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(54) Title: HEARING DEVICE

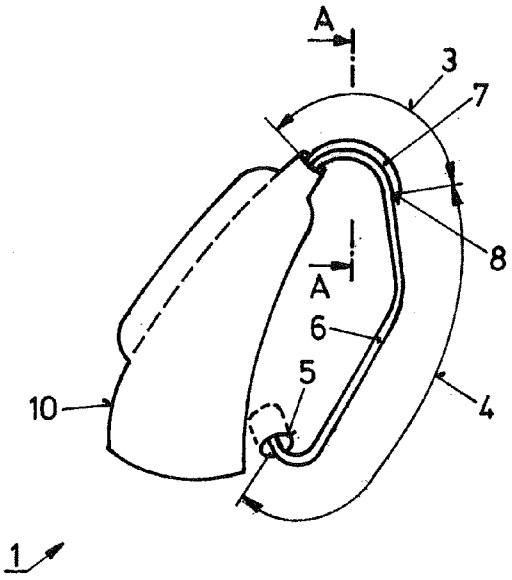

Fig. 1

(57) Abstract: A hearing device (1) comprising a housing (10) position- able behind an ear of a hearing device user, the housing (10) comprising at least one acoustical/electrical transducer (9), an ear piece (5) comprising a sound outlet, the ear piece (5) being position-able in the ear canal of the hearing device user, a connecting element (6) for interconnecting the housing (10) and the ear piece (5). The inventive hearing is characterized in that the connecting element (6) comprises a proximal section (3) and a distal section (4), one end of the proximal section (3) being connected to the housing (10) and one end of the distal section (4) being connected to the ear piece (5), that a tube element (7) extends along the proximal section (3), the tube element (7) comprising a first sound inlet (8), and that the tube element (7) is operationally connected to one of the at least one acoustical/electrical transducer (9) to pick up sound via the first sound inlet (8).

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HEARING DEVICE

FIELD OF THE INVENTION

The present invention is related to a hearing device according to the pre-characterizing part of claim 1.

BACKGROUND OF THE INVENTION

In general, a hearing device is used to improve the hearing of patients having a hearing loss. Thereto, sound is picked up by a microphone, processed in a signal processing unit, in the simplest case by applying a gain, and the processed sound is then transmitted to a receiver positioned in the ear canal of the patient. For a mild hearing loss, so called open ear canal hearing devices are also used, as described, for example, in US-5 987 146.

One type of hearing devices is called BTE-(Behind-The-Ear) hearing device. A BTE comprises a housing with a sound inlet, a processing unit and a hook element that is used to transmit the sound into the ear canal. A known BTE is disclosed in US 2004/0057592 A1, for example. Other known hearing devices are disclosed in US-4 291 203, US-5 987 146 and in EP-1 463 375 B1.

In order that the housing of BTEs can be hidden behind the ear, the housings get smaller and smaller. Although this is advantageous from an aesthetic point of view, the hiding of

the housing behind the ear leads to a covering or at least shadowing of the sound inlet by the ear itself, resulting in a decreased signal quality of the acoustic signal picked up by the microphone.

It is therefore one object of the present invention to provide a behind the ear hearing devices that does at least not have the above-mentioned drawback.

SUMMARY OF THE INVENTION

These and other objects are addressed by the hearing device of the present invention.

It is expressly pointed out the term "hearing device", as it is used in connection with the present invention, is not only limited to a device for improving the hearing of a hearing impaired person but must also be understood as a communication device for improving communication or as a hearing protection device for protecting a user from excessive noise.

The present invention is directed to a hearing device comprising:

- a housing position-able behind an ear of a hearing device user, the housing comprising at least one acoustical/electrical transducer,
- an ear piece comprising a sound outlet, the ear piece being position-able in the ear canal of the hearing device user,

- a connecting element for interconnecting the housing and the ear piece,
- that the connecting element comprises a proximal section and a distal section, one end of the proximal section being connected to the housing and one end of the distal section being connected to the ear piece,
- that a tube element extends along the proximal section, the tube element comprising a first sound inlet, and
- that the tube element is operationally connected to one of the at least one acoustical/electrical transducer to pick up sound via the first sound inlet.

By providing the first sound inlet in a region where sound can very well be picked up by the acoustical/electrical transducer without overly being shadowed by the ear of the hearing device user, acoustics of the hearing device can be improved to a large extent.

An embodiment of the hearing device according to the present invention is characterized in that the proximal section of the connecting element is preformed such that the proximal section acts as a hook for holding the housing behind the ear of the hearing device user.

Further embodiments of the hearing device according to the present invention are characterized in that the first sound inlet is directed downward if the hearing device is worn by the hearing device user and the hearing device user is upright.

If the first sound inlet generally is directed downwardly, moisture and dirt cannot enter the inlet. Therefore, such an arrangement has the advantage that first sound inlet cannot get clogged. In addition, even if the first sound inlet gets clogged, there is no immediate danger that dirt reaches the acoustical/electrical transducer. Once the first sound inlet is clogged, it can be cleaned by washing out the dirt or, if need be, the tube element can simply be replaced.

In order to further improve the hearing device according to the present invention, a filter element can be positioned in the sound inlet. The filter element may act for compensating a delay and/or it may act as a protective element to keep off moisture and dirt.

Further embodiments of the hearing device according to the present invention are characterized in that the housing comprises a second sound inlet via which sound is directed to one of the at least one acoustical/electrical transducer.

The hearing device is very well suitable for implementing beam forming because the sound inlets can very well be positioned to obtain a maximal directionality.

Further embodiments of the hearing device according to the present invention are characterized in that the ear piece comprises an electrical/acoustical transducer that is

operationally connected to a signal processing unit via wires comprised in the connecting element.

Further embodiments of the hearing device according to the present invention are characterized in that the housing comprises an electrical/acoustical transducer that is connected to the connecting element comprising a tube for acoustically transmitting sounds to the ear piece.

Further embodiments of the hearing device according to the present invention are characterized in that a horizontal distance D between the first and the second sound inlet is within the range of 8 to 20mm, preferably equal to 12mm, the horizontal distance D being defined by a distance between positions of the first and the second sound inlet projected onto a horizontal plane while the hearing device is worn by the hearing device user and while the hearing device user is upright.

Further embodiments of the hearing device according to the present invention are characterized in that the distal section is adaptable to individual geometry of the hearing device user to provide high wearing comfort for the hearing device user.

Further embodiments of the hearing device according to the present invention are characterized in that at least two acoustical/electrical transducer are provided, that the first sound inlet is operationally connected to one of the at least two acoustical/electrical transducer and that the

second sound inlet is operationally connected to another of the at least two acoustical/electrical transducer.

Further embodiments of the hearing device according to the present invention are characterized in that the first sound inlet as well as the second sound inlet is operationally connected to the same acoustical/electrical transducer.

Further embodiments of the hearing device according to the present invention are characterized in that the housing comprises a further sound inlet.

It is expressly pointed out that any combination of the above-mentioned embodiments, or combinations of combinations, is subject to a further combination. Only those combinations are excluded that would result in a contradiction.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a side view of a first embodiment of a hearing device according to the present invention,

Fig. 2 shows a cross-sectional view of a connecting element at a position A-A indicated in Fig. 1,

Fig. 3 shows a cross-sectional view of another connecting element at the position A-A indicated in Fig. 1, and

Fig. 4 shows sections of a side view of a further embodiment of a hearing device according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In Fig. 1, a first embodiment of a hearing device 1 according to the present invention is depicted. The hearing device 1 is of the type Behind-The-Ear or BTE comprising a housing 10 to which a connecting element 6 is attached. The housing 10 comprises an acoustical/electrical transducer, a battery for supplying energy to the components, a signal processing unit for processing sound that is picked up by the acoustical/electrical transducer, and, for some embodiments, an electrical/acoustical transducer for generating output sound. The internal components are not shown in Fig. 1.

Via the connecting element 6, sound is transmitted from the housing 10 to the ear piece 5 that is positioned within or at the entrance of an ear canal of the hearing device user. Usually, the ear piece 5 is adapted to the individual geometry of the ear canal or its entrance of the hearing device user in order to provide a good wearing comfort.

Depending on the position of the electrical/acoustical transducer, the manner how a signal is transmitted to the ear piece 5 is implemented accordingly: In case the electrical/acoustical transducer is positioned within the

housing 10, the connecting element 6 comprises a tube via which sound generated by the electrical/acoustical transducer is transmitted to the ear piece 5. In case the electrical/acoustical transducer is positioned within the ear piece 5, the connecting element 6 comprises electrically conducting elements, such as wires, to transmit an electrical signal corresponding to sound to the ear piece 5 respectively to the electrical/acoustical transducer in the ear piece 5. The electrical transmission of the signal results in the advantage that the connecting element 6 is less visible due to is tinier realization compared to a connecting element comprising a sound tube for transmitting the sound generated by the electrical/acoustical transducer positioned in the housing 10.

As it is illustrated in Fig. 1, the connecting element 6 is divided into two sections, namely a proximal section 3 being attached to the housing 10 and a distal section 4 being arranged subsequently to the proximal section 3. It is pointed out that - according to the present invention - the proximal section 3 extends and forms the hook-type part providing a secure hold for the hearing device at the hearing device user's ear. Therefore, the proximal section 3 of the connecting element 6 is - in one embodiment - preformed, i.e. the proximal section 3 has a rigid form that is not adapted to the individual wearing the hearing device but is rather a standard form manufactured at the manufacturing site of the hearing device. Furthermore, the distal end 4 is connected to the ear piece 5.

According to the present invention, a tube element 7 is arranged in the proximal section 3 of the connecting element 6. The tube element 7 is connectable to the housing 10 in a similar manner as the connecting element 6, and extends into the proximal section 3. While in one embodiment, the tube element 7 completely extends over the whole proximal section 3, the tube element 7 may only cover a part of the proximal section 3 in another embodiment. Furthermore, the tube element 7 may be attached to the proximal section 3 of the connecting element 6. However, the tube element 7 may also be an independent part that is only attached in subsections of the proximal section 3 or that is not at all attached to the connecting element 6.

The tube element 7 is used to pick up sound via a first sound inlet 8 and to transmit the sound to the acoustical/electrical transducer that is comprised in the housing 10. Therewith, the first sound inlet 8 is positioned clearly apart from a sound inlet of the acoustical/electrical transducer making it much more difficult that the acoustical/electrical transducer gets contaminated by ear wax or other dirt. In addition, the tube element 7 can easily get cleaned once it is detached from the housing 10. If cleaning is not possible anymore, the tube element 7 can simply be replaced without replacing the acoustical/electrical transducer itself.

In Fig. 1, the tube element 7 is attached to the proximal section 3 of the connecting element 6 and is long enough

that the first sound inlet 8 is directed downwardly if the hearing device 1 is worn by the hearing device user and the hearing device user is in an upright position, i.e. looking straight ahead. Because the first sound inlet 8 is directed downwardly, moisture and dirt cannot easily enter the tube element 7. This is also true even though no protecting membrane or cover is provided over the first sound inlet 8 resulting in a very advantageous sound pick up arrangement.

Figs. 2 and 3 show cross-sections A-A of two embodiments of the proximal section 3 of the connecting element 6. The position of the section plane is also indicated in Fig. 1.

While Fig. 2 shows a proximal section 3 comprising two tubes, one as the tube element 7 and the other as the sound tube 12, Fig. 3 only shows one tube, namely the tube element 7. Instead of the sound tube 12, two wires 11 are indicated by 12 being the electrical conducting elements for transmitting electrical signals representing the sound to be emitted by the electrical/acoustical transducer. Having said the above, it is apparent that, while Fig. 2 represents an embodiment with a electrical/acoustical transducer in the housing 10 of the hearing device 1, Fig. 3 represents an embodiment in which the electrical/acoustical transducer is positioned in the ear piece 5. As can be seen from Figs. 2 and 3, the tubes as well as the electrically conducting elements are encompassed within a surrounding tube that can be produced, for example, by an extrusion process.

In Fig. 4, essential parts of a further embodiment according to the present invention are depicted. The reference signs used in connection with Figs. 1 to 3 are again used for the same components.

The embodiment depicted in Fig. 1 differs from the embodiment depicted in Fig. 4 in that a second sound inlet 2 is provided in the housing 10 of the hearing device 1. Thereby, a directional acoustical/electrical transducer (e.g. a microphone) can be obtained by interrelating and/or processing the two signals generated by the two acoustical/electrical transducers 9, 9' in order to allow directional information, such as it is obtained in a so called a beam former. The second sound inlet 2 is preferably arranged at the upper section of the housing 10 in order to ensure a good pick up of sound. The positioning in the upper section is particularly important when the housing is rather small which is more and more the case for BTE hearing device because it is a general desire to hide hearing devices as much as possible. In turn, a small BTE hearing device with a sound inlet in its housing may lead to a reduced sound pick-up because of the shadowing by the ear itself.

For illustration purposes, Fig. 4 shows an embodiment in which the electrical/acoustical transducer - indicated at 13 - is comprised within the housing 10. Accordingly, the connecting element 6 is implemented as sound tube for transmitting the sound of the electrical/acoustical transducer 13 to the ear piece 5. However, the same applies

for an embodiment in which the electrical/acoustical transducer is positioned in the ear piece 5, as it is the case for a so called CRT-(Canal Receiver Technology) hearing device that has been explained in connection with Fig. 1.

It is pointed out that for each of the acoustical/electrical transducers 9 and 9' a single unit (single microphone) is provided. However, in yet a further embodiment, a single acoustical/electrical transducer can be used having two sound openings and a membrane dividing a common volume into two sub-volumes, one sub-volume being in communication with the first sound opening, the other sub-volume being in communication with the second sound opening.

The two sound inlets 2 and 8 form the basis for a beam former generally known in the art. According to the present invention, it has been shown that the two sound inlets 2 and 8 must have a horizontal distance D which is in the range of 8 to 15mm, preferably in the range of 11 to 13mm, or which is equal to 12mm. Thereby, the horizontal distance D is defined by a distance between positions of the first and the second sound inlet 2, 8 projected onto a horizontal plane while the hearing device is worn by the hearing device user and while the hearing device user is upright, i.e. the head of the hearing device user is upright and the hearing device user is looking straight ahead.

It is to be understood that the above-described embodiments are merely illustrative for the present invention and that many variations of the above-described embodiments can be devised by those skilled in the art without departing from the scope of the present invention. It is therefore intended that such variations be included within the scope of the following claims and their equivalents.

CLAIMS:

1. A hearing device (1) comprising:

- a housing (10) position-able behind an ear of a hearing device user, the housing (10) comprising at least one acoustical/electrical transducer (9),
- an ear piece (5) comprising a sound outlet, the ear piece (5) being position-able in the ear canal of the hearing device user,
- a connecting element (6) for interconnecting the housing (10) and the ear piece (5),

characterized in

- that the connecting element (6) comprises a proximal section (3) and a distal section (4), one end of the proximal section (3) being connected to the housing (10) and one end of the distal section (4) being connected to the ear piece (5),
- that a tube element (7) extends along the proximal section (3), the tube element (7) comprising a first sound inlet (8), and
- that the tube element (7) is operationally connected to one of the at least one acoustical/electrical transducer (9) to pick up sound via the first sound inlet (8).

2. The hearing device of claim 1, characterized in that the proximal section (3) of the connecting element (6) is preformed such that the proximal section (3) acts as a hook

for holding the housing (10) behind the ear of the hearing device user.

3. The hearing device of claim 1 or 2, characterized in that the first sound inlet (8) is directed downward if the hearing device (1) is worn by the hearing device user and the hearing device user is upright.

4. The hearing device of one of the claims 1 to 3, characterized in that the housing (10) comprises a second sound inlet (2) via which sound is directed to one of the at least one acoustical/electrical transducer (9).

5. The hearing device of one of the claims 1 to 4, characterized in that the ear piece (5) comprises an electrical/acoustical transducer that is operationally connected to a signal processing unit via wires comprised in the connecting element (6).

6. The hearing device of one of the claims 1 to 4, characterized in that the housing (10) comprises an electrical/acoustical transducer that is connected to the connecting element (6) comprising a tube for acoustically transmitting sounds to the ear piece (5).

7. The hearing device of one of the claims 4 to 6, characterized in that a horizontal distance D between the first and the second sound inlet (8, 2) is within the range of 8 to 20mm, preferably equal to 12mm, the horizontal distance D being defined by a distance between positions of

the first and the second sound inlet (8, 2) projected onto a horizontal plane while the hearing device is worn by the hearing device user and while the hearing device user is upright.

8. The hearing device of one of the claims 1 to 7, characterized in that the distal section (4) is adaptable to individual geometry of the hearing device user to provide high wearing comfort for the hearing device user.

9. The hearing device of one of the claims 4 to 8, characterized in that at least two acoustical/electrical transducer are provided, that the first sound inlet (8) is operationally connected to one of the at least two acoustical/electrical transducer and that the second sound inlet (2) is operationally connected to another of the at least two acoustical/electrical transducer.

10. The hearing device of one of the claims 4 to 8, characterized in that the first sound inlet (8) as well as the second sound inlet (2) are operationally connected to the same acoustical/electrical transducer.

11. The hearing device of one of the claims 1 to 9, characterized in that the housing (10) comprises a further sound inlet.

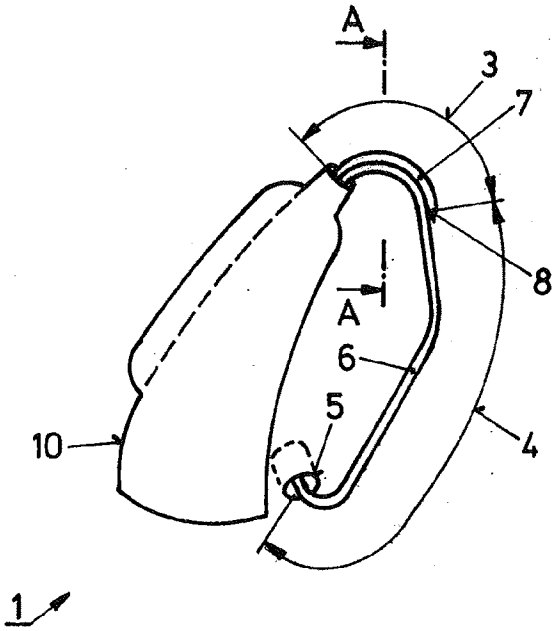

Fig. 1

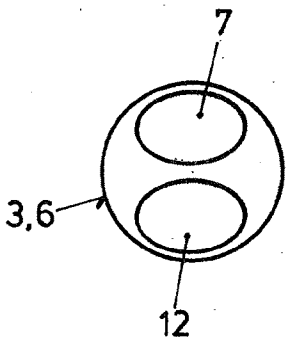

Fig. 2

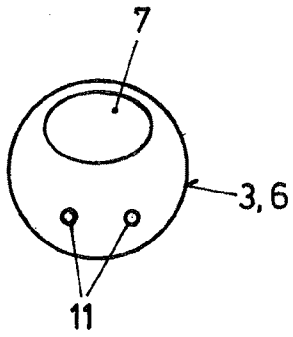

Fig. 3

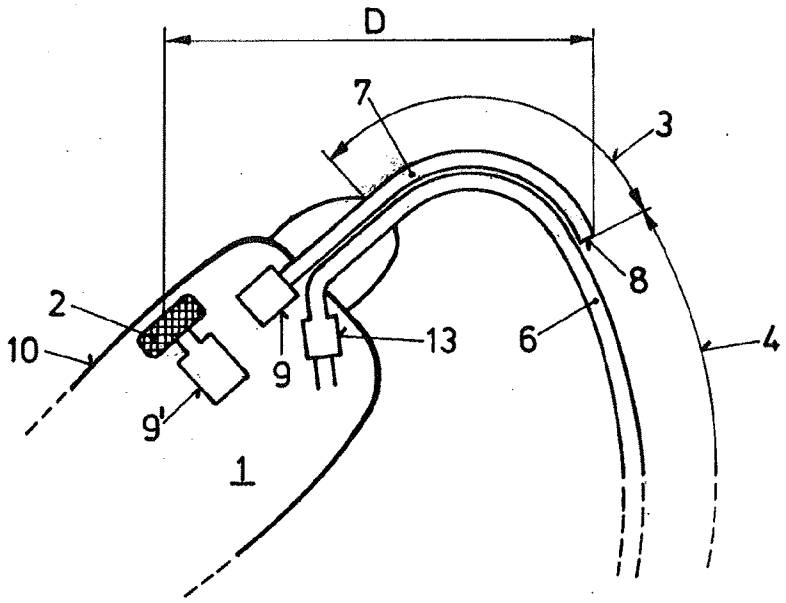

Fig. 4