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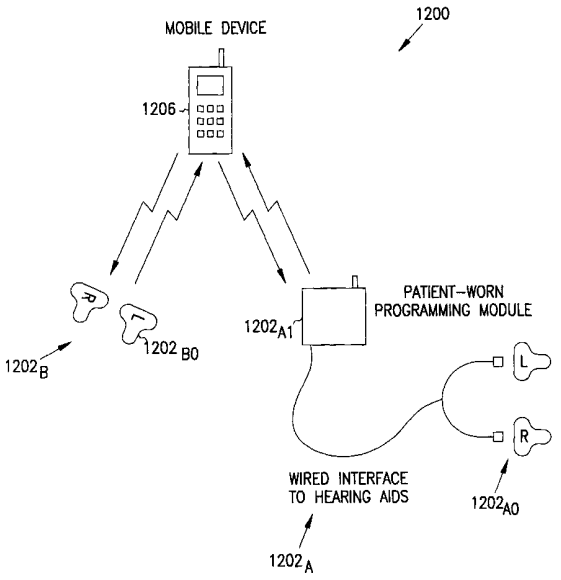

(57) Abstract: Systems, structures, and methods are provided to fit, program, or upgrade a hearing aid system to a patient. One embodiment includes the use of a mobile device to interact with the hearing aid system through a short-range network. The mobile device is also adapted to communicate with a server through a long-range wireless network. The server may reside on the Internet.

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HEARING AID SYSTEMS

Technical Field

The present invention relates generally to hearing aid systems. More particularly, it pertains to fitting, programming, or upgrading hearing aid systems.

Background Information

Sound systems can be broken down into three general components: an input device (such as a microphone); a processing system (such as a digital signal processor); and an output device (such as a speaker). Sounds are picked up by the microphone, transmitted to the processing system where they are processed, and then projected by the speaker so that the sounds can be heard at an appropriate distance.

The described sound systems may include a hearing aid device. The hearing aid device serves a patient by picking up desired sounds, processing them, and projecting them into the ear of the patient to facilitate communications. The processing system of the hearing aid device is adjusted to fit a specific patient.

Adjustment of hearing aid devices to fit a patient is laborious and time intensive. An audiologist who is engaged in the fitting of hearing aid devices must, during a session with a patient, have on hand not only hearing aid devices from different manufacturers, but also equipment to adjust the different hearing aid devices. The equipment includes proprietary programming hardware and software, interface hardware, and connector cables from these different manufacturers. The process of reconnecting different interface hardware and connector cables renders the fitting experience frustrating for both the audiologist and the patient.

What has also been frustrating is that there is a lack of a reliable method to ensure that the software on the hearing aid devices or the programming hardware is current. An updated version of software may have been released, but this updated software often does not get installed. This may be due to miscommunications, forward incompatibility between older equipment and

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newer software, procrastination, or perhaps it is because the audiologist was not trained to maintain a complicated software system. This problem prevents a patient from benefiting from newer software.

Thus, what is needed are systems, methods, and structures to fit, program, or upgrade hearing aid systems.

Summary

The above-mentioned problems with hearing aid systems as well as other problems are addressed by the present invention and will be understood by reading and studying the following specification. Systems, methods, and structures are described which address the problems of programming hearing aid systems.

One illustrative embodiment includes a method. The method includes programming a hearing aid system using at least one wireless communication protocol.

Another illustrative embodiment includes a method for tailoring an audiological therapy for a patient. The method includes deriving at least one audiological parameter by obtaining data about at least one aural response of the patient, and programming a hearing aid system based on the at least one audiological parameter by a mobile device so as to tailor an audiological therapy for the patient.

Another illustrative embodiment includes a business method. The business method includes deriving at least one audiological parameter by obtaining data about at least one aural response of a patient, upgrading a piece of software capable of executing on the hearing aid system based on the at least one audiological parameter, wherein upgrading includes downloading the software by a mobile device. The business method further comprises charging for upgrading the software in the hearing aid system.

Another illustrative embodiment includes a system. The system comprises a hearing aid system and a mobile device adapted to program the hearing aid system. The system further comprises a server adapted to communicate with the mobile device. The system further comprises at least one network to facilitate communications at least among the hearing aid system, the mobile device, and the server.

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These and other embodiments, aspects, advantages, and features of the present invention will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art by reference to the following description of the invention and drawings or by practice of the invention.

Brief Description of the Drawings

Figure 1 is a pictorial diagram illustrating a system in accordance with one embodiment.

Figure 2 is a process diagram illustrating a method in accordance with one embodiment.

Figure 3 is a structure diagram illustrating a data structure in accordance with one embodiment.

Figure 4 is a structure diagram illustrating a data structure in accordance with one embodiment.

Figure 5 is a structure diagram illustrating a data structure in accordance with one embodiment.

Figure 6 is a pictorial diagram illustrating a system in accordance with one embodiment.

Figure 7 is a process diagram illustrating a method in accordance with one embodiment.

Figure 8 is a pictorial diagram illustrating a system in accordance with one embodiment.

Figure 9 is a pictorial diagram illustrating a system in accordance with one embodiment.

Figure 10 is a pictorial diagram illustrating a system in accordance with one embodiment.

Figure 11 is a pictorial diagram illustrating a system in accordance with one embodiment.

Figure 12 is a pictorial diagram illustrating a system in accordance with one embodiment.

Figure 13 is a pictorial diagram illustrating a system in accordance with one embodiment.

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Detailed Description

In the following detailed description of the invention, reference is made to the accompanying drawings that form a part hereof, and in which are shown, by way of illustration, specific embodiments in which the invention may be practiced. In the drawings, like numerals describe substantially similar components throughout the several views. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. Other embodiments may be utilized and structural, logical, and electrical changes may be made without departing from the scope of the present invention.

The embodiments described herein focus on, among other things, programming hearing aid systems. One component of a hearing aid system includes a processing system. The processing system provides audio signal processing. The audio signal processing includes audiological parameters that may be adjusted so as to enhance the sense of hearing for a patient. This adjustment of the audiological parameters is a tailoring of an audiological therapy for a specific patient.

In tailoring, the patient is tested to obtain aural responses to various conditions. These responses are then used to determine which audiological parameters to adjust as well as the ranges of audiological parameter values that may be adjusted. Different brands of hearing aid may have different audiological parameters. This process of adjustment may be considered a programming of the hearing aid system.

Such programming of the hearing aid system may be accomplished using wireless information technology. Information technology has grown at an unprecedented rate as a result of the synergistic marriage of communication networks and the computer. Milestones in the development of these communication networks have included the wired telephone networks, radio, television, cable, cellular networks, and communication satellites. Computers have made dramatic progress from being hulking machines with human operators to today's postage-stamp-size integrated circuits. The merging of the communication networks and the computer has replaced the model of forcing workers to bring their work to the machine with a model of allowing anyone to access information on any computers at diverse locations and times.

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The programming of hearing aid systems can leverage from that synergy of communication networks and the computer. One consequence of the execution of the described embodiments is that a professional can focus on his/her main task -- providing the best audiological therapy to a patient through a hearing aid system -- and not focus on managing a complicated software or programming system. The term professional means the inclusion of anyone, such as an audiologist, who is capable and qualified for providing professional services related to providing audiological therapy. This is possible because the embodiments provide the appropriate software and information at the instant they are needed by the professional. In yet other embodiments, diagnostics and adjustment can be made without the immediate presence of a professional. In one embodiment, such diagnostics and adjustment is initiated by a patient. Because of the ability of the patient to initiate remote communication with either a professional or to the central server that comprises an expert system trained in providing audiological therapy, the patient can benefit from diagnostics and adjustments to the hearing aid system even without the presence of a professional. In another embodiment, the diagnostics and adjustment is initiated by the remote server. The following embodiments discuss that and other concepts.

Figure 1 is a pictorial diagram illustrating a system in accordance with one embodiment. The system 100 includes a hearing aid system 102 that is adapted to wear by a person. The hearing aid system 102 is capable of audio signal processing. Such an audio signal processing system can be used, for example, to tailor the hearing aid system 102 to provide an appropriate audiological therapy for a specific patient. In one embodiment, the hearing aid system 102 comprises a hearing aid device 102_0. In this embodiment, the hearing aid system 102 may comprise a digital signal processor that is capable of accepting different generations of software. In another embodiment, the hearing aid device 102_0 is capable of digital audio compression and decompression.

In another embodiment, the hearing aid system 102 comprises a hearing aid device 102_0 and a programming module 102_1. The programming module 102_1 is communicatively coupled to the hearing aid device 102_0. The term communicatively coupled means the inclusion of wireless coupling or wired

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coupling. In one embodiment, the hearing aid device 102_0 and the programming module 102_1 are each capable of digital audio compression and decompression. In another embodiment, the programming module 102_1 is capable of sending a test signal to the hearing aid device 102_0 so as to test for at least one aural response of the patient. In another embodiment, the programming module 102_1 includes a headset. In another embodiment, the programming module 102_1 is adapted to provide Bluetooth wireless connectivity, signal processing, and power for programming of the hearing aid device 102_0. In one embodiment, the programming module 102_1 is adapted to be worn around the patient's neck, or integrated into a headset or eyeglass fixture.

The hearing aid system 102 can communicate bi-directionally via a short-range network 104. In one embodiment, the short-range network is a pico-cellular network. In another embodiment, the short-range network includes a network occupying an un-licensed frequency-band. In one embodiment, the short-range network 104 includes wired networking. In another embodiment, the short-range network 104 includes a wireless short-range network such as a radio transmission network or an optical transmission network. One implementation of the radio transmission network includes Bluetooth technology. Bluetooth technology provides a short-range, low-cost radio communication link. Bluetooth may be used to replace wired cables that connect peripherals to this sample of equipment: cellular phones, audio headsets, computer laptops, personal digital assistants, digital cameras, etc. Another implementation of the radio transmission network includes HomeRF, DECT, PHS, or Wireless LAN (WLAN), or other equivalent proprietary wireless communications protocols that do not depart from the present invention.

An optical transmission network provides short-range wireless connectivity for line-of-sight applications. This type of network includes the Infrared Data Associate (IrDA) protocol.

The hearing aid system 102 can communicate with a device 106 facilitated by the short-range network 104. In various embodiments, the device 106 includes a mobile device or a terminal. The term "mobile device" means the inclusion of a digital cellular telephone, a personal digital assistant, a personal communication and information device. Furthermore, the term "mobile device"

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means the inclusion of a handheld device. The term "terminal" means the inclusion of a data terminal. The term "personal digital assistant" means the inclusion of a portable personal-computing device. The term "personal communication and information device" means the inclusion of a device capable of mobile communication as well as being capable of functioning as a personal digital assistant. In one embodiment, the device 106 can provide instructions to the hearing aid device 102_0 so as to tailor the audiological therapy, program existing software, or upgrade to new software. In another embodiment, the device 106 can provide instructions to the programming module 102_1 so as to tailor the audiological therapy, program existing software, or upgrade to new software. In another embodiment, the device 106 is adapted to store and execute a browser. The term browser means the inclusion of a software environment that is adapted to receive and execute distributed applications, such as applets. The device 106 is adapted to use data service protocol such as General Packet Radio Service (GPRS), High-Speed Circuit-Switched Data Service (HSCSD), Enhanced Data Rate for GSM Evolution (EDGE), Integrated Services Digital Network (ISDN), Universal Mobile Telecommunications System (UMTS), or Cellular Digital Packet Data (CDPD). In one embodiment, the data service protocol can be a wireless data service protocol.

The device 106 can communicate bi-directionally via a long-range wireless network 110. In one embodiment, the long-range wireless network includes cellular network. In another embodiment, the long-range wireless network includes a paging network. In another embodiment, the long-range wireless network includes a multimedia communications network. In another embodiment, the long-range wireless network 110 includes wireless technologies such as Global System for Mobile Communications (GSM), Code Division Multiple Access-One (cdmaOne), Time Division Multiple Access (TDMA), PDC, Japan Digital Cellular (JDC), Universal Mobile Telecommunications System (UMTS), Code Division Multiple Access-2000 (cdma2000), and Digital Enhanced Cordless Telephony (DECT).

A gateway 112 is communicatively coupled to the long-range wireless network 110. The term gateway is understood to mean the inclusion of a device that connects networks using different communications protocols so that

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information can be passed from one network to the other without incompatibility.

The gateway 112 connects Internet 114 to the long-range wireless network 110. In one embodiment, the term Internet means the inclusion of a worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another. In another embodiment, the term Internet means the inclusion of Internet2.

A server 116 is coupled to the Internet 114. In one embodiment, the server 116 is adapted to communicate with the device 106 through the Internet 114 and the long-range wireless network 110. In one embodiment, the device 106 is adapted to synchronize data with the server, such as the personal digital assistant. In another embodiment, the device 106 is adapted to receive an upgraded audiological software from the server 116. In one embodiment, the server 116 includes a database that includes patient data and audiological data associated with at least one type of hearing aid system. The server 116 stores a number of distributed applications, such as Java applications. The term Java application means the inclusion of a Java applet. The term distributed application means the inclusion of an object that can be distributed through mechanisms, such as Java-based distribution techniques, Common Object Request Broker Architecture (CORBA), or Component Object Model (COM). These distributed applications are adapted to interact with the hearing aid system 102.

In one embodiment, these distributed applications, such as a Java applet, are adapted to move from the server 116 to the device 106 to execute on the device 106. In another embodiment, once a distributed application is executed on the device 106, the device 106 may interact with the hearing aid system 102 through the user interface provided by the distributed application. In yet another embodiment, the distributed application when moved to the device 106 would dynamically plug into existing software that includes a user interface already on the mobile device.

When such distributed applications are executing on the device 106, the distributed applications are adapted to receive additional information from the

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server 116. Such distributed applications are also adapted to send information to the server 116 from the device 106.

In another embodiment, the server 116 receives from the device 106 a patient identification. Based on this patient identification, the server 116 accesses the patient's medical history and the information regarding the hearing device system being worn by the patient. Next, the server 116 calculates a best fit procedure to obtain programmable audiological parameters for the hearing aid system. These programmable audiological parameters are communicated to the mobile device 106 so as to allow a programming of the hearing aid system.

One of the various benefits of the heretofore described embodiments include allowing the professional to access the most relevant software and information to aid him/her in his/her task of providing the best audiological therapy through a hearing aid system for a patient. This is possible because the embodiments allow storage of the software and information on a central server. The professional can thus access the information anywhere he needs to be to provide professional services needed by the patient. Another benefits of the heretofore described embodiments include the upgrading of software in the processing component (not shown) of the hearing aid system 102.

Figure 2 is a process diagram illustrating a method in accordance with one embodiment. Process 200 is a business method. At block 202, the process 200 includes deriving at least one audiological parameter by testing a patient to obtain at least one aural response. The term aural response means the inclusion of a result obtained by applying a series of tests on the patient; one test may include sending audio test signals and measuring the response of the patient to those audio test signals. Once sufficient aural responses are obtained, the business method derives at least one audiological parameter. The term audiological parameter means the inclusion of an adjustable parameter of an audio signal processing component of a hearing aid system; although certain audiological parameters are general and are available for adjustment across different types of hearing aid systems, other audiological parameter may be specific for a particular brand and made of a hearing aid system.

The process 200 includes upgrading software capable of executing on the hearing aid system. The upgrading of the software depends at least on the

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audiological parameter or audiological parameters that were derived in block 202. In one embodiment, such audiological parameters serve as an index into a database containing the appropriate software that can be used to upgrade existing software executing on the hearing aid system. In one embodiment, the database resides on a server. In one embodiment, the software stores in the database is adapted to be distributable. Such software is adapted to be downloadable to a mobile device that is communicatively coupled to the server. At least one network is engaged to facilitate the communication between the mobile device and the hearing aid system and the server.

The process 200 includes charging at block 206 for upgrading the software in the hearing aid system. Such charging includes identifying the patient, identifying the patient's health care insurance, identifying the type of hearing device worn by the patient, and identifying the type of therapy needed by the patient. The charging may be accomplished using a billable account or through a credit-card transaction.

Figure 3 is a structure diagram illustrating a data structure in accordance with one embodiment. The structure 300 includes a data structure to store a patient identification 302. The implementation of patient identification 302 includes using any type of data structure including a class or a structure. The structure 300 includes a data structure to store an aural response 304. The implementation of the aural response 304 includes using any type of data structure, such as an array or a linked list.

The structure 300 is adapted to be uploaded from a mobile device to a server through at least one network. In one embodiment, the structure 300 is adapted for tailoring an audiological therapy for the patient.

Figure 4 is a structure diagram illustrating a data structure in accordance with one embodiment. The structure 400 includes a data structure to store a distributed application, such as an applet 402. The applet 402 is adapted to be executed on a device to interact with a hearing aid system so as to tailor an audiological therapy. The applet 402 is also adapted to be downloadable to a mobile device from a server on at least one type of network.

Figure 5 is a structure diagram illustrating a data structure in accordance with one embodiment. The structure 500 includes a data structure to store a

distributed application, such as a distributed object 502. The distributed object 502 is adapted to be executed on a device to interact with a hearing aid system so as to tailor an audiological therapy. The distributed object 502 is also adapted to be downloadable to a mobile device from a server on at least one type of network.

Figure 6 is a pictorial diagram illustrating a system in accordance with one embodiment. Figure 6 contains elements similar to those discussed in Figure 1. For these elements, the aforementioned discussion related to them is incorporated here in full. The system 600 includes hearing aid systems 602_A and 602_B. The hearing aid system 602_A comprises a programming module 602_{A1} and a hearing aid device 602_{A0}. The hearing aid system 602_B comprises the hearing aid device 602_{B0}. Whereas a mobile device 606 communicates with the hearing aid device 602_{A0} of the hearing aid system 602_A through the programming module 602_{A1}, the mobile device 606 communicates directly with the hearing aid device 602_{B0} of the hearing aid system 602_B.

For illustrative purposes only, suppose a patient is being fitted with the hearing aid system 602_B. During the fitting process, a piece of software may be executed on the mobile device 606 to interact with the patient wearing the hearing aid system 602_B. Such interaction includes sending audio test signals from the software executing on the mobile device 606 to the hearing aid system 602_B. Such software includes a user interface. The aural response from the patient is either automatically sent back to the testing software by the hearing aid system 602_B or is recorded manually into the testing software through the mobile device 606. Once sufficient aural responses are collected, in one embodiment, such aural responses are sent to a programming fitting server 616 through the cellular/mobile network 610 and the Internet 614; in another embodiment, such aural responses are formatted to form an audiogram before sending the information to the programming fitting server 616. The term audiogram means the inclusion of profiling from the aural responses so as to obtain the extent of the hearing loss of the patient. The programming fitting server 616 derives at least one audiological parameter from the aural responses. Such audiological parameters are used to tailor an audiological therapy, to program existing audiological software, or to upgrade existing audiological software. For the

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purpose of this illustration, the programming fitting server 616 derives an adjustment to an audio signal processing component of the hearing aid system 602_B. Such adjustment incrementally tailors an audiological therapy provided by the hearing aid system 602_B so that the hearing aid system 602_B fits the patient.

The foregoing illustrative discussion is also applicable in an embodiment that includes the hearing aid system 602_A.

Figure 7 is a process diagram illustrating a method in accordance with one embodiment. Process 700 includes, at block 702, interacting with a client application that is executing on a mobile device. In one embodiment, the mobile device is adapted to communicate using a wireless protocol or a Wireless Access Protocol. The term Wireless Access Protocol (WAP) means the inclusion of an open communications standard (protocol and mark-up language) designed to bring Internet access and other value-added services to a mobile device. WAP defines an application environment (mark-up and programming language) and an application protocol. The application protocol allows WAP applications to be downloaded to mobile devices on demand and removed when no longer in use.

The act of interacting includes entering an identification of a patient, entering an identification of a type of hearing aid system that is being fitted or worn by the patient, or recording aural responses of the patient to audio test signals.

The process 700 includes, at block 704, communicating with a server application that is executing on a server. In one embodiment, the server is coupled to the Internet. The client application is adapted to communicate with the server application through a long-range wireless network. The act of communicating includes uploading information gathered during the act of interacting, such as the identification of the patient. The act of communicating further includes communicating with the client application to download information such as a programming interface.

The process 700 includes, at block 706, determining at least one programming interface to program the hearing aid system. The act of determining includes using at least the type of the hearing aid system to derive the programming interface. The term programming interface means the inclusion of an application programming interface for a specific type of hearing

aid system; the application programming interface includes a set of audiological parameters that may be adjusted so as to fit the hearing aid system to the patient.

The process 700 includes, at block 708, programming the hearing aid system. The act of programming includes adjusting the set of audiological parameters through the application programming interface. The act of programming may also include downloading new software to replace the existing software in the hearing aid system. The act of programming may further include downloading an incremental upgrade to the existing software in the hearing aid system.

The process 700 includes, at block 710, tailoring the hearing aid system to the patient by adjusting at least one programming interface by the client application. The act of tailoring includes the incremental adjustment of the hearing aid system so that the hearing aid system fits the patient.

The foregoing discussion is also applicable to an embodiment where a client application is executing on a terminal.

Figure 8 is a pictorial diagram illustrating a system in accordance with one embodiment. Figure 8 contains elements similar to those discussed in Figures 1 and 6. The aforementioned discussion of those similar elements is incorporated here in full. System 800 includes a custom interface module 806_1. The custom interface module 806_1 is adapted to be communicatively coupled to the mobile device 806. In one embodiment, the custom interface module 806_1 is adapted to be wirelessly communicable with the hearing aid system 802_B. In another embodiment, the custom interface module 806_1 is adapted to be wiredly communicable with the hearing aid system 802_A. Such custom interface module 806_1 may be implemented using Bluetooth technology or other equivalent technologies to provide a proprietary wireless interface directly to the hearing aid systems 802_A or 802_B. One implementation of the customer interface module 806_1 includes using a serial or data port (not shown) of the mobile device 806.

In various embodiments, a client application executing on the mobile device 806 can interact with the hearing aid systems 802_A or 802_B through the custom interface module 806_1. The client application may be in communication with a server application executing on a programming fitting server 816 through an Internet 814, gateway 812, and cellular/mobile network 810.

Figure 9 is a pictorial diagram illustrating a system in accordance with one embodiment. Figure 9 contains elements similar to those discussed in Figures 1, 6, and 8. The aforementioned discussion of those elements is incorporated here in full. System 900 includes a personal communication and information device (PCID) 906 or a personal digital assistant with wireless communication capability. In one embodiment, the PCID 906 is adapted to communicate wirelessly using technology such as Bluetooth or IrDA. The PCID 906 includes a pen 906_A. The pen 906_A is an inputting device adapted to interact with the user interface of the PCID 906.

In various embodiments, the PCID 906 is adapted to communicate with hearing aid systems 902_A or 902_B using a short-range wireless network. The hearing aid system 902_A includes a hearing aid device 902_{A0} and a programming module 902_{A1}. The PCID 906 is also adapted to communicate with a programming fitting server 916. Such communication may occur over a cellular/mobile network 910, gateway 912, and Internet 914.

In any embodiments that include the PCID 906, the PCID 906 can send audio test signals to the hearing aid systems 902_A or 902_B. Such audio test signals are compressed before transmission. Once these compressed audio test signals are received by either the hearing aid systems 902_A or 902_B, the audio test signals are decompressed. These test signals are then presented to the patient. In yet any other embodiments that include the PCID 906, the PCID 906 can send instructions to the hearing aid systems 902_A or 902_B. Based on the instructions, the hearing aid systems 902_A or 902_B generates the audio test signals using its audio signal processing capability.

Figure 10 is a pictorial diagram illustrating a system in accordance with one embodiment. Figure 10 contains elements similar to those discussed in Figures 1, 6, 8, and 9. The aforementioned discussion of those elements is incorporated here in full. System 1000 includes a personal communication and information device (PCID) 1006 or a personal digital assistant with wireless communication capability. In one embodiment, the PCID 1006 includes a PCMIA module. In another embodiment, the PCID 1006 includes a CompactFlash module 1006_1. The CompactFlash module 1006_1 is communicatively coupled to hearing aid systems 1002_A and 1002_B. In one

embodiment, the CompactFlash module 1006_1 is implemented using short-range wireless technology, such as Bluetooth. In another embodiment, the CompactFlash module 1006_1 is adapted to be used even when the PCID 1006 lacks short-range wireless ability. The PCID 1006 is also adapted to communicate with a programming fitting server 1016. Such communication may occur over a cellular/mobile network 1010, gateway 1012, and Internet 1014.

Figure 11 is a pictorial diagram illustrating a system in accordance with one embodiment. Figure 11 contains elements similar to those discussed in Figures 1, 6, 8, 9, and 10. The aforementioned discussion of those elements is incorporated here in full. System 1100 includes a terminal 1106. The term terminal means the inclusion of a data terminal. In one embodiment, the terminal 1106 is adapted to use a data service protocol such as General Packet Radio Service (GPRS), High-Speed Circuit-Switched Data Service (HSCSD), Enhanced Data Rate for GSM Evolution (EDGE), Integrated Services Digital Network (ISDN), Universal Mobile Telecommunications System (UMTS), or Cellular Digital Packet Data (CDPD).

The terminal 1106 is adapted to communicate with hearing aid systems 1102_A, 1102_B, and 1102_C through at least one short-range network. In various embodiments, the short-range network includes a radio communication network such as Bluetooth, an optical communication network such as Infrared Data Association (IrDA) protocol, or a wired communication network. In one embodiment, the short-range network is a wireless network.

In various embodiments, the hearing aid systems 1102_A, 1102_B, and 1102_C include a hearing aid device. In various embodiments, the hearing aid systems 1102_A, 1102_B, and 1102_C are adapted to be capable of audio signal processing. In various embodiments, the hearing aid systems 1102_A, 1102_B, and 1102_C are adapted to be capable of digital audio compression and decompression. The hearing aid system 1102_A includes a hearing aid device 1102_{A0} and a programming module 1102_{A1}. The programming module 1102_{A1} is adapted to communicate with the hearing aid device 1102_{A0} so as to receive at least one programming instruction from the terminal 1106 to program the hearing aid device 1102_{A0}. In all embodiments described above and below, the

hearing aid system 1102_A may include a headset. The headset is capable of detecting and communicating ambient information to a server application so as to provide additional information to fit, program, or upgrade the audiological software of the hearing aid system 1102_A. In another embodiment, the programming module 1102_{A1} is implemented as a headset. The programming module 1102_{A1} is adapted to be capable of sending a test audio signal to the hearing aid so as to test at least one aural response of a patient.

The terminal 1106 is also adapted to communicate wirelessly using a long-range wireless network 1110. In various embodiments, the long-range wireless network includes various wireless technologies such as Global System for Mobile Communications (GSM), Code Division Multiple Access-one (cdmaOne), Time Division Multiple Access (TDMA), PDC, Universal Mobile Telecommunications System (UMTS), Code Division Multiple Access-2000 (cdma2000), and Digital Enhanced Cordless Telephony (DECT).

The terminal 1106 is adapted to communicate with a server 1116 through the long-range wireless network 1110. The server 1116 contains distributed applications, such as a distributed object that is adapted to interact with hearing aid systems 1102_A, 1102_B, and 1102_C. The distributed object is adapted to move from the server 1116 to the terminal 1106 so as to execute on the terminal 1106 to interact with the hearing aid systems 1102_A, 1102_B, and 1102_C. In one embodiment, the distributed object can receive information from the server 1116 and can transmit information to the server 1116. In one embodiment, the terminal 1106 includes a software environment, such as a browser, that is capable of receiving a distributed object. Such a distributed object can execute on the terminal 1106 so as to interact with the hearing aid systems 1102_A, 1102_B, and 1102_C. In a further embodiment, the server 1116 includes a database that includes patient data and audiological data associated with at least one type of hearing aid system. In one embodiment, the terminal 1106 is a customized or application specific device.

Figure 12 is a pictorial diagram illustrating a system in accordance with one embodiment. Figure 12 contains elements similar to those discussed in Figure 6. For these elements, the aforementioned discussion related to them is incorporated here in full. The system 1200 includes hearing aid systems 1202_A

and 1202_B. The hearing aid system 1202_A comprises a programming module 1202_{A1} and a hearing aid device 1202_{A0}. The hearing aid system 1202_B comprises the hearing aid device 1202_{B0}. Whereas a mobile device 1206 communicates with the hearing aid device 1202_{A0} of the hearing aid system 1202_A through the programming module 1202_{A1}, the mobile device 1206 communicates directly with the hearing aid device 1202_{B0} of the hearing aid system 1202_B.

In this embodiment, the mobile device 1206 contains all the software and information to interact with either hearing aid systems 1202_A and 1202_B without having to interact with a server. In such embodiment, the mobile device 1206 can derive at least one audiological parameter from the aural responses obtained from the patient. As previously discussed, such audiological parameters are used to tailor an audiological therapy, to program existing audiological software, or to upgrade existing audiological software.

Figure 13 is a pictorial diagram illustrating a system in accordance with one embodiment. Figure 13 contains elements similar to those discussed in Figure 8. The aforementioned discussion of those similar elements is incorporated here in full. System 1300 includes a custom interface module 1306_1. The custom interface module 1306_1 is adapted to be communicatively coupled to the mobile device 1306. In one embodiment, the custom interface module 1306_1 is adapted to be wirelessly communicable with the hearing aid system 1302_B. In another embodiment, the custom interface module 1306_1 is adapted to be wiredly communicable with the hearing aid system 1302_A.

In this embodiment, both the client and server applications reside on the mobile device 806. Thus, the mobile device 806 does not necessarily need to interact with a server.

Conclusion

Thus, systems, devices, structures, and methods have been described for fitting, programming, or upgrading hearing aid systems. In the embodiments where wireless communication is used, the processes of fitting, programming, and upgrading hearing aid systems may avoid the frustration of prior process due to the myriad of programming equipment. The equipment used in the described processes may benefit from running the most recent and relevant version of

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software. The equipment may also benefit from the ability to process data remotely or synchronizing of data. Professionals who are engaged in these processes may benefit from the ability to access a central database to store information as well as access patient and account information. Also, by leveraging the economy of scale offered by wireless information technology, the embodiments provide a solution that is low cost. This is the case because wireless information technology is often built into mass-marketed mobile devices such as a cellular telephone.

Although the specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement which is calculated to achieve the same purpose may be substituted for the specific embodiment shown. This application is intended to cover any adaptations or variations of the present invention. It is to be understood that the above description is intended to be illustrative and not restrictive. Combinations of the above embodiments and other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention includes any other applications in which the above structures and fabrication methods are used. Accordingly, the scope of the invention should only be determined with reference to the appended claims, along with the full scope of quivalents to which such claims are entitled.

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We claim:

1. A method comprising:

programming a hearing aid system using at least one mobile wireless communication protocol.

2. The method of claim 1, wherein programming includes programming the hearing aid system by a mobile device.

3. The method of claim 2, wherein programming includes programming the hearing aid system by the mobile device that is adapted to communicate with a server.

4. The method of claim 3, wherein programming includes programming the hearing aid system by the mobile device that is adapted to communicate with a server through at least one network using the at least one mobile wireless communication protocol.

5. The method of claim 4, wherein the programming includes programming a programming module coupled to the hearing aid system.

6. A method for tailoring an audiological therapy for a patient, the method comprising:

deriving at least one audiological parameter by obtaining data about at least one aural response of the patient; and

programming a hearing aid system based on the at least one audiological parameter by a mobile device so as to tailor an audiological therapy for the patient.

7. The method of claim 6, wherein programming includes programming the hearing aid system based on the at least one audiological parameter by the mobile device that is adapted to communicate with a server.

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8. The method of claim 7, wherein programming includes programming the hearing aid system based on the at least one audiological parameter by the mobile device that is adapted to communicate with the server through at least one network so as to tailor the audiological therapy for the patient.

9. A method comprising:

deriving at least one audiological parameter by obtaining data about at least one aural response of a patient; and

upgrading a piece of software capable of executing on the hearing aid system based on the at least one audiological parameter, wherein upgrading includes downloading the software by a mobile device.

10. The method of claim 9, wherein downloading includes downloading the software by the mobile device that is adapted to communicate with a server.

11. The method of claim 10, wherein downloading includes downloading the software by the mobile device that is adapted to communicate with the server through at least one network.

12. A business method comprising:

deriving at least one audiological parameter by obtaining data about at least one aural response of a patient;

upgrading a piece of software capable of executing on the hearing aid system based on the at least one audiological parameter, wherein upgrading includes downloading the software by a mobile device; and

charging for upgrading the software in the hearing aid system.

13. The business method of claim 12, wherein downloading includes downloading the software by the mobile device that is adapted to communicate with a server.

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14. The business method of claim 13, wherein downloading includes downloading the software by the mobile device that is adapted to communicate with a server through at least one network.

15. A system comprising:
a hearing aid system; and
a mobile device adapted to program the hearing aid system.

16. The system of claim 15, further comprising a server adapted to communicate with the mobile device.

17. The system of claim 16, further comprising at least one network to facilitate communications at least among the hearing aid system, the mobile device, and the server.

18. The system of claim 15, wherein the hearing aid system includes a hearing aid.

19. The system of claim 15, wherein the hearing aid system is capable of audio signal processing.

20. The system of claim 15, wherein the hearing aid system includes a hearing aid and a programming module adapted to communicate with the hearing aid, and wherein the programming module is adapted to communicate with the mobile device so as to receive at least one programming instruction from the mobile device to program the hearing aid.

21. The system of claim 20, wherein the programming module includes a headset.

22. The system of claim 20, wherein the hearing aid is capable of digital audio compression and decompression, and wherein the programming module is capable of digital audio compression and decompression.

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23. The system of claim 20, wherein the programming module is capable of sending a test audio signal to the hearing aid so as to test at least one aural response of a patient.

24. The system of claim 15, wherein the mobile device includes a mobile device selected from a group consisting of a digital cellular telephone, a personal digital assistant, and a personal communication and information device.

25. The system of claim 24, wherein the mobile device is adapted to synchronize data with the server.

26. The system of claim 25, wherein the mobile device is adapted to receive an upgraded audiological software from the server.

27. The system of claim 15, wherein the mobile device is adapted to use a data service protocol selected from a group consisting of General Packet Radio Service (GPRS), High-Speed Circuit-Switched Data Service (HSCSD), Enhanced Data Rate for GSM Evolution (EDGE), Integrated Services Digital Network (ISDN), Universal Mobile Telecommunications System (UMTS), and Cellular Digital Packet Data (CDPD).

28. The system of claim 17, wherein the at least one network includes a long-range wireless network.

29. The system of claim 28, wherein the long-range wireless network includes a long-range wireless network including a protocol selected from a group consisting of Global System for Mobile Communications (GSM), Code Division Multiple Access-One (cdmaOne), Time Division Multiple Access (TDMA), PDC, JDC, Universal Mobile Telecommunications System (UMTS), Code Division Multiple Access-2000 (cdma2000), and Digital Enhanced Cordless Telephony (DECT).

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30. The system of claim 17, wherein the at least one network includes a short-range network.

31. The system of claim 30, wherein the short-range network includes a short-range network selected from a group consisting of a radio communication network, an optical communication network, and a wired communication network.

32. The system of claim 31, wherein the optical communication network includes an optical communication network using Infrared Data Association (IrDA) protocol.

33. The system of claim 30, wherein the hearing aid system is adapted to communicate with the mobile device wirelessly through the short-range network.

34. The system of claim 17, further comprising an Internet coupled to the server.

35. The system of claim 34, further comprising a gateway coupled to the at least one network and the Internet.

36. The system of claim 16, further comprising at least one Java application adapted to interact with the hearing aid system, wherein the at least one Java application is adapted to be stored on the server.

37. The system of claim 36, wherein the at least one Java application includes an applet.

38. The system of claim 37, wherein the applet is adapted to move from the server to the mobile device so as to execute on the mobile device to interact with the hearing aid system.

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39. The system of claim 38, wherein the applet is adapted to receive information from the server, and wherein the applet is adapted to transmit information to the server.

40. The system of claim 37, wherein the mobile device includes a browser that is adapted to receive the applet to execute on the mobile device so as to interact with the hearing aid system.

41. The system of claim 16, wherein the server includes a database that includes patient data, and audiological data associated with at least one hearing aid system.

42. The system of claim 31, wherein the radio communication network includes a network selected from a group consisting of HomeRF, DECT, PHS, WLAN, and Bluetooth technology.

43. The system of claim 24, wherein the personal communication and information device includes a CompactFlash module that is adapted to communicate with the hearing aid system.

44. The system of claim 24, wherein the digital cellular phone includes a custom interface module that is adapted to communicate with the hearing aid system.

45. The system of claim 26, wherein the upgraded audiological software includes a piece of software to be executed on the mobile device.

46. The system of claim 26, wherein the hearing aid system includes a hearing aid, and wherein the upgraded audiological software includes a piece of software to be executed on the hearing aid.

47. A system comprising:

a hearing aid system; and

a terminal adapted to program the hearing aid system.

48. The system of claim 47, further comprising a server adapted to communicate with the terminal.

49. The system of claim 48, further comprising at least one network to facilitate communications at least among the hearing aid system, the terminal, and the server.

50. The system of claim 47, wherein the hearing aid system includes a hearing aid.

51. The system of claim 47, wherein the hearing aid system is capable of audio signal processing.

52. The system of claim 47, wherein the hearing aid system includes a hearing aid and a programming module adapted to communicate with the hearing aid, and wherein the programming module is adapted to communicate with the terminal so as to receive at least one programming instruction from the terminal to program the hearing aid.

53. The system of claim 52, wherein the programming module includes a headset that is capable of communicating ambient information.

54. The system of claim 52, wherein the hearing aid is capable of digital audio compression and decompression, and wherein the programming module is capable of digital audio compression and decompression.

55. The system of claim 52, wherein the programming module is capable of sending a test audio signal to the hearing aid so as to test at least one aural response of a patient.

56. The system of claim 47, wherein the terminal is a data terminal.

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57. The system of claim 48, wherein the terminal is adapted to synchronize data with the server.

58. The system of claim 57, wherein the terminal is adapted to receive an upgraded audiological software from the server.

59. The system of claim 47, wherein the terminal is adapted to use a data service protocol selected from a group consisting of General Packet Radio Service (GPRS), High-Speed Circuit-Switched Data Service (HSCSD), Enhanced Data Rate for GSM Evolution (EDGE), Integrated Services Digital Network (ISDN), Universal Mobile Telecommunications System (UMTS), and Cellular Digital Packet Data (CDPD).

60. The system of claim 49, wherein the at least one network includes a long-range wireless network.

61. The system of claim 60, wherein the long-range wireless network includes a long-range wireless network including a protocol selected from a group consisting of Global System for Mobile Communications (GSM), Code Division Multiple Access-One (cdmaOne), Time Division Multiple Access (TDMA), PDC, JDC, Universal Mobile Telecommunications System (UMTS), Code Division Multiple Access-2000 (cdma2000), and Digital Enhanced Cordless Telephony (DECT).

62. The system of claim 49, wherein the at least one network includes a short-range network.

63. The system of claim 62, wherein the short-range network includes a short-range network selected from a group consisting of a radio communication network, an optical communication network, and a wired communication network.

64. The system of claim 63, wherein the optical communication network includes an optical communication network using Infrared Data Association (IrDA) protocol.

65. The system of claim 62, wherein the hearing aid system is adapted to communicate with the terminal wirelessly through the short-range network.

66. The system of claim 48, further comprising at least one distributed application adapted to interact with the hearing aid system, wherein the at least one distributed application is adapted to be stored on the server.

67. The system of claim 66, wherein the at least one distributed application includes at least one object that is capable of being distributed.

68. The system of claim 67, wherein the at least one object is adapted to move from the server to the terminal so as to execute on the terminal to interact with the hearing aid system.

69. The system of claim 68, wherein the at least one object is adapted to receive information from the server, and wherein the at least one object is adapted to transmit information to the server.

70. The system of claim 67, wherein the terminal includes a software environment that is adapted to receive the at least one object to execute on the terminal so as to interact with the hearing aid system.

71. The system of claim 48, wherein the server includes a database that includes patient data, and audiological data associated with at least one hearing aid system.

72. The system of claim 63, wherein the radio communication network includes a network implemented using Bluetooth technology.

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73. A method comprising:

interacting with a client application executing on a mobile device, wherein interacting with the client application includes entering an identification of a patient;

determining at least one programming interface to program a hearing aid system that is at least based on a type of hearing aid system; and

programming the hearing aid system by the client application with the at least one programming interface.

74. The method of claim 73, wherein interacting with the client application includes interacting with the client application on the mobile device that is adapted to communicate using a wireless protocol.

75. The method of claim 73, wherein interacting with the client application includes interacting with the client application on the mobile device that is adapted to communicate using a Wireless Access Protocol.

76. The method of claim 73, further comprising communicating with a server application executing on a server coupled to an Internet through a long-range wireless network.

77. The method of claim 76, wherein communicating with the server application includes uploading the identification of the patient to the server application.

78. The method of claim 77, further comprising communicating with the client application by the server application.

79. The method of claim 78, wherein communicating with the client application includes downloading the at least one programming interface from the server application to the client application.

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80. The method of claim 79, further comprising tailoring the hearing aid system to the patient by adjusting the at least one programming interface by the client application executing on the mobile device.

81. A method comprising:

interacting with a client application executing on a terminal, wherein interacting with the client application includes entering an identification of a patient;

determining at least one programming interface to program a hearing aid system that is at least based on a type of the hearing aid system; and

programming the hearing aid system by the client application with the at least one programming interface.

82. The method of claim 81, wherein interacting with the client application includes interacting with the client application on the terminal that is adapted to communicate using a wireless protocol.

83. The method of claim 82, wherein interacting with the client application includes interacting with the client application on the terminal that is adapted to communicate using a Wireless Access Protocol.

84. The method of claim 81, further comprising communicating with a server application executing on a server coupled to an Internet through a long-range wireless network.

85. The method of claim 84, wherein communicating with the server application includes uploading the identification of the patient to the server application.

86. The method of claim 85, further comprising communicating with the client application by the server application.

87. The method of claim 86, wherein communicating with the client application includes downloading the at least one programming interface from the server application to the client application.

88. The method of claim 87, further comprising tailoring the hearing aid system to the patient by adjusting the at least one programming interface by the client application executing on the terminal.

89. A data structure to be uploaded to a server for tailoring an audiological therapy, the data structure comprising:

a patient identification to identify a patient; and

at least one aural response obtained by testing the patient.

90. A data structure to be downloaded from a server for tailoring an audiological therapy, the data structure comprising:

a distributed application to be executed on a device to interact with a hearing aid system so as to tailor an audiological therapy.

91. The data structure of claim 90, wherein the distributed application is an applet.

92. The data structure of claim 90, wherein the distributed application is at least one object adapted to be distributed.

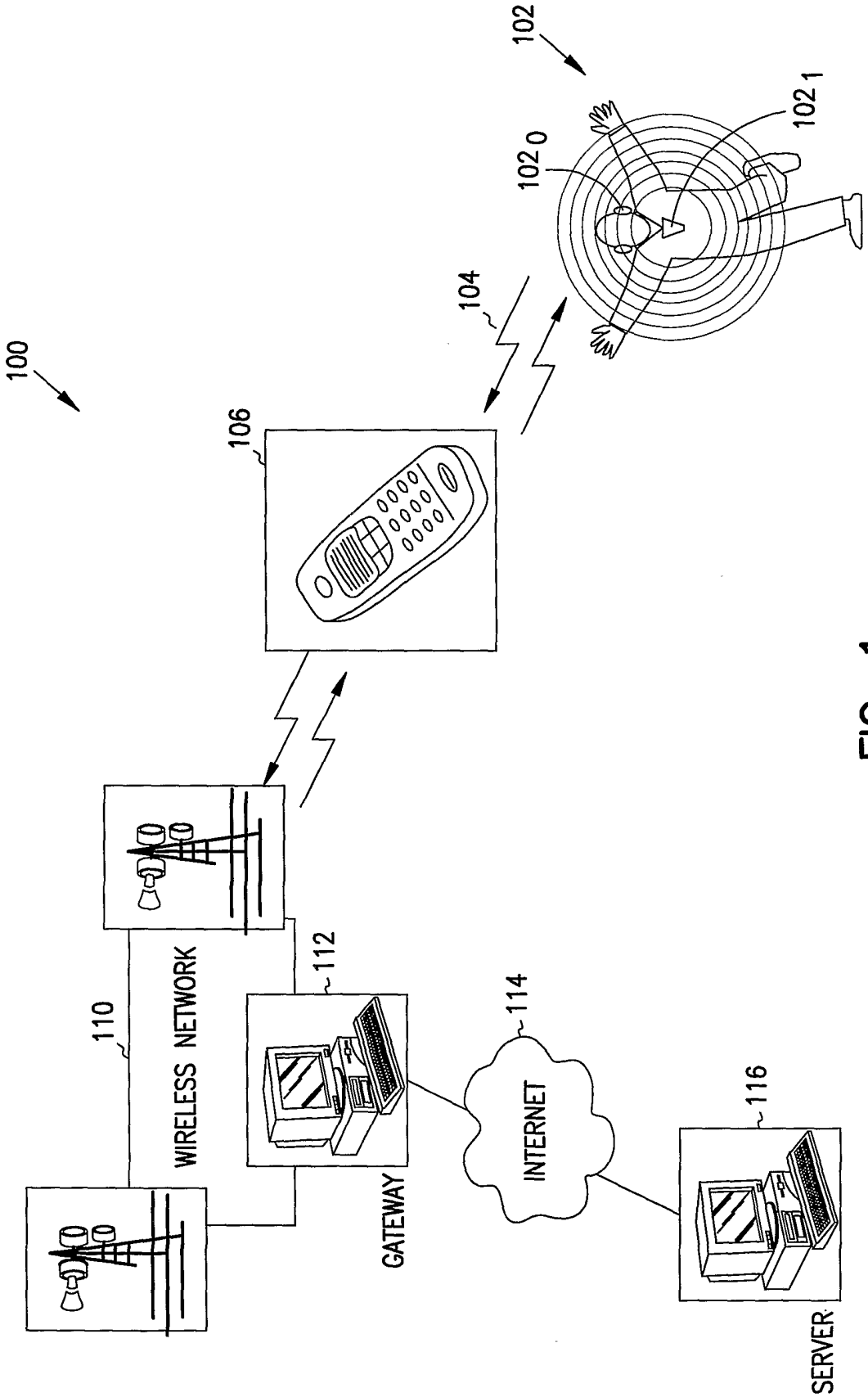
100
102
102 0
102 1
104
106
110
WIRELESS NETWORK
112
GATEWAY
114
INTERNET
116
SERVER

FIG. 1

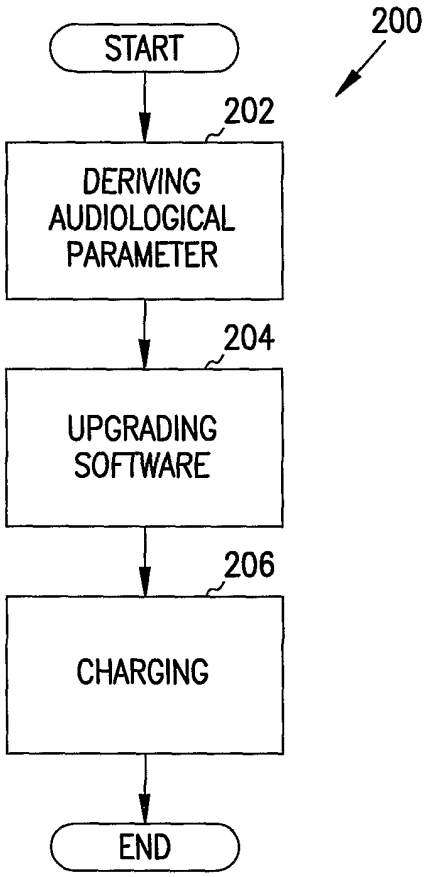
200
START
202
DERIVING AUDIOLOGICAL PARAMETER
204
UPGRADING SOFTWARE
206
CHARGING
END

FIG. 2

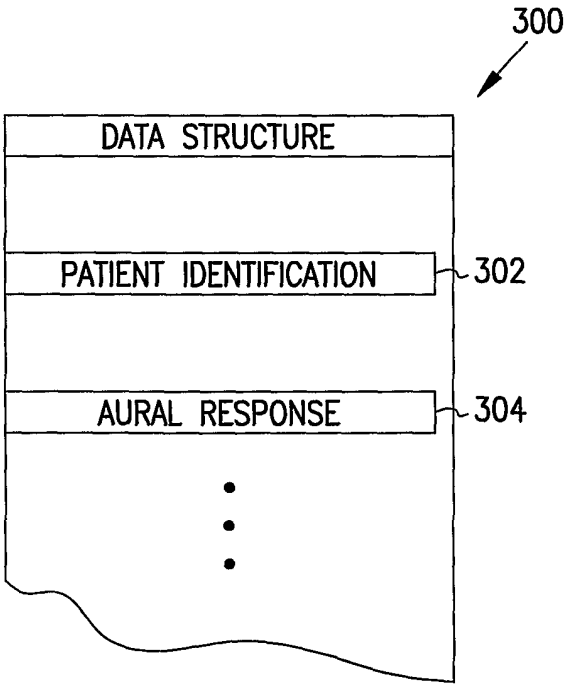
300
DATA STRUCTURE
PATIENT IDENTIFICATION
302
AURAL RESPONSE
304

FIG. 3

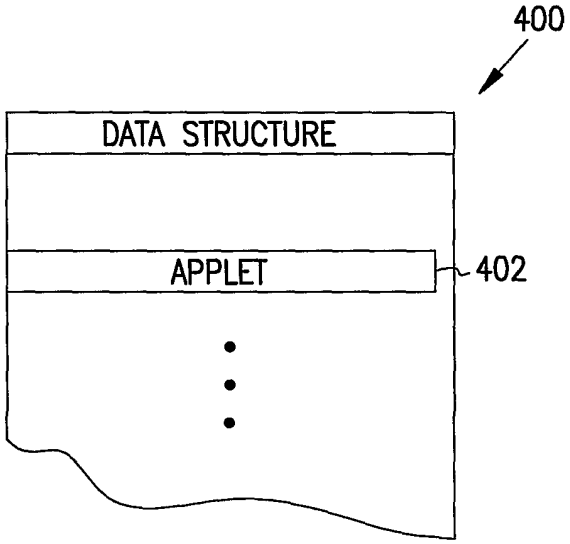
400
DATA STRUCTURE
APPLET
402

FIG. 4

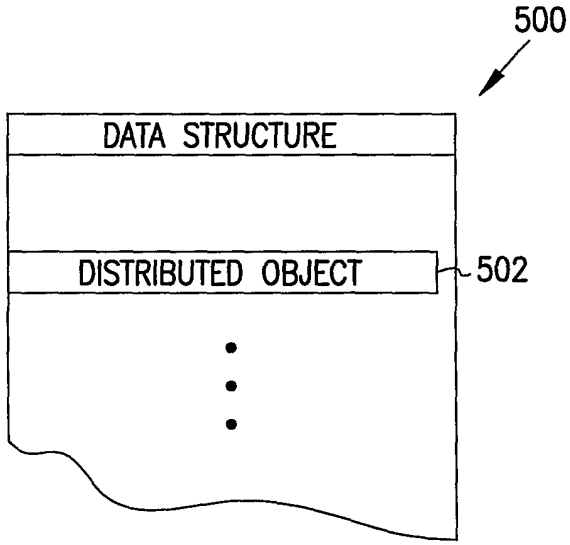
500
DATA STRUCTURE
DISTRIBUTED OBJECT
502

FIG. 5

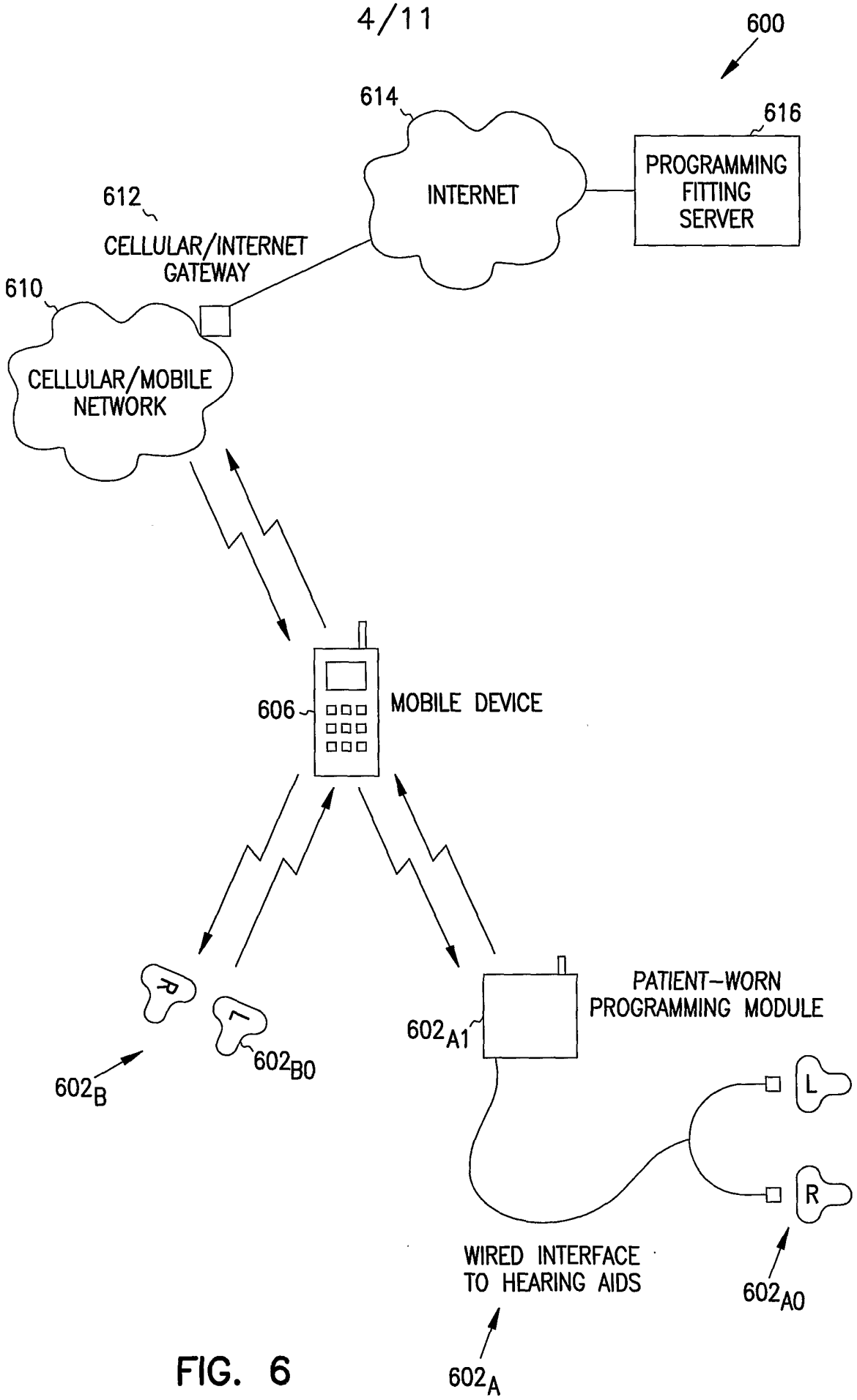
600
614
616
INTERNET
PROGRAMMING
FITTING
SERVER
612
CELLULAR/INTERNET
GATEWAY
610
CELLULAR/MOBILE
NETWORK
606
MOBILE DEVICE
PATIENT-WORN
PROGRAMMING MODULE
602A1
602B0
602B
L
R
WIRED INTERFACE
TO HEARING AIDS
602A0
602A

FIG. 6

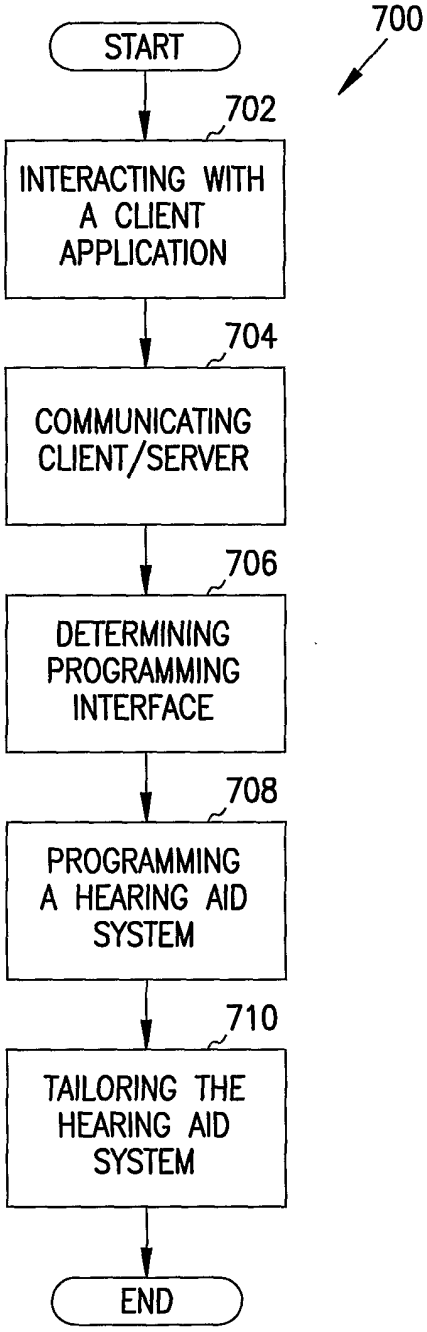
700
START
702
INTERACTING WITH A CLIENT APPLICATION
704
COMMUNICATING CLIENT/SERVER
706
DETERMINING PROGRAMMING INTERFACE
708
PROGRAMMING A HEARING AID SYSTEM
710
TAILORING THE HEARING AID SYSTEM
END

FIG. 7

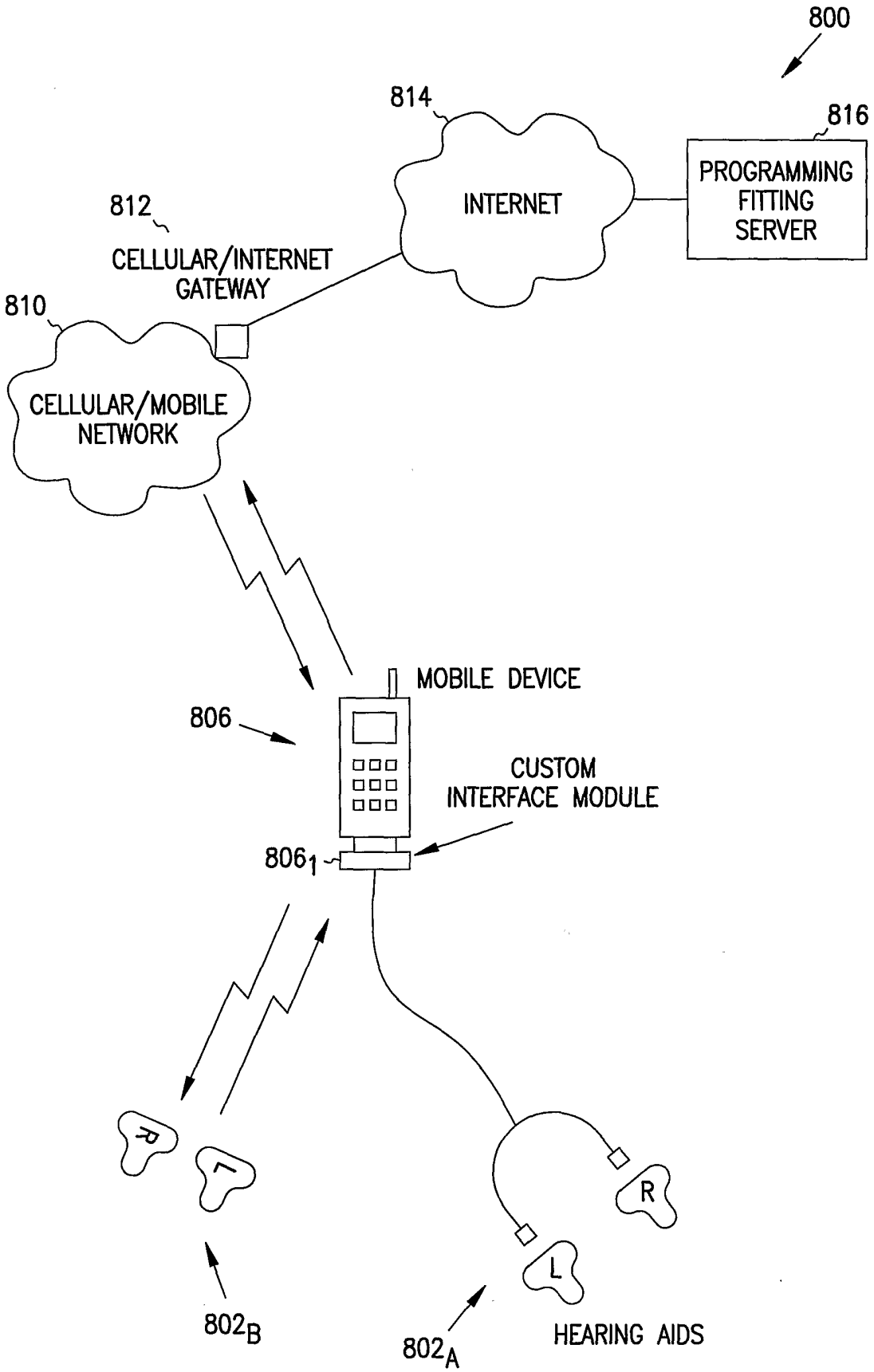
800
814
816
INTERNET
PROGRAMMING
FITTING
SERVER
812
CELLULAR/INTERNET
GATEWAY
810
CELLULAR/MOBILE
NETWORK
MOBILE DEVICE
806
CUSTOM
INTERFACE MODULE
806₁
R
L
R
L
802B
802A
HEARING AIDS

FIG. 8

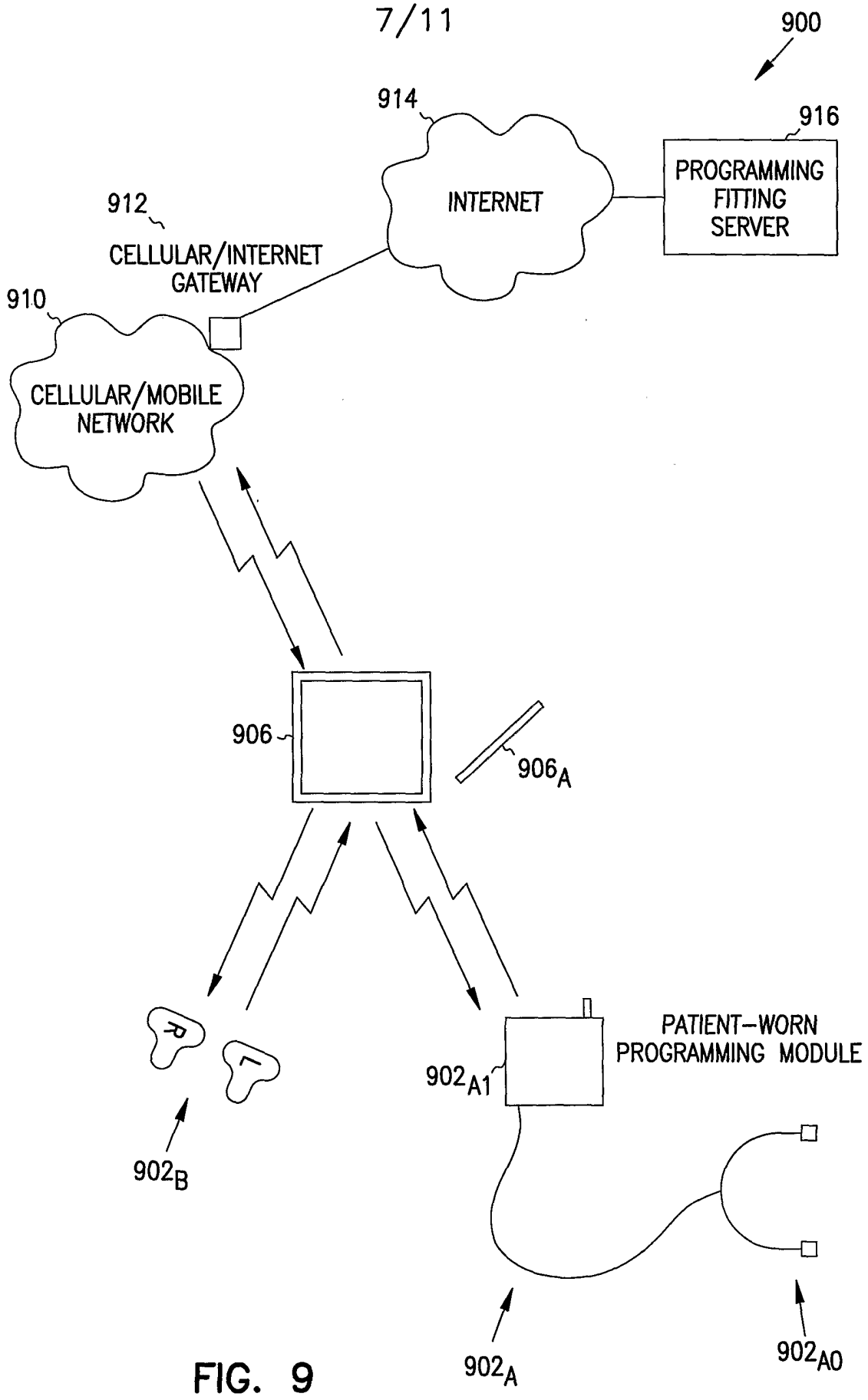
900
914
916
INTERNET
PROGRAMMING
FITTING
SERVER
912
CELLULAR/INTERNET
GATEWAY
910
CELLULAR/MOBILE
NETWORK
906
906A
PATIENT-WORN
PROGRAMMING MODULE
902A1
902B
902A
902A0

FIG. 9

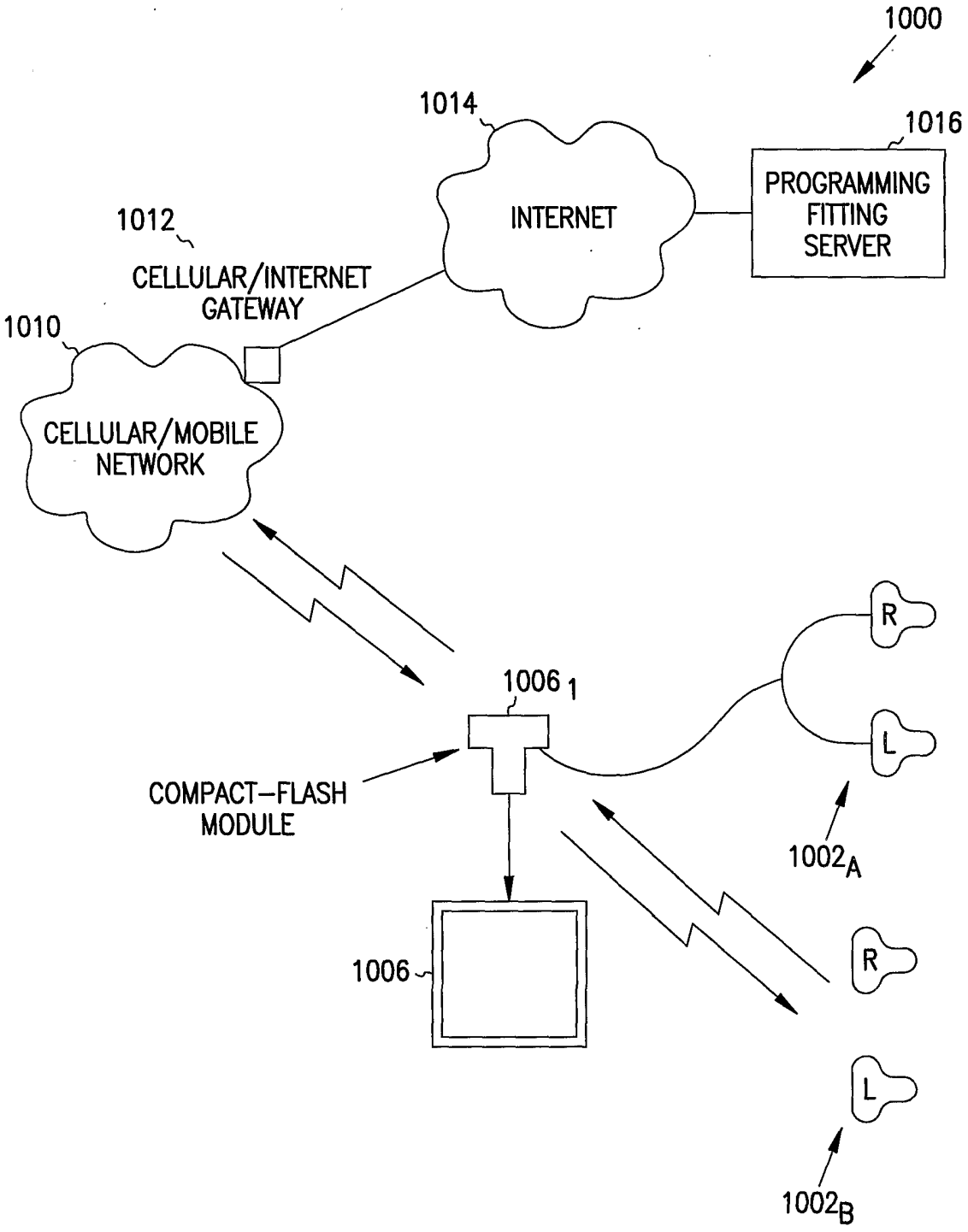
1000
1014
1016
INTERNET
PROGRAMMING FITTING SERVER
1012
CELLULAR/INTERNET GATEWAY
1010
CELLULAR/MOBILE NETWORK
R
L
1006 1
COMPACT-FLASH MODULE
1002A
1006
R
L
1002B

FIG. 10

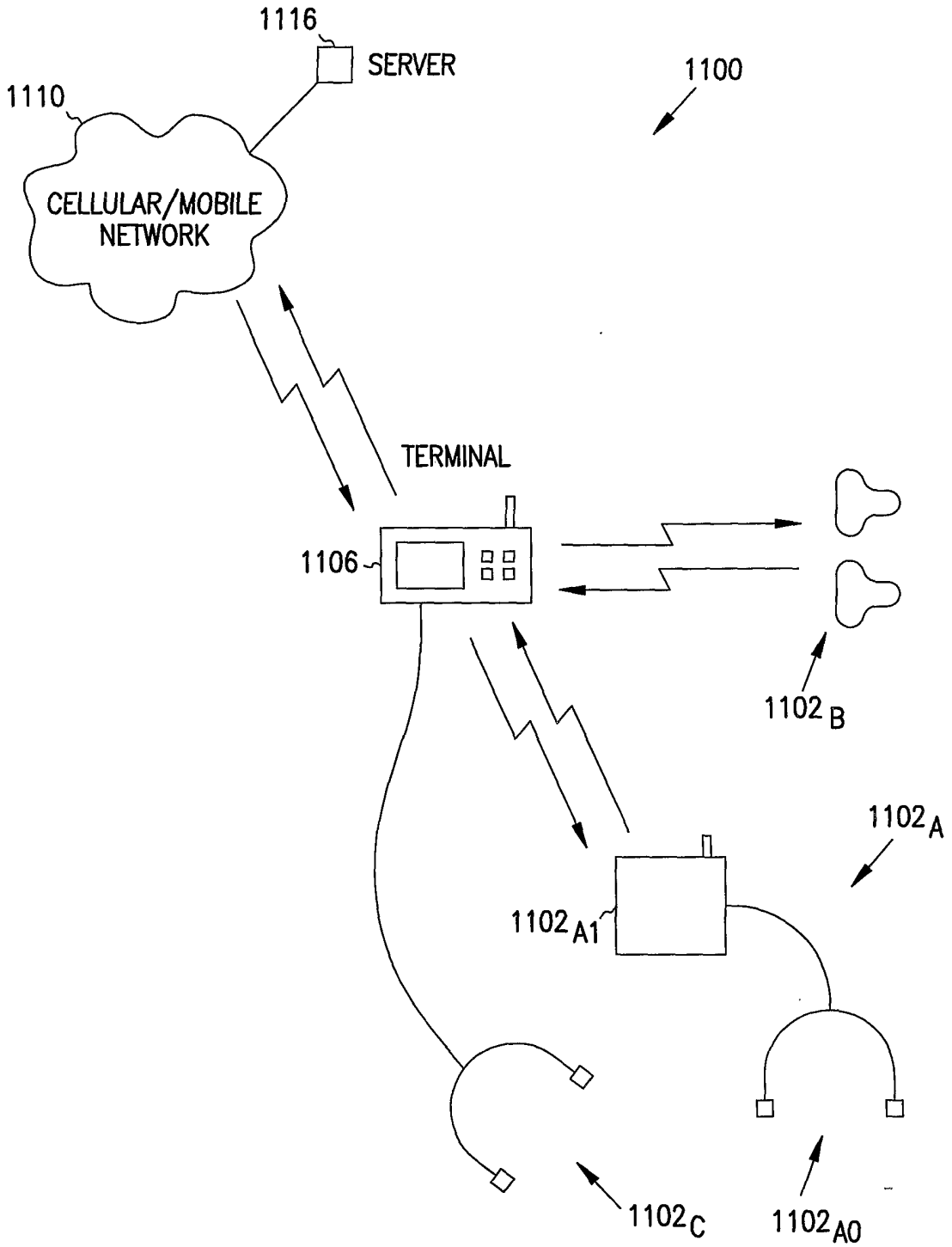
1116
SERVER
1100
1110
CELLULAR/MOBILE NETWORK
TERMINAL
1106
1102 B
1102 A
1102 A1
1102 C
1102 A0

FIG. 11

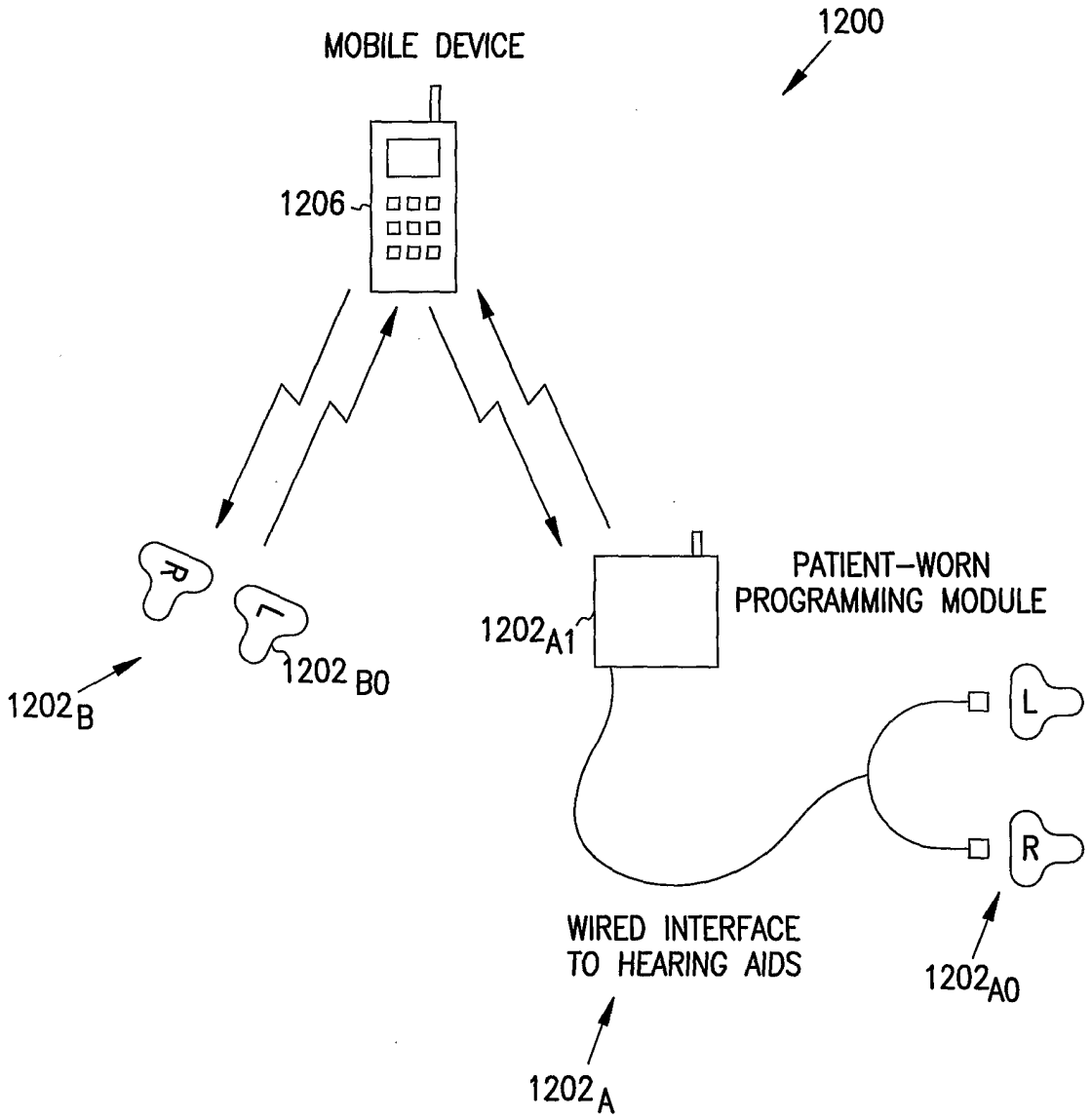
1200
MOBILE DEVICE
1206
R
L
1202 B0
1202B
1202A1
PATIENT–WORN
PROGRAMMING MODULE
L
R
WIRED INTERFACE
TO HEARING AIDS
1202A0
1202A

FIG. 12

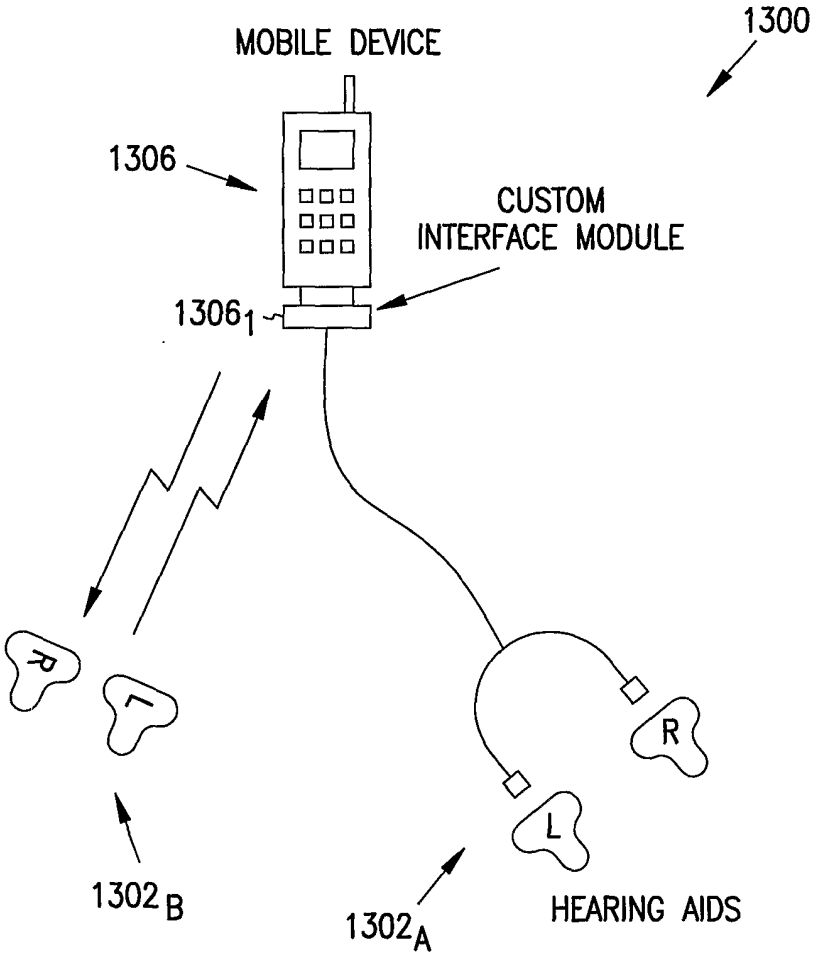
MOBILE DEVICE
1300
1306
CUSTOM
INTERFACE MODULE
1306₁
R
L
R
L
1302B
1302A
HEARING AIDS

FIG. 13