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

(11) **EP 3 435 688 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.01.2019 Bulletin 2019/05

(51) Int Cl.:
H04R 25/00 *(2006.01)*

(21) Application number: **18161445.4**

(22) Date of filing: **13.03.2018**

(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
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Oticon A/S**
2765 Smørum (DK)

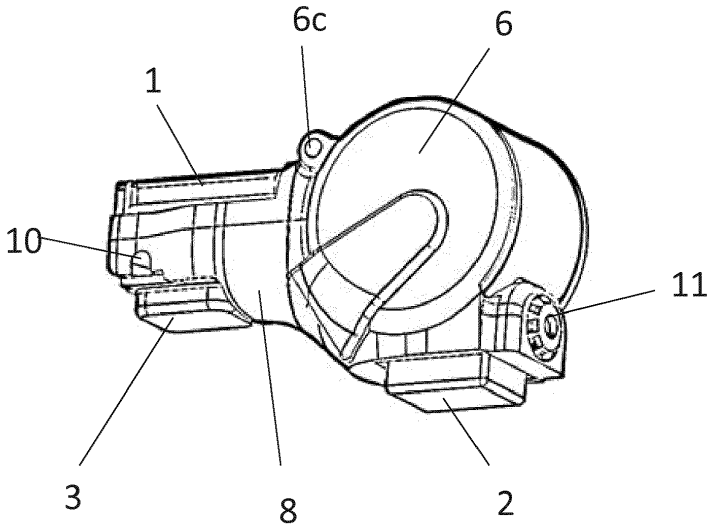
(72) Inventors:
- **PEDERSEN, Troels Holm**
DK-2765 Smørum (DK)
- **MØLLER, Kenneth Rueskov**
DK-2765 Smørum (DK)
- **PETERSEN, Svend Oscar**
DK-2765 Smørum (DK)
- **RASMUSSEN, Karsten Bo**
DK-2765 Smørum (DK)

(74) Representative: **William Demant**
Oticon A/S
Kongebakken 9
2765 Smørum (DK)

(54) IN THE EAR HEARING AID WITH EXPOSED ELECTRONIC COMPONENTS

(57) A hearing aid comprises a housing configured to be inserted into an ear canal of a hearing aid user. The housing accommodates at least one microphone, a receiver, a battery, and electrical components configured to create electrical connections between the at least one microphone, the battery and the receiver. The housing is configured as a casing having an outer surface. The outer surface comprises at least a first opening and a second opening. The first opening is configured to have arranged therein a first microphone of the at least one microphone, and the second opening is configured to have arranged therein the receiver. The receiver and the first microphone is arranged in said second and first opening, respectively, so that at least a surface of said receiver and said first microphone protrudes from said outer surface of the casing.

Fig. 4



EP 3 435 688 A1

Description

FIELD

[0001] The present disclosure relates to a hearing aid having exposed electronic components, where the electronic components includes at least a microphone and a receiver. More particularly, the disclosure relates to an in the ear type hearing aid, which comprises a housing configured to be inserted into the ear canal of a user, and which comprises at least a receiver and at least one microphone which protrudes from the housing.

BACKGROUND

[0002] When designing In-the-ear type hearing aids, which should be dimensioned to match a plurality of different sized ear canals, it is important that the hearing aid housing is made as compact as possibility in order to allow a greater fit rate in the ear canal. It is generally known that the size of the ear canals differs in the human population, why some hearing aids are custom designed to provide a perfectly matched hearing aid.

[0003] However, such custom designed in-the-ear type hearing aids are expensive to produce and requires a substantive fitting and molding process, which are adjusted exactly for individual ear canals of humans.

[0004] Accordingly, there is an interest in avoiding custom designed in-the-ear hearing aids, while at the same time maintaining a high fit rate, and which allows improved audiological features in the hearing aid. However, when designing non-custom designed hearing aids, it is often a challenge to arrange the hearing aid components internally to the housing in a manner which provides a sufficient sized hearing aid, which allows for a high fit rate, that is, which fits a high percentage of different human ear canals.

[0005] Therefore, there is a need to provide a solution that allows for an in-the-ear type hearing aid, which has a construction that allows for a high fit rate while at the same time improving the audiology of the hearing aid. The presented solution provides at least an alternative to already known in-the-ear hearing aids.

SUMMARY

[0006] According to an aspect, a hearing aid comprises a housing configured to be inserted into an ear canal of a hearing aid user. The housing accommodates at least one microphone, a receiver, a battery, and electrical components configured to create electrical connections between the at least one microphone, the battery and the receiver. The housing is configured as a casing having an outer surface. The outer surface comprises at least a first opening and a second opening. The first opening is configured to have arranged therein a first microphone of the at least one microphone, and the second opening is configured to have arranged therein the receiver. The receiver and the first microphone is arranged in said second and first opening, respectively, so that at least a surface of said receiver and said first microphone protrudes from said outer surface of the casing.

[0007] This allows a construction of a hearing aid that well matches into the space available in an ear canal, thereby allowing a high fit rate while at the same time improving the audiology.

[0008] The outer surface of the casing may comprise a third opening, said third opening is configured to receive a second microphone, wherein a surface of the second microphone is exposed to the surroundings or protrudes from the outer surface of the casing. This allows improving the configuration of said hearing aid even for a dual microphone type in ear hearing aid.

[0009] Furthermore, the casing defines a longitudinal direction, wherein a first end faces towards the eardrum and a second end faces towards the ear canal opening when the hearing aid is inserted into an ear canal, wherein the first end may comprise the receiver, which in one end of the receiver may face towards a first surface of the battery, and the first microphone may be arranged in the second end and may face another surface of the battery. Thereby, the second microphone may be arranged in the first end of the casing, and substantially faces a first longitudinal side of the receiver. This further improves the configuration of said hearing aid for single as well as dual microphone type in ear hearing aids.

[0010] Still further, a first electrical component of said electrical components may be arranged between the second microphone and the receiver. This allows creating a physical separation between the receiver and the inner microphone, thereby lowering the risk of vibratory feedback between receiver and microphone while allowing efficient use of physical space.

[0011] Moreover, the second end may comprise a battery drawer configured to receive a battery, the battery drawer is hingedly connected to the casing on a side of the battery drawer facing an end of the receiver. This allows simple replacement of the battery while efficiently using the available space.

[0012] The hearing aid may further comprise a sleeve configured to be arranged around and substantially enclose at least a part of the casing, wherein the sleeve is configured to enclose the protruding surfaces of the at least one microphone and the receiver. Thereby, the sleeve may be configured to allow a part of the casing comprising said battery to be exposed to the surroundings. This allows for providing a well-defined comfortable sealing to the ear canal walls and to ensure retention of the device is the ear canal.

[0013] Further, the battery drawer may comprise a cover configured to rotate around the hinged connection of said battery drawer, wherein the first microphone is configured to be arranged on a surface of the battery opposing the cover of the battery drawer. This allows simple replacement of the battery while efficiently using the available space.

[0014] Still further, the electrical connection elements connecting said first microphone to said first electrical component may run substantially from said first microphone along the outer counters of said battery to said first electrical component. The first electrical component may be configured as a printed circuit board (PCB).

[0015] The hearing aid may further comprise a coil configured for providing at least one of a communication link (e.g. near-field communication) and a charging link. Thereby, the coil may be arranged at substantially the same side of the battery as said first microphone.

[0016] The casing may comprise a first microphone inlet, which is located between the first microphone and the battery. This ensures free sound access to the microphone input while obtaining a solution where the physical length of the device is minimized through taking advantage of the elongated cross section of the outer ear canal.

[0017] Further, the casing may comprise a second microphone inlet located in the first end thereof, which is formed in a T-shape such that two inlet ports are provided on opposite sides on the first end of the casing. This enables increased security against wax build-up blocking the sound from entering the hearing instrument, since two separate sound inlet openings are provided.

[0018] Moreover the battery may be rechargeable battery, which is mounted on a printed circuit board (PCB) provided within the casing. Thereby, the battery drawer is not necessary, which allows further saving material and space.

BRIEF DESCRIPTION OF DRAWINGS

[0019] 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 schematically illustrates relative positions of components of a dual microphone type hearing aid according to an embodiment of the disclosure, illustrated without sleeve and casing;

Fig. 2 shows a cross section of a hearing aid, indicating positional relationships between components thereof

Fig. 3 schematically illustrates a hearing aid according to an embodiment of the disclosure with attached sleeve and casing;

Fig. 4 schematically illustrates a hearing aid according to an embodiment of the disclosure with casing and without attached sleeve;

Fig. 5 schematically illustrates a hearing aid according to an embodiment of the disclosure with attached sleeve and casing, wherein the sleeve is formed as dome;

Figs. 6A to 6C show examples of battery connection locations;

Figs. 7A to 7C show examples of providing a sound inlet to the front (second) microphone;

Fig. 8 shows an exploded view of a hearing aid according to the present invention;

Fig. 9 shows possible states of the receiver and second microphone with regard to the casing; and

Fig. 10 shows estimated geometrical parameters representative of the relevant part of the ear canal.

DETAILED DESCRIPTION

[0020] 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 are described by various blocks, functional units, modules, components, 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.

[0021] The electronic hardware may include microprocessors, microcontrollers, digital signal processors (DSPs), field programmable gate arrays (FPGAs), programmable logic devices (PLDs), gated logic, discrete hardware circuits, and other suitable hardware configured to perform the various functionality described throughout this disclosure. 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.

[0022] A hearing device may include a hearing aid that is adapted to improve or augment the hearing capability of a user by receiving an acoustic signal from a user's

surroundings, generating a corresponding audio signal, possibly modifying the audio signal and providing the possibly modified audio signal as an audible signal to at least one of the user's ears. The "hearing device" may further refer to a device such as an earphone or a headset adapted to receive an audio signal electronically, possibly modifying the audio signal and providing the possibly modified audio signals as an audible signal to at least one of the user's ears. Such audible signals may be provided in the form of an acoustic signal radiated into the user's outer ear, or an acoustic signal transferred as mechanical vibrations to the user's inner ears through bone structure of the user's head and/or through parts of middle ear of the user or electric signals transferred directly or indirectly to cochlear nerve and/or to auditory cortex of the user.

[0023] The hearing device is adapted to be worn in any known way. This may include i) arranging a unit of the hearing device behind the ear with a tube leading air-borne acoustic signals into the ear canal or with a receiver/ loudspeaker arranged close to or in the ear canal such as in a Behind-the-Ear type hearing aid, and/ or ii) arranging the hearing device entirely or partly in the pinna and/ or in the ear canal of the user such as in a In-the-Ear type hearing aid or In-the-Canal/ Completely-in-Canal type hearing aid, or iii) arranging a unit of the hearing device attached to a fixture implanted into the skull bone such as in Bone Anchored Hearing Aid or Cochlear Implant, or iv) arranging a unit of the hearing device as an entirely or partly implanted unit such as in Bone Anchored Hearing Aid or Cochlear Implant.

[0024] A "hearing system" refers to a system comprising one or two hearing devices, and a "binaural hearing system" refers to a system comprising two hearing devices where the devices are adapted to cooperatively provide audible signals to both of the user's ears. The hearing system or binaural hearing system may further include auxiliary device(s) that communicates with at least one hearing device, the auxiliary device affecting the operation of the hearing devices and/or benefitting from the functioning of the hearing devices. A wired or wireless communication link between the at least one hearing device and the auxiliary device is established that allows for exchanging information (e.g. control and status signals, possibly audio signals) between the at least one hearing device and the auxiliary device. Such auxiliary devices may include at least one of remote controls, remote microphones, audio gateway devices, mobile phones, public-address systems, car audio systems or music players or a combination thereof. The audio gateway is adapted to receive a multitude of audio signals such as from an entertainment device like a TV or a music player, a telephone apparatus like a mobile telephone or a computer, a PC. The audio gateway is further adapted to select and/or combine an appropriate one of the received audio signals (or combination of signals) for transmission to the at least one hearing device. The remote control is adapted to control functionality and operation of the at least one hearing devices. The function of the remote control may be implemented in a Smartphone or other electronic device, the Smartphone/electronic device possibly running an application that controls functionality of the at least one hearing device.

[0025] In general, a hearing device includes i) an input unit such as a microphone for receiving an acoustic signal from a user's surroundings and providing a corresponding input audio signal, and/or ii) a receiving unit for electronically receiving an input audio signal. The hearing device further includes a signal processing unit for processing the input audio signal and an output unit for providing an audible signal to the user in dependence on the processed audio signal.

[0026] The input unit may include multiple input microphones, e.g. for providing direction-dependent audio signal processing. Such directional microphone system is adapted to enhance a target acoustic source among a multitude of acoustic sources in the user's environment. In one aspect, the directional system is adapted to detect (such as adaptively detect) from which direction a particular part of the microphone signal originates. This may be achieved by using conventionally known methods. The signal-processing unit may include amplifier that is adapted to apply a frequency dependent gain to the input audio signal. The signal-processing unit may further be adapted to provide other relevant functionality such as compression, noise reduction, etc. The output unit may include an output transducer such as a loudspeaker/ receiver for providing an air-borne acoustic signal transcutaneously or percutaneously to the skull bone or a vibrator for providing a structure-borne or liquid-borne acoustic signal. In some hearing devices, the output unit may include one or more output electrodes for providing the electric signals such as in a Cochlear Implant.

[0027] When designing a hearing aid intended to be manufactured without the use of ear impressions- i.e. one and the same body shape is used for all clients - the design of the device with internal components is important for the size and usability of the device. Hence, it is intended to provide a hearing aid that is physically compact as possible while maintaining an outer shape that is well matched to the ear canal being slightly oval.

[0028] The sketch shown in Fig. 10 indicates estimated geometrical parameters (in millimeters) representative of the relevant part of the ear canal where the smallest cross section (seen in the right hand side of the diagram) represents innermost part of the ear canal section. A hearing instrument in the ear canal should be designed to conform to such dimensions.

[0029] Now referring to Fig. 1, which schematically illustrates relative positions of components of a dual microphone type hearing aid according to an embodiment of the disclosure, illustrated without sleeve and casing.

[0030] A hearing aid in accordance with the present disclosure may comprise, as components thereof, at least one microphone 2, 3, a receiver 1, a battery 6, and electrical components 4, which may be mounted on a

printed circuit board (PCB) 4a that may extend through the device, as is indicated by a dashed line in Fig. 1, and which is configured to create electrical connections between the at least one microphone 2, 3, the battery 6 and the receiver 1. The PCB may be formed e.g. as solid single- or multilayered PCB, or as a flexible PCB, which may be configured so as to follow the outer contours of at least one of the battery 6, the receiver 1 and the microphone 2.

[0031] As is indicated in Fig. 2, the PCB may extend from one end of the hearing aid, on which a front microphone 3 and the receiver 1 is provided, along the battery 6 to the rear microphone 2. As already indicated above, the PCB may be flexible, wherein amplifier electronics (electrical components) 4, the receiver 1 and the microphones 2, 3 may be mounted directly thereon or via additional PCB(s). Sound inlets 10, 11 for the front microphone 3 and the rear microphone 2, respectively, may be formed in the casing 8.

[0032] Back to Fig. 1, in case of a hearing aid providing a communication link, such as near-field communication, Bluetooth, etc., a respective coil 5 for providing a communication link may be provided, as is shown in Fig. 1. Thereby, the coil 5 is arranged at substantially the same side of the battery 6 as the first microphone 2. The coil may also be used for wirelessly charging the battery 6 (e.g. by induction), in case the battery is a rechargeable battery. Further, separate coils for communication link and charging link may be provided.

[0033] The battery 6 of the hearing aid may be rechargeable. In particular, the in the ear apparatus comprises the battery, microphone and receiver construction as described above, however with a rechargeable battery. That is, the battery is e.g. SMD mounted to the PCB so as to be integrated (i.e. cannot be displaced/removed) into the casing. According to an example, the battery is SMD mounted to the PCB, which extends through the entire device. Therefore, the battery drawer would no longer be necessary, and material and space would be saved.

[0034] Also, as is indicated in Fig. 1, the hearing aid may be provided with a removal handle 7, so as to enable removal of the hearing aid from an ear canal.

[0035] Fig. 3 schematically illustrates a hearing aid according to an embodiment of the disclosure with sleeve 9 and housing 8, wherein the inner part thereof is similarly configured as the hearing aid shown in Fig. 1.

[0036] In this example, the hearing aid is configured as an instant-shaped in-ear canal device (i.e. no need for ear canal impressions) equipped with a soft sleeve 9 covering the frontal part and having a dome-shaped structure which may be of circular shape or elongated /ellipsoidal outer shape. The sleeve is made from soft material such as silicone in order to provide a comfortable ear insertion. The primary function of the sleeve 9 is to provide a well-defined comfortable sealing to the ear canal walls and to ensure retention of the device is the ear canal.

[0037] The device may be configured by having two microphones 2, 3 and a receiver 1 which is not fully accommodated in the casing and not covered by plastic or similar casing material. This results in a smaller instrument than if the transducers are mounted inside the casing.

[0038] The transducers may be covered by a layer of lacquer or paint in order to protect the user from electrical currents migrating from the surface of the transducers into the skin of the user. As examples, silicone coating, polyurethane coating or epoxy coating may be applied, which may be biocompatible, or may be at least produced as biocompatible coatings. The sleeve 9 may offer protection from wax entering into the hearing aid transducer openings and alleviates the problem of the end user having to change separate wax-protective filters. The sleeve 9 may be changeable, (e.g. once per week), and this effectively renews the wax protection also.

[0039] Particularly, as is shown in Fig. 3, the sleeve is configured to be arranged around and substantially enclose at least a part of the housing 8 (casing), wherein the sleeve 9 is configured to enclose the protruding surfaces of the microphones 2 and 3 as well as the receiver 1. Nevertheless, the sleeve 9 is configured to allow a part of the housing 8 (casing) comprising the battery 6 to be exposed to the surroundings.

[0040] As becomes apparent from each of Figs. 3 and 4, the housing 8 of the hearing aid is configured as a casing having an outer surface. The outer surface comprises at least a first opening and a second opening, wherein the first opening is configured to have arranged therein a first microphone 2 (of the at least one microphone), and the second opening is configured to have arranged therein the receiver 1. The first microphone 2 is arranged in the first opening, and the receiver 1 is arranged in the second opening, so that at least a surface of the receiver 1 and the first microphone 2 protrudes from said outer surface of the casing.

[0041] Figs. 3 and 4 each shows an example in which the outer surface of the casing further comprises a third opening, which is configured to receive a second microphone 3, and a surface of the second microphone 3 protrudes from the outer surface of the casing 8.

[0042] As is illustrated in Fig. 3, the casing 8 defines a longitudinal direction, wherein a first end 8a faces towards the eardrum and a second end 8b faces towards the ear canal opening when the hearing aid is inserted into an ear canal. Thereby, the first end 8a comprises the receiver 1, which in one end of the receiver 1 faces towards a first surface of the battery 6, and the first microphone 2 is arranged in the second end 8b and faces another surface of the battery 6.

[0043] Further, in the example of Fig. 3, the second microphone 3 is arranged in the first end 8a of the casing, and substantially faces a first longitudinal side of the receiver 1.

[0044] The device may also comprise electronic components 4 (e.g. amplifier, signal processing, etc.) which

are mounted wholly or partially between the frontal microphone 3 and the receiver 1. This allows for efficient use of physical space in the device while at the same time creating a physical separation between the receiver and the inner microphone, wherein this is advantageous because of the risk of vibratory feedback between receiver and inner microphone. In particular, a first electrical component 4a, which may be configured as the above indicated printed circuit board, may be arranged between the second microphone 3 and the receiver 1, as is shown in Fig. 1.

[0045] As is further shown in Figs. 3 and 4, the housing 8 may comprise a battery drawer 6a configured to receive the battery 6 at the second end 8b of the casing, wherein the battery drawer 6a is hingedly connected to the casing on a side of the battery drawer 6a facing an end of the receiver 1. That is, the battery drawer 6a comprises a cover 6b configured to rotate around the hinged connection 6c of the battery drawer 6a, wherein the first microphone 2 is configured to be arranged on a surface of the battery 6 opposing the cover 6b of the battery drawer 6a.

[0046] In addition, according to certain embodiments, the device may comprise a T-shaped microphone inlet 10 at the inner microphone 3. T-shaped means that openings exist on both sides of the instrument, since the hole penetrates all the way through the instrument. The T-inlet has the advantage of increased security against wax build-up blocking the sound from entering the hearing instrument, since two separate sound inlet openings exist in this design.

[0047] Further, the device may comprise an outer (rear) microphone inlet 11 which is located between the outer microphone 2 and the battery 6. This solution ensures free sound access to the microphone input while obtaining a solution where the physical length of the device is minimized through taking advantage of the elongated cross section of the outer ear canal.

[0048] The transducers may be protected by the sleeve 9 as seen in Fig. 3 or they may be partially or wholly unprotected as seen in Fig. 5 for a concept using dome instead of the long sleeve. Thereby, the sleeve may also cover the battery and has the function of a dome, ensuring a seal towards the inner surfaces of the ear canal. Further, the sleeve may be furthermore covered by a dome, which seals the hearing aid to the inner walls of the ear canal.

[0049] In particular, while Fig. 3 shows an example of a dual microphone type in-ear device with silicone sleeve having a shape including a part partially covering the outer end of the device, thereby ensuring that the sleeve will not fall off in the ear canal, the embodiment shown in Fig. 5 shows a device with a dome instead of the long sleeve seen in Fig. 3.

[0050] Each of Figs. 6A to 6C shows examples of locations for battery connection (e.g. soldering or contact springs) based on the cross-section view of Fig. 2. According to Fig. 6A, the electrical connection of the battery 6 to the PCB 4a may be formed in a middle section between the receiver 1 and the rear (first) microphone 2, according to Fig. 6B, the electrical connection may be formed adjacent to the rear (first) microphone 2, and according to Fig. 6C, the electrical connection may be formed adjacent to the receiver 1. Nevertheless, the position of the electrical connection of the battery 6 is not restricted on these examples.

[0051] The inlet 10 of the second (inner/front) microphone 3 is arranged to be directed into the channel formed in the relatively small space formed between the receiver 1 and the second microphone 3 (see e.g. Fig. 2). Figs. 7A to 7C show examples of the sound inlet 10 to the front (second) microphone 3. In the above-indicated channel/relatively small space, the second microphone 3, which may be a MEMS-microphone, comprises an inlet structure (i.e. the T-shaped structure), which mount onto the inlet of the second microphone 3, and then extends to each side in the channel and substantially takes of the relatively small space between the receiver 1 and the microphone 3. That is, a surface of the receiver 1 abuts the "T-inlet". It does not necessarily need to be a t-inlet, as long as the inlet takes up the above-indicated relative small space.

[0052] In order to protect the user from the electronics, the transducer may be retracted into the casing or arranged substantially flush with the outer surface of the casing in the respective opening into the surfaces.

[0053] Furthermore, the transducers may be protected from e.g. electrostatic discharge, especially when bearing in mind that such device are intended to be in very close contact with humans. The transducer (as described above), may be coated with a non-conductive coating - this could be e.g. a paint. Also, a type of conductor may be used which leads the potential currents away from the transducers. E.g. the in a PCB to which the transducers are connected, a metal wire could be integrated, through which metal wires, the currents are lead away from the transducers. Another approach is to glue onto the transducers a metal sheet, which leads the potential electrostatic discharge currents away from the transducers.

[0054] Fig. 8 shows an exploded view according to an example of the hearing aid according to the invention comprising the casing 8, the receiver 1, the first microphone 2, the second microphone 3, the battery cover 6b which may be provided at the casing 8 via a hinged connection 6c.

[0055] As becomes apparent from Fig. 9, the front (second) microphone 3, the receiver and/or any of the further components may be disposed in the respective openings of the casing (housing) 8, so as to be completely exposed to the surroundings (left side of Fig. 9), so as to partially protrude from the housing 8 (middle of Fig. 9), or so as to be only partially exposed to the surroundings (right side of Fig. 9).

[0056] 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 a method, when appropriately substituted by a corre-

sponding process (e.g. for manufacturing a hearing aid).

[0057] 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 elements 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 is not limited to the exact order stated herein, unless expressly stated otherwise.

[0058] 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.

[0059] The claims are not intended to be limited to the aspects shown herein, but is 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.

[0060] Accordingly, the scope should be judged in terms of the claims that follow.

Claims

1. A hearing aid, comprising:

a housing configured to be inserted into an ear canal of a hearing aid user, said housing accommodating:

at least one microphone,
a receiver,
a battery, and
electrical components configured to create electrical connections between the at least one microphone, the battery and the receiver,

wherein:

the housing is configured as a casing having an outer surface,
said outer surface comprises at least a first opening and a second opening,
the first opening is configured to have arranged therein a first microphone of the at least one microphone, and the second opening is configured to have arranged therein the receiver, and
said receiver and said first microphone is arranged in said second and first opening, respectively, so that at least a surface of said receiver and said first microphone protrudes from said outer surface of the casing.

2. The hearing aid according to claim 1, wherein said outer surface of said casing comprises a third opening, said third opening is configured to receive a second microphone, wherein a surface of the second microphone is exposed to the surroundings or protrudes from the outer surface of the casing.

3. The hearing aid according to claim 1 or 2, wherein said casing defines a longitudinal direction, wherein a first end faces towards the eardrum and a second end faces towards the ear canal opening when the hearing aid is inserted into an ear canal,
said first end comprises the receiver, which in one end of the receiver faces towards a first surface of the battery, and
the first microphone is arranged in the second end and faces another surface of the battery.

4. The hearing aid according to claim 3, wherein the second microphone is arranged in the first end of the casing, and substantially faces a first longitudinal side of the receiver.

5. The hearing aid according to any of claims 2 to 4, wherein a first electrical component of said electrical components is arranged between the second microphone and the receiver.

6. The hearing aid according to any of claims 3 to 5, wherein the second end comprises a battery drawer configured to receive a battery, the battery drawer is hingedly connected to the casing on a side of the battery drawer facing an end of the receiver.

7. The hearing aid according to any of claims 1 to 6, further comprising a sleeve configured to be ar-

ranged around and substantially enclose at least a part of the casing, wherein the sleeve is configured to enclose the protruding surfaces of the at least one microphone and the receiver.

8. The hearing aid according to claim 7, wherein the sleeve is configured to allow a part of the casing comprising said battery to be exposed to the surroundings.

9. The hearing aid according to claim 7 or 8, wherein the battery drawer comprises a cover configured to rotate around the hinged connection of said battery drawer, wherein said first microphone is configured to be arranged on a surface of said battery opposing said cover of said battery drawer.

10. The hearing aid according to any of claims 5 to 9, wherein the electrical connection elements connecting said first microphone to said first electrical component runs substantially from said first microphone along the outer counters of said battery to said first electrical component.

11. The hearing aid according to any of claims 5 to 10, wherein the first electrical component is configured as a printed circuit board.

12. The hearing aid according to any of claims 1 to 11, further comprising a coil configured for providing at least one of a communication link and charging link.

13. The hearing aid according to claim 12, wherein said coil is arranged at substantially the same side of the battery as said first microphone.

14. The hearing aid according to any of claims 1 to 13, wherein the casing comprises a first microphone inlet, which is located between the first microphone and the battery.

15. The hearing aid according to any of claims 4 to 14, wherein the casing comprises a second microphone inlet located in the first end thereof, which is formed in a T-shape such that two inlet ports are provided on opposite sides on the first end of the casing.

16. The hearing aid according to claim 1 or 2, wherein the battery is a rechargeable battery, which is mounted on a printed circuit board provided within the casing.

Fig. 1

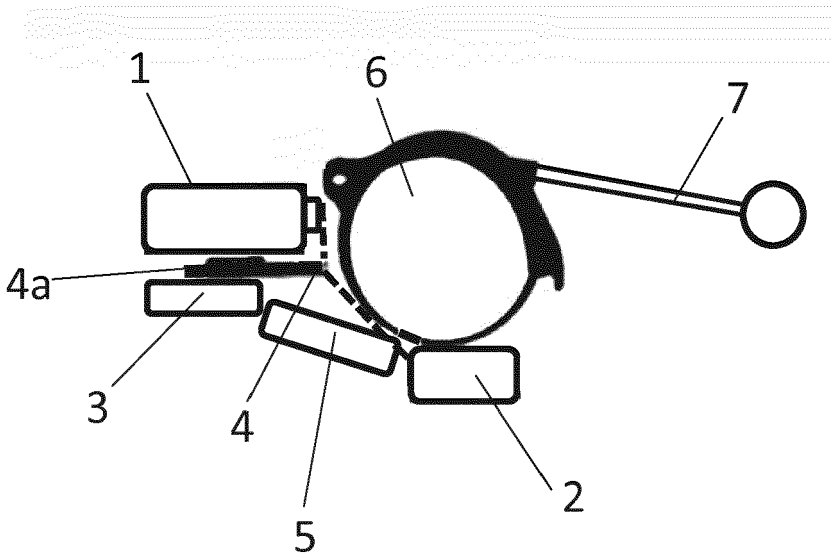


Fig. 2

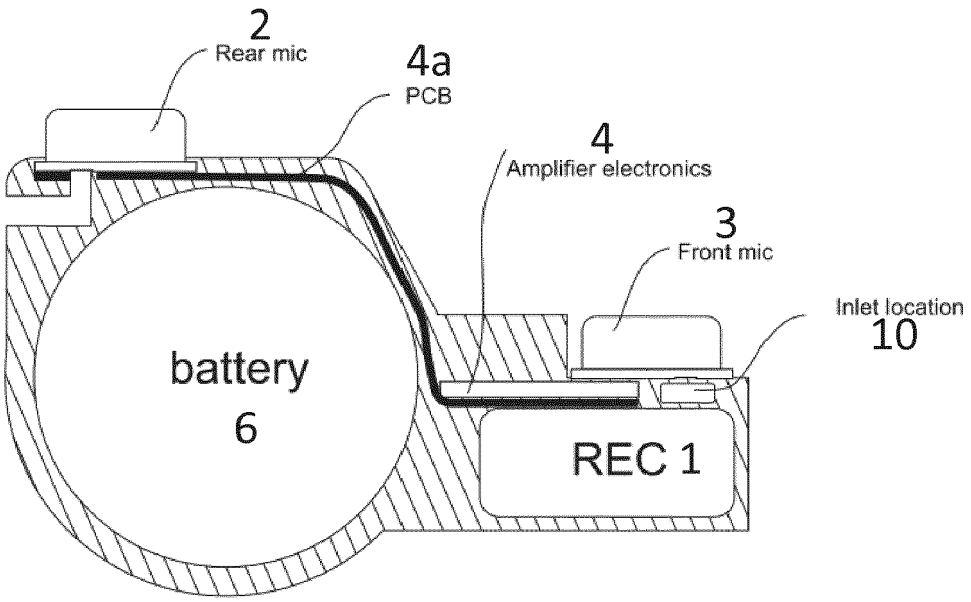

2
Rear mic
4a
PCB
4
Amplifier electronics
3
Front mic
Inlet location
10
battery
6
REC 1

Fig. 3

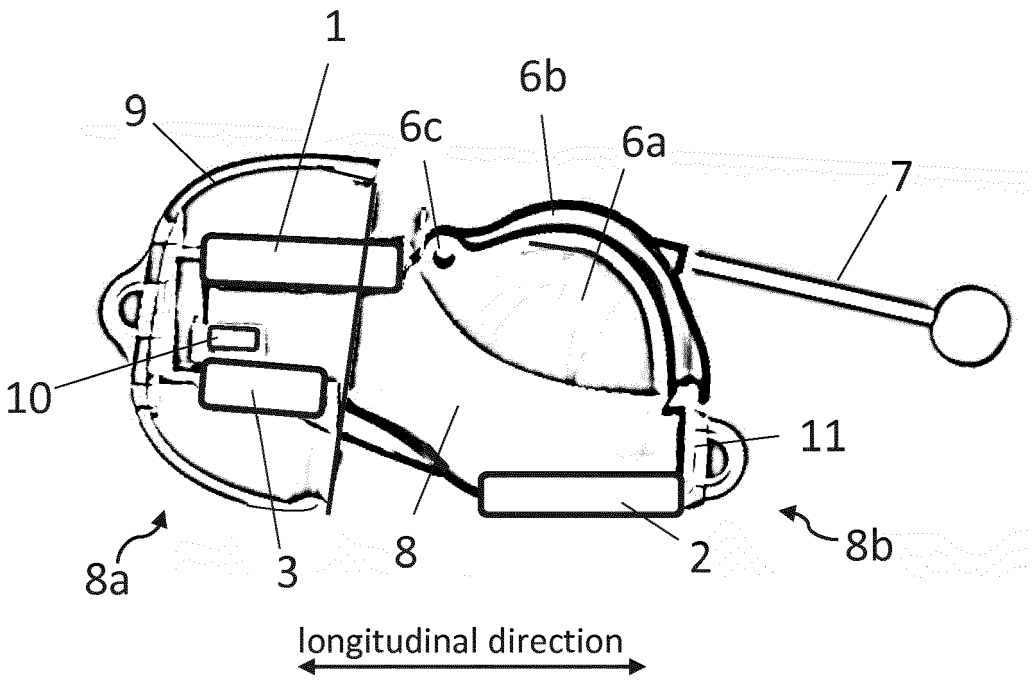


Fig. 4

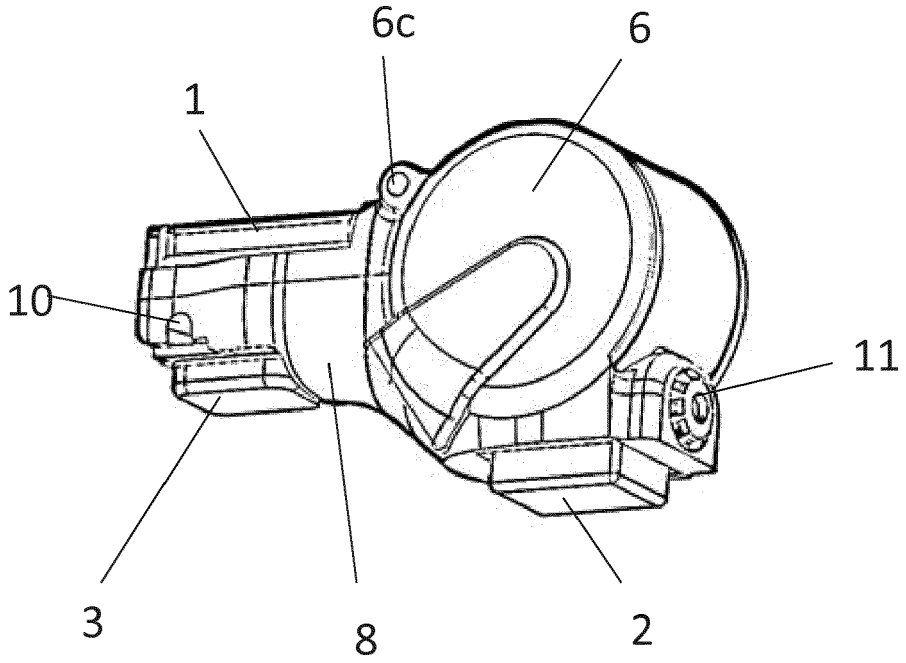


Fig. 5

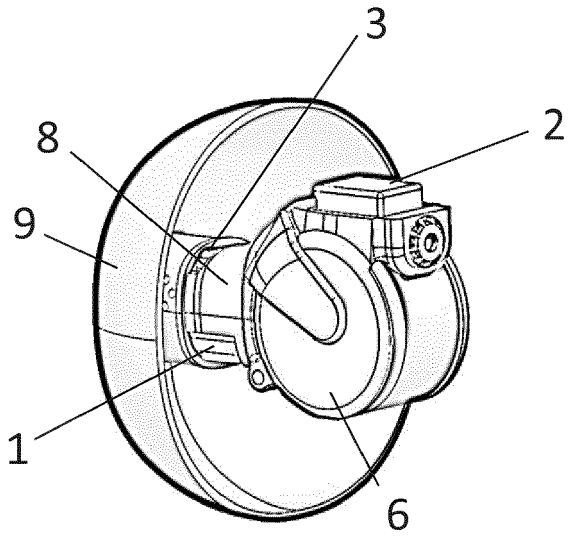


Fig. 6A

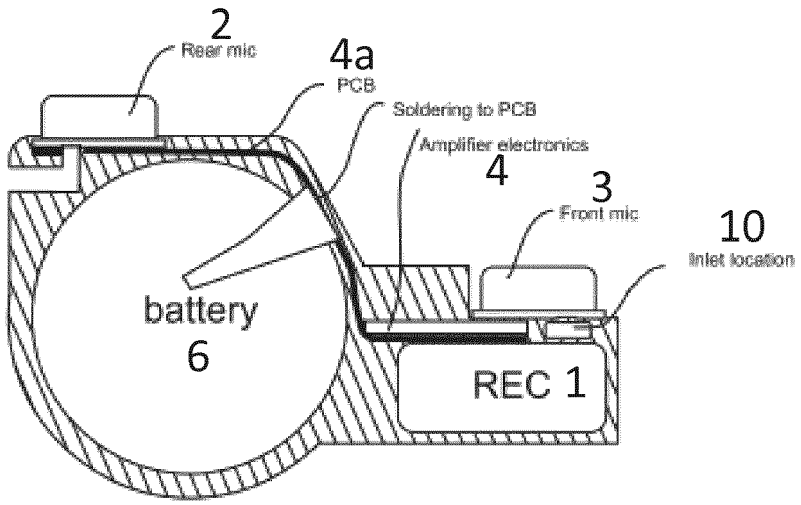


Fig. 6B

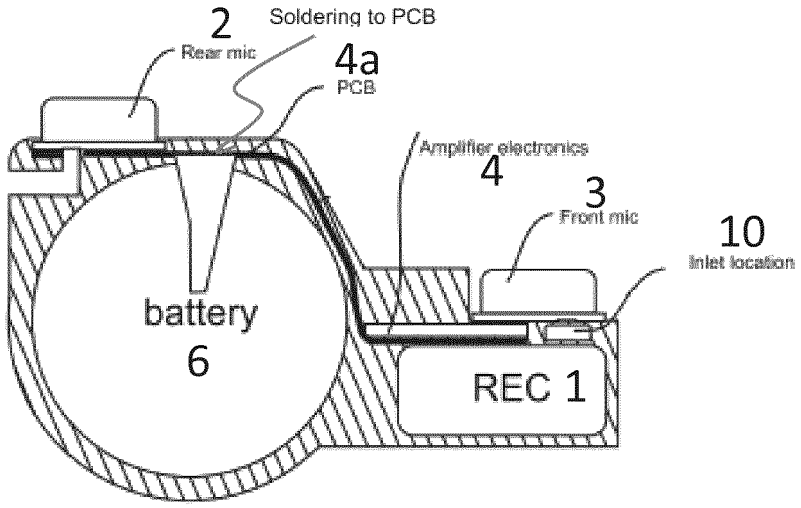


Fig. 6C

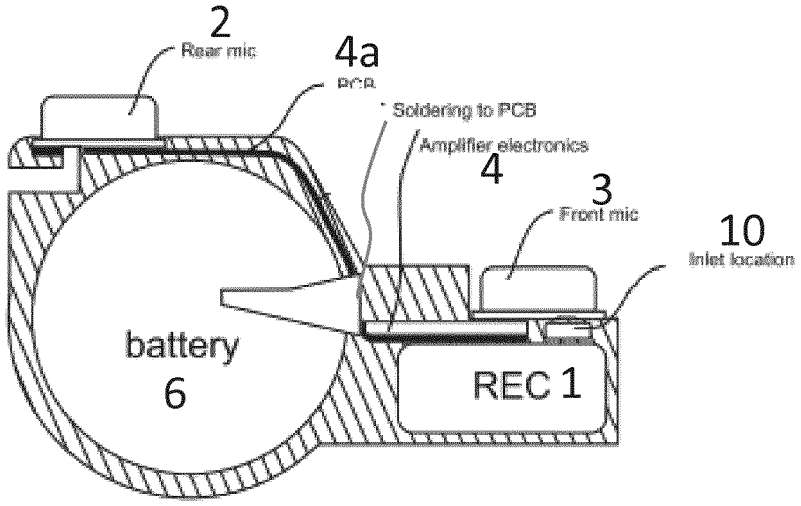


Fig. 7A

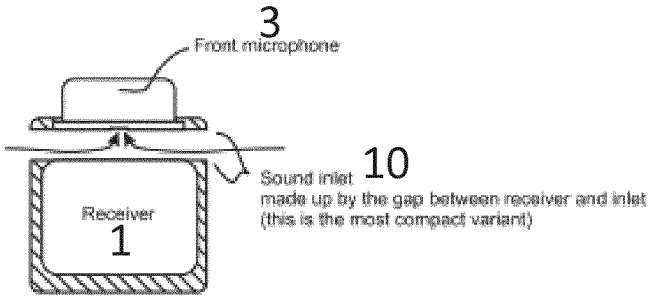


Fig. 7B

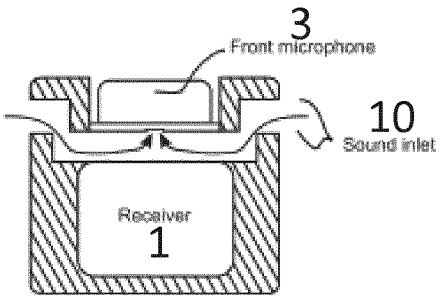


Fig. 7C

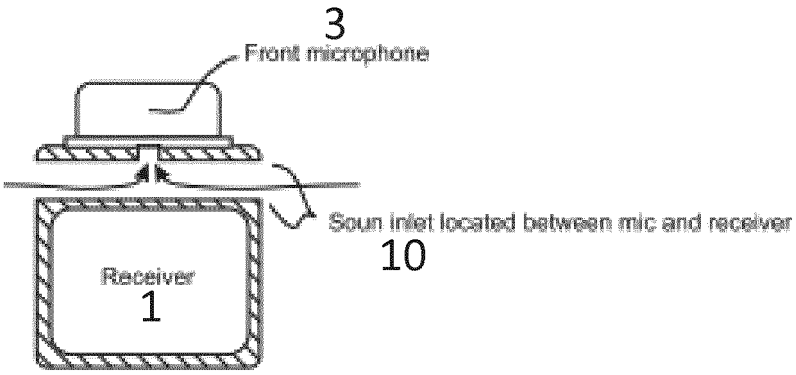


Fig. 8

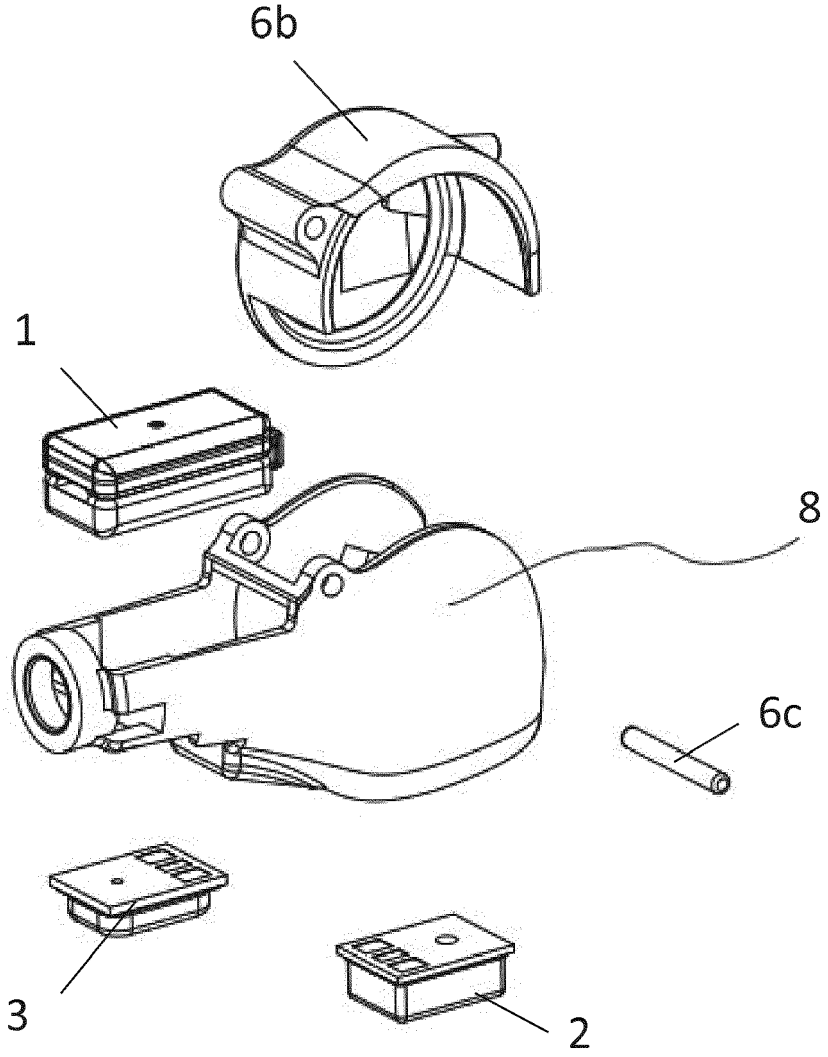


Fig. 9

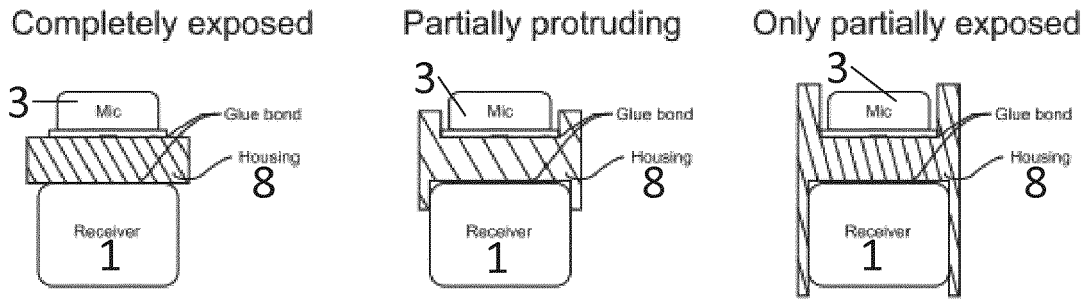
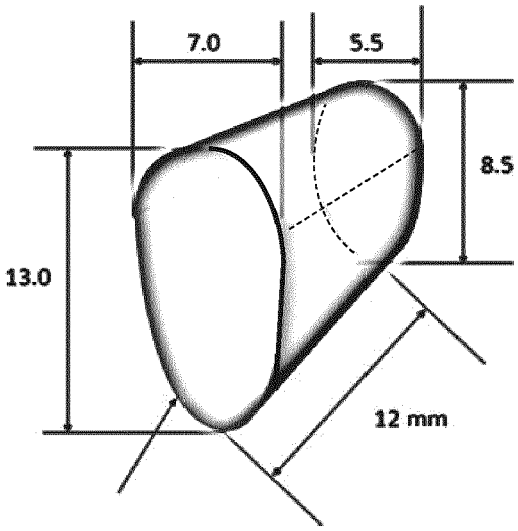

Completely exposed
Partially protruding
Only partially exposed
3
Mic
Glue bond
Housing
8
Receiver
1

Fig. 10


7.0
5.5
8.5
13.0
12 mm

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 16 1445

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	WO 95/22879 A2 (KNOWLES ELECTRONICS INC [US]; CARLSON ELMER V [US]; DAYTON PAUL C [US]) 24 August 1995 (1995-08-24)	1-16	INV. H04R25/00
Y	* p. 1, l. 1-p. 4, l. 6; p. 5, l. 20-p. 16, l. 30 *	1-16	
Y	US 2014/314263 A1 (PARSI SALMAN [US] ET AL) 23 October 2014 (2014-10-23) * para. 4-12; para. 24-38 *	1-16	
Y	US 2018/020302 A1 (RASMUSSEN KARSTEN BO [DK] ET AL) 18 January 2018 (2018-01-18) * para. 1-69, 90-139 *	1-16	
Y	US 2005/232453 A1 (FIDELER BRIAN [US]) 20 October 2005 (2005-10-20) * para. 1-9, 28-63 *	1-16	
Y	US 2002/027996 A1 (LEEDOM MARVIN A [US] ET AL) 7 March 2002 (2002-03-07) * para. 1-35, 73-153 *	6,7	

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
Munich	3 September 2018	Peirs, Karel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 16 1445

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

03-09-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9522879 A2	24-08-1995	AU 1928395 A	04-09-1995
		WO 9522879 A2	24-08-1995
US 2014314263 A1	23-10-2014	CN 103843371 A	04-06-2014
		EP 2737725 A1	04-06-2014
		US 2014314263 A1	23-10-2014
		WO 2013056043 A1	18-04-2013
US 2018020302 A1	18-01-2018	CN 107613444 A	19-01-2018
		EP 3280158 A2	07-02-2018
		US 2018020302 A1	18-01-2018
US 2005232453 A1	20-10-2005	CA 2504064 A1	15-10-2005
		EP 1587344 A2	19-10-2005
		US 2005232453 A1	20-10-2005
		US 2008304685 A1	11-12-2008
		US 2009016554 A1	15-01-2009
US 2002027996 A1	07-03-2002	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82