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(71) Applicant *(for all designated States except US):* **SIEMENS MEDICAL INSTRUMENTS PTE. LTD.** [SG/SG]; Block 28, Ayer Rajah Crescent No. 06-08, Singapore 139959 (SG).

(72) Inventor; and
(75) Inventor/Applicant *(for US only):* **GEBERT, Anton** [DE/DE]; Hohenrothstr. 11, 91077 Kleinsendelbach (DE).

(74) Agent: **MAIER, Daniel;** Postfach 22 16 34, 80506 Munchen (DE).

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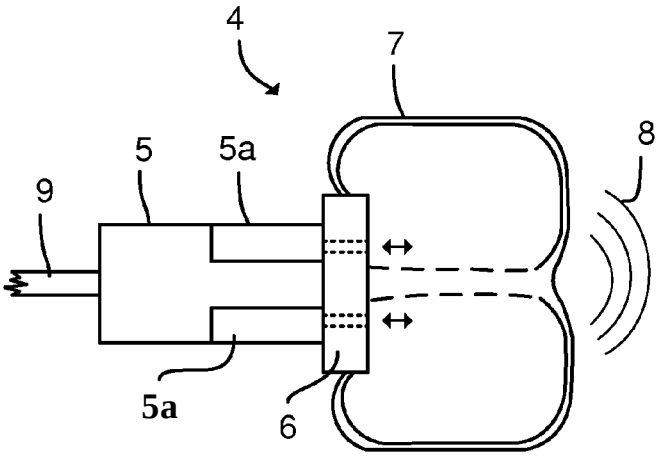
(54) Title: INFLATABLE EAR MOLD INTERFACE CONNECTION SYSTEM

FIG. 2



(57) Abstract: An ear piece (4) is formed for insertion and placement in an external auditory canal (2). The ear piece has an inflatable balloon (7) that may be selectively inflated and deflated. When the balloon is inflated, it expands and braces against the walls of the auditory canal (2). When it is deflated, it may be withdrawn from the auditory canal (2). The ear piece has a receiver module (5) and a connection (9) to an exterior device (e.g., hearing aid, MP3 player, cell phone). The sound waves generated in the receiver module are guided to the ear drum (3) via a carrier (6) which also holds the balloon (7). A pump is provided for inflating, or selectively deflating, the balloon (7). According to the invention, the interface between the carrier (6) and the receiver module (5) allows the inflatable member to be easily removed from the receiver/pump combination or for the inflatable member together with the pump to be removed from the receiver module (5).

DESCRIPTION

INFLATABLE EAR MOLD INTERFACE CONNECTION SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention:
The invention relates to an ear piece for a hearing device, in particular, an inflatable ear mold or an ear piece with an inflatable balloon. The ear piece is particularly suitable for delivering sound from a hearing aid, an audio player, and/or a cell phone.

Along with the ever-increasing miniaturization of electronic devices and the increasing prevalence of audiological devices that require direct delivery of sound to the human ear, there is a desire to provide ever smaller devices that may be placed in the auditory canal of a user.

For example, hearing devices are wearable hearing apparatuses which are used to supply the hard-of -hearing . A variety of different configurations of hearing devices are known, such as, for example, behind-the-ear hearing devices (BTE) , hearing device with an external receiver (RIC: receiver in the canal) and in-the-ear hearing devices (ITE), e.g. also concha hearing devices or canal hearing devices (ITE - in-the-ear, CIC - completely in the canal) . Similarly, headphones for the personal delivery of auditory materials have recently become more miniaturized and they have progressed to very small earbuds with in-the-canal speakers.

Primarily important components of a hearing device include an input converter (e.g., a microphone), an amplifier, and an output converter. In the case of a sound player (e.g., an MP3 player) , the signal originating from a memory is amplified and fed to the output converter. Typically, the output converter in an electroacoustic converter (e.g., a miniature loudspeaker) which converts the electrical signal into a me-

chanical vibration. In the case of a loudspeaker, the vibration is converted to longitudinal pressure waves which impinge on the tympanic membrane of the user. There, the sound waves are converted into neurological signals which are fed to the brain, where they are decoded for content.

United States Patent No. US 7,227,968 B2 describes a two-part hearing aid in which the receiver, which is separate from the remaining components, may be inserted deep into the auditory canal. The receiver houses a speaker, which is driven by way of an electrical connection through the canal. The receiver housing is surrounded by an inflatable soft shell, which, when inflated and thus expanded, fixes the receiver in position in the auditory canal. Similarly, U.S. Patent No. US 7,425,196 B2 also describes a receiver module for a hearing aid that may be positioned deep in the auditory canal. The receiver housing is surrounded by an expandable material, which may be expanded against the walls of the canal.

It is desirable for the insertion members of the ear piece to be replaced at certain intervals. Typically, only those parts which come into contact with the ear canal are replaced and the electronics (i.e., the receiver or receiver module) are returned into the canal. It is quite difficult and cumbersome to refurbish currently available state of the art devices and it is therefore desirable to render the refurbishment, and even the original assembly, less complicated and more efficient .

BRIEF SUMMARY OF THE INVENTION

It is an object of the invention to provide an inflatable ear piece, which overcomes a variety of disadvantages of the heretofore-known devices and methods of this general type and which provides for a device that may be selectively inflated for safe placement in the ear canal and which simplifies the exchange of the inflatable module or of the balloon. The ear

piece, furthermore, should be simple in its assembly and it should be modular for easy and simple refurbishment.

With the foregoing and other objects in view there is provided, in accordance with the invention, an ear piece for a hearing device which comprises:

a receiver module;

a carrier and an inflatable balloon sealingly mounted on the carrier;

a pressure source fluidically (e.g., pneumatically) connected through the carrier to an interior space of the inflatable balloon for selectively inflating the balloon; and

a locking mechanism for locking the carrier with the inflatable balloon to the receiver module and for selectively releasing the carrier with the inflatable balloon from the receiver module;

wherein the locking mechanism is a pin-lock locking mechanism or a snap-lock locking mechanism.

The pin-lock or snap-lock locking mechanism provide for a safe yet easily actuated interface connection between the primary parts of the ear piece. Both connections may be easily actuated by an audiologist, for example, for replacing the balloon. The snap-lock locking mechanism may even be actuated by the user for exchanging the balloon and its carrier .

In accordance with an added feature of the invention, the pin-lock locking mechanism comprises at least one substantially cylindrical pin to be seated in a depression formed in the carrier and in a depression formed in the receiver, wherein, when the cylindrical pin is seated in the depressions, the carrier is locked to the receiver and when the cylindrical pin is removed from the depressions, the carrier can be freely removed from the receiver.

In accordance with an additional feature of the invention, the cylindrical pin is inserted in a transverse direction

into an opening formed by the depressions, after the carrier has been pushed onto the receiver in a longitudinal direction.

In accordance with another feature of the invention, the pin-lock locking mechanism defines a form-locking connection between the carrier and the receiver.

In accordance with a further feature of the invention, the snap-lock locking mechanism comprises at least one bulge formed on one of the receiver or the carrier and at least one corresponding depression on the other of the carrier or the receiver, wherein the at least one bulge engages in the at least one depression when the carrier is snapped onto the receiver.

In accordance with again an added feature of the invention, there are provided two bulges formed on the receiver and the depression is one of two depressions formed in the carrier, and wherein the receiver and the carrier are rotationally symmetrical about a longitudinal axis and connectible in either of two relative orientations. It should be readily understood that the disposition of the snap-lock elements may be reversed. That is, the carrier may be formed with two bulges while two depressions are formed in the receiver. Again, the receiver and the carrier are rotationally symmetrical and connectible in either of two relative orientations.

In accordance with again an additional feature of the invention, the snap-lock locking mechanism is configured to allow the carrier and the receiver to be connected to one another and to be disconnected from one another by manual actuation. The materials and the respective wall strengths are chosen with two parameters in mind, namely, manual connectability and manual disconnectability should be assured.

In accordance with again another feature of the invention, the pressure source is at least one pump integrally formed

with the receiver, and wherein the receiver and the carrier are formed to establish the fluidic connection when the carrier is connected to the receiver and to establish a seal between the at least one pump and the interior of the balloon.

Preferably, the pressure source is integrally formed with the carrier and pneumatically sealed relative to the interior of the balloon. The pressure source may be a pump assembly comprising an air pump for inflating the balloon and a deflation valve for selectively deflating the balloon.

As noted, the ear piece is particularly suited as an insertion or a deep-insertion inflatable ear mold (IEM) for use with a hearing aid. For that purpose, the invention also encompasses a combination hearing device with an ear piece as outlined above and an external unit for transmitting to the ear piece sound signals or signals for generating sound waves to be perceived by the tympanic membrane. The hearing device may be a hearing aid, wherein the external unit is a hearing unit selected from the group consisting of behind-the-ear, in-the-ear, concha, in-the-canal , and completely-in-the-canal hearing unit. The external unit may also be a sound player (e.g., MP3) or a telephone.

The placement and fixation of the respective devices by way of otoplastic materials need not be described in further detail. Those of skill in the art of hearing devices are quite familiar with the pertinent technology and are able to configure the respective system according to the specific requirements.

The invention is not limited to the combined assembly including the entire ear piece of the hearing device, or an entire hearing aid, but it is also directed separately to a balloon module and to a receiver module each to be used in connection with the hearing device. The receiver module according to the invention is configured for or with the locking mechanism and to form a fluid-tight connection between the pressure source

and the inflatable balloon when the pin-lock locking mechanism or the snap-lock locking mechanism is engaged. The balloon module according to the invention includes a carrier and an inflatable balloon sealingly mounted to the carrier. In that case, the carrier is configured with, or to cooperate with, the locking mechanism so that the carrier and the balloon may be readily connected to the receiver of the hearing device. When the pin-lock locking mechanism or the snap-lock locking mechanism is engaged, a fluid-tight connection is also established between the pressure source and said inflatable balloon.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in an inflatable ear piece to be inserted into an auditory canal, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of the specific embodiment when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

Fig. 1 is a schematic view of an outer ear with an auditory canal leading to an ear drum and an inflatable ear mold inserted into the canal;

Fig. 2 is a schematic longitudinal section taken through an ear piece having a receiver and a carrier with an inflatable balloon attached to the receiver;

Fig. 3 is a schematic transverse section taken through a forward end of a receiver module illustrating a pin-lock locking mechanism;

Fig. 4 is a schematic view of a longitudinal section through a forward end of a receiver and a rearward end of a balloon carrier of the embodiment of Fig. 3;

Fig. 5 is a schematic transverse section taken through an embodiment of the forward end of the receiver module with an alternative pin-lock locking mechanism;

Fig. 6 is a schematic view of a longitudinal section through a forward end of a receiver and a rearward end of a balloon carrier of the embodiment of Fig. 5;

Fig. 7 is a schematic view of a section through the embodiment of Figs. 5 and 6 taken along a plane that is orthogonal to the section plane of Fig. 6;

Fig. 8 is a schematic transverse section taken through a further alternative embodiment of the connection between the receiver module and the balloon carrier, in the form of a snap-lock locking mechanism;

Fig. 9 is a schematic view of a longitudinal section through a forward end of a receiver and a rearward end of the balloon carrier of the embodiment of Fig. 8;

Fig. 10 is a schematic view of a section through the embodiment of Figs. 8 and 9 taken along a plane that is orthogonal to the section plane of Fig. 9.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the figures of the drawing in detail and first, particularly, to Fig. 1 thereof, there is seen a human ear 1 and an external auditory canal 2. The auditory canal is

bounded by a tympanic membrane 3, also referred to as an ear-drum. In unassisted hearing, pressure waves (sound waves are longitudinal pressure waves) are funneled at the concha 1a of the ear 1, they travel through the external auditory canal 2, also referred to as the ear canal or, simply canal, before they impinge on the tympanic membrane 3.

In assisted hearing, such as with hearing aids or ear pieces of sound players or cell phones, the propagation of the sound waves through the auditory canal 2 may be interrupted. The sound waves are instead picked up by a microphone or the like, the resulting signal is processed, typically by way of digital signal processing, and the processed signal is utilized to excite a loudspeaker, typically in the vicinity of or at the tympanic membrane 3. In the case of ear buds for music or telephony, the sound waves are directly injected at the concha 1a for delivery through the auditory canal 2.

Referring now to Fig. 2 in connection with Fig. 1, an ear piece 4 according to the invention has a receiver module 5, a carrier module 6, also referred to as a carrier 6, and an inflatable member 7. The inflatable member 7 is a balloon or a bag or an accordion-type bellows. While we may simply refer to the inflatable member as a balloon 7, the term "balloon" should be understood in its broadest sense as any inflatable member. It may be in the form of a balloon with resiliently stretchable material, or a bag, or an accordion-type bellows with folded/crimped balloon shapes. Further the material is chosen such that it provides a pleasant haptic feel as it is pressed against the wall of the ear canal 2 and, once inflated, does not shift relative to the canal 2. The balloon 7 is formed of a flexible material which is impermeable to cerumen, or earwax, and also to water. The balloon 7 is preferably formed of silicone or latex, or any of the known flexible materials that are used for otoplasties and other cavity-insertible products known, especially, in the hearing aid arts. It may further be covered on the laterally outside walls, i.e., the walls that are braced into contact with the

walls of the ear canal 2, with a soft silicone or rubber material layer.

As illustrated here, the balloon 7 resembles a tubeless tire, that is, it is sealed against the rim of the carrier 6 and, upon inflation, it forms a doughnut-shaped thoroid fluid space. The receiver module 5 carries one or two pumps 5a forming the compressed air sources for inflating the balloon 7. The pumps 5a are fully integrated in and form a part of the receiver module 5. It is also possible, however, for the pumps 5a to be fixedly mounted to (or, integrated with) the carrier 6. In this case, the carrier 6 and the pumps 5a may be removed together from the receiver module 5 in order to exchange the inflatable member (i.e., the carrier and the balloon) . These two variants of the interface, therefore, enable the balloon to be removed from the receiver-pump combination or the balloon and the pump combination to be removed from the receiver. There are also provided valves for enabling the balloon 7 to be deflated, for removal or simply to alleviate the occlusion afforded by the earpiece. They may be provided in the pumps 5a or in the pneumatic line traversing the interface, i.e., the carrier 6. The pressurization and the deflation of the balloon are schematically indicated by the two-way arrows.

The receiver module 5 contains the necessary electronics for generating a speaker signal for conversion to sound waves 8 at the forward end of the inflatable ear mold and for delivery to the tympanic membrane 3. As illustrated, the forward end of the receiver 5 may be formed with a sound opening through which the sound waves 8 are delivered in the direction toward the ear drum 3. As will be seen in the following specific description of the carrier 6, there is provided a through-bore through the carrier 6 as well and, possibly, a funnel pipe to deliver the sound toward and past the forward end of the balloon 7. The receiver module 5 receives its information signal from an external assembly through a signal line 9, which may also double as a pull-out tether for the

ear piece (IEM, insertable ear mold) . The external assembly may be a behind-the-ear (BTE) unit, a concha unit, an in-the-ear (ITE) unit, or even a completely-in-the-canal (CIC) hearing unit. It will be understood that the ear piece 4 as described herein may be integrally formed together with a CIC unit .

Referring now to Figs. 3 and 4, which pertain to a first embodiment of an interface with a pin-lock locking mechanism, the receiver module 5 and its various channels are shown with rectangular shapes. Two parallel pumps are provided in this embodiment and two air inflation channels 10 for compressed air lead into and through the carrier 6 for inflating the balloon 7. Two nozzle spouts 11 are formed on the forward end of the receiver 5 which project into the carrier 6, where they are sealed against corresponding carrier walls by a circumferential seal 12. An acoustic sound channel 13 is formed at the forward wall of the receiver module 5 through which the sound generated in the receiver travels toward the ear drum 3.

In a preferred embodiment, the module 5 has a height of approximately 2 mm and a width of approximately 2.7 mm. The acoustic sound channel has an equivalent area of a circular cross-section of 1.2 mm and the two air inflation channels have an equivalent circular cross-section of 0.6 mm. In order to prevent unwanted deflation, the airtight seal should last for a minimum of 16 hours, which corresponds to a single-day use. The connection to the sound channel does not require a completely airtight seal, but a certain amount of seal must be provided so as to prevent acoustic feedback.

The carrier 6 and the receiver module 5 are interlocked by way of two locking pins 14. The locking pins 14 are slid into corresponding cutouts or depressions 15 in the spouts 11 and a cutout or depression 16 formed in a rearward spout 17 formed on the carrier 6. The depressions 15 and 16 are shaped so as to enclose a cylindrical space therebetween when the

carrier 6 and the receiver 5 are connected. The pins 14 can be inserted laterally from the side into the cylindrical space so as to lock the carrier 6 to the receiver 5. The connection between the carrier 6 and the receiver 5 is thus easily released by simply pushing out the two locking pins 14 to the side and a new carrier 6 with a balloon 7 can be attached by first pushing the spouts 11 into the corresponding seals 12 in the carrier and then inserting the pins 14 for locking. The pins 14 thus define a form-locking or positive connection between the carrier 6 and the receiver 5. In order to safely retain the pins 14 in the cylindrical openings and to avoid their sliding out, the depressions may be formed with a slightly undersized diameter relative to the pins 14 or the pins may be coated so as to improve their frictional retention in the cylindrical openings.

It should be understood that the connections of spouts 11 and the spout 17 may be reversed. Here, the air injection spouts 11 are integrally formed on the receiver 5 while the acoustic sound conducting spout 17 is rigidly formed onto the carrier. In light of the increased air-sealing requirement, as opposed to the lesser sealing required for the spout 17, the illustrated embodiment may be preferred. It is also possible, however, to provide the spouts 11 integrally formed on the carrier 6 and the spout 17 formed on the forward wall of the receiver 5.

Referring now to Figs. 5, 6, and 7, there is shown an alternative embodiment that uses the same connection principle as the embodiment in the preceding description. Here, the pins 14 are inserted in a direction that is rotated by 90° relative to the direction in Figs. 3, 4. The depressions 15 and 16 are not formed in the spouts 11 and 17, but instead in a sidewall 18 of the carrier 6 and in a sidewall 19 of the receiver 5. Again, the pins 14 are frictionally retained so as to prevent them from sliding out of the cylindrical opening.

Referring now to Figs. 8, 9, and 10, there is shown a further embodiment of the invention that uses a modified connection principle between the carrier 6 and the receiver 5. Here, the two elements may be connected via click-lock or snap-locking connection. The connection is formed in that the sidewall 18 of the carrier 6 is formed with a depression 20 and the sidewall 19 of the receiver 5 is formed with a congruent bulge 21. The sidewalls 18 and 19 and the bulge 21 are formed of a material that allows the carrier 6 to snap or click onto the receiver 5, for example, by squeezing the two elements between the index finger and the thumb, yet to provide sufficient stability so that the elements will not come apart while the ear mold is being worn in the ear canal 2. It will be understood, of course, that the relative positions of the bulge 21 and the depression 20 may be reversed. In that case, the bulge 21 would be formed inwardly on the sidewall 18 so as to snap into a depression formed in the sidewall 19 of the receiver 5.

CLAIMS

1. An ear piece for a hearing device, the ear piece comprising:

a receiver module (5);

a carrier (6) and an inflatable balloon (7) sealingly mounted on said carrier (6);

a pressure source (5a) fluidically connected through said carrier to an interior space of said inflatable balloon (7) for selectively inflating said balloon (7); and

a locking mechanism (14, 15, 16; 20, 21) for locking said carrier (6) with said inflatable balloon (7) to said receiver module (5) and for selectively releasing said carrier (6) with said inflatable balloon (7) from said receiver module (5);

wherein said locking mechanism is a pin-lock (14, 15, 16) locking mechanism or a snap-lock (20, 21) locking mechanism.

2. The ear piece according to claim 1, wherein said pin-lock locking mechanism comprises at least one substantially cylindrical pin (14) to be seated in a depression (16) formed in said carrier (6) and in a depression (15) formed in said receiver (5), wherein, when said cylindrical pin (14) is seated in said depressions, said carrier (6) is locked to said receiver (5) and when said cylindrical pin (14) is removed from said depressions, said carrier (6) can be freely removed from said receiver (5).

3. The ear piece according to claim 2, wherein said cylindrical pin (14) is inserted in a transverse direction into an opening formed by said depressions (15, 16), after said carrier (6) has been pushed onto said receiver (5) in a longitudinal direction.

4. The ear piece according to claim 1, wherein said pin-lock locking mechanism defines a form-locking connection between said carrier (6) and said receiver (5).

5. The ear piece according to claim 1, wherein said snap-lock locking mechanism comprises at least one bulge (21) formed on one of said receiver (5) or said carrier (6) and at least one corresponding depression on the other of said carrier (6) or said receiver (5), wherein said at least one bulge (21) engages in said at least one depression (20) when said carrier (6) is snapped onto said receiver (5).

6. The ear piece according to claim 5, wherein said bulge (21) is one of two bulges (21) formed on said receiver (5) and said depression is one of two depressions (20) formed in said carrier, and wherein said receiver (5) and said carrier (6) are rotationally symmetrical and connectible in either of two relative orientations.

7. The ear piece according to claim 5, wherein said bulge (21) is one of two bulges (21) formed on said carrier (6) said depression is one of two depressions (20) formed in said receiver (5), and wherein said receiver (5) and said carrier (6) are rotationally symmetrical and connectible in either of two relative orientations.

8. The ear piece according to claim 1, wherein said snap-lock locking mechanism is configured to allow said carrier (6) and said receiver (5) to be connected to one another and to be disconnected from one another by manual actuation.

9. The ear piece according to claim 1, wherein said pressure source (5a) is at least one pump integrally formed with said receiver (5), and wherein said receiver (5) and said carrier (6) are formed to establish the fluidic connection when said carrier (6) is connected to said receiver (5) and to establish a seal between said at least one pump (5a) and the interior of said balloon (7).

10. The ear piece according to claim 1, wherein said pressure source (5a) is integrally formed with said carrier (6)

and pneumatically sealed relative to the interior of said balloon (7).

11. The ear piece according to claim 1, wherein said pressure source (5a) is a pump assembly comprising an air pump for inflating said balloon and a deflation valve for deflating said balloon.

12. The ear piece according to claim 1, wherein said receiver (5) is connected by way of a signal line (9) to a device for delivering electronic signals for processing in said receiver (5).

13. The ear piece according to any of the claims 1 to 10 for use in combination with a hearing aid.

14. A hearing device, comprising:
an ear piece according to any of claims 1 to 13; and
an external unit for transmitting to said ear piece sound signals or signals for generating sound waves to be perceived by the tympanic membrane.

15. The hearing device according to claim 14 formed as a hearing aid, wherein the external unit is a hearing unit selected from the group consisting of behind-the-ear (BTE), in-the-ear (ITE), concha, in-the-canal (ITC), and completely-in-the-canal (CIC) hearing unit.

16. The hearing device according to claim 14, wherein the external unit is a sound player or a telephone.

17. A receiver module (5) for an ear piece according to any of claims 1 to 13, the receiver module (5) being configured for or with the locking mechanism and to form a fluid-tight connection between the pressure source (5a) and the inflatable balloon (7) when the pin-lock (14, 15, 16) locking mechanism or the snap-lock (20, 21) locking mechanism is engaged.

18. A balloon module (6, 7) for an ear piece according to any of claims 1 to 13, the balloon module comprising:

a carrier (6) and an inflatable balloon (7) sealingly mounted on said carrier (6);

said carrier (6) being configured for or with the locking mechanism to connect said carrier to the receiver of the hearing device when the pin-lock (14, 15, 16) locking mechanism or the snap-lock (20, 21) locking mechanism is engaged, and to form a fluid-tight connection between the pressure source (5a) and said inflatable balloon (7).

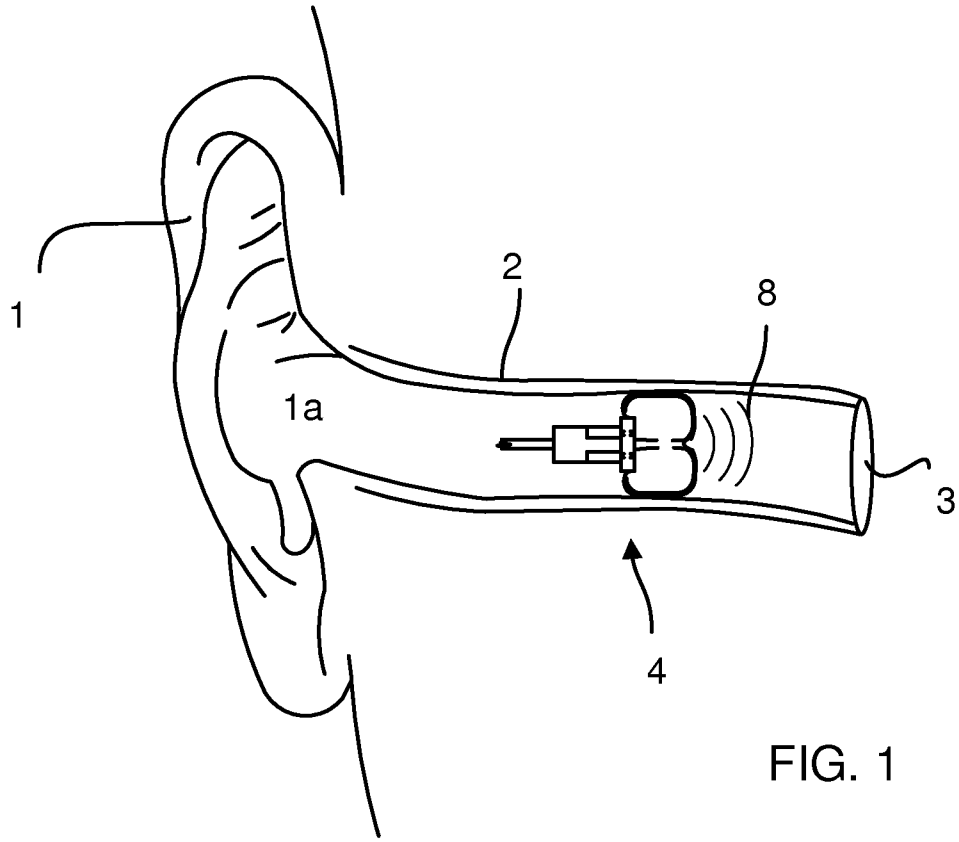


FIG. 1

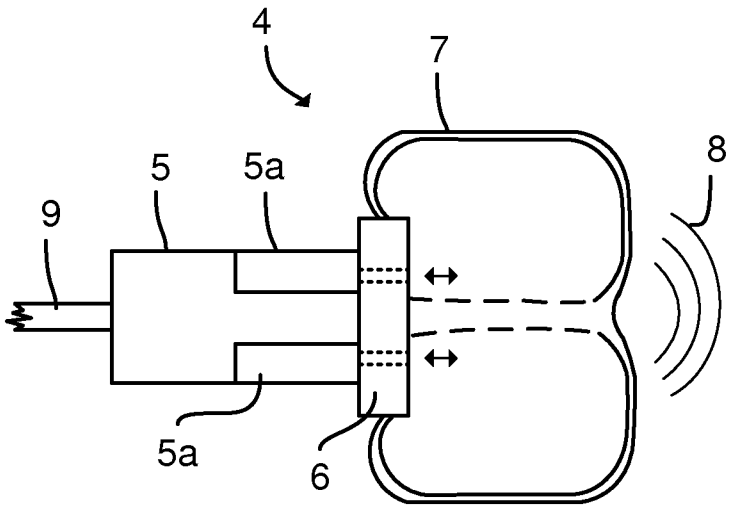


FIG. 2

FIG. 3

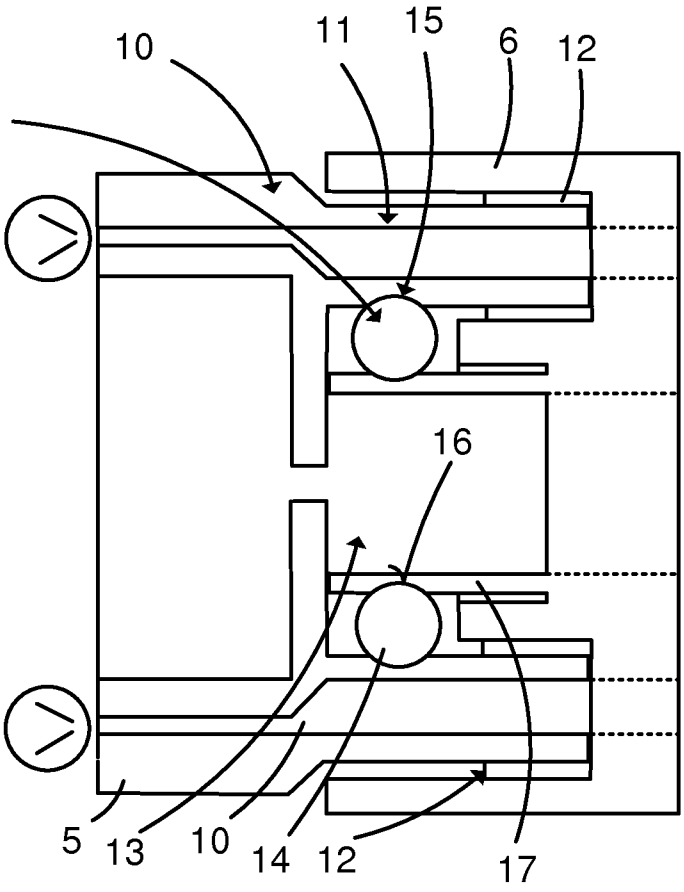


FIG. 4

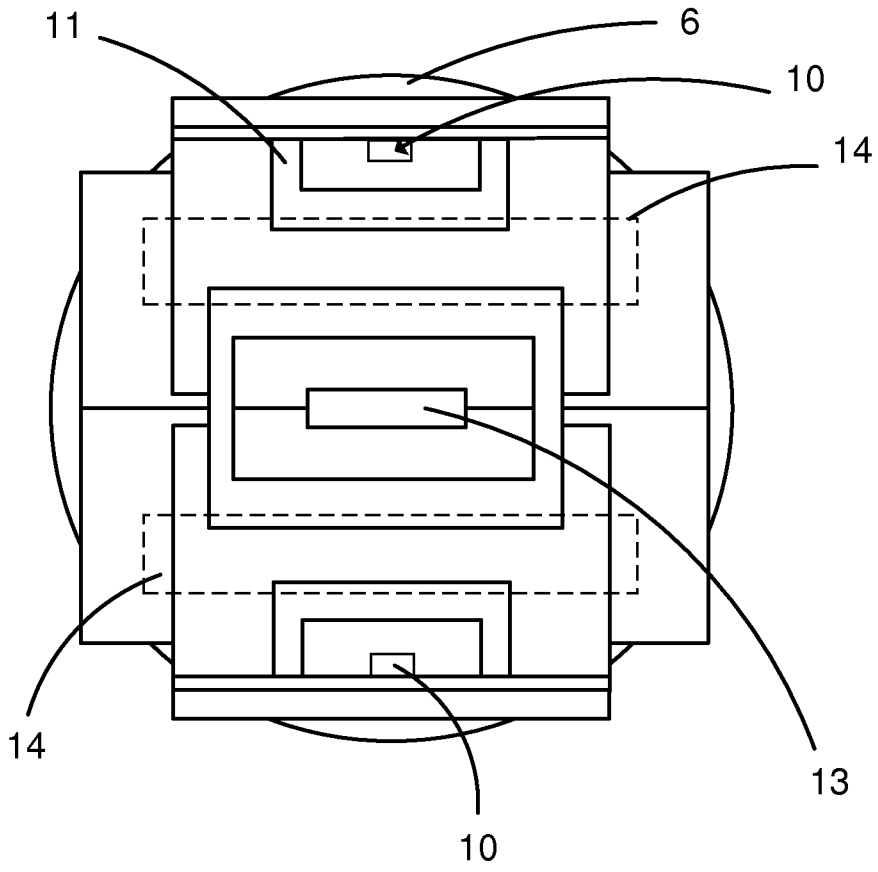


FIG. 5

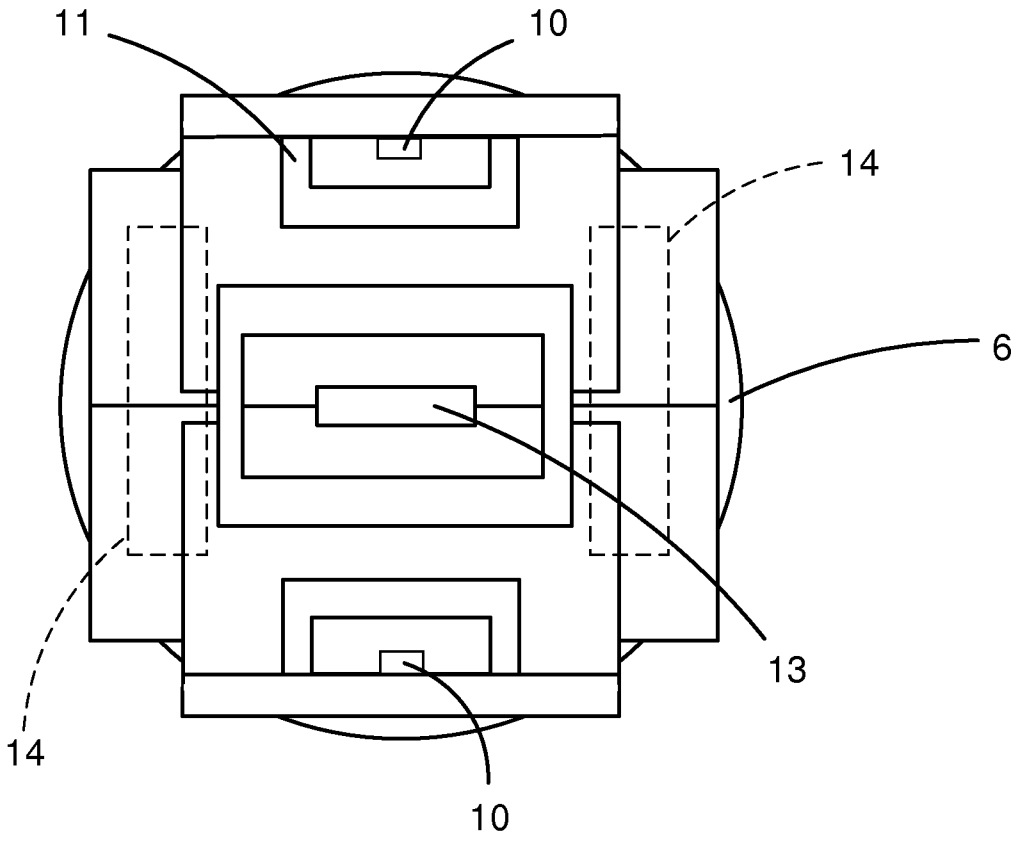
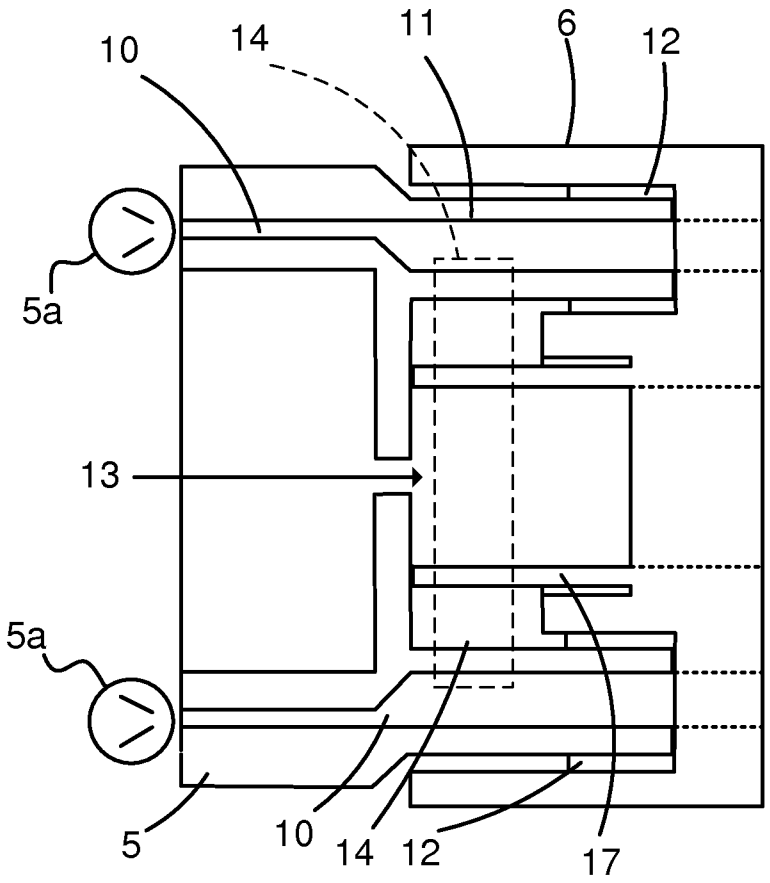


FIG. 6



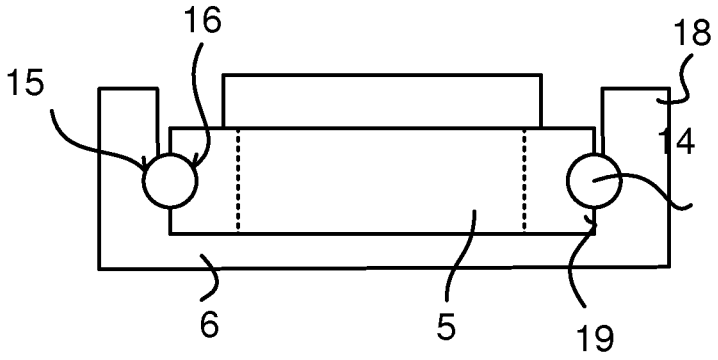


FIG. 7

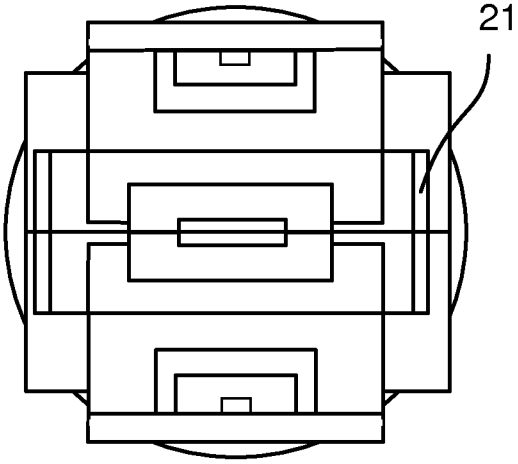
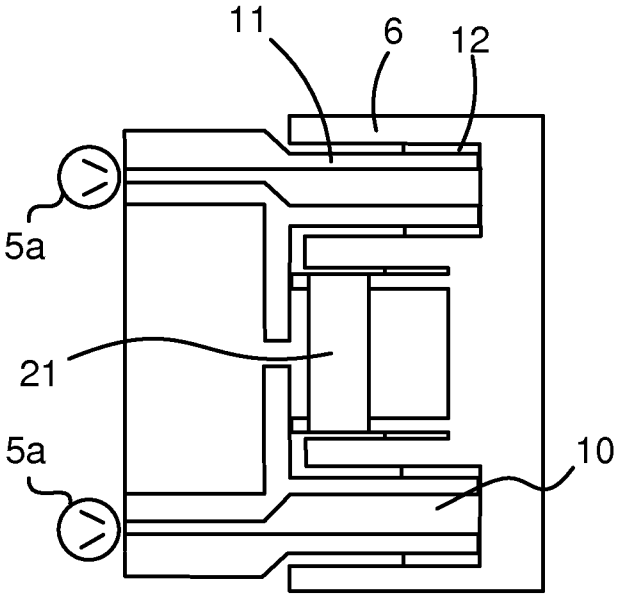


FIG. 8

FIG. 9



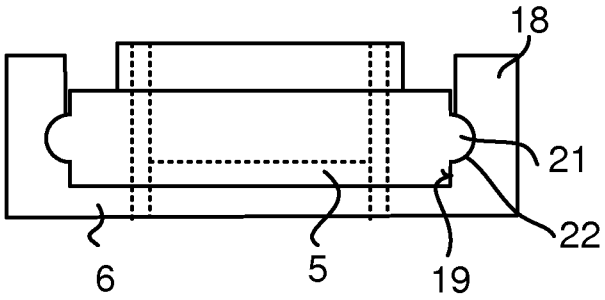


FIG. 10