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(54) **AN ELECTRICALLY ISOLATED POWER AND SIGNAL COUPLER SYSTEM FOR A PATIENT CONNECTED DEVICE**

EIN ELKTRISCH ISOLIERTER VERSORGUNGS- UND SIGNALKOPPLER FÜR EINE MIT EINEM PATIENTEN VERBUNDENE VORRICHTUNG

SYSTEME DE COUPLAGE DE SIGNAUX ET DE PUISSANCE ISOLE ELECTRIQUEMENT POUR UN DISPOSITIF RELIE A UN PATIENT

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a power and signal coupler for a portable medical monitoring device designed to be connected to a patient in a medical environment.

BACKGROUND OF THE INVENTION

[0002] Monitoring systems for patients in a medical environment have long been known. These monitors include electrodes which are designed to be attached to the patient. The electrodes receive electrical signals which represent physiological functions in the patient. Some form of indication of the values of those signals is then displayed. For example, an electrocardiogram (ECG) system includes electrodes designed to be attached to the patient on the chest, *inter alia*. These electrodes receive electrical signals indicative of the instantaneous operation of the patient's heart. Images representing waveforms related to the ECG electrode signals are displayed on a display device for a doctor to analyze.

[0003] Recently, it has been recognized that, in a hospital setting, there are advantages to maintaining all monitoring data gathered from patients, and other data gathered about those patients, such as lab results etc., in a central location. Such an arrangement would allow patient information to be available anywhere in the hospital. Such an arrangement would also permit patient information, possibly derived from monitoring equipment, to be received and stored in the central location from anywhere in the hospital.

[0004] In the past, monitoring equipment was maintained at one fixed location, e.g. an examining room. Patients requiring that type of monitoring were moved to the room containing the monitoring equipment, and connected to the monitoring equipment. The monitoring equipment was plugged into the AC power socket at the fixed location. In addition, a direct wired connection between the monitoring equipment at this fixed location and the central storage location was maintained, making it easy to transfer monitoring data to the central location to be stored. However, recently, it has been recognized that in some cases it is important to maintain monitoring of a patient at all times; even those times when the patient is in transit, e.g. among patient room, examining room, operating room, etc. This requires that monitoring equipment be portable. By this method, the monitoring equipment may be transported along with the patient from one location to another. There are two aspects to enabling portability of monitoring equipment: first is supplying power to the monitoring equipment; second is maintaining a data link between the monitoring equipment and the central location, while it is in transit with the patient.

[0005] The aspect relating to providing power to the monitoring equipment was solved by including batteries in the monitoring equipment. One skilled in the art will understand that batteries require charging, and that patients are in transit a small fraction of the time. Current portable monitoring equipment includes fixed docking stations in all appropriate fixed locations, such as operating rooms, examining rooms and patient rooms. When a patient is in one of these locations, the portable monitoring equipment is inserted into the docking station at that location. These docking stations are connected to the AC power at that location, and provide charging current for the batteries in the monitoring equipment. This permits the batteries to maintain their charge. When a patient is moved, the monitoring equipment, with a charged battery, is removed from the docking station, and transported with the patient until another docking station is available.

[0006] Because the docking station is connected to AC power, and because it is well known that it is dangerous for electrical power to be applied directly to a patient, especially above the waist, standards have been developed to ensure that all electrical power is isolated from electrodes intended to be attached to the patient. This has required that battery charging current be provided to the portable monitoring equipment without a direct electrical connection between the AC power socket and the portable monitoring equipment. This has been done using the known technique of split transformers in the form of a bobbin in the monitoring equipment which surrounds a magnetic core in the docking station when the equipment is docked. The AC current induces an alternating magnetic flux around the magnetic core in the docking station, which, in turn, induces a current in the bobbin in the monitoring equipment when docked. This current, in turn, provides operating power for the monitoring equipment and also maintains the batteries charged, all in a known manner. Operating efficiencies of around 60% may be obtained using this known system.

[0007] The aspect relating to maintaining a data link when the monitoring equipment is docked was solved by providing a wireless, e.g. radio frequency (RF), link for transmitting monitoring data from the monitoring equipment to the central location. Each piece of monitoring equipment includes an RF transceiver and antenna. Each docking station also includes a corresponding RF transceiver and antenna. In addition, free-standing antennae and transceivers are located throughout the hospital, in particular at locations where patients would be transported, e.g. halls, etc. Each of the transceivers in the docking stations and the free standing locations is connected by a wired connection to the central location. Using RF communications between the docking station and the monitoring equipment further provides electrical isolation.

[0008] When a patient is in a fixed location, and the monitoring equipment is placed in a docking station, the docking station receives the RF signal from the monitoring equipment and transmits the data to the central location via its wired connection. When a patient is in transit from one fixed location to another, the free standing antennae/transceiver locations receive the RF signal from the monitoring equipment and transmit the data to the central location. This provides the ability to monitor a patient continuously.

[0009] However, there are locations in which continuous RF transmissions from the monitoring equipment may cause problems and must be carefully planned for. For example, in operating rooms, electro-cautery machines use RF energy to cut tissue and coagulate blood during surgery. This instrument causes an unpredictable amount of RF energy and could possibly interfere with the RF link of the monitoring equipment. However, it is in this environment that it is most important that no monitoring data be lost or corrupted.

[0010] US 4409652 discloses an apparatus for processing digital medical signals including replaceable modules that slide into a coupling unit. The unit provides power coupling to the modules using coils and signal transmission using LEDs and photodiodes. US A 4236086 discloses a galvanically separative power and signal coupling again using coils and opto-couplers. EP 0 755 653 discloses a patient monitoring module including power transfer and signal transfer using optical transceivers.

[0011] Monitoring equipment which is portable, in which power efficiency is higher than 50%, and in which potential RF interference is minimized is desirable.

BRIEF SUMMARY OF THE INVENTION

[0012] In accordance with principles of the present invention, an electrically isolated combined power and signal coupler for a patient connected device, is disclosed. A docking station, and a portable device capable of docking with the docking station, each include a power coupler and an electrically isolated data transducer. The respective power couplers include a magnetically permeable element including a central pole and a peripheral pole and a printed circuit board with an opening through which the central pole protrudes. The printed circuit board includes windings surrounding the central pole opening: a primary winding in the docking station and a secondary winding in the portable device. When the portable device is docked with the docking station, the magnetically permeable element in the portable device and the magnetically permeable element in the docking station are arranged to form a magnetic circuit, and the data transducer in the portable device and the data transducer in the docking station are arranged to exchange data.

BRIEF DESCRIPTION OF THE DRAWING

[0013] In the drawing:

Fig. 1 is a block diagram of a monitoring system including a central location, docking stations and portable monitoring devices; and

Fig. 2 and Fig. 3 are block diagrams of a monitoring device illustrating an arrangement for using alternative transmission media; and

Fig. 4 is an assembly diagram illustrating the power and data transmission apparatus for a monitoring system as illustrated in Fig. 1.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Fig. 1 is a block diagram of a monitoring system including a central location, docking stations and portable monitoring devices. Fig. 1 illustrates a plurality (300A and 300B) of portable monitoring devices 310 and docking stations 340 each coupled to a central controller 100 and central power supply 200. Each monitoring device 310 includes electrodes 324 intended to be attached to a patient (PATIENT A and PATIENT B).

[0015] Each portable monitoring device 310 includes an RF antenna 312. A bidirectional terminal of the RF antenna 312 is coupled to a corresponding terminal of a transceiver 314. The transceiver 314 is coupled (not shown) to other circuitry (also not shown) in the monitoring device 310. Each portable monitoring device 310 also includes a battery 318. The battery 318 is coupled to a power supply 316. The power supply 316 is also coupled (not shown) to the other circuitry in the monitor 310, all in a known manner. The design, operation and interconnections of the other circuitry discussed above is well known to one skilled in the art, is not germane to the present invention and will not be described in detail below.

[0016] An optical transducer 320 in the illustrated embodiment represents a wireless two-way full duplex optical transducer. One skilled in the art will understand that this transducer may include a light emitting diode (LED) for transmitting and a photo-transistor for simultaneously receiving optical signals. A bidirectional terminal of the optical transducer 320 is coupled to a corresponding terminal of the transceiver 314. Data terminals (not shown) of the transceiver 314 are connected to other circuitry (also not shown) in the monitoring device 310.

[0017] The monitoring device 310 also includes a secondary 322 of a split transformer. The secondary 322 is coupled to an input terminal of the power supply 316. The structure and operation of the split transformer 316 will be described in detail below.

[0018] Each docking station 340 includes an optical transducer 342 representing a wireless two-way full duplex optical transducer. The optical transducer 342 corresponds to the optical transducer 320 in the monitoring device 310, and is arranged physically so that full duplex communication may be carried on between the corresponding optical transducers 320 and 342 when the monitoring device 310 is docked in the docking station

340.

[0019] The docking station 340 also includes a primary 344 of the split transformer. The primary 344 corresponds to the secondary 322 of the split transformer in the monitoring device 310, and is arranged so that a complete transformer is formed, and electrical power transferred, when the monitoring device 310 is docked in the docking station 340.

[0020] Fig. 1, also illustrates a central controller 100. The central controller 100 includes a bidirectional data terminal coupled to a local area network (LAN). This LAN connects with various workstations (not shown) within the hospital and also may include a bridge (also not shown) to a wide area network (WAN) such as, for example, the internet. The optical transducers 342 in the plurality 340 of docking stations are bidirectionally coupled to the LAN. Although the optical transducers 342 are illustrated as being coupled to the central controller 100 via the LAN, one skilled in the art will understand that respective bidirectional signal lines may be coupled directly between the optical transducers 342 in each of the plurality of docking stations 340 and corresponding bidirectional terminals on the central controller 100. These respective signal lines may then be used to communicate directly between docking stations 340 and the central controller 100.

[0021] The central controller 100 also includes an RF antenna 110. This RF antenna 110 is capable of communicating with the respective RF antennae 312 of the monitoring devices 310 via radio transmission in a known manner. Although illustrated as a single antenna 110, one skilled in the art will understand that multiple antennae, distributed throughout the hospital, may all be connected to the central controller 100. For example, a standalone transceiver 120 is coupled to the LAN. The standalone transceiver 120 includes an RF antenna 122 capable of exchanging data with the portable devices 310, as illustrated in phantom in Fig. 1. As described above, these standalone transceivers may also be connected to the central controller 100 via respective direct connections. Such standalone transceivers may be placed throughout the hospital for communicating with the portable monitoring devices 310 while undocked and in transit.

[0022] A power supply 200 is coupled to the respective primaries 344 in the plurality of base stations 340. Although illustrated as a separate element in Fig. 1, the standard distributed AC power system may be used for providing power to the plurality of primaries 344 in the plurality of base stations 340.

[0023] In operation, the monitoring devices 310 operate in one of two states: docked or undocked. The monitoring device 310 and docking station 340 pair in the upper part of the figure, 300A, are in the undocked condition, and the monitoring device 310 and docking station 340 pair in the lower part of the figure, 300B, are in the docked condition. In general, when a monitoring device 310 is docked, data communications takes place through the optical transducers 320,342 and power is supplied to the monitoring device 310 through the split transformer 344,322. When a monitoring device is undocked, data communications takes place through the RF antenna 312 and power is supplied from the battery 318.

[0024] In 300A (undocked), the connection between the optical transducer 320 and the transceiver 314 is illustrated in phantom to indicate that it is currently inoperative, while the connection between the antenna 312 and the transceiver 314 is indicated by a solid line to indicate it is operating. The zigged line between the antenna 110 on the central controller 100 and the antenna 312 on the monitoring device 310 illustrates that an RF link is being maintained between the monitoring device 310 and the central controller 100. Similarly, the connection between the secondary 322 of the split transformer and the power supply 316 is illustrated in phantom to indicate that it is currently inoperative, while the connection between the battery 318 and the power supply 316 is indicated by a solid line with an arrow to indicate that power is being transferred from the battery 318 to the power supply 316. The data connection between the optical transducer 342 in the docking station 340 and the LAN, and the power connection between the power supply 200 and the primary 344 of the split transformer are illustrated in phantom to illustrate that they are currently inoperative.

[0025] In 300B (docked), the connection between the antenna 312 and the transceiver 314 is illustrated in phantom to indicate that it is currently inoperative, while the connection between the optical transducer 320 and the transceiver 314 is indicated by a solid line to indicate it is operating. The zigged line between the optical transducer 342 in the docking station 340 and the optical transducer 320 in the monitoring device 310 illustrates that an optical link is being maintained between the monitoring device 310 and the central controller 100. Similarly, the connection between the secondary 322 of the split transformer and the power supply 316 is illustrated by a solid line to indicate that it is currently operating. The connection between the battery 318 and the power supply 316 is indicated by a solid line with an arrow to indicate that charging power is being transferred from the power supply 316 to the battery 318. The connections between the LAN and the optical transducer 342 in the docking station 340 and between the power supply 200 and the primary 344 of the split transformer are illustrated as solid lines to indicate they are operative. There is no zigged line between the antenna 312 of the monitoring device 310 and the antenna 110 of the central controller 100 which indicates that there is no RF communications taking place.

[0026] One skilled in the art will understand that the central controller 100 will be in communications with many monitoring devices 310 simultaneously, through the LAN and/or through respective hardwired connections (not shown) to docking stations 340 in which the monitoring devices 310 are docked, and/or through wireless RF links to undocked monitoring devices 310. Any of the known techniques for carrying on simultaneous communications, such as time division multiplexing, frequency division multiplexing, packetized communication, or any combination of such techniques may be used to provide this simultaneous communications. For example, various protocols are in general usage for network communications among a plurality of network nodes. More specifically, such protocols include, among many others: internet protocol (IP), universal serial bus (USB), I.E.E.E. newtork protocol. Any of these known protocols may be used to communicate between the plurality of monitoring devices 310 and the central controller 100 via the LAN. These same protocols may be also used for wireless RF communications between undocked monitoring devices 310 and the antenna 110 of the central controller 100, directly or through standalone transceivers 120 connected to the central controller 100 via the LAN or through respective hardwired connections.

[0027] Known circuitry in the monitoring device 310 and the docking station 340 detects when the monitoring device 310 is docked with the docking station 340. In one embodiment, because electrical power is transferred only when the monitoring device 310 is docked with the docking station 340, such circuitry in the docking station 340 may detect a load (secondary 322) attached to the primary 344 and corresponding circuitry in the monitoring device 310 may detect the presence of power at the secondary 322. For another example, because data will be exchanged via the optical transducer pair 320,342 only when the monitoring device 310 is docked with the docking station 340, such circuitry in the docking station 310 may detect the presence of data from the optical transducer 320 and corresponding circuitry in the docking station 340 may detect the presence of data from the optical transducer 342.

[0028] When the docking station 340 detects that a monitoring device 310 is docked, the central controller 100 begins communicating through the LAN with the optical transducer 342 in the docking station 340. Simultaneously, when the monitoring device 310 detects that it has been docked, the transceiver 314 is connected to the optical transducer 320, and communications is initiated via the optical transducer pair 320,342 through the LAN, with the central controller 100. More specifically, the transceiver 314 in the monitoring device 310 generates data in the network protocol used by the LAN, i.e. IP packets. The packetized data is then passed through the optical transducer pair 320,342 to the LAN. The central controller 100, in turn, receives the IP packets from the LAN and extracts the data. This data is then processed by the central controller 100. For example, patient monitoring data is stored in the central location. Concurrently, data from the central controller 100 meant for the monitoring device 310 is packetized and placed on the LAN. The packetized data is received by the monitoring device 310 via the optical transducer pair 342,320. The transceiver 314 extracts the data and controls the operation of the monitoring device 310 in the manner specified by the received data. For example, monitoring parameters may be set or changed by the central controller 100.

[0029] At the same time, when it is detected that the monitoring device 310 is docked in the docking station 340, power from the secondary 322 of the split transformer powers the circuitry in the monitoring device 310, including charging the battery 318.

[0030] When the docking station 340 detects that a monitoring device 310 has been undocked, the central controller 100 is notified and it begins communicating through the RF antenna 110. Concurrently, when the monitoring device 310 detects that it has been undocked, the transceiver 314 is connected to the RF antenna 312, and communications is initiated via the RF link to the central controller 100. As described above, the transceiver 314 generates the data in the selected network protocol, i.e. IP packets. This packetized data is transmitted to the central controller 100 via the wireless RF antenna 110. The central controller 100 receives the IP packets, extracts the data and processes the data, e.g. stores the patient monitoring data. The central controller 100 may also generate IP packets of data meant for the monitoring device 310. The central controller 100 transmits this packetized data to the antenna 312 of the monitoring device 310 via the wireless RF antenna 110. The transceiver 314 in the monitoring device 310, in turn, receives the IP packets, extracts the data and controls the operation of the monitoring device 310 in response.

[0031] Alternatively, the standalone transceiver 120 may communicate via a wireless RF signal with the monitoring device 310. In this case, the antenna 312 of the monitoring device 310 transmits the packetized patient monitoring data to the antenna 122 of the standalone transceiver 120, as described above. The standalone transceiver 120 receives this packetized data and places it on the LAN. The central controller 100 receives the IP packets from the LAN, extracts the data and processes it in the desired manner. The central controller 100, in turn, places packetized data meant for the monitoring device 310 on the LAN. The standalone transceiver 120 receives the packetized data and transmits it to the antenna 312 of the monitoring device 310. The transceiver 314 in the monitoring device 310 receives the packets, extracts the data from the received packets and controls the operation of the monitoring device in response.

[0032] In addition, power from the battery 318 powers the circuitry in the monitoring device 310 when the monitoring device is undocked.

[0033] In the embodiment illustrated in Fig. 1 and described above, the transmission medium changes from when the monitoring device 310 is docked (optical) to when it is undocked (RF). However, one skilled in the art will understand that it is possible to share the same transmission medium in both modes. Fig. 2 illustrates a monitoring device 310 with an alternate means for communicating with the central controller 100 when docked. In Fig. 2, the transceiver 314 in the monitoring device 310 is coupled to an RF antenna 326 physically arranged to be adjacent to the docking station 340 when it is docked. The docking station 340 includes a corresponding RF antenna 346 physically arranged to be adjacent the RF antenna 326 in the monitoring device 310 when it is docked. These antennae 326 and 346 may be small and are arranged to be close to each other. A shield 328, illustrated by a dotted line, in the monitoring device 310 surrounds the antenna 326, and a corresponding shield 348 in the docking station 340 surrounds the antenna 346. The shields 328 and 348 are physically arranged to cooperate when the monitoring device 310 is docked in the docking station 340 to completely shield the antennae 326 and 346 so that they do not radiate to the surrounding area, and so that RF interference in the surrounding area, such as may be generated by surgical equipment, does not produce interference in the communication between them.

[0034] In this manner, the central controller 110 may use a common RF transceiver for both docked and undocked monitoring devices 310. When docked, the RF antenna pair 326 and 346 are used, and when undocked, the RF antenna pair 110 and 312 are used. One skilled in the art will understand that the signal level from an RF antenna 346 in a docking station 340 will be stronger than that from the broadcast antenna 110. One skilled in the art will understand that attenuators and/or amplifiers may be necessary to enable use of an RF transceiver with normal dynamic range in the central controller 100.

[0035] Fig. 3 illustrates a monitoring device 310 with another alternate means for communicating with the central controller 100 when docked and undocked. In Fig. 3, the monitoring device 310 does not include an antenna 312 as in Fig. 1 and Fig. 2. Instead, in Fig. 3, the embedded antenna 326 operates as the RF antenna both when the monitoring device 310 is docked, as in Fig. 2, and also when the monitoring device 310 is undocked, as illustrated by the thick zigged line in Fig. 3. As in Fig. 2, when the monitoring device 310 is docked, the shields 326 and 346 cooperate to completely shield the antennae 326 and 346 from the surrounding area. However, in Fig. 3, when the monitoring device 310 is undocked, the shields 328 and 348 part and the antenna 326 is able to transmit to the surrounding area. That is, the antenna 326 is able to transmit to the antenna 110 on the central location or any of the plurality of free standing antennae in the hospital, as described above. Furthermore, the antenna 346 in the docking station 340 is able to act as one of the standalone antennae (such as 122 - Figure 1) receiving RF signals from the antenna 326 in the monitoring device 310. Therefore, the antenna 326 in the monitoring device 310 is able to communication with the antenna 346 in the docking station 340 even when it is undocked. This is illustrated in Fig. 3 by a thin zigged line.

[0036] One skilled in the art will understand that additional reliability may be obtained by using redundant transmission media. For example, a monitoring device 310 and docking station 340 may include both optical transducers 320 and 342, as illustrated in Fig. 1, and also RF antennae 326 and 346 as .illustrated in Fig. 2 and Fig. 3. In operation, both media are used to transmit data between the monitoring device 310 and the docking station 340 concurrently.

[0037] Fig. 4a is an assembly diagram illustrating apparatus for implementing the split transformer 322,344 and corresponding optical transducers 320,342 illustrated in Fig. 1. In Fig. 4a, the assembly in the upper left portion represents elements contained in the monitoring device 310 and the assembly in the lower right portion represents elements contained in the docking station 340. In the actual implementation, these two assemblies are molded into the sides of the monitoring station 310 and docking station 340, respectively, in locations such that, when the monitoring device 310 is docked in the docking station 340, they are aligned in a manner to be described in more detail below.

[0038] The assembly in the docking station 340 includes a portion 344 forming the primary of the split transformer 322,344. The primary 344 includes a magnetically permeable element, which in the illustrated embodiment is a ferrite armature 444 having a central pole 462 and two peripheral poles 464 and 466, respectively. The primary 344 further includes a printed circuit board (PCB) 442 having an opening 468 through which the central pole 462 protrudes. The PCB 442 also includes other openings through which the peripheral poles 464 and 466 protrude. This PCB 442 is preferably a multilayer PCB having on the order of 10 or more layers. Windings are fabricated in the PCB 442 in the area immediately surrounding opening 468 for the central pole 462 in a known manner by laying traces (not shown to simplify the figure) around the central core and providing feed-throughs from layer to layer to form a cylinder of windings. This cylinder corresponds to a layer of a traditional, bobbin wound transformer winding when the gaps in each winding ring are connected together, serially. Additional cylinders of windings, around the central pole 462, may be formed in the same manner. Many more winding turns can be realized in this manner over a spiral winding on a single layer. The windings in the PCB 442 form the primary winding of the split transformer 344.

[0039] Similarly, the assembly in the monitoring device 310 includes a portion 322 forming the secondary of the split transformer 322,344. The secondary 322 includes a magnetically permeable element, e.g. a ferrite armature 404 having a central pole 422 and two peripheral poles 424 and 426, respectively. The faces of these poles are shown cross-hatched in Fig. 4a. These poles

422,424,426 correspond to the central pole 462 and peripheral poles 464 and 466, respectively, in the primary 344 of the split transformer and are fabricated so that the faces of these poles 422,424,426 align with the faces (not shown) of the corresponding poles 462,464,466 in the primary 344 when the monitoring device 310 is docked in the docking station 340. The secondary 322 further includes a PCB 402 having an opening 428 through which the central pole 422 protrudes. The PCB 402 includes other openings through which the peripheral poles 424 and 426 protrude. Windings are fabricated in the PCB 402 in the area, indicated in phantom as 432, immediately surrounding opening for the central pole 422 in the manner described above. The windings in the PCB 402 form the secondary winding of the split transformer 322.

[0040] One skilled in the art will recognize that the magnetic cores 404 and 444 illustrated in Fig. 4a are matching E-cores. As is well known, in an E-core a winding around a central pole forms one magnetic-field-pole and the outside two poles surrounding the central pole form the other magnetic-field-pole. In Fig. 4a, the center poles 422 and 462 correspond to the central poles in the respective E-cores and the peripheral poles 426,466 and 424,464 correspond to the outside poles in the respective E-cores. One skilled in the art will further recognize that, although the PCBs 402, 442 must surround the central poles 422 and 462 in order to provide the secondary and primary windings respectively, there is no requirement for the PCBs 402,442 to surround the peripheral poles 424,464 and 426,466 for electrical or magnetic reasons.

[0041] In addition, the skilled practitioner will recognize that the magnetic armatures 404,444 may be fabricated from any magnetically permeable material, including iron or laminated iron. However, the efficiency of the power transferred from primary 344 to secondary 322 will vary with the selected magnetic material, among other factors.

[0042] In a preferred embodiment, the faces of the poles 422,424,426 in the secondary 322, and the faces of the poles 462,464,466 in the primary 344 are fabricated very close to the surface of the housing of the monitoring device 310 and docking station 340, respectively, so that only a thin layer of non-magnetic nonconductive material, e.g. plastic, covers them. Fig. 4b illustrates an end view of the split transformer illustrated in Fig. 4a looking in the direction of the arrow 490 when the monitoring device 310 is undocked from the docking device 340. In Fig. 4b, the left hand side represents the monitoring device 310 and the right hand side represents the docking station 340. In Fig. 4b, the cross-hatched area represents an encapsulating material, such as plastic. The ferrite core 404 in the monitoring device 310 and the ferrite core 444 in the docking station 340 are fabricated so that a very thin layer of the plastic is deposited atop the faces of the poles 422,424,426 and 462,464,466. In the illustrated embodiment, the thickness of the plastic over the faces of the poles is 0.25-0.4mm (10 to 15 thousandths of an inch). The PCBs 402 and 442 provide the secondary and primary windings, respectively, as described above. Fig. 4c illustrates an end view of the split transformer when the monitoring device 310 is docked with the docking station 340. In a docked position the thickness of the plastic between the faces of the poles of the respective ferrite cores 404 and 444 totals 0.5-0.8 mm (20 to 30 thousandths of an inch). This provides a very high degree of magnetic coupling and correspondingly high magnetic and power transfer efficiency.

[0043] Fig. 4a also illustrates the apparatus for implementing the optical transducers 320 and 342. The optical transducer 342 in the docking station 340 includes an optical transmitter, in the form of a light emitting diode (LED) 446, and an optical receiver, in the form of a photo-transistor 448. The optical transducer 320 in the monitoring device 310 also includes an optical transmitter in the form of an LED 410 and an optical receiver in the form of a photo-transistor 408. These LEDs and phototransistors operate in a known manner in response to electrical signals provided to them via the respective PCBs 442,402. The LED 446 in the docking station is physically arranged so that its light emissions are received only by the photo-transistor 408 in the monitoring device 310, and the LED 410 in the monitoring device 310 is physically arranged so that its light emissions are received only by the photo-transistor 448 in the docking station 340 when the monitoring device 310 is docked in the docking station 340. The use of optical transducers 320,342 eliminates adverse effects due to surrounding RF fields, such as might occur in an operating room, as described above.

[0044] As described with reference to Fig. 2, the LEDs and photo-transistors may be replaced or augmented with a small RF antenna, possibly in the form of a strip line, shielded in a known manner. The use of an RF link simplifies the circuitry required in the central location 100 because needs only a single RF transceiver rather than an RF transceiver and an optical transceiver. With proper shielding, adverse effects of interfering RF signals may be minimized.

[0045] In operation, when the monitoring device 310 is docked in the docking station 340, indicated by dashed arrows in Fig. 4a and illustrated in Fig. 4c, an alternating current is supplied from the power supply 200 to the primary windings (not shown) in PCB 442 surrounding the central pole 462 in the primary 344 of the split transformer. This alternating current induces a magnetic field within the armature formed by the primary and secondary ferrite armatures, 444,404. As described above, the faces of the central poles 462,422, and peripheral poles 464,424 and 466,426, are aligned and separated only by thin layers of plastic. A complete magnetic circuit is, therefore, formed by the central poles 462,422 and the peripheral poles 464,424 and 466,426. A secondary current is thereby induced in the secondary winding (also not shown) in the PCB 402 in the monitoring device 310. This secondary current is supplied to the power supply 316 to power the monitoring device 310 and recharge the battery 318. Simultaneously, the alignment of the LED 446 with photo-transistor 408 and the LED 410 with photo-transistor 448 provides full duplex data communication between the monitoring device 310 and docking station 340.

[0046] Because of the relatively wide area of the PCBs 442,402 around the central poles 462,422, a relatively large number of windings may be fabricated around those poles. Also, this large primary winding area facing and close to its corresponding congruent secondary winding maximizes coupling and minimizes losses. In addition, because of the relatively small separation of the faces of the poles 462,422; 464,424 and 466,426, there is only minor leakage of magnetic flux. This leads to increased efficiency of operation, on the order of 85%, of the split transformer illustrated in Fig. 4 compared to prior split transformers. A compact, efficient configuration can be realized using these principles.

Claims

1. A portable patient monitor device (310) using an electrically isolated, combined power and signal coupler system, comprising:

a power coupler (322), comprising:

a magnetically permeable element (404) including a central pole (422) and a peripheral pole (424, 426); and
a winding (432), forming an opening through which the central pole protrudes; and

an electrically isolated data transducer (320);

wherein said portable patient monitor device is suitable for docking with a docking station (340) by,

(a) forming a magnetic circuit including said magnetically permeable element in said portable patient monitor device and a corresponding magnetically permeable element (444) in said docking station, and
(b) coupling said data transducer in said portable patient monitor device to a corresponding transducer (342) in said docking station to support connection of said portable patient monitor device to a network and to bidirectionally exchange data.

2. A docking station (340) using an electrically isolated, combined power and signal coupler system, comprising:

a power coupler (344), comprising:

a magnetically permeable element (444) including a central pole (462) and a peripheral pole (464, 466); and
a winding (442), forming an opening through which the central pole protrudes; and

an electrically isolated data transducer (342);

wherein said docking station is suitable for docking with a portable patient monitor device by,

(a) forming a magnetic circuit including a magnetically permeable element (404) in said portable patient monitor device and said magnetically permeable element in said docking station, and
(b) coupling a data transducer (320) in a portable patient monitor device to said transducer in said docking station to support connection of said portable patient monitor device to a network and to bidirectionally exchange data.

3. A portable patient monitor device (310) according to claim 1 or a docking station (340) according to claim 2 wherein,
said bidirectionally exchanged data includes patient monitor parameters derived by said portable patient monitor device and information for controlling a function of said portable patient monitor device.

4. A portable patient monitor device (310) according to claim 1 or a docking station (340) according to claim 2 wherein,
said network connection of said portable device comprises at least one of, (a) an Internet Protocol (IP) compatible connection, (b) a Universal Serial Bus (USB) compatible connection (c) a Local Area Network (LAN) compatible connection and (d) and I.E.E.E. protocol compatible connection.

5. A portable patient monitor device (310) according to claim 1 or a docking station (340) according to claim 2 wherein,
the magnetically permeable element is a ferrite armature.

6. A portable patient monitor device (310) according to claim 1 or a docking station (340) according to claim 2
wherein
the magnetically permeable element is ar-

ranged to have a relatively thin covering of non-magnetic nonconductive material.

7. A portable patient monitor device (310) or a docking station (340) according to claim 6 wherein
the relatively thin covering is substantially from 0.25 to 0.4mm (10 to 15 thousandths of an inch).

8. A portable patient monitor device (310) or a docking station (340) according to claim 6 wherein
the non-magnetic nonconductive material is plastic.

9. A portable patient monitor device (310) according to claim 1 or a docking station (340) according to claim 2 wherein the winding is comprises of a printed circuit board which includes an opening through which the central pole of the magnetically permeable element protrudes.

10. A portable patient monitor device (310) or a docking station (340) according to claim 9 wherein
the printed circuit board is a multilayer printed circuit board and the winding comprises a trace around the opening on each layer, connected by feed-throughs between adjacent layers to form a cylinder of traces.

11. A portable patient monitor device (310) or a docking station (340) according to claim 9 wherein the winding comprises a plurality of cylinders of traces.

12. A portable patient monitor device (310) according to claim 1 or docking station (340) according to claim 2 wherein the electrically isolated data transducer is an optical data transducer eliminating adverse effects due to surrounding RF fields and including at least one of, (a) a light-emitting-diode and (b) a photo-transistor.

13. A portable patient monitor device (310) according to claim 1 or a docking station (340) according to claim 2 wherein the electrically isolated data transducer comprises a radio-frequency (RF) data transducer with shielding to minimize adverse effects of interfering RF signals.

14. A portable patient monitor device (310) or a docking station (340) according to claim 13 wherein the RF data transducer comprises an antenna.

15. A portable patient monitor device (310) or a docking station (340) according to claim 14 wherein the antenna is shielded.

16. A communications system suitable for use in a portable patient monitoring network network including a central controller (100); one or more docking stations (340) as claimed in any one of claims 2 to 15 each coupled in communications with the central controller; and one or more portable patient monitor devices (310) as claimed in any of the preceding claims each capable of docking with a selected one of the docking stations, said system comprising:

circuitry for providing a first electrically isolated bidirectional communications channel between said portable patient monitoring device and said central controller (100) via a selected docking station;
circuitry for providing a second electrically isolated bi-directional communications channel between the portable patient monitor device (310) directly and the central controller; and
circuitry for establishing communications via the first communications channel when the portable patient monitor device is docked to the selected docking station (340) and establishing communications via the second communications channel otherwise.

17. The system of claim 16 wherein said central controller (100) is bidirectionally coupled to the network; the or each said docking station is bidirectionally coupled to the network; and the or each said portable patient monitor device (310) is capable of docking with a selected one of the docking stations.

18. The system of claim 16 wherein
said circuitry for establishing communications automatically selects and establishes a particular communication channel in response to at least one of, (a) docking of a portable patient monitor device (310), (b) detection of loss of communication on an established communication channel and (c) detection of an absence of a particular communication channel.

19. The system of claim 17 wherein the circuitry for providing the first communications channel comprises:

circuitry in the docking station (340) for receiving network-compatible data from the network; and
circuitry in the portable device for extracting data from the received network-compatible data.

20. The system of claim 16 wherein the circuitry for providing the second communications channel further comprises a standalone transceiver, coupled to the network, for receiving the network-compatible data from the portable patient monitor device and the received network-compatible data on the network.

21. The system of claim 17 wherein the circuitry for providing the second communications channel comprises:

circuitry in the central controller (100) for generating network-compatible data according to a predetermined network protocol and transmitting this data wirelessly to the portable patient monitor device; and
circuitry in the portable patient monitoring device (310) for receiving the network-compatible data from the central controller and extracting data from the received network-compatible data.

22. The system of claim 16 wherein the circuitry for providing the second communications channel further comprises a standalone transceiver (120), coupled to the network, for receiving network compatible data from the central controller and transmitting this data wirelessly to the portable patient monitor device.

23. The system of claim 17 wherein each of the portable patient monitor devices (310) transmits patient monitoring data to the central controller (100) and the central controller transmits data for controlling the operation of the portable patient monitor device to the portable patient monitor device.

24. The system of claim 17 wherein:

the network transmits data formatted according to a predetermined network-compatible protocol; and each portable patient monitor device (310) comprises circuitry for generating data according to the network-compatible protocol.

25. The system of claim 24 wherein the selected network protocol is selected from the group consisting of internet protocol (IP), universal serial bus (USB), I.E.E.E. network protocol, and local area network (LAN) protocol.

26. The system of claim 16 wherein a data transducer in each docking station (340) is hardwire coupled to the central controller (100).

27. The system of claim 16 wherein:

a transducer in each docking station comprises a wireless communications antenna (326); and
the transducer in each portable device comprises a wireless communications antenna (346) arranged to communicate with the wireless communications antenna in the selected docking station when the portable patient monitor device is docked with the selected docking station.

28. The system of claim 25, wherein:

the central controller (100) comprises a wireless communications antenna (110); and
the circuitry in each portable patient monitor device for providing the second communications channel comprises an additional wireless antenna (312) arranged to exchange data with the antenna in the central controller when the portable device is not docked with any of the docking stations.

29. The system of claim 28 wherein:

the central controller (100) comprises a wireless communications antenna; and
the wireless communications antenna in the portable patient monitor device is further arranged to exchange data with the antenna in the central controller when the portable patient monitor device is not docked with any of the docking stations.

30. The system of claim 16 wherein:

the central controller (100) comprises a wireless communications antenna; and
the circuitry in each portable patient monitor device (310) for providing the second communications channel comprises a wireless antenna arranged to exchange data with the antenna in the central controller when the portable patient monitor device is not docked with any of the docking stations.

31. The system of claim 16 wherein the circuitry for establishing communications is coupled to the circuitry providing the first communications channel and comprises circuitry that determines that the portable patient monitor device is docked to a selected docking station when data is detected on the first communications channel.

32. The system of claim 16 wherein:

each of the docking stations (340) further comprises an electrically isolated power coupler;
each of the portable patient monitor devices (310) further comprises an electrically isolated power coupler arranged to receive power from the power coupler in the selected docking station when the portable patient monitor device is docked to the selected docking station; and
the circuitry for establishing communications comprises:

circuitry in each portable patient monitor device, coupled to the power coupler in the

portable device, that determines that the portable device is docked to a selected docking station when received power is detected; and
circuitry in each docking station, coupled to the power coupler in the docking station, that determines that the portable patient monitor device is docked to the docking station when a load is detected on the power coupler in the docking station.

33. An electrically isolated, combined power and signal coupler, for coupling a docking station (340) and a portable device (310) in a patient connected monitoring system, comprising:

a first power coupler (344) positioned within the docking station, comprising:

a magnetically permeable element (444) including a central pole (462) and a peripheral pole (464, 466); and
a primary winding (442), forming an opening through which the central pole protrudes; and

an electrically isolated data transducer (342) positioned within the docking station; and
a second power coupler (322) positioned within the portable device, comprising:

a magnetically permeable element (404) including a central pole (422) and a peripheral pole (424, 426); and
a secondary winding (432), forming an opening through which the central pole protrudes; and

an electrically isolated data transducer (320) positioned within the portable device;

wherein: when the portable device is docked with the docking station, the magnetically permeable element in the portable device and the magnetically permeable element in the docking station are arranged to form a magnetic circuit, and the data transducer in the portable device and the data transducer in the docking station are arranged to exchange data.

34. The power coupler of claim 33 wherein the magnetically permeable element in the docking station is arranged to have a relatively small separation substantially from 0.5 to 0.8 mm (20 to 30 thousandths of an inch) from the magnetically permeable element in the monitoring device when the portable device is docked with the docking station.

Patentansprüche

1. Tragbare Patientenüberwachungsvorrichtung (310) mit einem elektrisch isolierten, kombinierten Leistungs- und Signalkopplersystem, aufweisend:

einen Leistungskoppler (322), aufweisend:

ein magnetisch permeables Element (404) umfassend einen zentralen Pol (422) und einen Umfangspol (424, 426); und
eine Wicklung (232), welche eine Öffnung bildet, durch welche hindurch der zentrale Pol vorsteht; und

einen elektrisch isolierten Datenwandler (320);

wobei die tragbare Patientenüberwachungsvorrichtung geeignet ist, an einer Andockstation (340) anzudocken, indem

(a) eine magnetische Schaltung ausgebildet wird, welche das magnetisch permeable Element in der tragbaren Patientenüberwachungsvorrichtung und ein entsprechendes magnetisch permeables Element (444) in der Andockstation umfasst, und
(b) der Datenwandler in der tragbaren Patientenüberwachungsvorrichtung an einen entsprechenden Wandler (342) in der Andockstation gekoppelt wird, um die Verbindung der tragbaren Patientenüberwachungsvorrichtung mit einem Netzwerk zu unterstützen und um Daten in beiden Richtungen auszutauschen.

2. Andockstation (340) mit einem elektrisch isolierten, kombinierten Leistungs- und Signalkopplungssystem, aufweisend:

einen Leistungskoppler (344), aufweisend:

ein magnetisch permeables Element (444) mit einem zentralen Pol (462) und einem Umfangspol (464, 466); und
eine Wicklung (442), welche eine Öffnung bildet, durch welche hindurch der zentrale Pol vorsteht; und

einen elektrisch isolierten Datenwandler (342);

wobei die Andockstation dafür geeignet ist, an eine tragbare Patientenüberwachungsvorrichtung anzudocken, indem

(a) ein magnetischer Schaltkreis ausgebildet wird, der ein magnetisch permeables Element (404) in der tragbaren Patientenüberwachungsvorrichtung und das magnetisch permeable Element in der Andockstation umfasst, und

(b) ein Datenwandler (320) in einer tragbaren Patientenüberwachungsvorrichtung mit dem Wandler in der Andockstation gekoppelt wird, um die Verbindung der tragbaren Patientenüberwachungsvorrichtung mit einem Netzerk zu unterstützen und um Daten in beide Richtungen auszutauschen.

3. Tragbare Patientenüberwachungsvorrichtung (310) nach Anspruch 1 oder Andockstationen (340) nach Anspruch 2, wobei

die in zwei Richtungen ausgetauschten Daten Patientenüberwachungsparameter umfassen, die von der tragbaren Patientenüberwachungseinrichtung erhalten werden, sowie Information zum Steuern einer Funktion der tragbaren Patientenüberwachungsvorrichtung.

4. Tragbare Patientenüberwachungsvorrichtung (310) nach Anspruch 1 oder Andockstation (340) nach Anspruch 2, wobei

die Netzwerkverbindung der tragbaren Vorrichtung mindestens eines der folgenden Elemente umfasst: (a) eine mit einem Internetprotokoll (IP) kompatible Verbindung, (b) eine mit einem universellen seriellen Bus (USB) kompatible Verbindung, (c) eine mit einem lokalen Bereichsnetzwerk (LAN) kompatible Verbindung und (d) eine mit dem I.E.E. E.-Protokoll kompatible Verbindung.

5. Tragbare Patientenüberwachungsvorrichtung (310) nach Anspruch 1 oder Andockstation (340) nach Anspruch 2, wobei

das magnetisch permeable Element ein Ferritanker ist.

6. Tragbare Patientenüberwachungsvorrichtung (310) nach Anspruch 1 oder Andockstation (340) nach Anspruch 2, wobei

das magnetisch permeable Element angeordnet ist, einen relativ dünnen Überzug aus nichtmagnetischem nicht leitenden Material aufzuweisen.

7. Tragbare Patientenüberwachungsvorrichtung (310) oder Andockstation (340) nach Anspruch 6, wobei

der relativ dünne Überzug im Wesentlichen 0,25 bis 0,4 mm (10 bis 15 tausendstel Zoll) dick ist.

8. Tragbare Patientenüberwachungsvorrichtung (310) oder Andockstation (340) nach Anspruch 6, wobei

das nicht-magnetische nicht leitende Material Kunststoff ist.

9. Tragbare Patientenüberwachungsvorrichtung (310) nach Anspruch 1 oder Andockstation (340) nach Anspruch 2, wobei die Wicklung eine gedruckte Leiterplatte aufweist, welche eine Öffnung umfasst, durch die der zentrale Pol des magnetisch permeablen Elements vorsteht.

10. Tragbare Patientenüberwachungsvorrichtung (310) oder Andockstation (340) nach Anspruch 9, wobei

die gedruckte Leiterplatte eine mehrschichtige gedruckte Leiterplatte ist und die Wicklung eine Spur um die Öffnung auf jeder Schicht aufweist, die mittels Durchführungen zwischen benachbarten Schichten verbunden sind, um einen Zylinder aus Spuren zu bilden.

11. Tragbare Patientenüberwachungsvorrichtung (310) oder Andockstation (340) nach Anspruch 9, wobei die Wicklung eine Anzahl an Zylindern mit Spuren umfasst.

12. Tragbare Patientenüberwachungsvorrichtung (310) nach Anspruch 1 oder Andockstation (340) nach Anspruch 2, wobei der elektrisch isolierte Datenwandler ein optischer Datenwandler ist, welcher nachteilige Effekte aufgrund umgebender Radiofrequenzfelder eliminiert und (a) eine lichtemittierende Diode und/oder (b) einen Phototransistor umfasst.

13. Tragbare Patientenüberwachungsvorrichtung (310) nach Anspruch 1 oder Andockstation (340) nach Anspruch 2, wobei der elektrisch isolierte Datenwandler einen Funkfrequenz-Datenwandler (RF-Wandler) mit einer Abschirmung umfasst, um nachteilige Effekte interferierender RF-Signale zu minimieren.

14. Tragbare Patientenüberwachungsvorrichtung (310) oder Andockstation (340) nach Anspruch 13, wobei der RF-Datenwandler eine Antenne umfasst.

15. Tragbare Patientenüberwachungsvorrichtung (310) oder Andockstation (340) nach Anspruch 14, wobei die Antenne abgeschirmt ist.

16. Kommunikationssystem, geeignet zur Verwendung in einem tragbaren Patientenüberwachungsnetzwerk, wobei das Netzwerk eine zentrale Steuerung (100) umfasst; eine oder mehrere Andockstationen (340) nach einem der Ansprüche 2 bis 15, von denen jede in Kommunikationsverbindung mit der zentralen Steuerung steht; und eine oder mehrere tragbare Patientenüberwachungsvorrichtungen (310) nach einem der vorstehenden Ansprüche, von denen jede an eine ausgewählte der Andockstationen andocken kann, wobei das System folgendes umfasst:

eine Schaltung zum Schaffen eines ersten elektrisch isolierten bidirektionalen Kommunikationskanals zwischen der tragbaren Patientenüberwachungsvorrichtung und der zentralen Steuerung (100) über die ausgewählte Andockstation;
eine Schaltung zum Schaffen eines zweiten elektrisch isolierten bidirektionalen Kommunikationskanals zwischen der tragbaren Patientenüberwachungsvorrichtung (310) direkt und der zentralen Steuerung; und
eine Schaltung zum Schaffen von Kommunikationsverbindungen- über den ersten Kommunikationskanal, wenn die tragbare Patientenüberwachungsvorrichtung an der ausgewählten Andockstation (340) angedockt ist, und zum Schaffen von Kommunikationsverbindungen über den zweiten Kommunikatioriskanal im anderen Fall.

17. System nach Anspruch 16, wobei die zentrale Steuerung (100) bidirektional an das Netzwerk gekoppelt ist, die oder jede Andockstation bidirektional an das Netzwerk gekoppelt ist und die oder jede tragbare Patientenüberwachungsvorrichtung (310) an eine ausgewählte Andockstation andocken kann.

18. System nach Anspruch 16,

wobei die Schaltung zum Errichten von Kommunikationsverbindungen automatisch einen speziellen Kommunikationskanal als Antwort auf (a) das Andocken einer tragbaren Patientenüberwachungsvorrichtung (310) und/oder (b) das Detektieren eines Verlustes einer Kommunikationsverbindung auf einem errichteten Kommunikationskanal und/oder (c) das Detektieren des Fehlens eines speziellen Kommunikationskanales auswählt und errichtet.

19. System nach Anspruch 17, wobei die Schaltung zum Schaffen des ersten Kommunikationskanales folgendes umfasst:

eine Schaltung in der Andockstation (340) zum Empfangen netzwerkkompatibler Daten von dem Netzwerk; und
eine Schaltung in der tragbaren Vorrichtung zum Extrahieren von Daten aus den empfangenen netzwerkkompatiblen Daten.

20. System nach Anspruch 16, wobei die Schaltung zum Schaffen des zweiten Kommunikationskanales darüber hinaus einen alleinstehenden Tranceiver, der mit dem Netzwerk gekoppelt ist, umfasst, um die netzwerkkompatiblen Daten von der tragbaren Patientenüberwachungsvorrichtung und die empfangenen netzwerkkompatiblen Daten auf dem Netzwerk zu empfangen.

21. System nach Anspruch 17, wobei die Schaltung zum Schaffen des zweiten Kommunikationskanales folgendes umfasst:

eine Schaltung in der zentralen Steuerung (100) zum Erzeugen netzwerkkompatibler Daten gemäß einem vorgegebenen Netzwerkprotokoll und zum Übertragen dieser Daten drahtlos zur tragbaren Patientenüberwachungsvorrichtung; und
eine Schaltung in der tragbaren Patientenüberwachungsvorrichtung (310) zum Empfangen der netzwerkkompatiblen Daten von der zentralen Steuerung und Extrahieren von Daten aus den empfangenen netzwerkkompatiblen Daten.

22. System nach Anspruch 16, wobei die Schaltung zum Schaffen des zweiten Kommunikationskanals weiter einen alleinstehenden Transceiver (120) umfasst, der an das Netzwerk gekoppelt ist, um netzwerkkompatible Daten von der zentralen Steuerung zu empfangen und um diese Daten drahtlos an die tragbare Patientenüberwachungsvorrichtung zu senden.

23. System nach Anspruch 17, wobei jede der tragbaren Patientenüberwachungsvorrichtungen (310) Patientenüberwachungsdaten an die zentrale Steuerung (100) sendet und die zentrale Steuerung Daten zum Steuern des Betriebs der tragbaren Patientenüberwachungsvorrichtung an die tragbare Patientenüberwachungsvorrichtung sendet.

24. System nach Anspruch 17, wobei:

das Netzwerk Daten überträgt, welche gemäß einem vorgegebenen netzwerkkompatiblen Protokoll formatiert sind; und jede tragbare Patientenüberwachungsvorrichtung (310) eine Schaltung umfasst, um Daten gemäß dem netzwerkkompatiblen Protokoll zu erzeugen.

25. System nach Anspruch 24, wobei das ausgewählte Netzwerkprotokoll aus der Gruppe ausgewählt ist, die aus dem Intemetprotokoll (IP), dem universalen seriellen Busprotokoll (USB), dem I.E.E.E.-Netzwerkprotokoll und dem lokalen Bereichsnetzwerkprotokoll (LAN) besteht.

26. System nach Anspruch 16, wobei ein Datenwandler in jeder Andockstation (340) fest verdrahtet an die zentrale Steuerung (100) gekoppelt ist.

27. System nach Anspruch 16, wobei:

einem Wandler in jeder Andockstation eine drahtlose Kommunikationsantenne (326) umfasst; und
der Wandler in jeder tragbaren Vorrichtung eine drahtlose Kommunikationsantenne (346) umfasst, die dafür angeordnet ist, mit der drahtlosen Kommunikationsantenne in der ausgewählten Andockstation zu kommunizieren, wenn die tragbare Patientenüberwachungsvorrichtung an der ausgewählten Andockstation angedockt ist.

28. System nach Anspruch 25, wobei:

die zentrale Steuerung (100) eine drahtlose Kommunikationsantenne (110) umfasst; und
die Schaltung in jeder tragbaren Patientenüberwachungsvorrichtung zum Schaffen des zweiten Kommunikationskanales eine zusätzliche drahtlose Antenne (312) umfasst, die dafür angeordnet ist, Daten mit der Antenne in der zentralen Steuerung auszutauschen, wenn die tragbare Vorrichtung nicht an eine der Andockstationen angedockt ist.

29. System nach Anspruch 28, wobei:

die zentrale Steuerung (100) eine drahtlose Kommunikationsantenne umfasst; und
die drahtlose Kommunikationsantenne in der tragbaren Patientenüberwachungsvorrichtung darüber hinaus dafür angeordnet ist, Daten mit der Antenne in der zentralen Steuerung auszutauschen, wenn die tragbare Patientenüberwachungsvorrichtung nicht an eine der Andockstationen angedockt ist.

30. System nach Anspruch 16, wobei:

die zentrale Steuerung (100) eine drahtlose Kommunikationsantenne umfasst; und
die Schaltung in jeder tragbaren Patientenüberwachungsvorrichtung (310) zum Schaffen des zweiten Kommunikationskanales eine drahtlose Antenne umfasst, die dafür angeordnet ist, Daten mit der Antenne in der zentralen Steuerung auszutauschen, wenn die tragbare Patientenüberwachungsvorrichtung nicht an eine der Andockstationen angedockt ist.

31. System nach Anspruch 16, wobei die Schaltung zur Errichtung einer Kommunikationsverbindung an die Schaltung gekoppelt ist, die den ersten Kommunikationskanal schafft, und eine Schaltung umfasst, die dafür bestimmt ist, dass die tragbare Patientenüberwachungsvorrichtung an eine ausgewählte Andockstation angedockt ist, wenn Daten auf dem ersten Kommunikationkanal detektiert werden.

32. System nach Anspruch 16, wobei:

jede der Andockstationen (340) darüber hinaus einen elektrisch isolierten Leistungskoppler umfasst;
jede der tragbaren Patientenüberwachungsvorrichtungen (310) darüber hinaus einen elektrisch isolierten Leistungskoppler aufweist, der dafür angeordnet ist, Leistung vom Leistungskoppler in der ausgewählten Andockstation zu empfangen, wenn die tragbare Patientenüberwachungsvorrichtung an der ausgewählten Andockstation angedockt ist; und
die Schaltung zur Errichtung von Kommunikationsverbindungen folgendes umfasst:

eine Schaltung in jeder tragbaren Patientenüberwachungsvorrichtung, die an den Leistungskoppler in der tragbaren Vorrichtung gekoppelt ist, welche bestimmt, dass die tragbare Vorrichtung an eine ausgewählte Andockstation angedockt ist, wenn empfangene Leistung detektiert wird; und
eine Schaltung in jeder Andockstation, die mit dem Leistungskoppler in der Andockstation gekoppelt ist und die bestimmt, dass die tragbare Patientenüberwachungsvorrichtung an der Andockstation angedockt ist, wenn eine Last auf dem Leistungskoppler in der Andockstation detektiert wird.

33. Elektrisch isolierter, kombinierter Leistungs- und Signalkoppler zum Koppeln meiner Andockstation (340) und einer tragbaren Vorrichtung (310) in einem mit einem Patienten verbundenen Überwachungssystem, aufweisend:

einen ersten Leistungskoppler (344), der innerhalb der Andockstation positioniert ist, aufweisend:

ein magnetisch permeables Element (444), umfassend einen zentralen Pol (462) und einen umfangsseitigen Pol (464, 466); und
eine primäre Wicklung (442), in der eine Öffnung ausgebildet ist, durch die der zentrale Pol vorsteht; und
einen elektrisch isolierten Datenwandler (342), der innerhalb der Andockstation positioniert ist; und
einen zweiten Leistungskoppler (322), der innerhalb der tragbaren Vorrichtung positioniert ist, aufweisend:

ein magnetisch permeables Element (404) umfassend einen zentralen Pol

(422) und einen umfangsseitgen Pol (424, 426); und
eine sekundäre Wicklung (432), in der eine Öffnung ausgebildet ist, durch die sich der zentrale Pol erstreckt; und
einen elektrisch isolierten Datenwandler (320), der innerhalb der tragbaren Vorrichtung positioniert ist;

wobei, wenn die tragbare Vorrichtung an der Andockstation angedockt ist, das magnetisch permeable Element in der tragbaren Vorrichtung und das magnetisch permeable Element in der Andockstation dafür angeordnet sind, eine magnetische Schaltung zu bilden, und der Datenwandler in der tragbaren Vorrichtung und der Datenwandler in der Andockstation dafür angeordnet sind, Daten auszutauschen.

34. Leistungskoppler nach Anspruch 33, wobei das magnetisch permeable Element in der Andockstation dafür angeordnet ist, einen relativ geringen Abstand von im Wesentlichen von 0,5 bis 0,8 mm (20 bis 30 tausendstel Zoll) von dem magnetisch permeablen Element in der Überwachungsvorrichtung zu haben, wenn die tragbare Vorrichtung in der Andockstation angedockt ist.

Revendications

1. Un dispositif portatif de surveillance de patient (310) utilisant un système combiné électriquement isolé formant coupleur de puissance et de signaux, comprenant :

un coupleur de puissance (322) comprenant :

un élément magnétiquement perméable (404) incluant un pôle central (422) et un pôle périphérique (424, 426) ; et
un enroulement (432) délimitant une ouverture à travers laquelle le pôle central fait saillie ; et

un transducteur de données isolé électriquement (320) ;

où ledit dispositif portatif de surveillance de patient est approprié pour être amarré à un poste d'amarrage (340) par les étapes consistant à :

a) former un circuit magnétique incluant ledit élément magnétiquement perméable dudit dispositif portatif de surveillance de patient et un élément magnétiquement perméable correspondant (444) dudit poste d'amarrage, et
b) coupler ledit transducteur de données dudit dispositif portatif de surveillance de patient à un transducteur correspondant (342) dudit poste d'amarrage afin de permettre une connexion dudit dispositif portatif de surveillance de patient à un réseau et d'échanger des données de manière bidirectionnelle.

2. Un poste d'amarrage (340) utilisant un système combiné électriquement isolé formant coupleur de puissance et de signaux, comprenant :

un coupleur de puissance (344), comprenant :

un élément magnétiquement perméable (444) incluant un pôle central (462) et un pôle périphérique (464, 466) ; et
un enroulement (442) délimitant une ouverture à travers laquelle le pôle central fait sailllie ; et

un transducteur de données isolé électriquement (320) ;

où ledit poste d'amarrage est approprié pour être amarré à un dispositif portatif de surveillance de patient par les étapes consistant à :

a) former un circuit magnétique incluant un élément magnétiquement perméable (404) dudit dispositif portatif de surveillance de patient et ledit élément magnétiquement perméable dudit poste d'amarrage, et
b) coupler un transducteur de données (320) dudit dispositif portatif de surveillance de patient audit transducteur dudit poste d'amarrage afin de permettre une connexion dudit dispositif portatif de surveillance de patient à un réseau et d'échanger des données de manière bidirectionnelle.

3. Un dispositif portatif de surveillance de patient (310) selon la revendication 1 ou un poste d'amarrage (340) selon la revendication 2 dans lequel :

lesdites données échangées de manière bidirectionnelle comprennent des paramètres de surveillance de patient obtenus par ledit dispositif portatif de surveillance de patient et des informations pour réguler une fonction dudit dispositif portatif de surveillance de patient.

4. Un dispositif portatif de surveillance de patient (310) selon la revendication 1 ou un poste d'amarrage (340) selon la revendication 2 dans lequel :

ladite connexion au réseau dudit dispositif portatif comprend au moins l'une parmi : (a) une liaison compatible Internet Protocol (IP), (b) une liaison compatible Universal Serial Bus (USB), (c) une liaison compatible Local Area Network (LAN), et (d) une liaison compatible à protocole I.E.E.E.

5. Un dispositif portatif de surveillance de patient (310) selon la revendication 1 ou un poste d'amarrage (340) selon la revendication 2 dans lequel :

l'élément magnétiquement perméable est un induit de ferrite.

6. Un dispositif portatif de surveillance de patient (310) selon la revendication 1 ou un poste d'amarrage (340) selon la revendication 2 dans lequel :

l'élément magnétiquement perméable est disposé pour présenter un recouvrement relativement mince de matière amagnétique non conductrice.

7. Un dispositif portatif de surveillance de patient (310) ou un poste d'amarrage (340) selon la revendication 6 dans lequel :

le recouvrement relativement mince est sensiblement de 0,25 à 0,4 mm (10 à 15 millièmes d'un pouce).

8. Un dispositif portatif de surveillance de patient (310) ou un poste d'amarrage (340) selon la revendication 6 dans lequel :

la matière amagnétique non conductrice est une matière plastique.

9. Un dispositif portatif de surveillance de patient (310) selon la revendication 1 ou un dispositif d'amarrage (340) selon la revendication 2 dans lequel l'enroulement est composé d'une plaquette de circuit imprimé qui comprend une ouverture à travers laquelle le pôle central de l'élément magnétiquement perméable fait saillie.

10. Un dispositif portatif de surveillance de patient (310) ou un dispositif d'amarrage (340) selon la revendication 9 dans lequel :

la plaquette de circuit imprimé est une plaquette de circuit imprimé multicouche et l'enroulement comprend un ruban autour de l'ouverture de chaque couche, relié par des traversées entre couches adjacentes afin de former un cylindre de rubans.

11. Un dispositif portatif de surveillance de patient (310) ou un poste d'amarrage (340) selon la revendication 9 dans lequel l'enroulement comprend une pluralité de cylindres de rubans.

12. Un dispositif portatif de surveillance de patient (310) selon la revendication 1 ou un poste d'amarrage (340) selon la revendication 2 dans lequel le transducteur de données isolé électriquement est un transducteur de données optiques éliminant des effets nuisibles dus à des champs HF environnants et comprenant au moins l'un parmi (a) une diode électroluminescente et (b) un phototransistor.

13. Un dispositif portatif de surveillance de patient (310) selon la revendication 1 ou un poste d'amarrage (340) selon la revendication 2 dans lequel le transducteur de données isolé électriquement comprend un transducteur de données haute fréquence (HF) avec blindage pour minimiser les effets nuisibles d'interférences de signaux HF.

14. Un dispositif portatif de surveillance de patient (310) ou un poste d'amarrage (340) selon la revendication 13 dans lequel le transducteur de données HF comprend une antenne

15. Un dispositif portatif de surveillance de patient (310) ou un poste d'amarrage (340) selon la revendication 14 dans lequel l'antenne est blindée.

16. Un système de télécommunications approprié pour être utilisé dans un réseau portatif de surveillance de patient, réseau comprenant un organe de commande central (100) ; un ou plusieurs postes d'amarrage (340) tels que revendiqués dans l'une quelconque des revendications 2 à 15 couplés chacun en télécommunication -avec l'organe de commande central ; et un ou plusieurs dispositifs portatifs de surveillance de patient (310) tels que revendiqués dans l'une quelconque des revendications précédentes capables chacun d'être amarré à l'un sélectionné parmi les postes d'amarrage, ledit système comprenant :

un circuit pour créer un premier canal de télécommunications bidirectionnelles isolé électriquement entre ledit dispositif portatif de surveillance de patient et ledit organe de commande central (100) par l'intermédiaire d'un poste d'amarrage sélectionné ;
un circuit pour créer un second canal de télécommunications bidirectionnelles électriquement isolé entre le dispositif portatif de surveillance de patient (310) directement et l'organe de commande central ; et
un circuit prévu pour établir des télécommunications par l'intermédiaire du premier canal de télécommunications lorsque le dispositif portatif de surveillance de patient est amarré au poste d'amarrage sélectionné (340) et pour établir

sinon des télécommunications par l'intermédiaire du second canal de télécommunications.

17. Le système de la revendication 16 dans lequel ledit organe de commande central (100) est couplé de manière bidirectionnelle au réseau ; le poste d'amarrage ou chacun desdits postes d'amarrage est couplé de manière bidirectionnelle au réseau ; et le dispositif portatif de surveillance de patient ou chacun desdits dispositifs portatifs de surveillance de patient (310) peut être amarré à l'un sélectionné des postes d'amarrage.

18. Le système de la revendication 16 dans lequel :

ledit circuit prévu pour établir des télécommunications sélectionne et établit automatiquement un canal de communications particulier en réponse à au moins l'un parmi (a) l'amarrage d'un dispositif portatif de surveillance de patient (310), (b) la détection d'une perte de communication sur un canal de communication et (c) la détection d'une absence d'un canal de communication particulier.

19. Le système de la revendication 17 dans lequel le circuit prévu pour créer le premier canal de télécommunications comprend :

un circuit dans le poste d'amarrage (340) pour recevoir des données réseau-compatibles en provenance du réseau ; et
un circuit dans le dispositif portatif pour extraire des données depuis les données réseau-compatibles reçues.

20. Le système de la revendication 16 dans lequel le circuit prévu pour créer le second canal de télécommunications comprend en outre un émetteur-récepteur autonome, couplé au réseau, pour recevoir les données réseau-compatibles en provenance du dispositif portatif de surveillance de patient et les données réseau-compatibles reçues sur le réseau.

21. Le système de la revendication 17 dans lequel le circuit prévu pour créer le second canal de télécommunications comprend :

un circuit dans l'organe de commande central (100) pour produire des données réseau-compatibles selon un protocole réseau prédéterminé et transmettre sans fil ces données vers le dispositif portatif de surveillance de patient ; et
un circuit dans le dispositif portatif de surveillance de patient (310) pour recevoir les données réseau-compatibles en provenance de l'organe de commande central et pour extraire des données en provenance des données réseau-compatibles reçues.

22. Le système de la revendication 16 dans lequel le circuit prévu pour créer le second canal de télécommunications comprend en outre un émetteur-récepteur autonome (120), couplé au réseau, pour recevoir des données réseau-compatibles en provenance de l'organe de commande central et pour transmettre sans fil ces données vers le dispositif portatif de surveillance de patient.

23. Le système de la revendication 17 dans lequel chacun des dispositifs portatifs de surveillance de patient (310) émet vers l'organe de commande central (100) des données de surveillance de patient et où l'organe de commande central émet vers le dispositif portatif de surveillance de patient des données pour commander le fonctionnement du dispositif portatif de surveillance de patient.

24. Le système de la revendication 17 dans lequel :

le réseau émet des données formatées selon un protocole réseau-compatible prédéterminé ; et chacun des dispositifs portatifs de surveillance de patient (310) comprend un circuit pour produire des données selon le protocole réseau-compatible.

25. Le système de la revendication 24 dans lequel le protocole réseau sélectionné est sélectionné dans le groupe se composant de l'Internet Protocol (IP), de l'Universal Serial Bus (USB), du protocole de réseau I.E.E.E., et du protocole Local Area Network (LAN).

26. Le système de la revendication 16 dans lequel un transducteur de données prévu dans chaque poste d'amarrage (340) est couplé en matériel à l'organe de commande central (100).

27. Le système de la revendication 16 dans lequel :

un transducteur de chaque poste d'amarrage comprend une antenne de télécommunications sans fil (326) ; et
le transducteur de chaque dispositif portatif comprend une antenne de télécommunications sans fil (346) disposée pour communiquer avec l'antenne de télécommunications sans fil du poste d'amarrage sélectionné lorsque le dispositif portatif de surveillance de patient est amarré au poste d'amarrage sélectionné.

28. Le système de la revendication 25, dans lequel :

l'organe de commande central (100) comprend une antenne de télécommunications sans fil

(110) ; et

le circuit de chaque dispositif portatif de surveillance de patient prévu pour créer le second canal de télécommunications comprend une antenne sans fil supplémentaire (312) disposée pour échanger des données avec l'antenne de l'organe de commande central lorsque le dispositif portatif n'est pas amarré avec l'un quelconque des postes d'amarrage.

29. Le système de la revendication 28 dans lequel :

l'organe de commande central (100) comprend une antenne de télécommunications sans fil ; et

l'antenne de télécommunications sans fil du dispositif portatif de surveillance de patient est en outre disposée pour échanger des données avec l'antenne de l'organe de commande central lorsque le dispositif portatif de surveillance de patient n'est pas amarré à l'un quelconque des postes d'amarrage.

30. Le système de la revendication 16 dans lequel :

l'organe de commande central (100) comprend une antenne de télécommunications sans fil ; et

le circuit de chaque dispositif portatif de surveillance de patient (310) prévu pour créer le second canal de télécommunications comprend une antenne sans fil disposée pour échanger des données avec l'antenne de l'organe de commande central lorsque le dispositif portatif de surveillance de patient n'est pas amarré à l'un quelconque des postes d'amarrage.

31. Le système de la revendications 16 dans lequel le circuit prévu pour établir des télécommunications est couplé au circuit créant le premier canal de télécommunications et comprend un circuit qui détermine que le dispositif portatif de surveillance de patient est amarré à un poste d'amarrage sélectionné lorsque des données sont détectées sur le premier canal de télécommunications.

32. Le système de la revendication 16 dans lequel :

chacun des postes d'amarrage (340) comprend en outre un coupleur de puissance isolé électriquement ;

chacun des dispositifs portatifs de surveillance de patient (310) comprend en outre un coupleur de puissance isolé électriquement disposé pour recevoir de la puissance en provenance du coupleur de puissance du poste d'amarrage sélectionné lorsque le dispositif portatif de surveillance de patient est amarré au poste d'amarrage sélectionné ; et

le circuit prévu pour établir des télécommunications comprend :

un circuit dans chaque dispositif portatif de surveillance de patient, couplé au coupleur de puissance du dispositif portatif, lequel détermine que le dispositif portatif est amarré à un poste d'amarrage sélectionné lorsqu'une puissance reçue est détectée ; et

un circuit dans chaque poste d'amarrage, couplé au coupleur de puissance du poste d'amarrage, lequel détermine que le dispositif portatif de surveillance de patient est amarré au poste d'amarrage lorsqu'une charge est détectée sur le coupleur de puissance du poste d'amarrage.

33. Un coupleur de puissance et de signaux combinés électriquement isolé, prévu pour coupler un poste d'amarrage (340) et un dispositif portatif (310) d'un système de surveillance relié à un patient comprenant :

un premier coupleur de puissance (344) mis en place à l'intérieur du poste d'amarrage, comprenant :

un élément magnétiquement perméable (444) incluant un pôle central (462) et un pôle périphérique (464, 466) ; et

un enroulement primaire (442), délimitant une ouverture à travers laquelle le pôle central fait saillie ; et

un transducteur de données électriquement isolé (342) mis en place à l'intérieur du poste d'amarrage ; et

un second coupleur de puissance (322) mis en place à l'intérieur du dispositif portatif, comprenant :

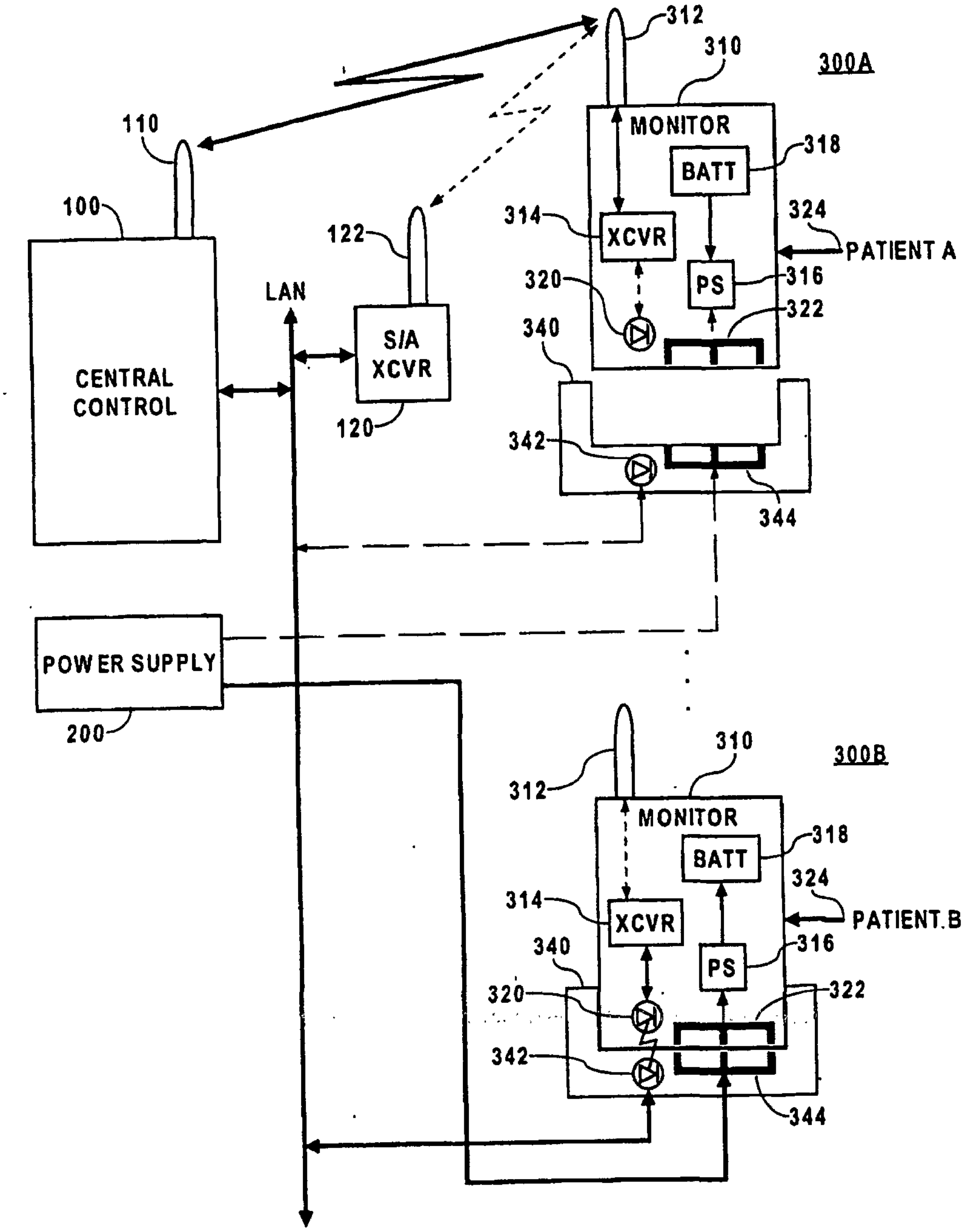
un élément magnétiquement perméable (404) incluant un pôle central (422) et un pôle périphérique (424, 426) ; et

un enroulement secondaire (432), délimitant une ouverture à travers laquelle le pâle central fait saillie ; et

un transducteur de données électriquement isolé (320) mis en place à l'intérieur du dispositif portatif ;

dans lequel lorsque le dispositif portatif est amarré au poste d'amarrage, l'élément magnétiquement perméable du dispositif portatif et l'élément électriquement perméable du poste d'amarrage sont disposés pour former un circuit magnétique, et le transducteur de données du dispositif portatif ainsi que le transducteur de données du poste d'amarrage sont disposés pour échanger des données.

34. Le coupleur de puissance de la revendication 33 dans lequel l'élément magnétiquement perméable du poste d'amarrage est disposé pour présenter une séparation relativement petite de sensiblement 0,5 à 0,8 mm (20 à 30 millièmes d'un pouce) par rapport à l'élément magnétiquement perméable du dispositif de surveillance lorsque le dispositif portatif est amarré au poste d'amarrage.


312
310
300A
MONITOR
110
BATT
318
100
324
122
314
XCVR
PATIENT A
LAN
320
PS
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XCVR
322
340
CENTRAL
CONTROL
120
342
344
POWER SUPPLY
200
310
300B
312
MONITOR
318
BATT
324
314
XCVR
PATIENT.B
340
316
PS
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342
344

Fig. 1 - System

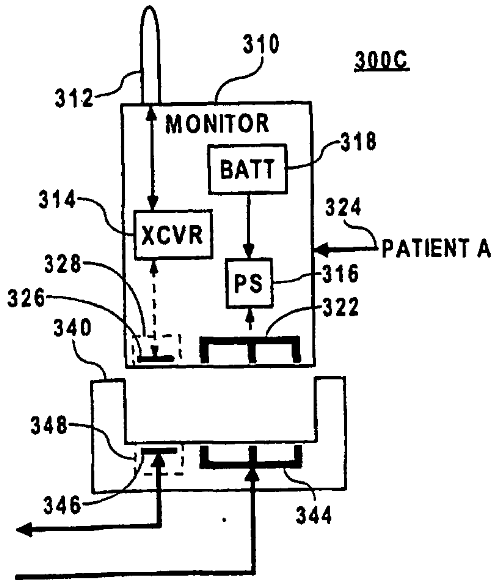

Fig. 2 – Alternate transmission medium

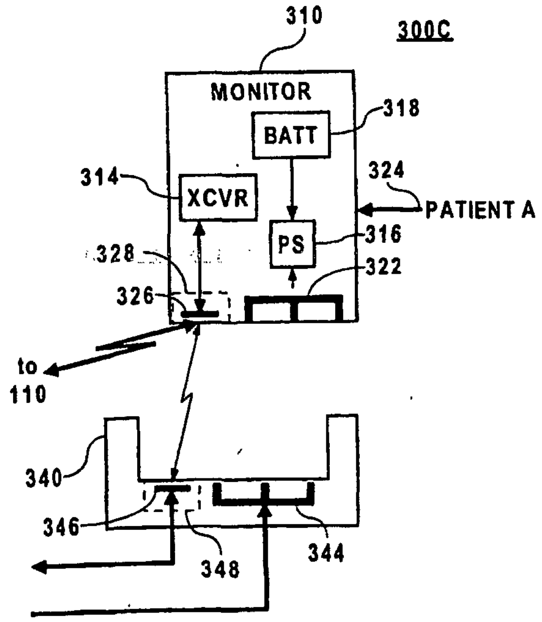

Fig. 3 –Alternative 2 transmission medium

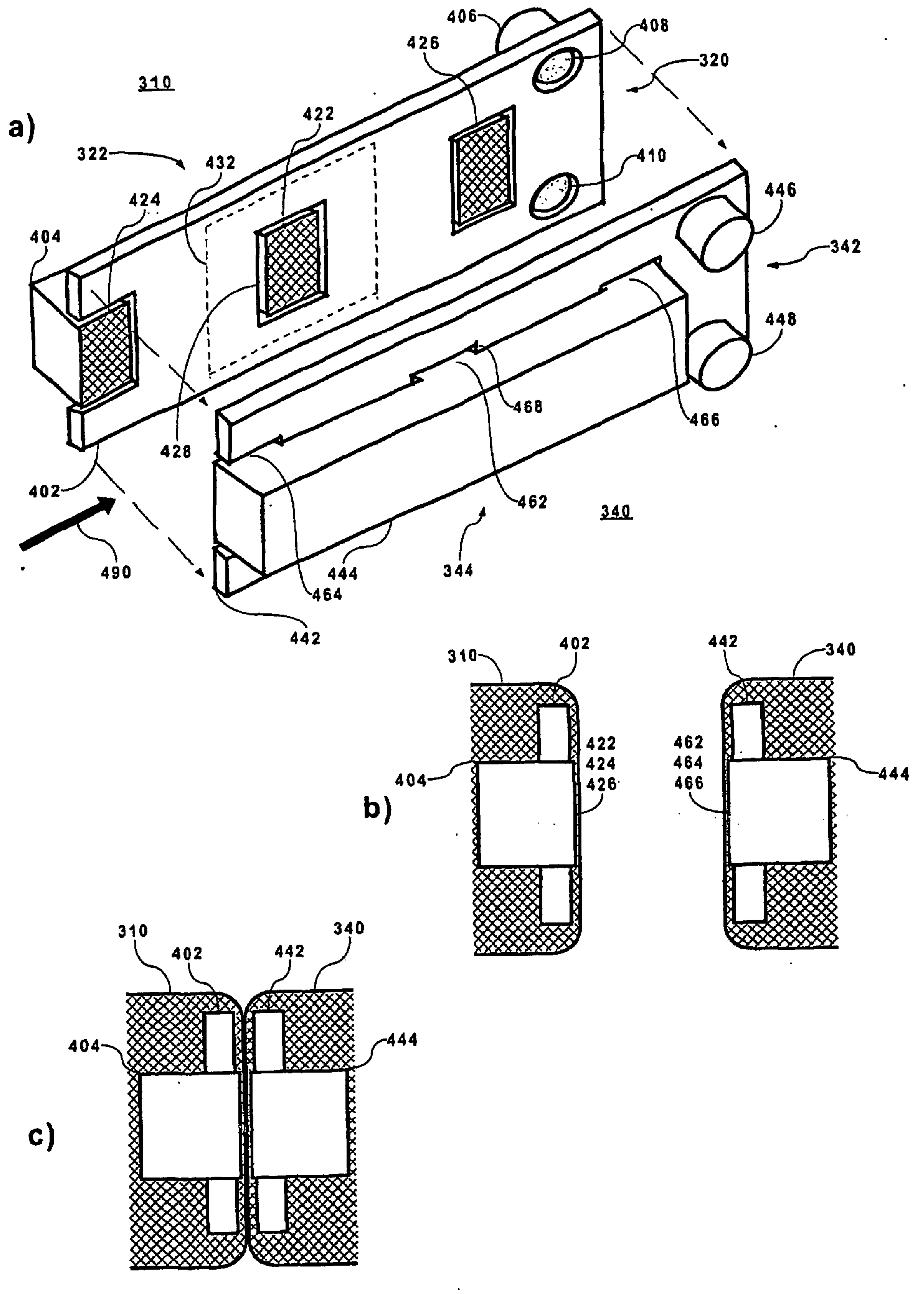

Fig. 4 – Detailed view

专利名称(译)	用于患者连接设备的电隔离电源和信号耦合器系统		
公开(公告)号	EP1246563B1	公开(公告)日	2005-02-23
申请号	EP2001995931	申请日	2001-11-20
[标]申请(专利权)人(译)	美国西门子医疗解决公司		
申请(专利权)人(译)	西门子医疗解决方案USA，INC.		
当前申请(专利权)人(译)	德尔格医疗系统公司.		
[标]发明人	KELLY CLIFFORD NEWELL SCOTT RUSS TOMAS		
发明人	KELLY, CLIFFORD NEWELL, SCOTT RUSS, TOMAS		
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CPC分类号	A61B5/0006 A61B5/04282 A61B2560/0456		
优先权	60/252112 2000-11-20 US		
其他公开文献	EP1246563A1		
外部链接	Espacenet		

摘要(译)

公开了一种用于患者连接装置的电隔离的组合电源和信号耦合器。能够与对接站对接的对接站和便携式设备均包括功率耦合器和电隔离数据换能器。各个功率耦合器包括：导磁元件，包括中心磁极和外围磁极;以及印刷电路板，具有开口，中心磁极通过该开口突出。印刷电路板包括围绕中心极开口的绕组：对接站中的初级绕组和便携式装置中的次级绕组。当便携式设备与扩展坞对接时，便携式设备中的导磁元件和扩展坞中的导磁元件被布置成形成磁路，并且便携式设备中的数据换能器和数据换能器中的数据换能器扩展坞用于交换数据。根据患者的位置，数据交换可以通过无线电信号或光电耦合发生。

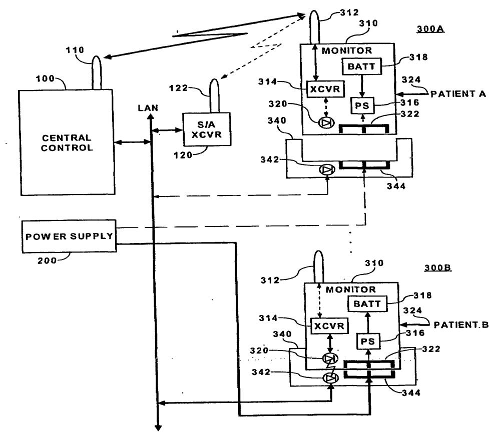

Fig. 1 - System