIGURING ULTRASOUND SYSTEMS FOR ULTRASOUND EXAMINATION filed 3 Apr. 2006; and

[0003] (ii) application No. 60/744,193 entitled ULTRASONIC IMAGING SYSTEM HAVING COMPUTER COUPLED TO RECEIVE AND PROCESS DATA filed 3 Apr. 2006

All three of these related applications are hereby incorporated by reference herein.

TECHNICAL FIELD

[0004] The invention applies to digital ultrasound imaging systems.

[0005] Particular embodiments of the invention provide modular housing units for digital ultrasound imaging systems.

BACKGROUND

[0006] Ultrasound technology has a wide variety of medical applications related to exploration and imaging of internal regions of a patient's body. Ultrasound imaging is generally non-destructive and versatile and can provide high quality images useful for medical examination, diagnosis of medical conditions and the like.

[0007] Ultrasound imaging systems typically comprise: an ultrasound transducer which incorporates an array of transducer elements for sensing information (in the form of acoustic signals) from the body of a patient; and a display unit for displaying information representative of the signals received by the transducer. Recent developments have led to the introduction of digital ultrasound imaging systems. Digital ultrasound systems sample and digitize ultrasound data that is captured by the ultrasound transducer. Digital ultrasound systems are typically controlled and/or controllable (at least in part) by software that runs on one or more processor(s), such as may be provided by custom embedded hardware systems and/or embedded hardware systems in combination with a personal computer (PC), for example. Examples of digital ultrasound imaging systems include those disclosed in U.S. Pat. No. 6,325,759 (Pelissier), U.S. Pat. No. 5,839,442 (Chiang et al.), U.S. Pat. No. 5,795,297 (Daigle) and U.S. Pat. No. 5,758,649 (Iwashita et al.), all of which are hereby incorporated herein by reference.

[0008] In addition to the ultrasound transducer and the video display, a digital ultrasound system includes one or more suitably programmed processor(s) which execute software instructions to control operation of the ultrasound system. Some digital ultrasound systems incorporate custom hardware which includes such suitably programmed processor(s). These systems suffer from the drawback that they are not easily updated or repaired by users (i.e. users, such as doctors, nurses or other medical professionals, are unlikely to be able to perform hardware or software upgrades or repairs). This disadvantage is particularly problematic because of the relatively rapid rate of increase in hardware processing power and corresponding software processing techniques. Increases in hardware processing power and corresponding software processing techniques can lead to new and useful ultrasound imaging modalities. Such new ultrasound imaging modalities may not be supported by the original custom hardware and software (i.e. upgrades may be required to take advantage of such new ultrasound imaging modalities). Consequently, ultrasound imaging systems which incorporate custom hardware may not be able to take advantage of the latest ultrasound techniques. In some circumstances, ultrasound imaging systems may have to be sent out from a medical facility or otherwise rendered unavailable for use, so that they can be serviced and/or updated by their manufacturer.

[0009] Another disadvantage of ultrasound systems incorporating custom hardware relates to the use of such systems in medical environments. Medical environments, such as hospitals, are typically subject to strict regulations regarding the equipment used therein. Such equipment must often meet safety standards set by policies of the hospital itself and/or by various regulatory authorities. An example requirement for hospital equipment is to maintain electrical and magnetic field (EMF) emissions below an acceptable threshold. System updates which involve changes to the custom hardware of an ultrasound system (typically requiring service by the manufacturer of the ultrasound system) may require that the entire ultrasound system be re-certified to ensure that it meets with regulatory approval.

[0010] Some digital ultrasound systems incorporate a combination of custom hardware (typically used for high speed processing or preprocessing of ultrasound signals received from the transducer) and conventional PC hardware (typically used for providing a user interface and for controlling the custom hardware). Systems which incorporate custom processing or preprocessing hardware may suffer from the same drawbacks as those systems having completely custom hardware. More specifically, systems which incorporate custom processing or preprocessing hardware are not easily user-updatable or user-repairable and such systems may not be able to take advantage of the latest ultrasound techniques.

[0011] Ultrasound systems incorporating a desktop PC may not be easily mobile. Mobility is advantageous in a hospital environment, where patients may not be mobile and where equipment and space are scarce. Where ultrasound systems incorporate a laptop PC, the PC may be susceptible to theft and/or damage. Also, laptop PCs are often insufficiently robust for use in a hospital environment where they may be handled by a large number of users. Laptop PCs may also emit unacceptable levels of EMF.

[0012] There is a general desire to provide digital ultrasound systems that overcome or at least ameliorate one or more of the aforementioned drawbacks with prior art systems.

SUMMARY OF THE INVENTION

[0013] One aspect of the invention provides a housing unit for an ultrasound system which comprises an ultrasound transducer, a video display, an input device and a removable PC computer. The removable PC may be housed within an enclosure defined by the housing unit. The removable PC may house all of the processor(s) required for control and operation of the ultrasound system. The removable PC is preferably capable of being coupled to and uncoupled from the ultrasound transducer, the video display and the input device using conventional connector interfaces. Such connectors permit users to interchange the removable PC with an updated PC (i.e. a PC having updated software and/or hardware) without having to send the ultrasound system to the manufacturer and without requiring the services of a technician. Such connectors permit users to replace damaged or faulty PCs without having to send the ultrasound system to the manufacturer and without requiring the services of a technician. In some embodiments, the housing unit can obtain regulatory certification separately from the PC, such that updates to the PC and/or replacement of the PC does not require separate regulatory certification of the system. Such certification may involve the amount of EMF generated by the system, for example.

[0014] Further features and applications of the invention are described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In drawings which depict non-limiting embodiments of the invention:

[0016] FIG. **1** is a front isometric view of a housing unit for a digital ultrasound system according to a particular embodiment of the invention;

[0017] FIG. **2**A is a rear isometric view of the FIG. **1** housing unit with its PC-enclosure in a closed configuration;

[0018] FIG. **2**B is a rear isometric view of the FIG. **1** housing unit with its PC-enclosure in an open configuration;

[0019] FIG. **3**A is a schematic block diagram showing the components of a digital ultrasound system according to a particular embodiment of the invention;

[0020] FIG. **3**B is a schematic block diagram showing the components of a digital ultrasound system according to another embodiment of the invention;

[0021] FIG. **4**A is a perspective view of a PC-enclosure of the FIG. **1** housing unit with the PC removed;

[0022] FIG. **4**B is an isometric view of a PC suitable for use with the housing unit and ultrasound system of FIG. **1**;

[0023] FIGS. **5**A, **5**B and **5**C depict isometric views of a housing unit for a digital ultrasound system according to another embodiment of the invention.

DETAILED DESCRIPTION

[0024] Throughout the following description, specific details are set forth in order to provide a more thorough understanding of the invention. However, the invention may be practiced without these particulars. In other instances, well known elements have not been shown or described in detail to avoid unnecessarily obscuring the invention. Accordingly, the specification and drawings are to be regarded in an illustrative, rather than a restrictive, sense.

[0025] FIGS. **1**, **2**A and **2**B show different views of a housing unit **100** for a modular digital ultrasound system **200** according to a particular embodiment of the invention. System **200** comprises a video display **102**, an input device **104**, a transducer **106** and a PC **105**. Preferably, video display **102** is a high resolution, color, flat-screen monitor. In general, however, video display **102** may comprise any other type(s) of video display(s) known in the art. In the illustrated embodiment, input device **104** comprises a keyboard **104**A with customized function keys **104**B. PC **105** may comprise a self-contained personal computer having its own case, power supply, processor, memory and ports. In some embodiments, system **200** may comprise one or more additional input devices (not shown in FIG. **1**), such as a pointing device (e.g. a mouse) or the like.

[0026] Transducer **106** typically comprises an array of piezoelectric transducers (not shown). Transducer **106** generates acoustic signals which are directed into an object to be imaged, such as the body of a patient. These acoustic signals are reflected from the patient's body as acoustic echo signals. The acoustic echo signals are received by transducer **106** and, in response to the acoustic echo signals, transducer **106** generates electrical echo signals. Ultrasound transducers (e.g. transducer **106**) are known in the art. U.S. Pat. No. 5,839,442 (Chiang et al.) provides a description of the components and operation of one example ultrasound transducer.

[0027] In the illustrated embodiment, all of the components of ultrasound imaging system **200** are contained in housing unit **100** except for transducer **106**, which is tethered to housing unit **100** by transducer cord **106**A and transducer interface **106**B, and plug **114**, which provides power to housing unit **100** via power cord **114**A. Housing unit **100** comprises a stand portion **108**. Stand portion **108** may comprise a transducer port **106**C for receiving transducer interface **106**B. In the illustrated embodiment, stand portion **108** supports video display **102** and input device **104**, although this is not necessary. Stand portion **108** may itself be supported by (and releasably or fixedly coupled to) a mobile cart **110**. Mobile cart **110** may comprise a plurality of castors **112**, wheels or the like which allow cart **110** to move about on a floor. In some embodiments, castors **112** may be mounted to the bottom surface of stand portion **108**, in which case cart **110** may not be required.

[0028] As shown in FIGS. **2**A and **2**B, stand portion **108** incorporates a PC-enclosure **120** which accommodates PC **105**. In the illustrated embodiment PC-enclosure **120** is accessed via a removable rear wall **108**B of stand **108**. Rear wall **108**B may be removably secured to stand portion by a suitable latch mechanism, which may be a locking latch mechanism. In other embodiments, the access to PC-enclosure **120** may be provided by another one or more of the walls **108**A, **108**B, **108**C, **108**D of stand portion **108** or by an openable and/or removable cover portion of one or more of the walls **108**A, **108**B, **108**C, **108**D of stand portion **108**. In the illustrated embodiment, side walls **108**C and **108**D are perforated by one or more apertures **108**E which allow for a flow of air therethrough. Such air may be used to cool PC-enclosure **120** and PC **105**.

[0029] FIGS. **2**C and **2**D show an embodiment with a cover **116** located in rear wall **108**B of stand **108**. Cover **116**

comprises a pair of hinged doors **116**A, **116**B. Doors **116**A, **116**B are pivotable about hinges (not shown), such that PC-enclosure **120** is configurable between a closed configuration (FIG. **2**C), where PC **105** is enclosed in enclosure **120**, and an open configuration (FIG. **2**D), where PC **105** is accessible. In some embodiments, cover **116** may be perforated by one or more apertures (not shown) which allow for a flow of air therethrough. Such air may be used to cool PC-enclosure **120** and PC **105**.

[**0030**] In the embodiment of FIGS. **2**C and **2**D, doors **116**A, **116**B each comprise a portion of a latch mechanism **118**, which latches doors **116**A, **116**B in the closed configuration of FIG. **2**C. Preferably, latch mechanism **118** may be locked using a conventional lock (not shown). In other embodiments, cover **116** comprises a single hinged door. In still other embodiments, cover **116** is slidable relative to stand portion **108** and/or removable from stand portion **108**, such that PC-enclosure **120** is configurable between open and closed configurations. Suitable latch mechanisms (preferably lockable latch mechanisms) may be provided for such other cover embodiments.

[**0031**] FIG. **3**A schematically depicts a digital ultrasound system **200** according to a particular embodiment of the invention. Ultrasound system **200** comprises video display **102**, input device **104**, ultrasound transducer **106** and PC **105**. Video display **102** and input device **104** are preferably used to provide a graphical user interface. In the illustrated embodiment, ultrasound transducer **106** comprises a transducer array **107**, which is connected to receive circuits **109** and transmit circuits **111** located within PC **105** via an interface **206**A. Interface **206**A may be a custom connector or a standard digital connector. In other embodiments, receive circuits **109** and transmit circuits **111** are provided by cards, circuit boards or the like, located within transducer **106** or external to both transducer **106** and PC **105**. Receive circuits **109** may comprise amplifiers, noise reduction filters and analog to digital converters (ADCs). Transmit circuits **111** may comprise signal drivers and the like.

[**0032**] In the illustrated embodiment, PC **105** comprises one or more main PC processors **128**, which communicate with RAM **132** and with non-volatile memory **130** (e.g. a hard drive). PC **105** of system **200** also comprises ultrasound signal preprocessing hardware **134**. Preprocessing hardware **134** may be implemented on one or more cards, circuit boards or the like located within PC **105**. In some embodiments, preprocessing hardware **134** is located external to PC **105**. In some embodiments, receive circuits **109** and transmit circuits **111** are implemented as a part of preprocessing hardware **134**. An example of suitable preprocessing hardware is describe in U.S. Pat. No. 6,325,759 (Pelissier).

[**0033**] In operation, a user operates input device **104** to provide a number of control instructions. In response to these control instructions, input device **104** generates input signal **204**, which is received at PC **105** and ultimately by PC processor(s) **128** via interface **204**A. In the case where input device **104** is a keyboard, interface **204**A may be a 5-pin Deutsche Industrie Norm (DIN) connector, a 6-pin mini-DIN (PS**2**) connector or a Universal Serial Bus (USB) connector, for example. System **200** may incorporate an optional additional input device **124** which may provide an additional input signal **224** to PC processor(s) **128** via interface **224**A. Optional additional input device **124** may comprise a mouse, a CD drive, a floppy disk drive, a pointing device, or the like. Where optional additional input device **124** is a mouse, interface **224**A may be DB**9** serial port connector, a 6-pin mini-DIN (PS**2**) connector or a USB connector.

[**0034**] In response to receiving input signal **204**, PC processor(s) **128** may commence an ultrasound imaging operation by sending configuration data signal **228** to pre-processing hardware **134**. Pre-processing hardware **134** interprets configuration data signal and outputs appropriate transducer drive signal **234**A to transmit circuits **111**. Transmit circuits **111** amplify transducer drive signal **234**A and provide the resultant amplified transducer drive signal **211** from PC **105** to transducer array **107** via interface **206**A. One or more of the individual transducers of array **107** then output acoustic signals as directed by amplified transducer drive signal **211**.

[**0035**] The acoustic signal(s) emitted from transducer array **107** reflect from the patient's body to result in acoustic echo signals. One or more of the individual transducers in array **107** detect these echo signals and convert them to electrical echo signals **207**. Electrical echo signals **207** are provided from transducer array to receive circuits **109** in PC **105** via interface **206**A. Receive circuits **109** convert electrical echo signals **207** to digital echo signals **209**. Digital echo signals **209** may be referred to as "RF echo data"**209** or simply "RF data"**209**. RF data **209** are provided to pre-processing hardware **134**. In the illustrated embodiment, transmit circuits **111** communicate amplified transducer drive signal **211** to transducer array **107** via the same interface **206**A as receive circuits **109** receive electrical echo signals **207** from transducer array **107**. In other embodiments, two separate interfaces may be used for these purposes.

[**0036**] Preprocessing hardware **134** processes digital echo signals **209** to generate preprocessed data **234**B which is provided to PC processor(s) **128**. PC processor(s) **128** perform additional processing on preprocessed data **234**B to generate an output signal **202**. Output signal **202** may be provided to display **102** via interface **202**A. Interface **202**A may comprise an HD15 connector, a DB9 or DB15 connector, a 13W3 connector, a four-pin mini-DIN connector, a DVI connector, one or more BNC connectors, one or more RCA connectors, or any other video connector. Display **102** outputs output signal **202** in the form of a video display that is viewable by users. PC processors **128** may also provide output signal **202** to other devices. Such other devices may include: non-volatile memory **130** (e.g. a hard drive) where output signal **202** can be recorded; and optional additional output device(s) **122** (e.g. a printer, a CD writer or the like), where the results of an ultrasound imaging operation can be outputted in a different format via signal **222** and interface **222**A.

[**0037**] Ultrasound system **200** may optionally incorporate a network device **126** for connecting to other digital devices (e.g. a router, an ethernet adapter or wireless internet adapter or the like). Signals **226** may be input and/or output between PC **105**, PC processor(s) **128** and network device **126** via interface **226**A.

[**0038**] In some embodiments, software updates for system **200** (e.g. updates to the software operating on PC processor(s) **128** and/or preprocessing hardware **134**) may be

updated via signals **226** received from network device **126**. For example, new software may be downloaded from a server that is connected to the same network as network device **126**. In other embodiments, software updates for system **200** may be provided via optional additional input device **124**. For example, updates to the software may be read from a CD.

[**0039**] FIG. **3**B schematically depicts a digital ultrasound system **200'** according to another embodiment of the invention. In many respects, digital ultrasound system **200'** is similar to system **200** of FIG. **3**A, except that system **200'** is implemented without preprocessing hardware **134**, and receive and transmit circuits **109** and **111** are located in transducer **106**. In system **200'**, PC processor(s) **128** use the information from input signal **204** to generate a transducer drive signal **228** which is provided directly to transmit circuits **111** (via interface **206**A) without preprocessing. RF data **209** from receive circuits **109** is buffered in memory buffer **140** (via interface **206**A) without preprocessing. Direct Memory Access (DMA) controller **142** provides a signal **242** to buffer **140** which causes buffer **140** to release RF data **209'** to PC processor(s) **128** at a rate that PC processor(s) **128** can handle.

[**0040**] FIGS. **4**A and **4**B respectively depict PC-enclosure **120** (with rear wall **108**B removed)of housing unit **100** and PC **105** of system **200** of the embodiment of FIGS. **1**, **2**A and **2**B. In the illustrated embodiment, enclosure **120** is defined by rear wall **108**B (not shown in FIG. **4**A) and walls **150**A, **150**B, **150**C, **150**D, **150**E (collectively, walls **150**). Rear wall **108**B and/or walls **150** may be apertured to allow for the flow of cooling air to PC **105**. PC **105** may be housed in a case **152**. Case **152** may also be apertured to allow for the flow of cooling air therethrough. Case **152** may be supported by legs (not shown) which provide clearance between case **152** and wall **150**D of enclosure **120**. In some embodiments, suitable brackets (not shown) may be used to fasten PC **105** in place within enclosure **120**.

[**0041**] A number of connector components are contained in enclosure **120** and a number of corresponding (i.e. mating) connector components are accessible through case **152** of PC **105** (e.g. on suitable cards, such as PCI cards, for example). More specifically, in the illustrated embodiment:

[**0042**] display **102** is connected to PC **105** via connector **202**A (FIGS. **3**A, **3**B) and connector **202**A is implemented by connector component **2**A' (in enclosure **120**) and mating connector component **202**A" (in PC **105**);

[**0043**] input device **104** is connected to PC **105** via connector **204**A (FIGS. **3**A, **3**B) and connector **204**A is implemented by connector component **4**A' (in enclosure **120**) and mating connector component **204**A" (in PC **105**); and

[**0044**] ultrasound transducer **206** is connected to PC **105** via connector **206**A (FIGS. **3**A, **3**B) and connector **206**A is implemented by connector component **206**A' (in enclosure **120**) and mating connector component **6**A" (in PC **105**).

[**0045**] In addition, system **200** may comprise:

[**0046**] optional additional output device **122** which may be connected to PC **105** via connector **222**A and connector **222**A may be implemented by connector component **222**A' (in enclosure **120**) and mating connector component **222**A" (in PC **105**);

[**0047**] optional additional input device **124** which may be connected to PC **105** via connector **224**A and connector **224**A may be implemented by connector component **224**A' (in enclosure **120**) and mating connector component **224**A" (in PC **105**); and

[**0048**] optional network device **126** which may be connected to PC **105** via connector **226**A and connector **226**A may be implemented by connector component **226**A' (in enclosure **120**) and mating connector component **226**A" (in PC **105**).

[**0049**] In some embodiments, optional additional output device **122** and/or optional additional input device **124** may be implemented by a floppy disc drive, a CD drive or the like (not shown) in which case, connectors **222**A, **222**B may be located within case **152**.

[**0050**] Advantageously, in the illustrated embodiments of ultrasound system **200** and ultrasound system **200'**, PC **105** incorporates all of the processing hardware (i.e. processor(s) **128** and preprocessor **134** in system **200**). As such, if system **200**, **200'** requires a hardware or software upgrade, such upgrade can be provided by simply unplugging the connector components contained in enclosure **120** from the connector components in PC **105**, replacing PC **105** with a newly upgraded PC and re-plugging the connector components. This type of unplugging and re-plugging of common connector components can be performed by the operators of ultrasound system **200**, **200'** (i.e. without requiring special service personnel). If a software upgrade only is required, then no disconnection of PC **105** is required and the new software can be introduced via network device **126** and/or additional input device **124**.

[**0051**] In a hospital situation, the reliability of ultrasound system **200**, **200'** may be critical. For example, the availability of system **200**, **200'** may be a matter of life and death. Consequently, it may be desirable for the hospital to stock a replacement PC, such that if the original PC **105** breaks down, the replacement PC may be substituted in its place. In some embodiments (e.g. where preprocessor **134** is located external to PC **105** or where DMA controller **142** and memory buffer **140** are located external to PC **105** or where such hardware is not required, any PC may be used to replace PC **105** if PC **105** breaks down. For example, a user may simply connect his or her laptop to the connector components **202**A', **204**A', **206**A' and any of the optional connector components **222**A', **224**A', **226**A' in enclosure **120**, load appropriate software onto their laptop and perform ultrasound imaging operations.

[**0052**] In some circumstances, housing **100** can be made to pass hospital safety regulations regardless of a change in PC **105**. Advantageously, this could allow PC **105** to be replaced and/or updated without having to subject the entire ultrasound system **200**, **200'** to additional safety testing. For example, housing **100** may provide shielding against EMF emitted by PC **105**. In some circumstances, the shielding effect of housing **100** may be certified independently of PC **105** such that PC **105** can be replaced and/or updated without having to subject the entire ultrasound system **200**, **200'** to additional safety testing.

[0053] Housing **100** and ultrasound systems **200**, **200'** housed therein are mobile and can be moved in circumstances where a patient is immobile.

[0054] FIGS. **5**A-**5**C show different views of a housing unit **300** for a modular digital ultrasound system **400** according to another embodiment of the invention. In many respects, housing unit **300** and system **400** are similar to housing unit **100** and system **200** described above. Reference numerals used to reflect components of housing unit **300** and ultrasound system **400** that are similar to components of housing unit **100** and ultrasound system **200** are preceded by a "3" or "4" rather than a "1" or "2" as the case may be.

[0055] System **400** comprises a video display **302**, an input device **304**, a transducer (not shown) and a PC **305**. In the illustrated embodiment, input device **304** comprises a keyboard. As with system **200**, all of the components of ultrasound imaging system **400** are contained in housing unit **300** except for the transducer, which is tethered to housing unit **300** by a transducer cord (not shown), and a plug (not shown), which provides power to housing unit **300**.

[0056] Housing unit **300** comprises a stand portion **308**. In the illustrated embodiment, stand portion **308** supports video display **302** and input device **304**, although this is not necessary. Stand portion **308** may itself be supported by (and releasably or fixedly coupled to) a mobile cart **310**. Mobile cart **310** may comprise a plurality of castors **312**, wheels or the like which allow cart **310** to move about on a floor.

[0057] Stand portion **308** incorporates a PC-enclosure **320** which accommodates PC **305**. PC-enclosure **320** is accessed via removable cover **316**. In some embodiments, the cover **316** is perforated by one or more apertures (not shown) which allow for a flow of cooling air therethrough.

[0058] As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. For example:

[0059] In some embodiments, DMA controller **142** and/or buffer **140** can be provided external to PC **105**.

[0060] In some embodiments, pre-processing hardware **134** may be provided external to PC **105**.

[0061] Although a tower-type PC is shown in the illustrated example embodiments, in other embodiments other types of data processing apparatus may be inserted into enclosure **120**, such as slim computers, laptop computers, or any other suitable data processing apparatus.

[0062] While a number of exemplary aspects and embodiments have been discussed above, those of skill in the art will recognize certain modifications, permutations, additions and sub-combinations thereof. It is therefore intended that the following appended claims and claims hereafter introduced are interpreted to include all such modifications, permutations, additions and sub-combinations as are within their true spirit and scope.

What is claimed is:

1. A housing apparatus for an ultrasound system comprising a display, an input device, a transducer, and a data processing apparatus, the housing apparatus comprising:

a stand portion defining an enclosure for removably receiving the data processing apparatus;

a display connector component located in the enclosure for coupling the data processing apparatus to the display;

an input device connector component located in the enclosure for coupling the data processing apparatus to the input device; and,

a transducer connector component located in the enclosure for coupling the data processing apparatus to the transducer; whereby the ultrasound system may be upgraded or repaired by removing the data processing apparatus from the enclosure and inserting a different data processing apparatus in the enclosure.

2. A housing apparatus according to claim 1 wherein the stand portion is configured to provide shielding against electromagnetic fields emitted within the enclosure.

3. A housing apparatus according to claim 2 wherein the display and the input device of the ultrasound system are mounted on the stand portion.

4. A housing apparatus according to claim 3 comprising a cart which supports the stand portion.

5. A housing apparatus according to claim 4 wherein the cart is mounted on castors to facilitate movement of the housing apparatus.

6. A housing apparatus according to claim 2 comprising a cover for providing access to the enclosure.

7. A housing apparatus according to claim 6 wherein the cover comprises a removable wall of the stand portion.

8. A housing apparatus according to claim 6 wherein the cover comprises a hinge which allows pivotable movement of the cover between a closed position and an open position.

9. A housing apparatus according to claim 8 comprising a latch for securing the cover in the closed position.

10. A housing apparatus according to claim 1 wherein the stand portion comprises a transducer port for receiving a transducer interface coupled to the transducer, the transducer interface connected to the transducer connector component.

11. A housing apparatus according to claim 2 comprising one or more additional connector components located in the enclosure for coupling the data processing apparatus to one or more of an additional input device, an additional output device, and a network device.

12. An ultrasound apparatus comprising:

a stand portion defining an enclosure;

a data processing apparatus removably mounted in the enclosure;

a display mounted on the stand portion and coupled to the data processing apparatus by a display connector extending into the enclosure;

an input device mounted on the stand portion and coupled to the data processing apparatus by an input device connector extending into the enclosure; and,

a transducer tethered to the stand portion by a transducer cord and coupled to the data processing apparatus by a transducer connector extending into the enclosure,

whereby the ultrasound apparatus may be upgraded or repaired by uncoupling the display, input device and transducer connectors from the data processing apparatus, removing the data processing apparatus from the enclosure, inserting a different data processing apparatus in the enclosure and coupling the display, input device and transducer connectors to the different data processing apparatus.

13. An ultrasound apparatus according to claim 12 wherein the enclosure is electromagnetically shielded.

14. An ultrasound apparatus according to claim 12 wherein the data processing apparatus comprises a power supply, a memory and a processor contained in a case.

15. An ultrasound apparatus according to claim 12 wherein the data processing apparatus comprises a computer.

16. An ultrasound apparatus according to claim 15 wherein the computer comprises memory storing instructions for receiving data from the transducer and displaying an image on the display based on the received data.

17. An ultrasound apparatus according to claim 15 wherein the computer comprises a self-contained personal computer comprising a case, a power supply, a processor, memory, and a plurality of ports.

18. An ultrasound apparatus according to claim 12 wherein the stand portion comprises a transducer port connected to the transducer connector, the transducer port configured to receive a transducer interface at an end of the transducer cord opposite the transducer.

19. A method of upgrading an ultrasound system comprising a display, an input device and a transducer coupled to a data processing apparatus, the method comprising:

providing a housing apparatus comprising a stand portion defining an enclosure for removably receiving the data processing apparatus, the housing apparatus comprising a cover moveable between an open position wherein the enclosure is accessible and a closed position wherein the enclosure in inacessible;

moving the cover to the open position;

uncoupling the display, the input device and the transducer from the data processing apparatus;

removing the data processing apparatus from the enclosure;

inserting a different data processing apparatus into the enclosure;

coupling the display, the input device and the transducer to the different data processing apparatus; and,

moving the cover to the closed position.

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摘要(译)

一种用于超声系统的壳体单元，包括超声换能器，视频显示器，输入设备和可拆卸的PC计算机。可拆卸PC可以容纳在由壳体单元限定的外壳内。可移除PC可以容纳控制和操作超声系统所需的所有处理器。可移除PC可以使用传统连接器耦合到超声换能器，视频显示器和输入设备以及与其分离。这种连接器允许用户将可移动PC与更新的PC互换，而无需将超声系统发送给制造商并且不需要技术人员的服务。