



(51) International Patent Classification:

H04R 1/10 (2006.01) **H04R 15/00** (2006.01)
H04R 25/00 (2006.01)

(21) International Application Number:

PCT/EP2010/066387

(22) International Filing Date:

28 October 2010 (28.10.2010)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/363,8 14 13 July 2010 (13.07.2010) US

(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): **KUKLA, Christoph**
[DE/DE]; Am Farberhof 16, 91052 Erlangen (DE).

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

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

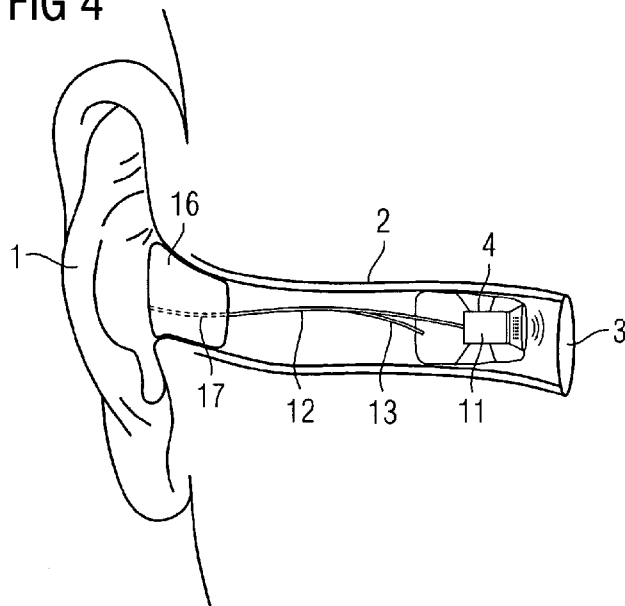
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: EAR PIECE AND HEARING DEVICE WITH EAR PIECE

FIG 4



(57) Abstract: A hearing device has an ear piece for insertion into an external auditory canal (2). The ear piece is connected to or encased in an inflatable balloon (5) that may be selectively inflated and deflated. When the balloon is inflated, it expands and braces against the walls of the auditory canal. When it is deflated, it may be withdrawn from the auditory canal (2). The ear piece includes a magnetic wave generator (10) that generates magnetic waves (9) and a forward wall (7) facing toward the tympanic membrane (3) that is coated with, formed with, or consists entirely of magnetically susceptible material. The magnetic material is exposed to the magnetic waves (9) generated by the magnetic wave generator (10) and the forward wall (7) thus converts the magnetic waves (9) to acoustic waves (8). An exterior device, such as a hearing aid, an MP3 player, a cell phone, or the like, feeds in signals to the deep-insertion ear piece for driving the magnetic wave generator (10) and thus the acoustic wave converter.

Ear piece and hearing device with ear piece

Background of the Invention

Field of the Invention:

The invention relates to a hearing device, in particular, a hearing device for a hearing aid or a sound player.

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 mechanical vibration. In the case of a loudspeaker, the vibra-

tion is converted to longitudinal pressure waves, also referred to as sound waves, which impinge on the tympanic membrane of the user. There, the soundwaves are converted into neurological signals which are fed to the brain, where they are decoded for content.

In many cases, the considerable size of the devices poses a drawback in that the device cannot be inserted into the auditory canal to a sufficient degree and that the distance between the receiver and the eardrum remains quite large. Further, it also poses a disadvantage with regard to the cosmetics requirements of such hearing devices.

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 formed with a sound opening that faces towards the eardrum and that allows the speaker to address the eardrum directly and at only a small spacing distance. The receiver housing is surrounded by an inflatable soft shell, by way of which the receiver is fixed in the auditory canal.

Similarly, U.S. Patent No. US 7,425,196 B2 also describes a receiver module for a hear 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.

Brief Summary of the Invention

It is accordingly an object of the invention to provide an in-the-ear hearing device, which overcomes the above-mentioned disadvantages of the heretofore-known devices and methods of this general type and which provides for a device that is sufficiently small so as to enable complete insertion

in the ear canal and, as a result, to reduce the rest volume between the sound generator and the ear drum. In addition, it is desirable for the device to be protected against earwax (i.e., cerumen) and moisture, yet be simple and inexpensive to produce.

With the foregoing and other objects in view there is provided, in accordance with the invention, an ear piece having a size and a shape enabling it to be inserted into an external auditory canal. The ear piece includes an inflatable balloon and a housing attached to the balloon, and the ear piece is further characterized by the following features:

- the balloon being selectively inflatable so as to expand and brace against a wall of the auditory canal and deflatable so as to enable withdrawal of the ear piece from the auditory canal;

- the housing including a magnetic wave generator for generating magnetic waves; and

- the ear piece having a forward wall disposed to face toward the tympanic membrane bounding an interior of the auditory canal and including magnetic material exposed to the magnetic waves generated by the magnetic wave generator, the forward wall converting the magnetic waves to acoustic waves for the tympanic membrane.

In accordance with an advantageous feature of the invention, there is provided a signal connection for feeding signals to the ear piece for driving the magnetic wave generator and the forward wall of the balloon. The signal connection may be wireless or it may be wire bound. In a CIC device, for instance, the ear piece with the forward wall may simply form an protruding extension of the device and, in that case the exposed cable connection may not be necessary.

In a preferred embodiment, the forward wall of the ear piece is formed by the forward wall of the balloon, which is coated or treated with magnetic material (i.e., magnetically suscep-

tible material) . In a further embodiment, the forward wall consists in its entirety of such magnetic material. In one embodiment of the invention, the forward wall of the balloon is a substantially solid disc of magnetic material integrally formed with, and forming a part of, the balloon.

The drive signals or control signals, as well as the energy supply, may be carried in an electric cable connected through the ear canal. The cable may also form a tether for the removal of the deep-insertion ear piece and/or it may limit an insertion into the canal and towards the ear drum.

In accordance with again another feature of the invention, there is provided a tube pneumatically connecting the balloon with an exterior pump for selectively inflating the balloon. In an alternative embodiment, the pump may be disposed in the housing of the ear piece for selectively inflating and deflating the balloon, and a pneumatic connection enabling aspiration of air through the auditory canal for inflation of the balloon.

With the above and other objects in view there is also provided a hearing aid with an external 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 units, connected to an ear piece as outlined above. The hearing unit and the ear piece are connected by way of the above-noted signal connection, and they together form the hearing aid. In the case of a CIC hearing aid, the external unit and the ear piece may be formed as an integral unit.

In other words, the part of the balloon which is placed close to the ear drum is treated or coated with magnetic material (i.e., magnetically susceptible material). In the alternative, it may also be formed entirely of such material. An electromagnetic output device is disposed in functional vi-

cinity of the magnetic material of the balloon. The electro-magnetic output device interacts magnetically with the magnetic material of the balloon in order to produce acoustic waves. The interaction is controlled by a control unit, which receives signals from the input unit. The latter may be a hearing aid, an MP3 player, a cell phone, or any other such electronic device.

In the case of a hearing aid implementation of the invention, the microphone, the amplifier, the control unit, and the power supply may be disposed in an external unit, such as a BTE (behind-the-ear) unit or an ITE (in-the-ear) unit, or in a CIC or concha device. The inflation pump may be disposed in the ear piece itself or in the external or partly inserted unit. The ear piece, or particularly the deep-insertion unit, is electrically connected to the other unit by way of an electrical control cable and, in one case, also through a pneumatic hose.

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.

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 a hearing device with a sound transducer to be fully 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 and an auditory canal leading to an ear drum bounding the canal;

Fig. 2 is a slightly enlarged view of the auditory canal with a first embodiment and the retaining balloon fully inflated;

Fig. 3 is a similar view showing a second embodiment of the invention; and

Fig. 4 is a similar view showing a third embodiment of the invention in the form of a hearing aid with a deep-insertion unit .

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 the eardrum. In unassisted hearing, pressure waves (sound waves are longitudinal waves with changes in pressure) are funneled at the concha la 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, the propagation of the sound waves through the auditory canal 2 is 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 an oscillator in the vicinity 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 la for delivery through the auditory canal 2.

The external auditory canal 2 is divided in Fig. 1 into three sections of approximately equal length. A first region I includes the concha la and an outer insertion region which would typically receive a CIC device. A second region II approximately covers the mid-section of the canal 2. Finally, a third region III is the bounded cavity in which the sound generation of the instant invention is placed. The following references to a "deep" insertion, therefore, will pertain to the insertion of a device primarily into region III, and also into region II.

Referring now to Fig. 2, there is shown a hearing device according to the invention. The hearing device includes an ear piece, which is illustrated here as a deep-insertion unit. In a first embodiment, the ear piece includes a housing 4 and a balloon 5 surrounding the housing 4. The housing 4 is braced against the balloon 5 by way of schematically illustrated braces 6. The braces 6 fulfill a suspension function, which need not be rigid. The housing 4 should remain substantially centered within the balloon 5 -- to assure that the housing 4 does not bang against the walls of the canal 2 upon considerable shock impulses -- and it should retain its position relative to the forward wall facing the eardrum 3.

The balloon 5 is formed of a flexible material which is impermeable to cerumen, or earwax, and also to water. The term "balloon" as used herein should be understood in its broadest sense as an 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 5 is preferably inflated with air, but it is also within the invention to inflate by injecting a liquid or a gel, or the like. It may also be possible to generally fill the cavity inside the balloon surrounding the housing 4 with an expandable foam. In order to deflate the balloon 5, the air is evacuated out of the balloon so as to collapse the foam. The balloon 5 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.

The forward wall of the balloon 5 -- illustrated on the right-hand side in Fig. 2 -- is coated with, or formed of, magnetic material 7. The coated or treated area of magnetic material 7 forms a converter that produces acoustic waves 8 upon being excited by a controlled magnetic field 9. In an alternative embodiment, the wall forming the converter may be rigid or substantially rigid, to improve acoustic quality and ensure acoustic linearity. A magnetic disc membrane may be integrated and/or vulcanized into the front of the balloon 5. It is only important to assure that the balloon 5 is entirely tight and impermeable with regard to the filling or inflation material, such as air.

The term "magnetic material" as used herein includes all magnetically susceptible materials, such as iron and/or ferromagnetic materials, as well as doped materials that are reactive to magnetic flux changes. The oscillatory movement of the wall of magnetic material 7 is driven by the magnetic field 9 which is generated by a magnetic wave generator 10. The generator 10 is driven by a control unit 11 disposed in the housing 4 and connected to a signal source via a cable 12. As previously described, the signal source may be a hear-

ing aid, an MP3 player, an earbud of a cellphone, or the like. The cable 12 may include a power cord, so as to remotely power the control unit 11. In the alternative, the ear piece may contain its own power source in the form of a battery.

The generator 10 and the converter 7 are spaced apart by a defined spacing distance. The distance is maintained by a suspension 14, which allows the relative movement of the wall 7 in terms of its oscillation, but maintains the spacing distance at its optimum value in order to assure acoustic linearity.

The balloon 5 is pneumatically connected toward the exterior by way of an inflation-deflation tube 13. The tube 13 is illustrated separately from the cable 12, but the cable 12 and the tube 13 are typically guided as a single cord unit. It is possible for the cladding of the signal/power cable 12 to form the pneumatic tube 13. In the implementation of Fig. 2, the balloon 5 may be inflated by way of an electric pump, preferably reversible, or it may be inflated by manual inflation.

The illustrated cable 12 also represents a tether, with which the deep-insertion ear piece may be safely removed from the auditory canal 2. In the case of a wireless connection (e.g., bluetooth) between the ear piece and the signal source, the tether may still be advantageously provided.

Referring now to Fig. 3, there is shown an alternative embodiment of the invention. Here, the ear piece itself includes a pump 15. The operation of the pump 15 may be controlled from the outside. The cable 12 carries a corresponding signal for that purpose. The pump 15 may be reversible so as to allow selective inflation and deflation of the balloon 5. The cable 12 in this embodiment also includes a tube 13 through which fresh air may be aspirated by the pump 15 for

inflating the balloon 5. In addition, the cable 12 carries control signals and energy to the ear piece.

Referring now to Fig. 4, there is shown yet a further alternative embodiment. Here, the hearing device includes the deep-insertion ear piece and a CIC (completely-in-the-canal) or a concha unit 16. It will be understood, of course, that the embodiment of Fig. 4 may utilize the ear piece of Fig. 2 with the remote pumping of the balloon 5 or the ear piece of Fig. 3 with the integrated pumping system. The CIC or concha unit 16 is shown with an air vent 17 or pressure compensation vent.

The above system has been described with regard to an embodiment in which the balloon 5 is expanded against the walls of the ear canal by inflation with a fluidic medium, such as air or a liquid. It is also possible to fill the space surrounding the housing 4 with the control unit 11 and the generator 10 inside the balloon 5 with an expandable foam. In that case, the balloon 5 is "inflated" in that the foam expands. The balloon 5 is then inflated by aspirating air (or another filling fluid) out of the foam and collapsing the foam. In that case, a vacuum is applied for placement of the ear piece and for its removal from the ear canal. Once the ear piece is properly in place, the vacuum lock is opened and the foam is allowed to expand. This causes the balloon walls to brace against the walls of the ear canal 2.

Claims

1. An ear piece for insertion into an external auditory canal (2), comprising:

5 an inflatable balloon (5) and a housing (4) attached to said balloon (5) ;

said balloon (5) being selectively inflatable so as to expand and brace against a wall of the auditory canal and deflatable so as to enable withdrawal of the ear piece from the
10 auditory canal (2);

said housing (4) including a magnetic wave generator (10) for generating magnetic waves (9); and

a forward wall (7) of the ear piece disposed to face toward the tympanic membrane (3) bounding an interior of the
15 auditory canal (2) and including magnetic material exposed to the magnetic waves (9) generated by said magnetic wave generator (10), said forward wall (7) converting the magnetic waves (9) to acoustic waves (8) for the tympanic membrane
(3) .

20 2. The ear piece according to claim 1, wherein said forward wall (7) of said ear piece is a forward wall of said balloon coated with magnetic material.

25 3. The ear piece according to claim 1, wherein said forward wall (7) of said ear piece is a forward wall of said balloon consisting of magnetic material.

30 4. The ear piece according to claim 1, wherein said forward wall (7) is a substantially solid disc of magnetic material integrally formed with, and forming a part of, said balloon (5) .

35 5. The ear piece according to claim 1, wherein said housing (4) is substantially completely encased in said balloon (5) .

6. The ear piece according to claim 1, which further comprises a signal connection (12) for feeding signals to the

ear piece for driving said magnetic wave generator (10) and said forward wall (7) .

7. The ear piece according to claim 6, wherein said signal connection (12) includes an electrical cable carrying electrical control signals and an energy supply.

8. The ear piece according to claim 1, which comprises a tube pneumatically connecting said balloon (5) with an exterior pump for selectively inflating said balloon.

9. The ear piece according to claim 1, which comprises a pump disposed in said housing for selectively inflating and deflating said balloon, and a pneumatic connection enabling aspiration of air through the auditory canal for inflation of said balloon.

10. The ear piece according to claim 1, wherein the ear piece has a size and a shape enabling deep insertion thereof into the external auditory canal (2) and in close vicinity of the tympanic membrane (3) bounding the auditory canal (2) .

11. A hearing device, comprising:

an ear piece according to any of the preceding claims;

and

an external unit for transmitting to said ear piece signals for generating sound to be perceived by the tympanic membrane .

12. The hearing device according to claim 11 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.

13. The hearing device according to claim 11, wherein the external unit is a sound player or a Telefone.

1/2

FIG 1

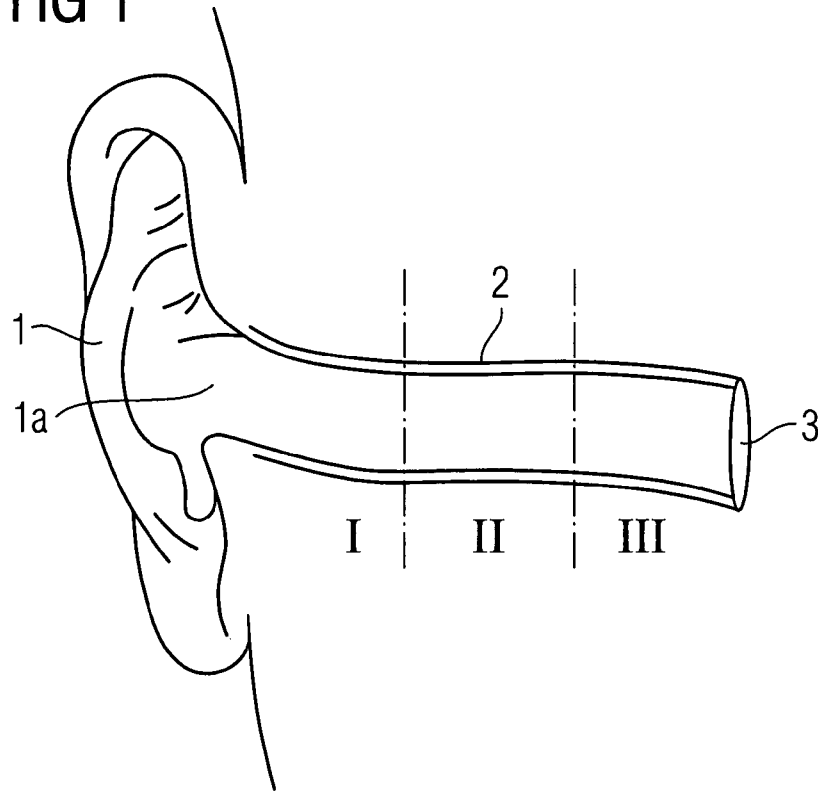


FIG 2

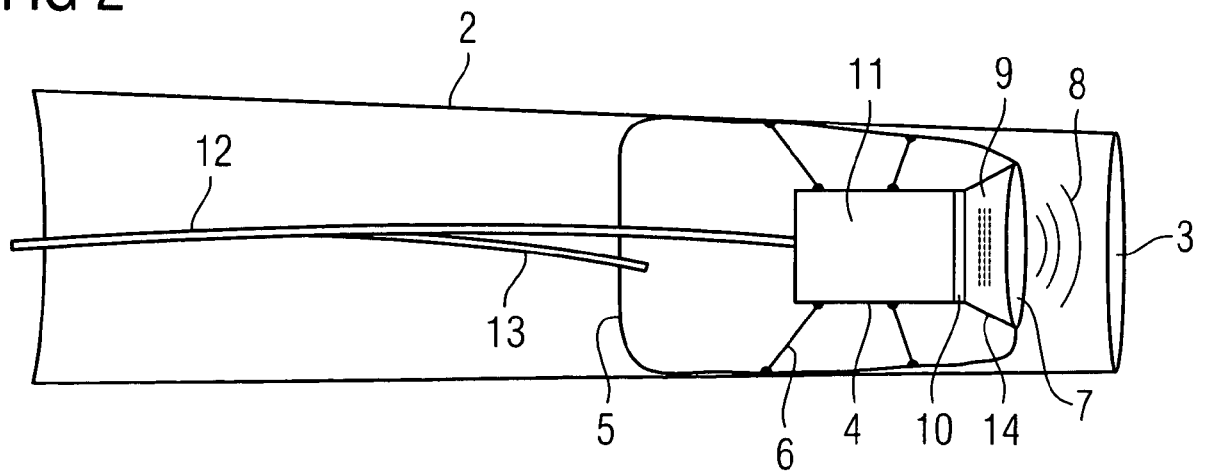


FIG 3

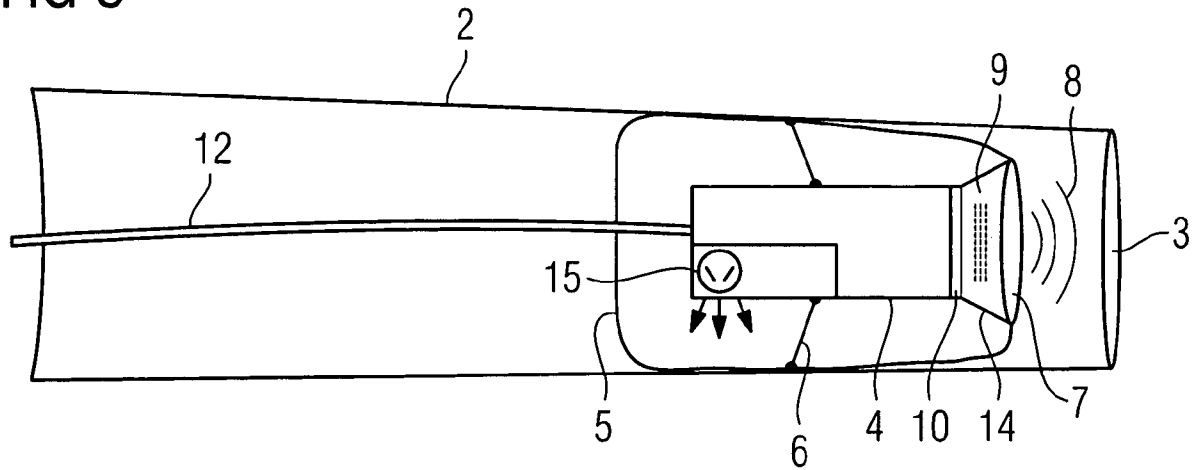
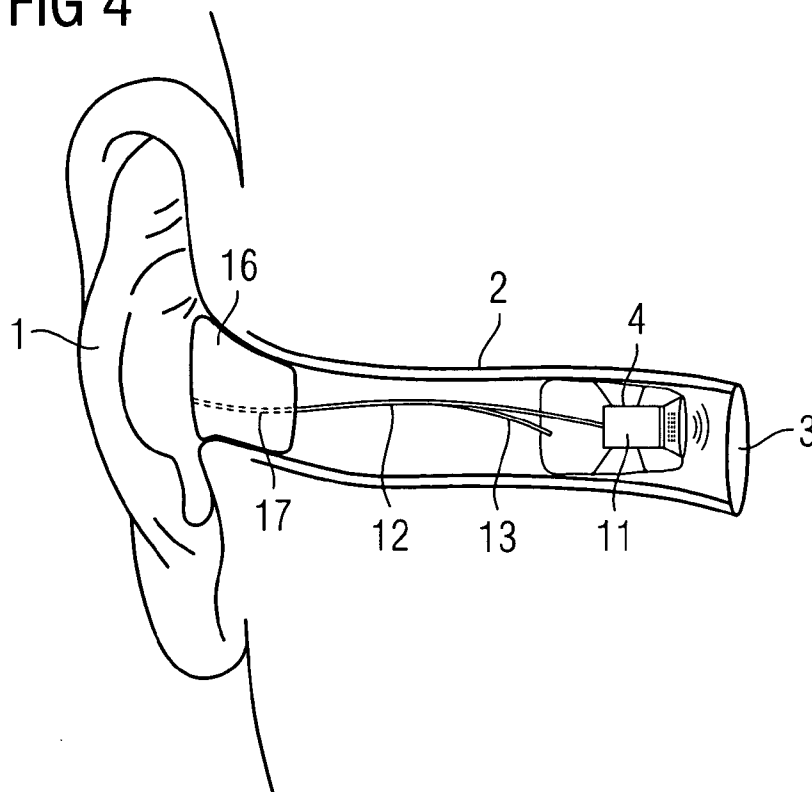


FIG 4



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/066387

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04R1/10 H04R25/00
ADD. H04R15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 272 003 AI (SONIONMICROTRONIC AS [DK] SONION AS [DK]) 2 January 2003 (2003-01-02) column 3, paragraph 11 - column 11, paragraph 57; figures 1-18 -----	1-13
A	US 2010/034418 AI (BONIN WAYNE ALLEN [US]) 11 February 2010 (2010-02-11) page 1, paragraph 1 - page 3, paragraph 3; figures 1-5 -----	1-13
A	US 2010/002897 AI (KEADY JOHN P [US]) 7 January 2010 (2010-01-07) page 1, paragraph 7 - page 4, paragraph 43; figures 1-9 ----- -/--	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search

15 December 2010

Date of mailing of the international search report

23/12/2010

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Duffner, Or I a

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2010/066387

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 137 889 A (SHENNIB ADNAN [US] ET AL) 24 October 2000 (2000-10-24) column 1, line 39 - column 15, line 53; figures 1-26 -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2010/066387

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1272003	A1	02-01-2003	AT US 485687 T 2002196958 A1	15-11-2010 26-12-2002
US 2010034418	A1	11-02-2010	NONE	
US 2010002897	A1	07-01-2010	WO 2010005899 A1	14-01-2010
US 6137889	A	24-10-2000	NONE	