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A HEARING AID WITH IMPROVED SUSPENSION

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A hearing aid is disclosed. The hearing aid includes a receiver configured to receive a sound in the environment, the receiver having a first end, a second end opposite the first end, and an outer surface connecting the first end with the second end. The hearing aid includes a suspension layer at least partially covering the outer surface of the receiver. The hearing aid includes

an impact absorbing layer at least partially covering the outer surface of the receiver, wherein the impact absorbing layer is a different material than the suspension layer. The hearing aid includes a housing surrounding the receiver, the suspension layer, and the impact absorbing layer.

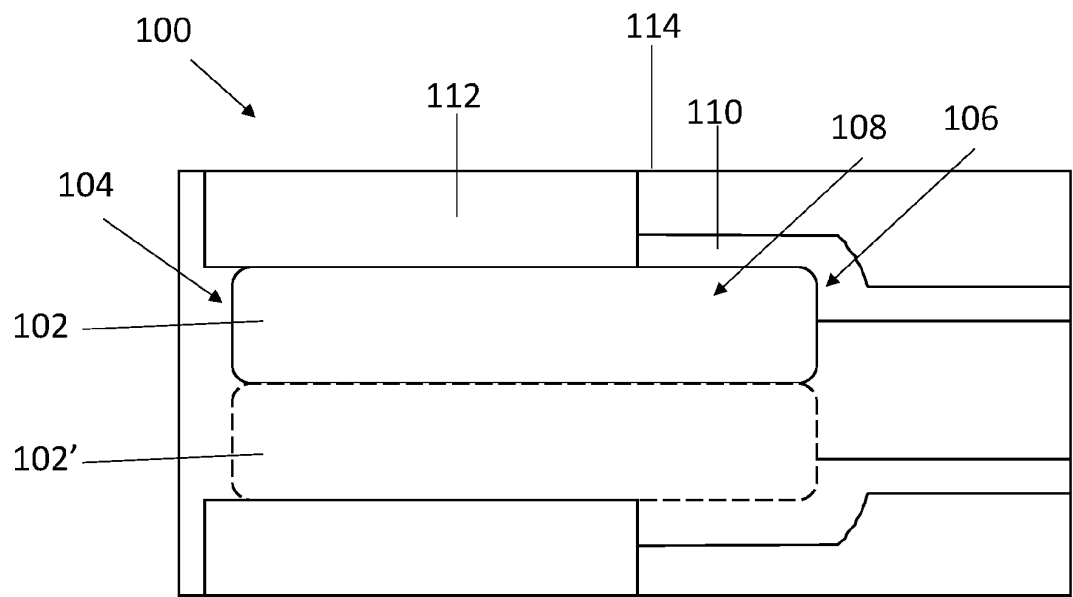


FIG. 1

Description

[0001] In an aspect of the present application, a hearing aid is provided. The hearing aid can include a receiver configured to receive a sound in the environment. The receiver can have a first end. The receiver can have a second end. The second end can be opposite the first end. The receiver can include an outer surface. The outer surface can connect the first end with the second end. The hearing aid includes a suspension layer. The suspension layer can at least partially cover the outer surface of the receiver. The hearing aid includes an impact absorbing layer. The impact absorbing layer can at least partially cover the outer surface of the receiver. The impact absorbing layer can be a different material than the suspension layer. The hearing aid can include a housing. The housing can surround the receiver, the suspension layer, and the impact absorbing layer.

[0002] Advantageously, the disclosed hearing aid can include both improved vibration dampening as well as shock absorption. For example, the disclosed hearing aid can prevent movement (e.g., vibrations) of a receiver in the hearing aid from affecting other components of the hearing aid, which could cause auditory problems and/or be irritations to a user of the hearing aid. Further, the disclosed hearing aid can have improved shock absorption, preventing and/or reducing damage to the hearing aid in case of drops. Accordingly, the disclosed hearing aids can have improved longevity for a user. For example, the disclosed hearing aids can have improved survivability. Further, the disclosed hearing aids can reduce irritating internal noises for a user wearing the hearing aid.

[0003] The hearing aid can include a receiver configured to receive sound in (e.g., from) the environment. For example, the receiver may be one or more microphones. The receiver may be an input unit. The particular type of receiver is not limiting. The receiver can include a first end and a second end. The second end can be opposite the first end. The second end can be longitudinally opposite the first end. The first end and the second end can be the ends of the receiver being the furthest apart. The first end can define a first surface of the receiver. The second end can define a second surface of the receiver. The first surface and the second surface can be opposite one another. One or more of the first end and the second end can include outlets for the receiver, such as tubes.

[0004] The receiver can extend from the first end to the second end along a longitudinal direction. A distance from the first end to the second end can be considered a length. Orthogonal to the longitudinal direction can be considered the radial direction. A distance along the radial direction can be considered a thickness and/or a width. Traversing a plane extending orthogonal to the longitudinal direction can be considered a circumferential direction. The same directionality can be applied to all components discussed herein with respect to the hearing aid.

[0005] The receiver can include an outer surface. The outer surface can connect the first end with the second end. The outer surface can be a three-dimensional surface. In some examples, the outer surface is the entire outward-facing surface (e.g., radially facing) of the receiver other than the first end and the second end. In some examples, the outer surface is the entire outward-facing surface of the receiver other than the first surface and the second surface. In some examples, the outer surface is the entire outward-facing surface of the receiver including one or more of the first end and the second end. In some examples, the outer surface is the entire outward-facing surface of the receiver including one or more of the first surface and the second surface. The outer surface can be a portion of the outwards-facing surface of the receiver. For example, if the receiver is a rectangular prism, the first end can be a first surface, the second end can be a second surface opposite the first surface, and the outer surface can be the remaining four surfaces of the rectangular prism. The outer surface can be the surface(s) of the receiver closest to the housing.

[0006] In one or more example hearing aids, the receiver comprises a single receiver. In one or more example hearing aids, the receiver comprises a dual receiver. For a dual receiver, the outer surface can be considered the outer surface of the dual receiver. The same features discussed with respect to the receiver can also be applied to the dual receiver. For example, the dual receiver can have the first end, the second end, the outer surface, etc.

[0007] The hearing aid can further include a suspension layer. The suspension layer may be known as a first layer. The suspension layer can be configured to reduce and/or eliminate vibrations from the receiver to the rest of the hearing aid. The suspension layer can have an impact on acoustic performance and reliability on the hearing aid. From an acoustic point of view, the suspension layer can reduce and/or eliminate feedback (such as hearing aid whistle) while maintaining good acoustic coupling between transducer and instrument. For example, the properties of the suspension layer can reduce vibrations from the receiver. Further, the suspension layer can be used to optimize drop test performance by absorbing impact force to protect the internal components of the receiver. Another advantageous function of the receiver suspension is to isolate and dampen the vibrations of the receiver. Vibration can come from both its own movement when generating sound, and from external influences, for example, when the user is walking up stairs.

[0008] The suspension layer can at least partially cover the outer surface of the receiver. The suspension layer can at least partially cover the first end and/or the second end. The suspension layer can be in direct contact with the outer surface. The suspension layer can be separated from the outer surface by a separate layer. The suspension layer can cover a single surface of the receiver. The suspension layer can cover multiple surfaces of the

receiver. As used herein, "cover" can include being radially around the receiver, whether in contact with the receiver or not. As used herein, "cover" can include being between the receiver and the housing. In one or more example hearing aids, the suspension layer can extend past the first end and/or the second end. For example, the suspension layer can extend past the first end and/or the second end and be attached to the housing. The suspension layer can have a thickness from 0.2mm to 0.4mm. The particular thickness is not limiting.

[0009] In one or more example hearing aids, the suspension layer can be attached to the receiver. The suspension layer can be mechanically and/or chemically attached to the receiver.

[0010] In one or more examples, the suspension layer can include one or more vibration spikes (e.g., points, posts) extending from the suspension layer towards the housing. The vibration spikes can be configured to provide a minimum contact area between the suspension layer and the receiver so that they do not transmit vibrations from the receiver to the rest of the hearing aid.

[0011] The hearing aid can further include an impact absorbing layer. The impact absorbing layer can be configured to prevent one or more of damage, movement, or vibration to the receiver, such as internal components of the receiver. For example, the impact absorbing layer can prevent damage to the receiver upon dropping of the hearing aid. The impact absorbing layer can work in conjunction with the suspension layer to prevent damage to the receiver of the hearing aid.

[0012] In one or more example hearing aids, the impact absorbing layer can include one or more vibration spikes. The one or more vibration spikes can be configured to provide a minimum contact area between the housing and the impact absorbing layer.

[0013] The impact absorbing layer can at least partially cover the outer surface of the receiver. The impact absorbing layer can at least partially cover the first end and/or the second end. The impact absorbing layer can be in direct contact with the outer surface. The impact absorbing layer can be separated from the outer surface by a separate layer. The impact absorbing layer can cover a single surface of the receiver. The impact absorbing layer can cover multiple surfaces of the receiver. As used herein, "cover" can include being radially around the receiver, whether in contact with the receiver or not. As used herein, "cover" can include being between the receiver and the housing. In one or more example hearing aids, the impact absorbing layer can extend past the first end and/or the second end.

[0014] In one or more example hearing aids, the impact absorbing layer covers an outer circumference of the outer surface. In one or more example hearing aids, the impact absorbing layer covers an outer circumference of the receiver. For example, the impact absorbing layer at least partially covers each of the surfaces of the outer surface. In some examples, the impact absorbing layer at least partially covers each surface of the receiver other

than the first end and/or the second end. In other words, the impact absorbing layer forms a ring (e.g., loop, band) around the receiver. The impact absorbing layer can encircle the outer surface.

[0015] In one or more example hearing aids, the impact absorbing layer can be attached to the receiver. The impact absorbing layer can be mechanically and/or chemically attached to the receiver.

[0016] In one or more example hearing aids, the suspension layer covers an outer circumference of the outer surface. In one or more example hearing aids, the suspension layer covers an outer circumference of the receiver. For example, the suspension layer at least partially covers each of the surfaces of the outer surface. In some examples, the suspension layer at least partially covers each surface of the receiver other than the first end and/or the second end. In other words, the suspension layer forms a ring (e.g., loop, band) around the receiver. The suspension layer can encircle the outer surface.

[0017] The impact absorbing layer and the suspension layer can be different material. For example, the impact absorbing layer and the suspension layer can be two different plastics. The impact absorbing layer and the suspension layer can be different types of material. For example, the impact absorbing layer can be a foam and the suspension layer can be a rubber. The impact absorbing layer and the suspension layer can be different variations of a material. For example, the impact absorbing layer can be an open-cell foam of a first foam material and the suspension layer can be a closed-cell foam of the first foam material.

[0018] In one or more example hearing aids, the suspension layer is a rubber layer. For example, the suspension layer can be a fluorocarbon rubber layer. The suspension layer can be other materials as well.

[0019] In one or more example hearing aids, the impact absorbing layer is a foam layer. The foam layer can be, for example, a urethane foam layer. In one or more examples, the foam layer comprises an open cell foam layer. The impact absorbing layer can have a thickness of one or more of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, and 1.0mm. The impact absorbing layer can vary in thickness. The impact absorbing layer may have the same thickness throughout.

[0020] In one or more example hearing aids, the impact absorbing layer can be thicker than the suspension layer. In one or more example hearing aids, the impact absorbing layer can be twice as thick as the suspension layer. In one or more example hearing aids, the impact absorbing layer can be three times as thick as the suspension layer. In one or more example hearing aids, the impact absorbing layer can be four, five, six, seven, eight, nine, and/or ten times as thick as the suspension layer.

[0021] In one or more example hearing aids, the impact absorbing layer comprises a foam pad. The foam pad can be a urethane foam pad. The foam pad can have a thickness of one or more of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6,

0.7, 0.8, 0.9, and 1.0mm. In one or more example hearing aids, the foam layer comprises a single foam pad. The single foam pad can at least partially cover a single surface of the outer surface. The single foam pad can at least partially cover a plurality of surfaces of the outer surface. The single foam pad can cover the outer circumference of the outer surface.

[0022] In one or more example hearing aids, the foam layer comprises a plurality of foam pads. In one or more example hearing aids, each of the plurality of foam pads cover a side of the receiver. In one or more example hearing aids, at least one of the plurality of foam pads covers a plurality of sides of the receiver. In one or more example, the foam layer comprises as many foam pads as outwardly facing surfaces. In one or more example, the foam layer comprises as many foam pads as outwardly facing surfaces except those forming the first end and/or the second end of the receiver. The plurality of foam pads can be connected. Adjacent foam pads of the plurality of foam pads can touch, such as abut. Adjacent foam pads of the plurality of foam pads may not touch, such as abut, such as by forming a gap between adjacent foam pads of the plurality of foam pads.

[0023] In one or more example hearing aids, the foam layer comprises an open cell foam. In one or more example hearing aids, the foam layer comprises urethane. In one or more examples, the foam layer comprises an open cell urethane foam.

[0024] The hearing aid can further include a housing. The housing can be, for example, a plastic shell forming (such as defining) an outer surface of the hearing aid. The housing can be a metal, in certain example hearing aids. The housing can be titanium in certain example hearing aids. The housing can contain one or more elements of the hearing aid. For example, the housing can contain the receiver, the impact absorbing layer, and the suspension layer. For example, the housing can at least partially contain the receiver, the impact absorbing layer, and the suspension layer.

[0025] In one or more example hearing aids, the suspension layer at least partially covers a first portion of the outer surface. In one or more example hearing aids, the impact absorbing layer at least partially covers a second portion of the outer surface. In one or more example hearing aids, the first portion and the second portion are different. In other words, the suspension layer and the impact layer do not overlap. For example, starting from the outer surface of the receiver and extending radially, there will only be: the suspension layer, the impact absorbing layer, or neither the suspension layer nor the impact absorbing layer. In one or more examples hearing aids, the suspension layer and the impact absorbing layer overlap one another. In one or more examples hearing aids, the suspension layer and the impact absorbing layer partially and/or fully overlap one another. For example, the suspension layer can be between the impact absorbing layer and the housing. For example, the impact absorbing layer

can be between the suspension layer and the housing.

[0026] In one or more example hearing aids, the suspension layer abuts the impact absorbing layer. In other words, the suspension layer can contact and/or touch the impact absorbing layer. For example, a longitudinal end of the suspension layer can abut a longitudinal end of the impact absorbing layer. In one or more example hearing aids, the suspension layer is separated from the impact absorbing layer by a gap. In other words, the suspension layer does not abut the impact absorbing layer. In one or more examples, the suspension layer is attached to the impact absorbing layer. For example, the suspension layer and the impact absorbing layer can be mechanically and/or chemically attached.

[0027] In one or more example hearing aids, the impact absorbing layer abuts the housing. In one or more example hearing aids, the suspension layer abuts the housing. In one or more example hearing aids, the impact absorbing layer is separated from the housing by a gap. In one or more example hearing aids, the suspension layer is separated from the housing by a gap.

[0028] In one or more example hearing aids, the impact absorbing layer covers a larger portion of the outer surface than the suspension layer. For example, the impact absorbing layer covers two thirds of the outer surface. For example, the suspension layer covers one third of the outer surface.

[0029] In one or more example hearing aids, the impact absorbing layer and the suspension layer are in contact with the outer surface of the receiver. In one or more example hearing aids, the impact absorbing layer is in contact with the outer surface of the receiver. In one or more example hearing aids, the impact absorbing layer is spaced apart from the outer surface of the receiver, for example by an additional layer. In one or more example hearing aids, the suspension layer is in contact with the outer surface of the receiver. In one or more example hearing aids, the suspension layer is spaced apart from the outer surface of the receiver, for example by an additional layer.

[0030] The hearing aid may be adapted to provide a frequency dependent gain and/or a level dependent compression and/or a transposition (with or without frequency compression) of one or more frequency ranges to one or more other frequency ranges, e.g. to compensate for a hearing impairment of a user. The hearing aid may comprise a signal processor for enhancing the input signals and providing a processed output signal.

[0031] The hearing aid may comprise an output unit for providing a stimulus perceived by the user as an acoustic signal based on a processed electric signal. The output unit may comprise a number of electrodes of a cochlear implant (for a CI type hearing aid) or a vibrator of a bone conducting hearing aid. The output unit may comprise an output transducer. The output transducer may comprise a receiver (loudspeaker) for providing the stimulus as an acoustic signal to the user (e.g. in an acoustic (air conduction based) hearing aid). The output

transducer may comprise a vibrator for providing the stimulus as mechanical vibration of a skull bone to the user (e.g. in a bone-attached or bone-anchored hearing aid). The output unit may (additionally or alternatively) comprise a transmitter for transmitting sound picked up by the hearing aid to another device, e.g. a far-end communication partner (e.g. via a network, e.g. in a telephone mode of operation, or in a headset configuration).

[0032] The hearing aid may comprise an input unit for providing an electric input signal representing sound. The input unit may comprise an input transducer, e.g. a microphone, for converting an input sound to an electric input signal. The input unit may comprise a wireless receiver for receiving a wireless signal comprising or representing sound and for providing an electric input signal representing said sound. The input unit may include the receiver disclosed herein.

[0033] The hearing aid may comprise a directional microphone system adapted to spatially filter sounds from the environment, and thereby enhance a target acoustic source among a multitude of acoustic sources in the local environment of the user wearing the hearing aid. The directional microphone system may include the receiver disclosed herein. The directional system may be adapted to detect (such as adaptively detect) from which direction a particular part of the microphone signal originates. This can be achieved in various different ways as e.g. described in the prior art. In hearing aids, a microphone array beamformer is often used for spatially attenuating background noise sources. The beamformer may comprise a linear constraint minimum variance (LCMV) beamformer. Many beamformer variants can be found in literature. The minimum variance distortionless response (MVDR) beamformer is widely used in microphone array signal processing. Ideally the MVDR beamformer keeps the signals from the target direction (also referred to as the look direction) unchanged, while attenuating sound signals from other directions maximally. The generalized sidelobe canceller (GSC) structure is an equivalent representation of the MVDR beamformer offering computational and numerical advantages over a direct implementation in its original form.

[0034] The hearing aid may comprise antenna and transceiver circuitry allowing a wireless link to an entertainment device (e.g. a TV-set), a communication device (e.g. a telephone), a wireless microphone, or another hearing aid, etc. The hearing aid may thus be configured to wirelessly receive a direct electric input signal from another device. Likewise, the hearing aid may be configured to wirelessly transmit a direct electric output signal to another device. The direct electric input or output signal may represent or comprise an audio signal and/or a control signal and/or an information signal.

[0035] In general, a wireless link established by antenna and transceiver circuitry of the hearing aid can be of any type. The wireless link may be a link based on near-field communication, e.g. an inductive link based on an inductive coupling between antenna coils of transmitter

and receiver parts. The wireless link may be based on far-field, electromagnetic radiation. Preferably, frequencies used to establish a communication link between the hearing aid and the other device is below 70 GHz, e.g. located in a range from 50 MHz to 70 GHz, e.g. above 300 MHz, e.g. in an ISM range above 300 MHz, e.g. in the 900 MHz range or in the 2.4 GHz range or in the 5.8 GHz range or in the 60 GHz range (ISM=Industrial, Scientific and Medical, such standardized ranges being e.g. defined by the International Telecommunication Union, ITU). The wireless link may be based on a standardized or proprietary technology. The wireless link may be based on Bluetooth technology (e.g. Bluetooth Low-Energy technology), or Ultra WideBand (UWB) technology.

[0036] The hearing aid may be or form part of a portable (i.e. configured to be wearable) device, e.g. a device comprising a local energy source, e.g. a battery, e.g. a rechargeable battery. The hearing aid may e.g. be a low weight, easily wearable, device, e.g. having a total weight less than 100 g, such as less than 20 g.

[0037] The hearing aid may comprise a 'forward' (or 'signal') path for processing an audio signal between an input and an output of the hearing aid. A signal processor may be located in the forward path. The signal processor may be adapted to provide a frequency dependent gain according to a user's particular needs (e.g. hearing impairment). The hearing aid may comprise an 'analysis' path comprising functional components for analyzing signals and/or controlling processing of the forward path. Some or all signal processing of the analysis path and/or the forward path may be conducted in the frequency domain, in which case the hearing aid comprises appropriate analysis and synthesis filter banks. Some or all signal processing of the analysis path and/or the forward path may be conducted in the time domain.

[0038] The hearing aid may be configured to operate in different modes, e.g. a normal mode and one or more specific modes, e.g. selectable by a user, or automatically selectable. A mode of operation may be optimized to a specific acoustic situation or environment, e.g. a communication mode, such as a telephone mode. A mode of operation may include a low-power mode, where functionality of the hearing aid is reduced (e.g. to save power), e.g. to disable wireless communication, and/or to disable specific features of the hearing aid.

[0039] The hearing aid may comprise a number of detectors configured to provide status signals relating to a current physical environment of the hearing aid (e.g. the current acoustic environment), and/or to a current state of the user wearing the hearing aid, and/or to a current state or mode of operation of the hearing aid. Alternatively or additionally, one or more detectors may form part of an *external* device in communication (e.g. wirelessly) with the hearing aid. An external device may e.g. comprise another hearing aid, a remote control, and audio delivery device, a telephone (e.g. a smartphone), an external sensor, etc.

[0040] The hearing aid may further comprise other rel-

evant functionality for the application in question, e.g. compression, noise reduction, etc.

[0041] The hearing aid may comprise a hearing instrument, e.g. a hearing instrument adapted for being located at the ear or fully or partially in the ear canal of a user, e.g. a headset, an earphone, an ear protection device or a combination thereof. A hearing system may comprise a speakerphone (comprising a number of input transducers and a number of output transducers, e.g. for use in an audio conference situation), e.g. comprising a beamformer filtering unit, e.g. providing multiple beamforming capabilities.

A hearing system:

[0042] In a further aspect, a hearing system comprising a hearing aid as described above, in the 'detailed description of embodiments', and in the claims, AND an auxiliary device is moreover provided.

[0043] The hearing system may be adapted to establish a communication link between the hearing aid and the auxiliary device to provide that information (e.g. control and status signals, possibly audio signals) can be exchanged or forwarded from one to the other.

[0044] The auxiliary device may comprise a remote control, a smartphone, or other portable or wearable electronic device, such as a smartwatch or the like.

[0045] The auxiliary device may be constituted by or comprise a remote control for controlling functionality and operation of the hearing aid(s). The function of a remote control may be implemented in a smartphone, the smartphone possibly running an APP allowing to control the functionality of the audio processing device via the smartphone (the hearing aid(s) comprising an appropriate wireless interface to the smartphone, e.g. based on Bluetooth or some other standardized or proprietary scheme).

[0046] The auxiliary device may be constituted by or comprise an audio gateway device adapted for receiving a multitude of audio signals (e.g. from an entertainment device, e.g. a TV or a music player, a telephone apparatus, e.g. a mobile telephone or a computer, e.g. a PC) and adapted for selecting and/or combining an appropriate one of the received audio signals (or combination of signals) for transmission to the hearing aid.

[0047] The auxiliary device may be constituted by or comprise another hearing aid. The hearing system may comprise two hearing aids adapted to implement a binaural hearing system, e.g. a binaural hearing aid system.

Definitions:

[0048] In the present context, a hearing aid, e.g. a hearing instrument, refers to a device, which is adapted to improve, augment and/or protect the hearing capability of a user by receiving acoustic signals from the user's surroundings, generating corresponding audio signals, possibly modifying the audio signals and providing the possibly modified audio signals as audible signals to at

least one of the user's ears. Such audible signals may e.g. be provided in the form of acoustic signals radiated into the user's outer ears, acoustic signals transferred as mechanical vibrations to the user's inner ears through the bone structure of the user's head and/or through parts of the middle ear as well as electric signals transferred directly or indirectly to the cochlear nerve of the user.

[0049] The hearing aid may be configured to be worn in any known way, e.g. as a unit arranged behind the ear with a tube leading radiated acoustic signals into the ear canal or with an output transducer, e.g. a loudspeaker, arranged close to or in the ear canal, as a unit entirely or partly arranged in the pinna and/or in the ear canal, as a unit, e.g. a vibrator, attached to a fixture implanted into the skull bone, as an attachable, or entirely or partly implanted, unit, etc. The hearing aid may comprise a single unit or several units communicating (e.g. acoustically, electrically or optically) with each other. The loudspeaker may be arranged in a housing together with other components of the hearing aid, or may be an external unit in itself (possibly in combination with a flexible guiding element, e.g. a dome-like element).

[0050] A hearing aid may be adapted to a particular user's needs, e.g. a hearing impairment. A configurable signal processing circuit of the hearing aid may be adapted to apply a frequency and level dependent compressive amplification of an input signal. A customized frequency and level dependent gain (amplification or compression) may be determined in a fitting process by a fitting system based on a user's hearing data, e.g. an audiogram, using a fitting rationale (e.g. adapted to speech). The frequency and level dependent gain may e.g. be embodied in processing parameters, e.g. uploaded to the hearing aid via an interface to a programming device (fitting system), and used by a processing algorithm executed by the configurable signal processing circuit of the hearing aid.

[0051] A 'hearing system' refers to a system comprising one or two hearing aids, and a 'binaural hearing system' refers to a system comprising two hearing aids and being adapted to cooperatively provide audible signals to both of the user's ears. Hearing systems or binaural hearing systems may further comprise one or more 'auxiliary devices', which communicate with the hearing aid(s) and affect and/or benefit from the function of the hearing aid(s). Such auxiliary devices may include at least one of a remote control, a remote microphone, an audio gateway device, an entertainment device, e.g. a music player, a wireless communication device, e.g. a mobile phone (such as a smartphone) or a tablet or another device, e.g. comprising a graphical interface. Hearing aids, hearing systems or binaural hearing systems may e.g. be used for compensating for a hearing-impaired person's loss of hearing capability, augmenting or protecting a normal-hearing person's hearing capability and/or conveying electronic audio signals to a person. Hearing aids or hearing systems may e.g. form part of or interact with public-address systems, active ear protection systems,

handsfree telephone systems, car audio systems, entertainment (e.g. TV, music playing or karaoke) systems, teleconferencing systems, classroom amplification systems, etc.

BRIEF DESCRIPTION OF DRAWINGS

[0052] The aspects of the disclosure may be best understood from the following detailed description taken in conjunction with the accompanying figures. The figures are schematic and simplified for clarity, and they just show details to improve the understanding of the claims, while other details are left out. Throughout, the same reference numerals are used for identical or corresponding parts. The individual features of each aspect may each be combined with any or all features of the other aspects. These and other aspects, features and/or technical effect will be apparent from and elucidated with reference to the illustrations described hereinafter in which:

FIG. 1 shows an example embodiment of a hearing aid according to the disclosure,

FIG. 2 shows an example embodiment of a hearing aid according to the disclosure,

FIGS. 3A-3B show example embodiments of a hearing aid according to the disclosure, and

FIG. 4 shows an example embodiment of a hearing aid according to the disclosure.

[0053] The figures are schematic and simplified for clarity, and they just show details which are essential to the understanding of the disclosure, while other details are left out. Throughout, the same reference signs are used for identical or corresponding parts.

[0054] Further scope of applicability of the present disclosure will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the disclosure, are given by way of illustration only. Other embodiments may become apparent to those skilled in the art from the following detailed description.

DETAILED DESCRIPTION OF EMBODIMENTS

[0055] The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. Several aspects of the apparatus and methods are described by various blocks, functional units, modules, components, circuits, steps, processes, algorithms, etc.

(collectively referred to as "elements"). Depending upon particular application, design constraints or other reasons, these elements may be implemented using electronic hardware, computer program, or any combination thereof.

[0056] The electronic hardware may include micro-electronic-mechanical systems (MEMS), integrated circuits (e.g. application specific), microprocessors, micro-controllers, digital signal processors (DSPs), field programmable gate arrays (FPGAs), programmable logic devices (PLDs), gated logic, discrete hardware circuits, printed circuit boards (PCB) (e.g. flexible PCBs), and other suitable hardware configured to perform the various functionality described throughout this disclosure, e.g. sensors, e.g. for sensing and/or registering physical properties of the environment, the device, the user, etc. Computer program shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

[0057] The present application relates to the field of hearing aids.

[0058] FIG. 1 shows an example embodiment of a hearing aid according to the disclosure. As shown, the hearing aid 100 can include a receiver 102. The receiver 102 is configured to receive a sound in the environment. For example, the receiver 102 can be a microphone. The receiver 102 has a first end 104, a second end 106 opposite the first end 104, and an outer surface 108 connecting the first 104 end with the second end 106. The first end 104 and the second end 106 can be considered longitudinal ends of the receiver 102. Optionally, the receiver 102 is a dual receiver 102, 102'. The dual receiver 102' can include any or all discussion regarding receiver 102. A longitudinal direction can be considered from the first end 104 to the second end 106. A radial direction can be considered from the outer surface 108 to the housing 114.

[0059] As shown, the outer surface 108 can be one or more surfaces of the receiver 102. The outer surface 108 can be surfaces of the receiver 102 extending radially away from a center of the receiver 102. The outer surface 108 can be one or more surfaces other than those forming the first end 104 and the second end 106. The outer surface 108 can be one or more surfaces including those forming the first end 104 and the second end 106.

[0060] The hearing aid 100 of FIG. 1 further includes a suspension layer 110. The suspension layer 110 at least partially covers the outer surface 108 of the receiver 102. The hearing aid 100 further includes an impact absorbing layer 112. The impact absorbing layer 112 at least partially covers the outer surface 108 of the receiver 102. The impact absorbing layer 112 is a different material than the suspension layer 110. The suspension layer

110 can be a rubber layer. The impact absorbing layer 112 can be a foam layer.

[0061] Further, the hearing aid 100 can include a housing 114 surrounding the receiver 102, the suspension layer 110, and the impact absorbing layer 112. The housing 114 can form an outer surface of the hearing aid 100, thereby defining its shape. As shown in FIG. 1, the foam layer comprises a plurality of foam pads, each of the plurality of foam pads covering a side of the receiver 102. The foam layer can be an open cell foam. The foam layer can be urethane.

[0062] As shown in FIG. 1, the suspension layer 110 at least partially covers a first portion of the outer surface 108, and the impact absorbing layer 112 at least partially covers a second portion of the outer surface 108, the first portion and the second portion being different. Thus, as shown, there is no radial overlap between the suspension layer 110 and the impact absorbing layer 112. The impact absorbing layer 112 covers a larger portion of the outer surface 108 than the suspension layer 110.

[0063] The suspension layer 110 can abut the impact absorbing layer 112. Further, as shown, the impact absorbing layer 112 can abut the housing 114. Moreover, the impact absorbing layer 112 and the suspension layer 110 are in contact with the outer surface 108 of the receiver 102.

[0064] FIG. 2 shows an example embodiment of a hearing aid according to the disclosure. In particular, as shown the impact absorbing layer 112 covers an outer circumference of the outer surface 108. As shown in FIG. 2, the impact absorbing layer 112 is a foam layer, and the foam layer can be a single foam pad.

[0065] FIGS. 3A-3B show example embodiments of a hearing aid according to the disclosure. The hearing aids shown in FIGS. 3A-3B can include some or all of the features discussed with respect to FIGS. 1-2. As shown in FIG. 3A, the suspension layer 110 is separated from the impact absorbing layer 112 by a gap 302 (e.g., the layers are spaced apart). As shown in FIG. 3B, the impact absorbing layer 112 can be separated from the housing 114 by a gap 304. This can allow some flexibility in the movement of the receiver 102 during wearing and/or operation.

[0066] FIG. 4 shows an example embodiment of a hearing aid according to the disclosure. As shown, the hearing 100 includes the housing 114 discussed herein. The hearing 100 is configured to be worn behind the user's ears and comprises a behind-the-ear part 402 and an in-the-ear part 404. The behind-the-ear part 402 is connected to the in-the-ear part 404 via connecting member 406. However, the hearing aid 100 may be configured in other ways e.g., as completely-in-the-ear hearing aids. In some examples, the hearing aid 100 is in communication with another hearing aid via a short-range wireless link, e.g., an inductive wireless link.

[0067] It is intended that the structural features of the devices described above, either in the detailed description and/or in the claims, may be combined with steps of

the method, when appropriately substituted by a corresponding process.

[0068] As used, the singular forms "a," "an," and "the" are intended to include the plural forms as well (i.e. to have the meaning "at least one"), unless expressly stated otherwise. It will be further understood that the terms "includes," "comprises," "including," and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. It will also be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element, but an intervening element may also be present, unless expressly stated otherwise. Furthermore, "connected" or "coupled" as used herein may include wirelessly connected or coupled. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. The steps of any disclosed method are not limited to the exact order stated herein, unless expressly stated otherwise.

[0069] It should be appreciated that reference throughout this specification to "one embodiment" or "an embodiment" or "an aspect" or features included as "may" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. Furthermore, the particular features, structures or characteristics may be combined as suitable in one or more embodiments of the disclosure. The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects.

[0070] The claims are not intended to be limited to the aspects shown herein but are to be accorded the full scope consistent with the language of the claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more.

Claims

1. A hearing aid (100) comprising:

a receiver (102) configured to receive a sound in the environment, the receiver (102) having a first end (104), a second end (106) opposite the first end (104), and an outer surface (106) connecting the first end (104) with the second end (106);

a suspension layer (110) at least partially covering the outer surface (108) of the receiver

- (102);
 an impact absorbing layer (112) at least partially covering the outer surface (108) of the receiver (102), wherein the impact absorbing layer (112) is a different material than the suspension layer (110); and
 a housing (114) surrounding the receiver (102), the suspension layer (110), and the impact absorbing layer (112). 5
2. The hearing aid (100) of claim 1, wherein the impact absorbing layer (112) covers an outer circumference of the outer surface (106). 10
3. The hearing aid (100) of any one of the preceding claims, wherein the suspension layer (110) is a rubber layer. 15
4. The hearing aid (100) of any one of the preceding claims, wherein the impact absorbing layer (112) is a foam layer. 20
5. The hearing aid (100) of claim 4, wherein the foam layer comprises a plurality of foam pads, each of the plurality of foam pads covering a side of the receiver. 25
6. The hearing aid (100) of claim 4, wherein the foam layer comprises a single foam pad.
7. The hearing aid (100) of any one of claims 4-6, wherein the foam layer comprises an open cell foam. 30
8. The hearing aid (100) of any one of claims 4-6, wherein the foam layer comprises urethane. 35
9. The hearing aid (100) of any one of the preceding claims, wherein the receiver (102) comprises a dual receiver (102, 102').
10. The hearing aid (100) of any one of the preceding claims, wherein the suspension layer (110) at least partially covers a first portion of the outer surface (106), and wherein the impact absorbing layer (112) at least partially covers a second portion of the outer surface (106), the first portion and the second portion being different. 40 45
11. The hearing aid (100) of any one of the preceding claims, wherein the suspension layer (110) abuts the impact absorbing layer (112). 50
12. The hearing aid (100) of any one of claims 1-10, wherein the suspension layer (110) is separated from the impact absorbing layer (112) by a gap. 55
13. The hearing aid (100) of any one of the preceding claims, wherein the impact absorbing layer (112) abuts the housing (114).
14. The hearing aid (100) of any one of the preceding claims, wherein the impact absorbing layer (112) covers a larger portion of the outer surface (106) than the suspension layer (110).
15. The hearing aid (100) of any one of the preceding claims, wherein the impact absorbing layer (112) and the suspension layer (110) are in contact with the outer surface (106) of the receiver (102).

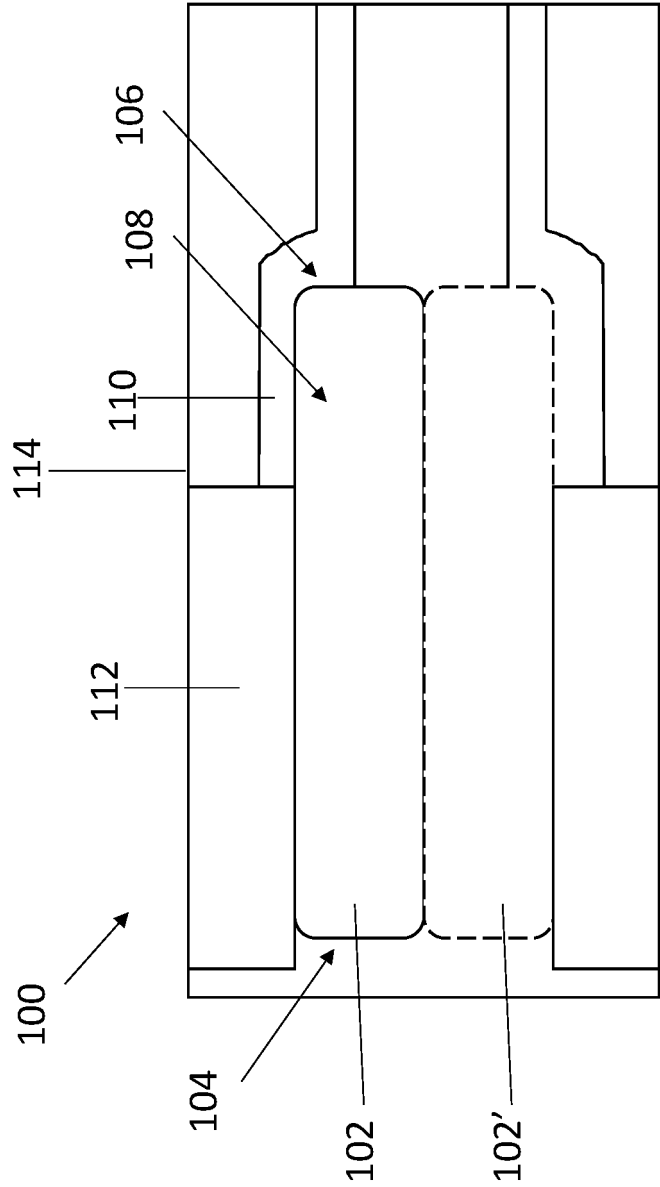


FIG. 1

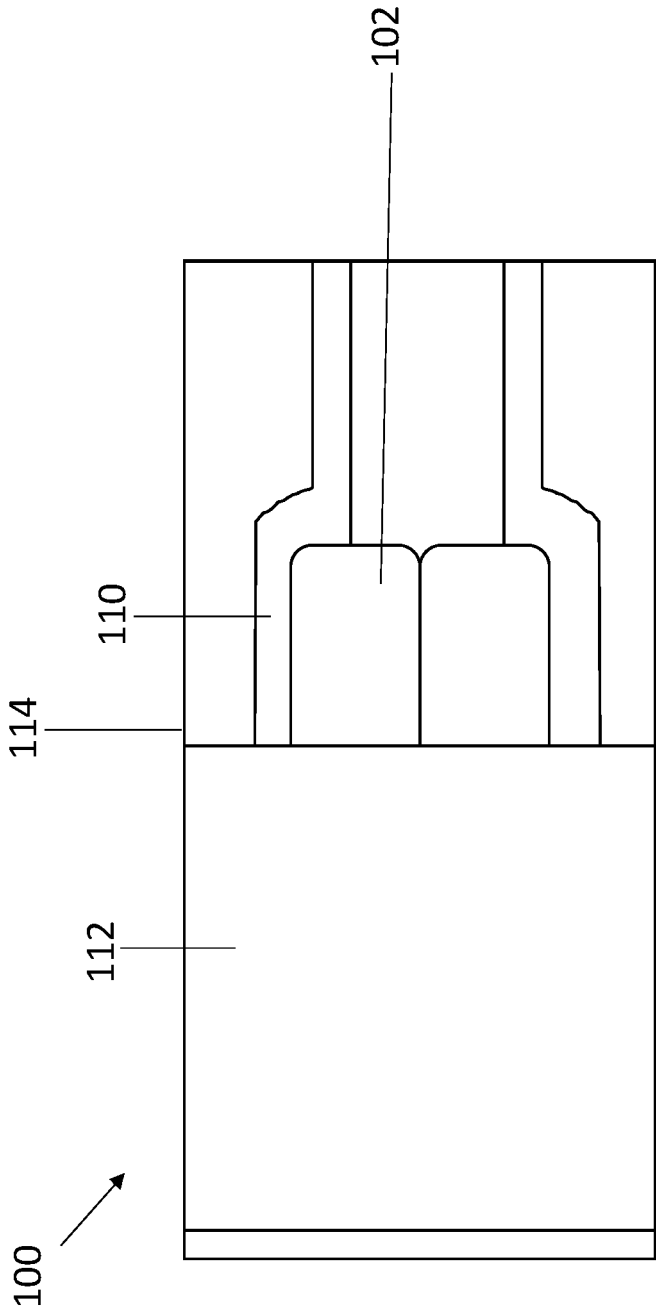


FIG. 2

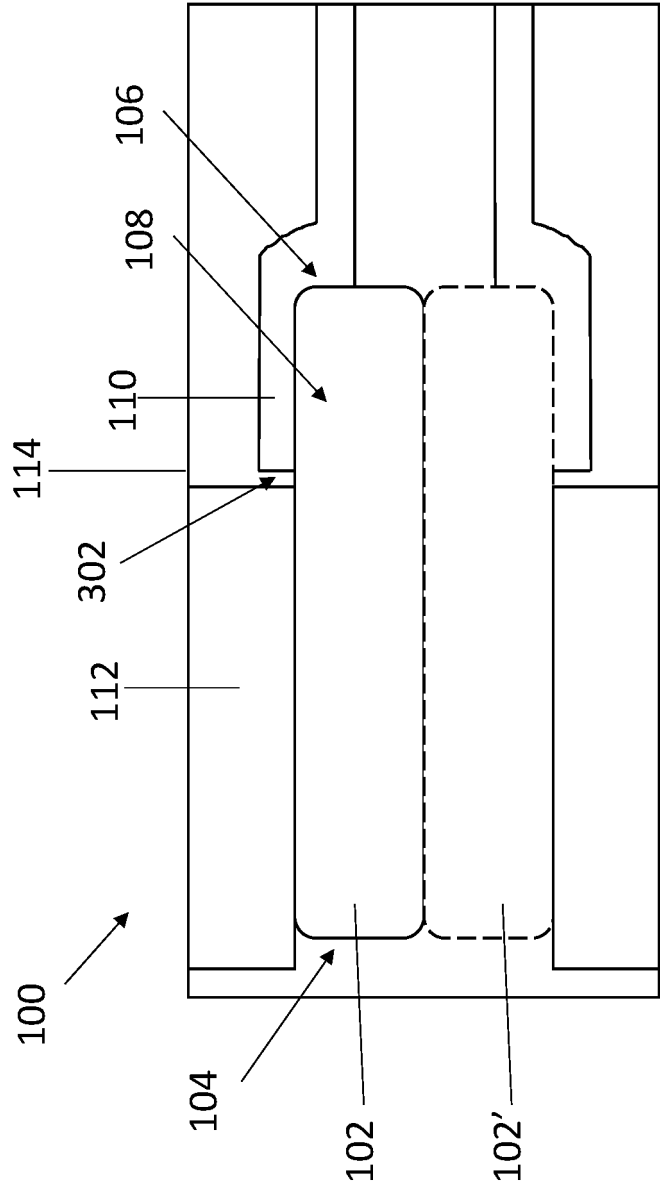


FIG. 3A

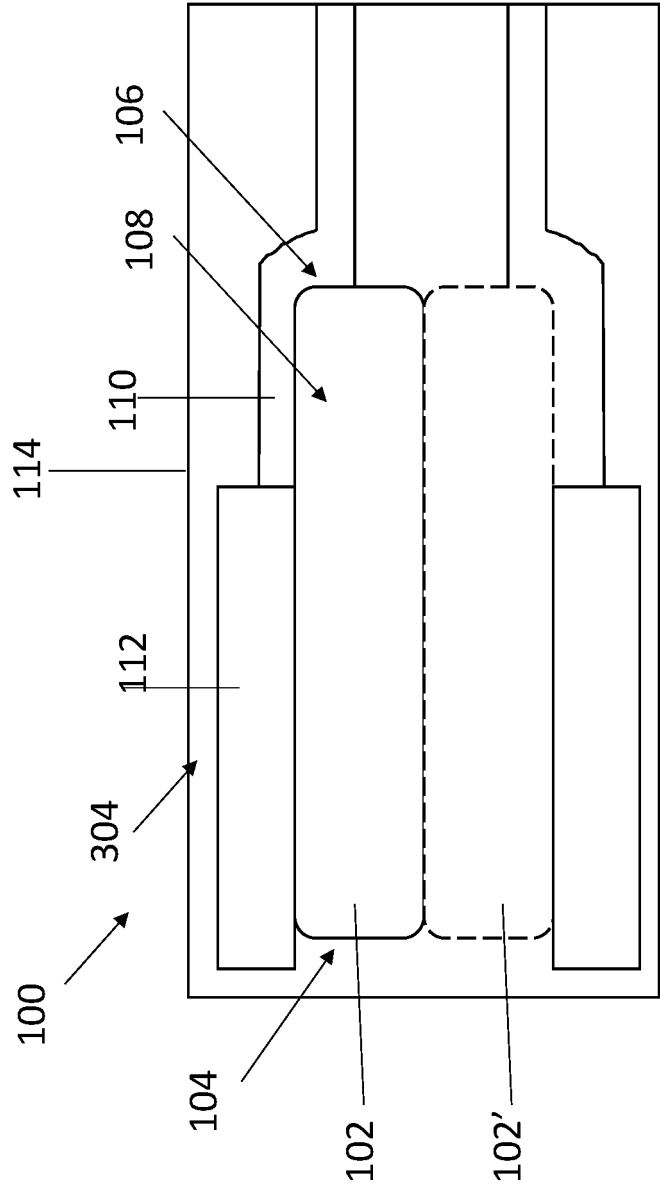


FIG. 3B

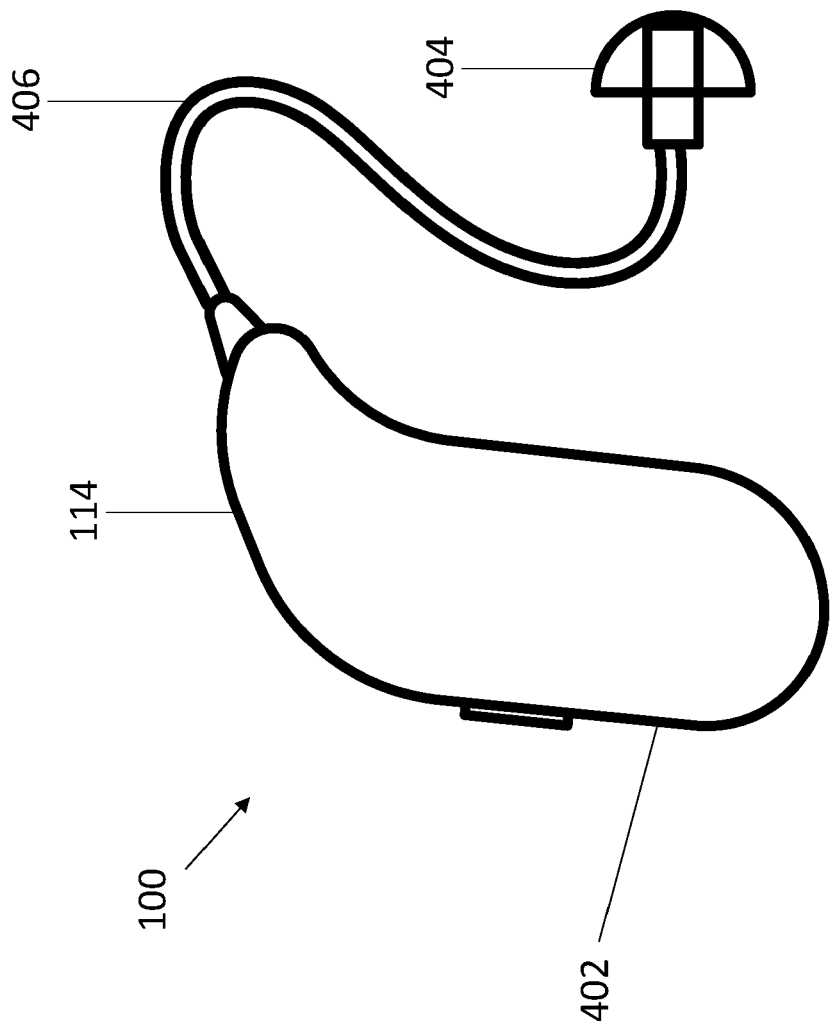


FIG. 4



EUROPEAN SEARCH REPORT

Application Number

EP 23 16 6456

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 4 156 708 A1 (GN HEARING AS [DK]) 29 March 2023 (2023-03-29) * the whole document *	1-15	INV. H04R25/00 H04R1/02 H04R1/28
X	US 2018/176678 A1 (BOLSMAN CASPAR TITUS [NL] ET AL) 21 June 2018 (2018-06-21) * the whole document *	1, 3-5, 7-10, 12, 13, 15	
X	US 2002/146141 A1 (GESCHIERE ONNO [NL] ET AL) 10 October 2002 (2002-10-10) * the whole document *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			H04R
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		31 August 2023	Bücker, Martin
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 23 16 6456

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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31-08-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 4156708 A1	29-03-2023	NONE	
US 2018176678 A1	21-06-2018	DK 3337191 T3	07-06-2021
		EP 3337191 A1	20-06-2018
		US 2018176678 A1	21-06-2018
US 2002146141 A1	10-10-2002	EP 1248496 A2	09-10-2002
		US 2002146141 A1	10-10-2002
		US 2006239488 A1	26-10-2006