(19) Europäisches Patentamt / European Patent Office / Office européen des brevets

(11) EP 3 739 905 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent: **27.11.2024 Bulletin 2024/48**

(21) Application number: **19174104.0**

(22) Date of filing: **13.05.2019**

(51) International Patent Classification (IPC): ***H04R 25/00*** *(2006.01)*

(52) Cooperative Patent Classification (CPC): **H04R 25/658; H04R 25/652;** H04R 25/552; H04R 2225/021; H04R 2225/023; H04R 2225/025; H04R 2225/77

(54) **EARPIECE FOR THE EAR CANAL WITH OFF-AXIS ELECTRONIC PACKAGE AND RECEIVER**

OHRSTÜCK MIT NICHT IN EINER ACHSE ANGEORDNETEM ELEKTRONIKGEHÄUSE UND HÖRER IM GEHÖRGANG

ÉCOUTEUR COMPORTANT UN BOÎTIER ÉLECTRONIQUE ET UN RÉCEPTEUR ORDONNES HORS-AXE DANS LE CANAL AUDITIF

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

(43) Date of publication of application: **18.11.2020 Bulletin 2020/47**

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(56) References cited:
**EP-A1- 1 246 507**
**EP-A1- 3 399 775**
**EP-A2- 2 747 455**
**EP-A2- 3 477 968**
**WO-A1-2017/205558**
**US-A1- 2014 270 191**
**US-B1- 6 212 283**





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## Description

FIELD OF THE INVENTION

**[0001]** The disclosed technology generally relates to an earpiece with an electronic package and a receiver, where the electronic package and the receiver are positioned off-axis within an ear canal, according to the preamble of claim 1. The disclosure further relates to a method of making an earpiece, according to the preamble of claim 7.

BACKGROUND

**[0002]** Hearing device technology has progressed in recent years. First generation hearing devices were primarily Behind-The-Ear (BTE) devices. BTE devices generally include an acoustic tube connecting an externally mounted device to a molded shell placed within the ear. Now, with the advancement of component miniaturization, In-The-Ear (ITE) and Completely-In-The-Canal (CIC) hearing devices are in greater use. These devices fit within the ear canal and are mostly hidden from an external view. Furthermore, Receiver-in-the-canal (RIC) hearing devices have also gained popularity in recent years, where RIC receivers are placed in ear canal and the receiver is attached via a wire to an external device that powers and controls the receiver.

**[0003]** With all of these hearing devices, one factor that can determine whether a user is willing to wear the hearing device is the fit. The fit of the hearing device is how well it fits and feels in a user's ear canal or around a user's ear. Whether a hearing device has a good or bad fit can be based on the anatomy and structure of a user's ear. Determining a good fit for a hearing device can be difficult because the shape and structure, or morphology, of an ear canal varies from person to person although some characteristics are common to all individuals, e.g., such as an ear canal with a first and second curve.

**[0004]** Because the anatomy of the ear canal varies from person to person, hearing device manufacturers and audiologists have employed custom manufactured devices to fit the dimensions of each user's ear canal. This frequently requires taking impressions of the user's ear canal. The resulting impression is then used to fabricate a rigid hearing device shell.

**[0005]** One way of improving fit rate for a hearing device is angling a spout as described in German Patent DE 10 2013 001 920 B3, which was filed on August 8, 2014, and titled "Earpiece for a Hearing Aid." The German Patent describes a receiver with a spout, where the spout is angled relative to the body of a receiver. The disclosed hearing aid in the German Patent can improve a fit rate for a hearing device user.

**[0006]** However, hearing device users can still be unsatisfied with a fit if other parts of the hearing device pressure the interior or exterior of an ear because of the size, position, or length of a hearing device component. Accordingly, there remains a need for reliable methods and systems for improving a fit rate for a hearing device.

US 2014/0270191 A1 discloses an earpiece for a binaural hearing instrument accommodating a signal processing facility, a receiver, and an antenna. A distal section of the earpiece houses the signal processing facility and the receiver which are spatially separated. The distal section is also spatially separated from a proximal section housing the antenna. When the earpiece is inserted into the ear canal, the antenna is arranged in the region of the second bend or proximally thereto in the auditory canal such that the signal processing facility, the receiver, and the antenna are angled relative to one another when extending between the first and second bend. The antenna is then positioned closest to the eardrum, the signal processing facility has the largest distance from the eardrum, and the receiver is positioned in between the antenna and the signal processing facility. The antenna has a distal opening and a proximal opening through which a sound channel is fed through.

EP 3 399 775 A1 discloses a module for installing in a hearing aid comprising a receiver and a sound channel surrounded by a beaker-shaped mount carrying a nozzle having an end adapted to mount an earmold. The receiver may be angled relative to the sound channel at an angle of 5, 10, 15, or 20 degrees.

WO 2017/205558 A1 discloses an in-ear utility device including a variety of sensors, e.g., an accelerometer sensor, which may be included in an electronic component package.

SUMMARY

**[0007]** Hearing device designers want to include more sensors in a hearing device to enable sensing of health data near the ear or within the ear canal. However, as the number of components inside of a hearing device or an earpiece for a hearing device increases, it can become more difficult to fit a hearing device or earpiece in or around an ear because of the limited space. For example, if an earpiece includes a sensor and a receiver, where the sensor and the receiver are positioned such that the back of the receiver is physically coupled to the front of a sensor, the combination of the components is a long straight component. The length and straightness of this component may not fit well in an ear canal because the ear canal has curves.

**[0008]** Accordingly, the disclosed technology includes a hearing device or earpiece and a method for making that hearing device or earpiece such that it improves the fit of the hearing device or earpiece. An earpiece generally refers to a component or instrument that is placed against or inserted (partially or completely) into an outer opening of an ear or ear canal. For example, a RIC hearing aid can have an earpiece, where the earpiece includes a receiver that can be positioned in the ear canal and other components of the RIC are positioned outside of the ear canal. Alternatively, the earpiece can be an

ITE or other in the ear device without components that are positioned outside the ear canal.

**[0009]** The earpiece can be part of a hearing device or be the entire hearing device. The earpiece comprises: an electronic package; a receiver configured to output audio signals (e.g., a loudspeaker or component to output audio signals); wherein the electronic package and the receiver are positioned at an angle alpha ($\alpha$) relative to each other, where the angle alpha ($\alpha$) is based on a difference between an axis of the electronic package relative to an axis of the receiver and the angle alpha ($\alpha$) is between 5-55 degrees, preferably 15-35 degrees.

**[0010]** The receiver has a spout configured to provide sound based on the audio signals, wherein the spout is angled at an angle beta ($\beta$) relative to the axis of the receiver, where the angle beta ($\beta$) is based on a difference between the axis (e.g., central or main axis) of the receiver and an axis of the spout (e.g., central or main axis) and the angle ($\beta$) is 2-15 degrees, preferably 8-10 degrees, and most preferably 10 degrees. Because of the two bends based on alpha ($\alpha$) and beta (beta), the electronic package and the receiver can be assembled in a single component, and wherein the single component has an S-shape. Optionally, the S-shape can be positioned within an ear canal such that it fits in a first and second bend of an ear canal. Further, optionally, the earpiece can have a housing that covers partially or completely the electronic package and the receiver, wherein the housing for the earpiece can have shape that varies according to the angle alpha ($\alpha$).

**[0011]** The electronic package includes a sensor, wherein the sensor is a photoplethysmography (PPG), electroencephalography (EEG) sensor, electrocardiography (ECG) sensor, temperature sensor, an accelerometer, a humidity sensor, chemical sensor, proximity detector or a photo detector. The actuator can be, e.g., a receiver or an active vent configured to actuate for ventilation of the ear canal. The electronic package can have a single sensor, a single actuator, a sensor and an actuator, or multiple sensors and/or multiple actuators. The electronic package can also include electronic circuitry and be configured to communicate with other components of the hearing device.

**[0012]** Optionally, the electronic package and/or the receiver are configured to rotate clockwise or counterclockwise or adapt their angles relative to each other. For example, the electronic package and/or receiver can include a pin, gear, bearing, or other rotatable connector or component to enable the two components to rotate or move relative to each other. In such implementations, the wires and/or connections between the electronic package and receiver can be configured to avoid breaking or pressure during rotation. The components can be rotated or bent to, e.g., provide a different fit, curve, or angle.

**[0013]** Optionally, the hearing device can be a RIC hearing device, wherein the earpiece is part of the hearing device that is placed in the ear canal. Optionally, the hearing device can be a CIC hearing device, an ITE hearing device, or an earphone ("hearable device"), wherein the earpiece comprising the electronic package and the receiver that are placed within a housing of the CIC, ITE, or earphone.

**[0014]** The disclosed technology also includes a method for making the earpiece or hearing device, wherein the earpiece is the entire hearing device or part of the hearing device. The method includes receiving ear shape information; estimating a design of a housing configured to fit an ear shape; adjusting the design of the housing based on at least partially an angle ($\alpha$) between 5-55 degrees, where the angle ($\alpha$) is based on a difference between an axis of an electronic package relative to an axis of a receiver that will be placed inside the housing. Ear shape information can include anatomy information, slope/curve information, position of tissue or bones in or around the ear, and/or features of the ear canal and corresponding locations. The method also includes adjusting the design of the housing based on an angle beta ($\beta$) between 2-15 degrees relative to the axis of the receiver, where the angle beta ($\beta$) is based on a difference between the axis (e.g., central or main axis) of the receiver and an axis of the spout (e.g., central or main axis). The electronic package includes a sensor, wherein the sensor is a photoplethysmography (PPG) sensor, electroencephalography (EEG) sensor, electrocardiography (ECG) sensor, temperature sensor, an accelerometer, a humidity sensor, chemical sensor, proximity detector or a photo detector.

**[0015]** Optionally, the method can further comprise positioning, at least partially, the earpiece inside of an ear canal. The earpiece can be encapsulated within a housing and placed inside an ear canal, where the ear canal is associated with the ear shape information, wherein the ear shape information is at least partially based on an ear impression or an ear canal scan for a user.

**[0016]** Optionally, the method can include using an ear modeling program to enhance the design process and use the ear shape information to generate a housing for the earpiece. The method can also include taking a mold of an ear canal and generating a model of the ear based on a computer program or measuring optically the ear canal. A processor can carry out the method based on instructions stored in a non-transitory computer-readable medium (e.g., the processor can implement software to execute the method as a computer-implemented method). Optionally, the method can include providing instructions to a hearing device professional for how to insert the earpiece into a person's ear (e.g., how far based on anatomy of the user's ear).

## DESCRIPTION OF THE DRAWINGS

**[0017]** The foregoing aspects and the advantages of the disclosed will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings.

Figure 1 is a schematic view of a user wearing two hearing devices in accordance with some implementations of the disclosed technology.

Figures 2A and 2B are a schematic view of off-axis an earpiece that can be a component of a hearing device from Figure 1 in accordance with some implementations of the disclosed technology.

Figures 3A, 3B, and 3C are a schematic view of a housing of a hearing device in accordance with some implementations of the disclosed technology.

**[0018]** The drawings are not to scale. Some components or operations may be separated into different blocks or combined into a single block for the purposes of discussion of some of the disclosed technology. Moreover, while the disclosed technology is amenable to various modifications and alternative forms, specific implementations have been shown by way of example in the drawings and are described in detail below. The intention, however, is not to limit the technology to the selected implementations described. Rather, the disclosed technology is intended to cover all modifications, equivalents, and alternatives falling within the scope of the technology as defined by the appended claims.

DETAILED DESCRIPTION

**[0019]** The following disclosure describes various embodiments of systems and associated methods for the hearing device.

**[0020]** Figure 1 illustrates a communication environment 100. The communication environment 100 includes hearing devices 102 (singular "hearing device 102" or multiple "hearing devices 102") and wireless communication devices 103 (singular "wireless communication device 103" and multiple "wireless communication devices 103").

**[0021]** A hearing device user can wear the hearing devices 102 and the hearing device is configured to provide audio to a hearing device user. A hearing device user can wear single hearing device 102 or two hearing devices 102, where one hearing device 102 is on or in each ear. Some example hearing devices include hearing aids, headphones, earphones, earpieces, assistive listening devices, cochlear device or component, or any combination thereof, where at least a partial thereof resides in the ear canal. Hearing devices can also include both prescription devices and non-prescription devices configured to be worn on or near a human head.

**[0022]** In some implementations, the hearing device 102 is a hearing aid that provides amplification, attenuation, or frequency modification of audio signals to compensate for hearing loss or difficulty. Some example hearing aids include a BTE, RIC, ITE, CIC, or Invisible-in-the-Canal (IIC) hearing aids. In some implementations, one hearing device 102 can be a hearing aid and another hearing device 102 can be a cochlear hearing device, where the cochlear hearing device has a device component and an implant component.

**[0023]** The hearing devices 102 can be configured to binaurally communicate or bimodally communicate as shown by the double-headed black arrow 104. The binaural communication can include a hearing device 102 transmitting information to or receiving information from another hearing device 102. Information can include volume control, signal processing information (e.g., noise reduction, wind canceling, directionality such as beam forming information), or compression information to modify sound fidelity or resolution.

**[0024]** Binaural communication can be bidirectional (i.e.., in both directions or between hearing devices) or unidirectional (e.g., one hearing device receiving or streaming information from another hearing device). Bimodal communication is like binaural communication, but bimodal communication includes two devices of a different type, e.g. a cochlear device communicating with a hearing aid. The hearing device can communicate to exchange information related to utterances or speech recognition. Communication can occur using a wireless communication protocol such as Bluetooth™ or a proprietary protocol. Wireless communication can include using a protocol such as Bluetooth BR/EDR™, Bluetooth Low Energy™, a proprietary communication (e.g., binaural communication protocol between hearing aids based on NFMI or bimodal communication protocol between hearing devices), ZigBee™, Wi-Fi™, or an Industry of Electrical and Electronic Engineers (IEEE) wireless communication standard.

**[0025]** The wireless communication devices 103 are computing devices that are configured to wirelessly communicate. Wireless communication includes wirelessly transmitting information, wirelessly receiving information, or both. The wireless communication devices 103 shown in Figure 1 can include mobile computing devices (e.g., mobile phone), computers (e.g., desktop or laptop), televisions (TVs) or components in communication with television (e.g., TV streamer), a car audio system or circuitry within the car, tablet, an accessory electronic device, a wireless speaker, or watch. Also, as shown by double-headed bold arrows in Figure 1, the hearing devices 102 can communicate wirelessly, e.g., with a wireless communication device 103. In some implementations, the hearing devices 102 include a sensor or sensors and these sensors measure data from the user's ear or ear canal. This measured information can be wirelessly communicated to the wireless communication device 103.

**[0026]** Figure 2A is a schematic view of off-axis components of an earpiece 212, wherein the earpiece 212 can be a component of a hearing device 102 from Figure 1 or the entire hearing device 102. The earpiece 212 can have an electronic package 201 and a receiver 202. The earpiece 212 can be positioned within an ear canal (e.g., near the ear drum) based the anatomy of the ear canal (e.g., determined from an impression or scan of the ear canal).

**[0027]** The electronic package 201 includes a sensor. The electronic package 201 may further include an actuator, and/or associated electronic circuitry. In some implementations, the electronic package 201 includes only a sensor. In other implementations, the electronic package 201 includes a sensor and an actuator. Determining whether to include a single sensor, or multiple sensors or at least one sensor and multiple actuators is based on the desired function of the hearing device. If the hearing device designer wants only an accelerometer to detect acceleration, then only an accelerometer is included; however, if the hearing device designer wants an accelerometer to detect acceleration and an active vent, then electronic package 201 can include both an accelerometer and an actuator to move the active vent (e.g., open and/or close).

**[0028]** The electronic package 201 can include a sensor for detecting or measuring health data. The sensor includes one or more of the following sensors: a photoplethysmography (PPG), electroencephalography (EEG) sensor, electrocardiography (ECG) sensor, temperature sensor, accelerometer, humidity sensor, chemical sensor, proximity detector or photo detector (e.g., to measure light, light intensity, or light frequency).

**[0029]** In some implementations, it may be an advantage to a have a sensor in the ear canal or at a particular position within the ear canal to detect health data that is better measured in the that location. For example, a humidity sensor may be more effective at measuring humidity in the ear canal when it placed closer to an ear drum 207. As an another example, a PPG or EEG sensor may receive a better measurement when positioned at certain points along the ear canal, where the changes in electric or magnetic fields are easier to detect. The positioning can be based on whether it is easier to detect a desired measurement (e.g., pulse, light, electrical resistance). Also, the electronic package 201 can be a few millimeters in width, length, and/or thickness (e.g., 1-10 mm) depending on the sensors and/or actuators inside the electronic package 201.

**[0030]** The receiver 202 provides audio signals to a user wearing the hearing device 102. In some implementations, the receiver 202 is a loudspeaker and provides sound to the ear drum 207 of a user wearing the hearing device. The receiver 202 can be a few millimeters in width, length, and/or thickness (e.g., 1-10 mm).

**[0031]** The receiver 202 has a spout 208 configured to provide sound based on the audio signals, and wherein the spout 208 is angled at an angle ($\beta$) relative to the axis of the receiver, where the angle ($\beta$) is based on a difference between the axis of the receiver and an axis of the spout 208. The angle $\beta$ can be 2-15 degrees, including a range from 7-12 degrees, and preferably 10 degrees. In general, the spout 208 can function as a wave guide to guide sound waves towards the ear drum 207.

**[0032]** The receiver 202 can be physically coupled to a dome 203. The dome 203 can be composed of plastic or other flexible material that fits inside of a user's ear canal. The dome 203 can have holes in it to enable venting or propagation of sound waves. The dome 203 can also reduce the buildup of ear wax on or in the receiver 202. Also, as shown in Figure 2A, the electronic package 201 can have a wire or tube that is physically and/or electronically coupled to another component of the hearing device 102 (e.g., a processor).

**[0033]** As shown in Figure 2A, the electronic package 201 and the receiver 202 are positioned at an angle ($\alpha$) relative to each other. The angle ($\alpha$) is based on a difference between an axis of the electronic package 201 relative to an axis of the receiver 202. An axis is generally a real or imaginary straight line that goes through the center of an object or divides an object into two equal halves. The axis can be, for example, the main axis of the electronic package 201 or the main axis of the receiver. The angle $\alpha$ can be 5-55 degrees, preferably between 10-35 degrees, and most preferably 15-20 degrees. The angle $\alpha$ varies partially based on where the earpiece 212 is placed within an ear canal (e.g., how close or far away from the ear drum) and based the anatomy of the ear canal (e.g., determined from an impression or scan of the ear canal). A hearing device design can use ear anatomy and/or a computer program to determine where the earpiece 212 can be placed within an ear canal.

**[0034]** The combination of the angle $\alpha$ and the angle $\beta$ can cause the components of the hearing device to have an S-shape, where the S-shape may generally follow the shape of a portion of an ear canal. More specifically, in some implementations, the electronic package 201 and the receiver 202 can enable the shape of a housing to generally follow the shape of an ear canal with a first bend 205 and a second bend 206 as shown in Figure 2A. In some implementations, hearing aid design software can calculate the location of the S-shape or where the angle $\alpha$ occurs based on the first bend 205 and second bend 206 of an ear canal, wherein the calculation is based on an ear mold or impression or digital scan of an ear canal for a user and general anatomy of the ear and/or ear canal.

**[0035]** Also as shown in Figure 2A, the electronic package 201 can be tapered or have a varying thickness as shown by the tapered edges 209. The tapered edges 209 can be less thick than other parts of the electronic package 201 to have a better fit in the ear canal. The tapered edges 209 can also be placed at a position within the ear based on improving a function of the electronic package 201. For example, the electronic package 201 can be tapered such that a sensor is better positioned to take a measurement from the skin of an ear canal, detect an electrical resistance or voltage potential, or measure a temperature or color of the skin in the ear canal. Also, Figure 2A illustrates some components of a hearing device 102, but one with ordinary skill in the art can understand the components can be encapsulated partially or entirely in a housing or other components can be positioned near or around the electronic package 201 and the receiver 202 (e.g., see housing in Figures 3A, 3B, and 3C). In some implementations, the housing can also have tapering that is similar to the tapering of the electronic package 201.

**[0036]** Although not shown in Figure 2A, the electronic package 201 and the receiver 202 can be covered partially or completely (e.g., encapsulated) in a housing. The housing can be plastic, metal, or a combination thereof. The housing can be configured to protect the electronic package 201 and/or the receiver 202 from the conditions inside of an ear canal. Additionally, the housing can be sloped or curved as shown in Figure 2B. Further, as disclosed in Figures 3A, 3B, and 3C, the earpiece 212 can be a component of a hearing device 102, where the hearing device 102 has its own housing.

**[0037]** Optionally, the electronic package 201 and/or the receiver 202 are configured to rotate clockwise or counterclockwise or bend around a joint relative to each other. For example, the electronic package 201 and/or receiver 202 can include a pin, gear, bearing, or other rotatable or movable connector or component to enable the two components to rotate or bend relative to each other. Optionally, the electronic package 201 and/or the receiver 202 can be configured to bend relative to each other based on a flexible joint or connection (e.g., a pin).

**[0038]** Figure 2B shows a view of the earpiece 212 as part of a RIC hearing device (e.g., the hearing device 102). As an RIC, the hearing device 102 has a behind-the-ear component 210 that is placed behind the ear and the earpiece 212 with a dome 203 that is inserted inside of an ear canal. The behind-the-ear component 210 can include a processor, battery, microphone, and/or other electronic circuitry configured to communicate with the earpiece 212 via the wire 204. The earpiece 212 also has a housing 214. The housing 214 can be plastic, metal, or a combination thereof. The housing 214 can be configured to protect the electronic package 201 and/or the receiver 202 from the conditions inside of an ear canal. Additionally, the housing 214 can be sloped or curved as shown in Figure 2B to approximately match shape of the earpiece 212 (e.g., shape according to angle $\alpha$ and the angle $\beta$ such that the housing 214 has an S-shape).

**[0039]** Figures 3A, 3B, and 3C are a schematic view of a housing of a hearing device including the earpiece 212 (not shown in the Figures). The Figure 3A shows an ITE device with a custom shell. A custom shell generally means the shell was designed from measurements of a user's ear canal. For example, a hearing device designer can take an impression of a user's ear and/or ear canal and then use this impression or a digital scan of the ear canal to generate a computer model of the user's ear and/or ear canal. The model can also include information related to ear anatomy and aggregate data collected from other impressions or models (e.g., a large data set of ear impressions or molds). In some implementations, the ear impression is a partial impression of the ear canal and a software can use that partial impression to design an entire shell or shape of an ear canal. In other implementations, the ear impression can be a full impression or an ear canal or ear.

**[0040]** As shown in Figure 3A, the hearing device is an ITE with a housing 305, where the housing can be a plastic, metal (e.g., titanium), a combination of plastic and metal, or other material compatible with an ear or ear canal. The housing 305 can have a curve 307 that is associated with the angle alpha ($\alpha$) and the angle beta ($\beta$). As shown in Figure 3B, the electronic package 201 and receiver 202 can be placed inside of a housing 310. The housing 310 has a curve 307 related to the angle alpha ($\alpha$) and/or the angle beta ($\beta$). The housing 310 can be part of an In-the-Ear hearing aid with a retention 111, where the retention 111 can be used to access or position the In-the-Ear hearing aid. As shown in Figure 3C, the electronic package 201 and receiver 202 can be placed inside of a housing 310. The housing 310 has a curve 307 related to the angle $\alpha$. The housing 310 can be an earpiece 212 as part of a RIC hearing aid were the wire 204 electrically connects with another component of the hearing aid (e.g., on the outside of the ear).

**[0041]** Many embodiments of the technology (e.g., the disclosed method) described above may take the form of computer-executable or controller-executable instructions, including routines stored on non-transitory memory and executed by a programmable computer or controller. Those skilled in the relevant art will appreciate that the technology can be practiced on computer/controller systems other than those shown and described above. The technology can be embodied in a special-purpose computer, application specific integrated circuit (ASIC), controller or data processor that is specifically programmed, configured or constructed to perform one or more of the computer-executable instructions described above. For example, the disclosed method can be executed partially or completely on an ASIC, wherein the ASIC is configured to carry out the method and operations for analyzing an impression or ear anatomy. In many embodiments, any logic or algorithm described herein can be implemented in software or hardware, or a combination of software and hardware.

## Claims

**1.** An earpiece (212), the earpiece (212) comprising:

an electronic package (201);
a receiver (202) configured to output audio signals; wherein the electronic package (201) and the receiver (202) are positioned at a first angle ($\alpha$) relative to each other, where the first angle ($\alpha$) is based on a difference between an axis of the electronic package (201) relative to an axis of the receiver (202), and the first angle ($\alpha$) is between 5-55 degrees; and the receiver (202)

has a spout (208) configured to provide sound based on the audio signals, and wherein the spout (208) is angled at a second angle (β) relative to the axis of the receiver, where the second angle (β) is based on a difference between the axis of the receiver and an axis of the spout, **characterized in that** the second angle (β) is 2-15 degrees; wherein the electronic package (201) includes a sensor, wherein the sensor is a photoplethysmography (PPG) sensor, electroencephalography (EEG) sensor, electrocardiography (ECG) sensor, temperature sensor, an accelerometer, a humidity sensor, chemical sensor, proximity detector or a photo detector.

**2.** The earpiece (212) of claim 1, wherein the electronic package (201) further includes an actuator, wherein the actuator is configured to actuate an active vent for ventilation of an ear canal.

**3.** The earpiece (212) of claim 1, wherein the axis of the electronic package (201) is a central or main axis and the axis for the receiver (202) is a central or main axis.

**4.** The earpiece (212) of claim 1, wherein the earpiece is a component of a hearing device (102), wherein the hearing device is a completely-in-ear-canal (CIC) hearing device, a receiver-in-canal (RIC) hearing device, an earphone, or an in-the-ear (ITE) hearing device.

**5.** The earpiece (212) of claim 1, wherein the electronic package (201) and/or the receiver (202) are configured to either rotate clockwise or counterclockwise or bend relative to each other.

**6.** The earpiece (212) of claim 1, wherein the electronic package (201) and the receiver (202) are assembled in a single component, wherein the single component has an S-shape, and wherein the single component has a housing (214) at least partially encapsulating the earpiece (212).

**7.** A method for making an earpiece (212), the method comprising:

receiving ear shape information, wherein ear shape information at least includes ear canal information;
estimating a design of a housing (305, 310) configured to fit an ear shape based at least partially on the received ear shape information; and
adjusting the design of the housing (305, 310) at least partially based on a first angle (α), where the first angle (α) is based on a difference between an axis of an electronic package (201) relative to an axis of a receiver (202) that will be placed inside the housing (305, 310) and the first angle (α) is between 5-55 degrees; and the adjusting the design of the housing (305, 310) is also at least partially based on a second angle (β) relative to the axis of the receiver, where the second angle (β) is based on a difference between the axis of the receiver (202) and an axis of a spout (208) of the receiver (202), **characterized in that** the second angle (β) is 2-15 degrees; wherein the electronic package (201) includes a sensor, wherein the sensor is a photoplethysmography (PPG) sensor, electroencephalography (EEG) sensor, electrocardiography (ECG) sensor, temperature sensor, an accelerometer, a humidity sensor, chemical sensor, proximity detector or a photo detector.

**8.** The method of claim 7, the method further comprising:
positioning, at least partially, the housing (305, 310) inside of an ear canal, wherein the ear canal is associated with the ear shape information.

**9.** The method of claim 7, wherein the receiving ear shape information is at least partially based on an ear impression; a digital scan of an ear canal for a user; an optical scan of the ear canal; and/or information received from an ear modeling program.

**Patentansprüche**

**1.** Ohrstück (212), wobei das Ohrstück (212) Folgendes umfasst:

ein elektronisches Package (201);
einen Empfänger (202), der zum Ausgeben von Audiosignalen ausgelegt ist; wobei das elektronische Package (201) und der Empfänger (202) in einem ersten Winkel (α) zueinander positioniert sind, wobei der erste Winkel (α) auf einer Differenz zwischen einer Achse des elektronischen Package (201) relativ zu einer Achse des Empfängers (202) basiert und der erste Winkel (α) 5-55 Grad beträgt; und der Empfänger (202) eine Tülle (208) aufweist, die zum Bereitstellen von Schall basierend auf Audiosignalen ausgelegt ist, und wobei die Tülle (208) in einem zweiten Winkel (β) relativ zur Achse des Empfängers angewinkelt ist, wobei der zweite Winkel (β) auf einer Differenz zwischen der Achse des Empfängers und einer Achse der Tülle basiert, **dadurch gekennzeichnet, dass** der zweite Winkel (β) 2-15 Grad beträgt; wobei das elektronische Package (201) einen Sensor enthält, wobei der Sensor ein Photoplethysmographie(PPG)-Sensor, ein Elektroenzephalographie(EEG)-Sensor, ein Elektrokardiogra-

phie(EKG)-Sensor, ein Temperatursensor, ein Beschleunigungsmesser, ein Feuchtigkeitssensor, ein chemischer Sensor, ein Nähedetektor oder ein Fotodetektor ist.

**2.** Ohrstück (212) nach Anspruch 1, wobei das elektronische Package (201) ferner einen Aktuator enthält, wobei der Aktuator zum Betätigen eines aktiven Belüftungselements zur Belüftung eines Gehörgangs ausgelegt ist.

**3.** Ohrstücke (212) nach Anspruch 1, wobei die Achse des elektronischen Package (201) eine Mittel- oder Hauptachse ist und die Achse für den Empfänger (202) eine Mittel- oder Hauptachse ist.

**4.** Ohrstück (212) nach Anspruch 1, wobei das Ohrstück eine Komponente eines Hörgeräts (102) ist, wobei das Hörgerät ein Vollständig-im-Gehörgang(CIC)-Hörgerät, ein Ex-Hörer(RIC)-Hörgerät, ein Ohrhörer oder ein Im-Ohr(ITE)-Hörgerät ist.

**5.** Ohrstück (212) nach Anspruch 1, wobei das elektronische Package (201) und/oder der Empfänger (202) dazu ausgelegt sind, sich zueinander entweder im Uhrzeigersinn oder entgegen des Uhrzeigersinns zu drehen oder zu biegen.

**6.** Ohrstück (212) nach Anspruch 1, wobei das elektronische Package (201) und der Empfänger (202) in einer einzelnen Komponente montiert sind, wobei die einzelne Komponente eine S-Form aufweist und wobei die einzelne Komponente ein Gehäuse (214) aufweist, das das Ohrstück (212) zumindest teilweise eingekapselt.

**7.** Verfahren zum Herstellen eines Ohrstücks (212), wobei das Verfahren Folgendes umfasst:

Empfangen von Ohrforminformationen, wobei Ohrforminformationen zumindest Gehörganginformationen enthalten;
Schätzen einer Gestaltung eines Gehäuses (305, 310), das dazu ausgelegt ist, in eine Ohrform zu passen, zumindest teilweise basierend auf den empfangenen Ohrforminformationen; und
Anpassen der Gestaltung des Gehäuses (305, 310) zumindest teilweise basierend auf einem ersten Winkel ($\alpha$), wobei der erste Winkel ($\alpha$) auf einer Differenz zwischen einer Achse eines elektronischen Package (201) relativ zu einer Achse eines Empfängers (202), der in dem Gehäuse (305, 310) untergebracht wird, basiert, und der erste Winkel ($\alpha$) 5-55 Grad beträgt; und das Anpassen der Gestaltung des Gehäuses (305, 310) auch zumindest teilweise auf einem zweiten Winkel ($\beta$) relativ zur Achse des Empfängers basiert, wobei der zweite Winkel ($\beta$) auf einer Differenz zwischen der Achse des Empfängers (202) und einer Achse einer Tülle (208) des Empfängers (202) basiert, **dadurch gekennzeichnet, dass** der zweite Winkel ($\beta$) 2-15 Grad beträgt; wobei das elektronische Package (201) einen Sensor enthält, wobei der Sensor ein Photoplethysmographie(PPG)-Sensor, ein Elektroenzephalographie(EEG)-Sensor, ein Elektrokardiographie(EKG)-Sensor, ein Temperatursensor, ein Beschleunigungsmesser, ein Feuchtigkeitssensor, ein chemischer Sensor, ein Nähedetektor oder ein Fotodetektor ist.

**8.** Verfahren nach Anspruch 7, wobei das Verfahren ferner Folgendes umfasst:
Positionieren, zumindest teilweise, des Gehäuses (305, 310) innerhalb eines Gehörgangs, wobei der Gehörgang mit den Ohrforminformationen assoziiert ist.

**9.** Verfahren nach Anspruch 7, wobei das Empfangen von Ohrforminformationen zumindest teilweise auf einem Ohrabdruck; einem digitalen Scan eines Gehörgangs eines Benutzers; einem optischen Scan des Gehörgangs; und/oder von einem Ohrmodellierungsprogramm empfangenen Informationen basiert.

## Revendications

**1.** Embout auriculaire (212), l'embout auriculaire (212) comprenant :

un boîtier électronique (201) ;
un récepteur (202) conçu pour délivrer des signaux audio ; dans lequel le boîtier électronique (201) et le récepteur (202) sont positionnés à un premier angle ($\alpha$) l'un par rapport à l'autre, le premier angle ($\alpha$) étant basé sur une différence entre un axe du boîtier électronique (201) et un axe du récepteur (202), et le premier angle ($\alpha$) faisant entre 5 et 55 degrés ; et le récepteur (202) a une goulotte (208) conçue pour fournir un son basé sur les signaux audio, et dans lequel la goulotte (208) est inclinée d'un deuxième angle ($\beta$) par rapport à l'axe du récepteur, le deuxième angle ($\beta$) étant basé sur une différence entre l'axe du récepteur et un axe de la goulotte, **caractérisé en ce que** le deuxième angle ($\beta$) fait 2-15 degrés ; dans lequel le boîtier électronique (201) comporte un capteur, le capteur étant un capteur de photopléthysmographie (PPG), un capteur d'électroencéphalographie (EEG), un capteur d'électrocardiographie (ECG), un capteur de température, un accéléromètre, un capteur d'humidité, un capteur chi-

mique, un détecteur de proximité ou un photodétecteur.

**2.** Embout auriculaire (212) selon la revendication 1, dans lequel le boîtier électronique (201) comporte en outre un actionneur, l'actionneur étant conçu pour actionner un évent actif pour l'aération d'un conduit auditif.

**3.** Embout auriculaire (212) selon la revendication 1, dans lequel l'axe du boîtier électronique (201) est un axe central ou principal et l'axe du récepteur (202) est un axe central ou principal.

**4.** Embout auriculaire (212) selon la revendication 1, l'embout auriculaire étant un composant d'un appareil auditif (102), l'appareil auditif étant un appareil auditif entièrement dans le conduit auditif (CIC), un appareil auditif à récepteur dans le conduit (RIC), un écouteur, ou un appareil auditif intra-auriculaire (ITE).

**5.** Embout auriculaire (212) selon la revendication 1, dans lequel le boîtier électronique (201) et/ou le récepteur (202) sont conçus pour soit tourner dans le sens horaire ou le sens antihoraire, soit se plier l'un par rapport à l'autre.

**6.** Embout auriculaire (212) selon la revendication 1, dans lequel le boîtier électronique (201) et le récepteur (202) sont assemblés dans un unique composant, dans lequel l'unique composant a une forme de S, et dans lequel l'unique composant a une coque (214) encapsulant au moins partiellement l'embout auriculaire (212).

**7.** Procédé de fabrication d'un embout auriculaire (212), le procédé comprenant :

la réception d'informations de forme d'oreille, les informations de forme d'oreille comportant au moins des informations de conduit auditif ;
l'estimation d'une conception d'une coque (305, 310) conçue pour s'adapter à une forme d'oreille au moins partiellement sur la base des informations de forme d'oreille reçues ; et
l'ajustement de la conception de la coque (305, 310) au moins partiellement sur la base d'un premier angle ($\alpha$), le premier angle ($\alpha$) étant basé sur une différence entre un axe d'un boîtier électronique (201) et un axe d'un récepteur (202) qui seront placés à l'intérieur de la coque (305, 310) et le premier angle ($\alpha$) faisant entre 5 et 55 degrés ; et l'ajustement de la conception de la coque (305, 310) étant aussi au moins partiellement basé sur un deuxième angle ($\beta$) par rapport à l'axe du récepteur, le deuxième angle ($\beta$) étant basé sur une différence entre l'axe du récepteur (202) et un axe d'une goulotte (208) du récepteur (202), **caractérisé en ce que** le deuxième angle ($\beta$) fait 2-15 degrés ; dans lequel le boîtier électronique (201) comporte un capteur, le capteur étant un capteur de photopléthysmographie (PPG), un capteur d'électroencéphalographie (EEG), un capteur d'électrocardiographie (ECG), un capteur de température, un accéléromètre, un capteur d'humidité, un capteur chimique, un détecteur de proximité ou un photodétecteur.

**8.** Procédé selon la revendication 7, le procédé comprenant en outre :
le positionnement, au moins partiel, de la coque (305, 310) à l'intérieur d'un conduit auditif, le conduit auditif étant associé aux informations de forme d'oreille.

**9.** Procédé selon la revendication 7, dans lequel la réception d'informations de forme d'oreille est au moins partiellement basée sur une empreinte d'oreille ; un balayage numérique d'un conduit auditif pour un utilisateur ; un balayage optique du conduit auditif ; et/ou des informations reçues depuis un programme de modélisation d'oreille.

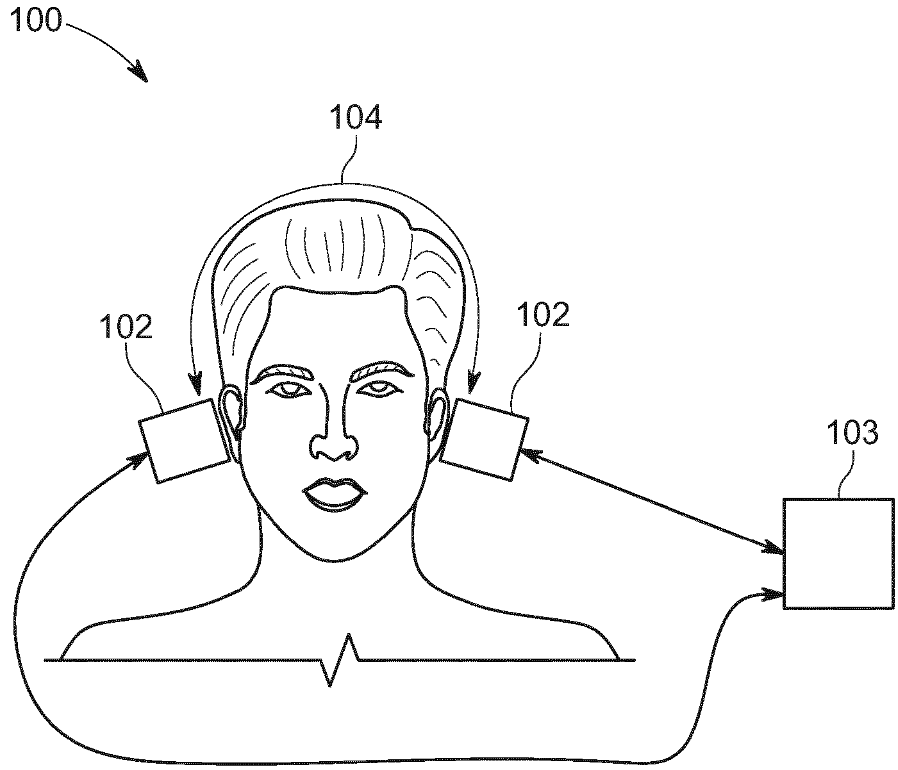


FIG. 1

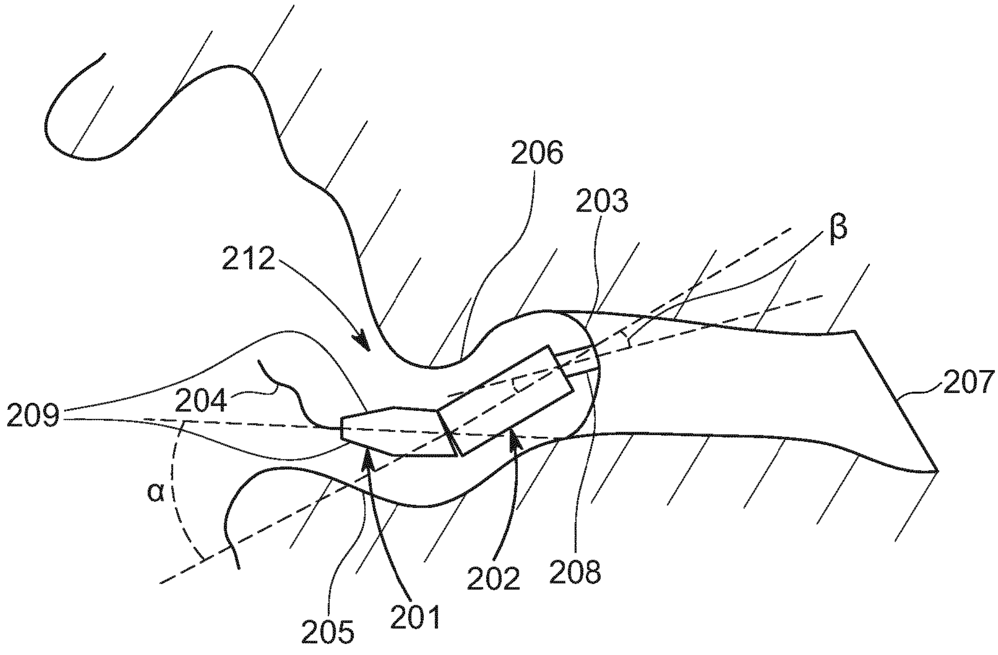
206
203
β
212
207
209
204
α
205
201
202
208

FIG. 2A

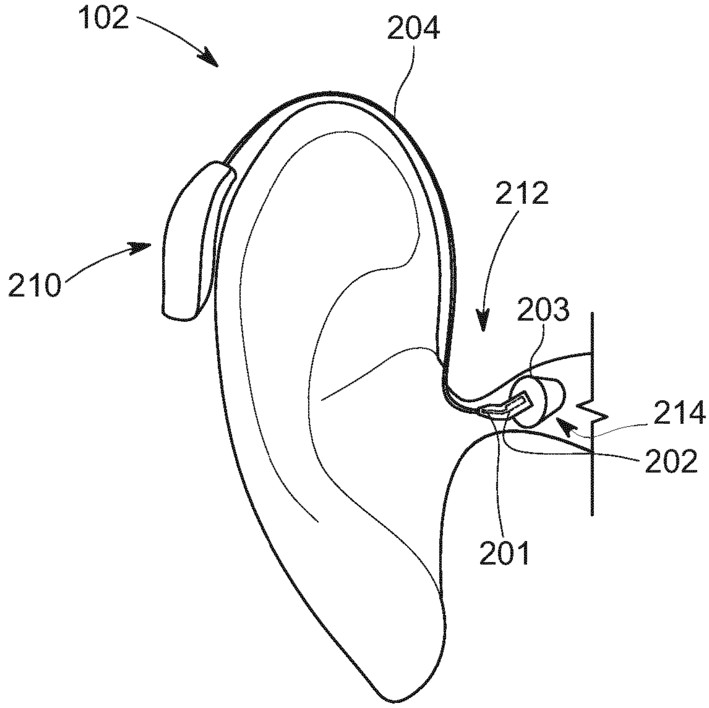
102
204
212
210
203
214
202
201

FIG. 2B

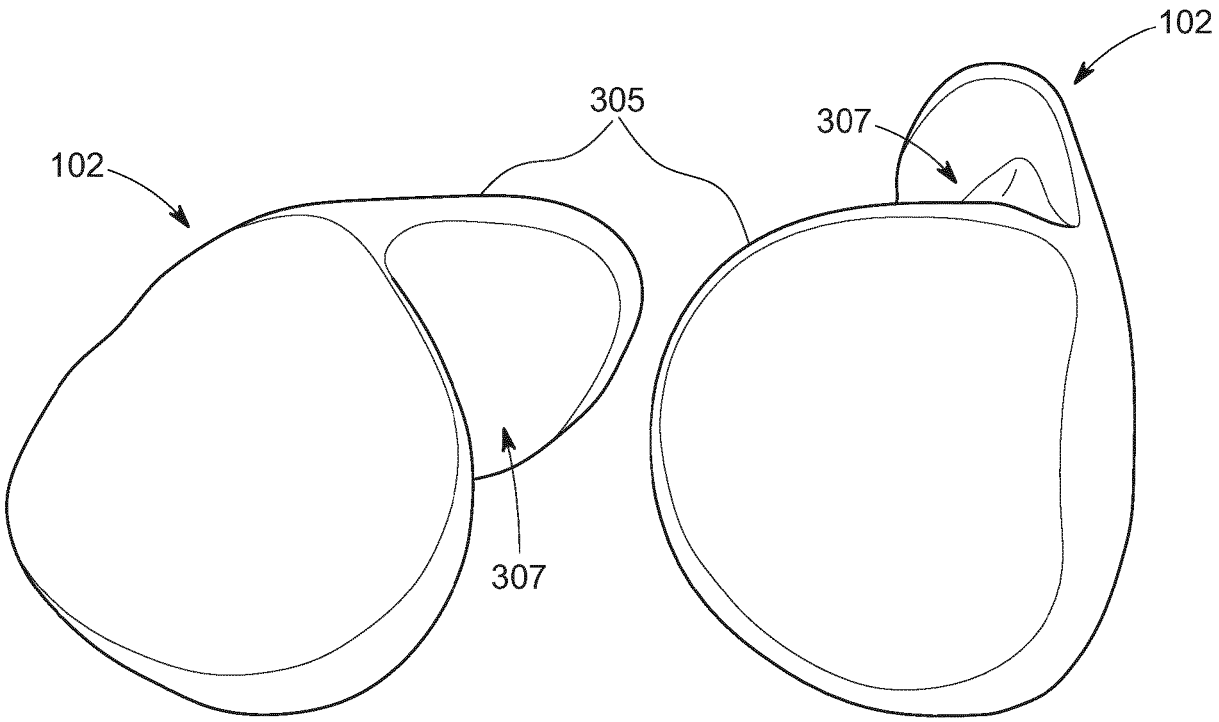


FIG.3A

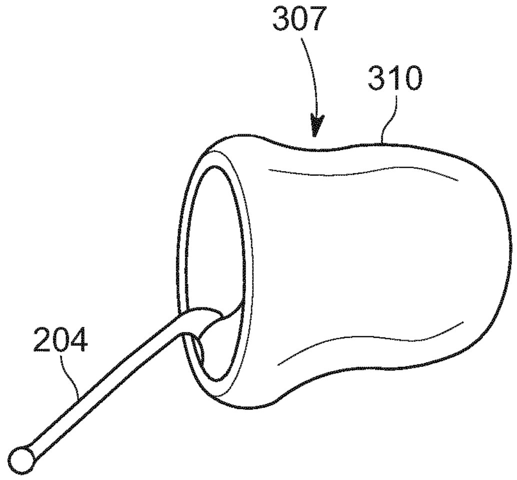


FIG. 3B

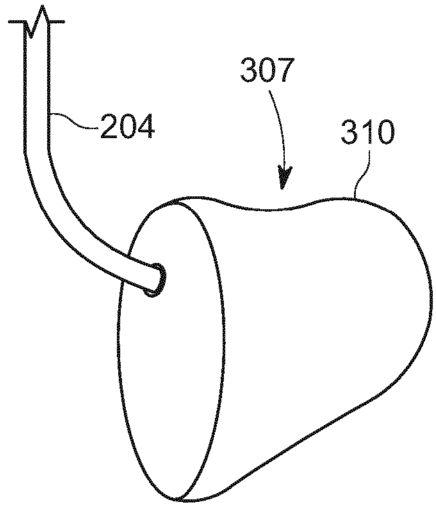


FIG. 3C

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- DE 102013001920 B3 **[0005]**
- US 20140270191 A1 **[0006]**
- EP 3399775 A1 **[0006]**
- WO 2017205558 A1 **[0006]**