

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
7 September 2007 (07.09.2007)

PCT

(10) International Publication Number
WO 2007/100336 A1

(51) International Patent Classification:
H04R 25/00 (2006.01) *A61B 7/02* (2006.01)
H04R 1/02 (2006.01)

(21) International Application Number:
PCT/US2006/007835

(22) International Filing Date: 3 March 2006 (03.03.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/366,092 2 March 2006 (02.03.2006) US

(71) Applicant (for all designated States except US):
KNOWLES ELECTRONICS, LLC [US/US]; 1151
Maplewood Drive, Itasca, Illinois 60143 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **WICKSTROM,**
Timothy, K. [US/US]; 1339 Wasdale Avenue, Elk Grove
Village, Illinois 60007 (US). **BALLAD, William, J.**
[US/US]; 895 Saybrook Lane, Buffalo Grove, Illinois
60089 (US). **SCHAEFER, David, M.** [US/US]; 4632
Woodward Avenue, Downers Grove, Illinois 60515 (US).

(74) Agents: **SAMPLES, Kenneth, H.** et al.; FITCH, EVEN,
TABIN & FLANNERY, 120 South LaSalle Street, Suite
1600, Chicago, Illinois 60603 (US).

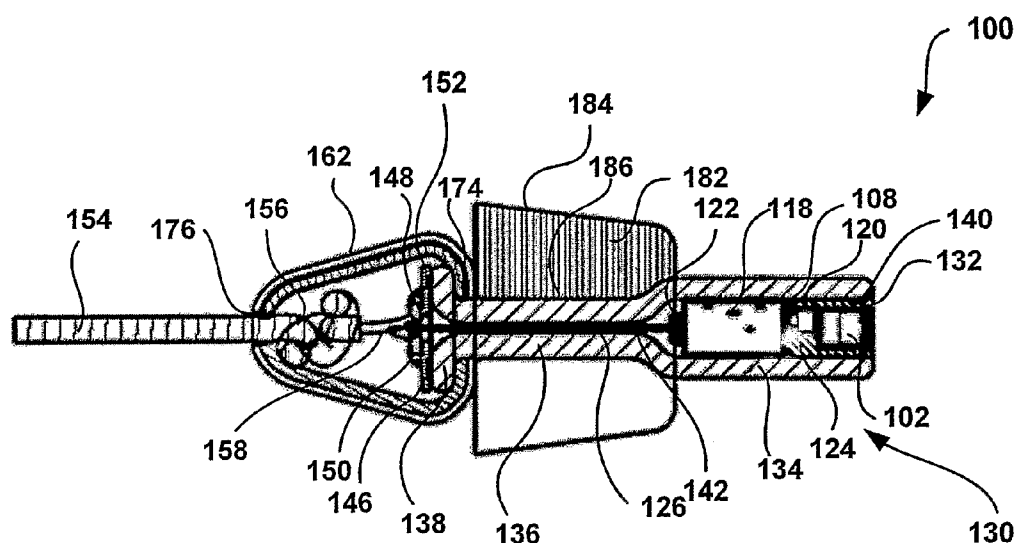
(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,
KG, KM, KN, KP, KR, KZ, LC,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

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT,
RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA,
GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

[Continued on next page]

(54) Title: ISOLATING DEEP CANAL FITTING EARPHONE



(57) Abstract: An insert earphone (100) comprises a housing (130) and at least one transducer (118) that is located in the housing (130). The transducer (118) is adapted to receive electrical energy and to responsively convert the electrical energy into acoustic energy for presentation to an eardrum (192) of a user. The transducer (118) is positioned within the housing (130) so as to be in close proximity to the eardrum (192) of the user when the housing (130) is inserted into the ear canal (190). At least one coupling member (182) is coupled to the housing (130). The at least one coupling member (182) is adapted to provide an acoustic seal within the ear canal (190) of the user.

WO 2007/100336 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

ISOLATING DEEP CANAL FITTING EARPHONE

TECHNICAL FIELD

[0001] This patent relates to listening devices, and more particularly, to isolating earphones.

BACKGROUND

[0002] Transducers such as receivers and speakers are useful in many listening devices such as earphones, headphones, Bluetooth wireless headsets, or the like. For instance, a receiver may convert electrical energy received from an audio signal device into acoustic energy and subsequently present the acoustic energy to the eardrum of the user for listening.

[0003] General speaking, conventional insert earphones are designed to isolate the desired sound presented at the user's ear drum from other sounds and/or noise from the outside environment. In this regard, previous insert earphones typically include a housing having a wide, rigid sound passage tube and a receiver mounted within the housing. A rigid eartip attached around the sound passage tube may be located externally to the housing. When the sound passage tube attached to the housing is inserted into the ear canal of the user, airborne sound moves through the eartip. The eartip engages the walls of the ear canal. In these systems, the receiver within the housing is positioned near the entrance to the ear canal to receive the sound energy.

[0004] Unfortunately, several problems exist with these previous approaches. For instance, achieving an airtight or otherwise adequate seal in the ear canal is often difficult or impossible. This leads to undesirable sounds (e.g., background noise) entering the ear canal and desirable sounds (e.g., music from an attached listening device) escaping from the ear canal. In addition, these previous devices frequently cause considerable discomfort when worn by the user, due to the hardness of the tube and shape of the eartip. Custom molded earphones have also been attempted, but the manufacture and assembly of these custom molded devices is expensive and labor intensive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For a more complete understanding of the disclosure, reference should be made to the following detailed description and accompanying drawings wherein:

[0006] FIG. 1 is an exploded view illustrating an earphone according to the present invention;

[0007] FIG. 2 is a perspective view of the earphone of FIG.1 according to the present invention;

[0008] FIG. 3 is a cross-sectional view of the earphone shown in FIG 1 according to the present invention; and

[0009] FIGs. 4 and 5 illustrate full insertion of the earphone of FIGs. 1-3 into the ear canal of a user according to the present invention.

[0010] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity. It will further be appreciated that certain actions and/or steps may be described or depicted in a particular order of occurrence while those skilled in the art will understand that such specificity with respect to sequence is not actually required. It will also be understood that the terms and expressions used herein have the ordinary meaning as is accorded to such terms and expressions with respect to their corresponding respective areas of inquiry and study except where specific meanings have otherwise been set forth herein.

DETAILED DESCRIPTION

[0011] While the present disclosure is susceptible to various modifications and alternative forms, certain embodiments are shown by way of example in the drawings and these embodiments will be described in detail herein. It will be understood, however, that this disclosure is not intended to limit the invention to the particular forms described, but to the contrary, the invention is intended to cover all modifications, alternatives, and equivalents falling within the spirit and scope of the invention defined by the appended claims.

[0012] Isolating earphones using deep canal fittings and approaches for assembling and using these devices are provided. The approaches described herein provide one or more seals to minimize the background noise received by listening

devices (e.g., transducers) that are positioned deeply within a user's ear canal. The seal or seals also prevent desirable sounds from escaping from the ear canal. These approaches reproduce sounds with audio fidelity and provide devices that are comfortable for a user to wear. In addition, the devices described herein are easy and cost effective to produce.

[0013] In many of these embodiments, an insert earphone comprises a housing and at least one transducer that is located in the housing. The transducer is adapted to receive electrical energy and to responsively convert the electrical energy into acoustic energy for presentation to an eardrum of a user. The transducer is positioned within the housing so as to be in close proximity to the eardrum of the user when the housing is inserted into the ear canal. At least one sealing member is coupled to the housing. The sealing member is adapted to provide an acoustic seal within the ear canal of the user.

[0014] The seal (or seals) provided by the at least one sealing member limit the transmission of sound into the ear canal from outside the ear canal. Consequently, outside sounds do not reach the transducer thereby eliminating or substantially reducing background noise presented to the user's ear drum. Furthermore, the seal or seals also prevent desirable sounds (i.e., those sounds desired to be presented to the ear drum of the user) from escaping from the ear canal. In addition, the earphone is comfortable to wear, provides high audio fidelity, and can be worn by the user over extended periods of time. Since the device is not custom designed or fitted for a particular user, it is cost effective and easy to produce.

[0015] The sealing member can take a number of different forms. For instance, the sealing member may be a coupling member that is coupled to an outer wall of the housing. In another example, the sealing member is a handle positioned at an end of the housing. In still another example, the sealing member is both a coupling member and a handle. In addition, other structural forms may be used as the sealing member or members.

[0016] If a coupling member is used, the coupling member may be formed from a number of soft compliant materials such as polyurethane foam, polymers, and silicones. In addition, the transducer may be a single device or multiple devices. For instance, the transducer may be a receiver, conjoined receiver and microphone, or a dual receiver.

[0017] As mentioned, the insert earphone is inserted into the ear canal of a user in close proximity to the eardrum of the user. If a coupling member is used, the coupling member may be supported substantially entirely or entirely by the ear canal of the user and provide a seal in the ear canal.

[0018] In others of these embodiments, approaches are provided to insert an earphone into the ear canal of a user. For instance, in one example, at least one transducer is inserted into the ear canal of a user. The transducer is positioned within the ear canal so as to be in close proximity to an eardrum of the user and converts electrical energy into acoustic energy for presentation to the ear drum of the user. At least one acoustic sealing member is positioned outward from the transducer so as to provide an acoustic seal that substantially prevents noise originating outside of the ear canal from entering the ear canal of the user. In addition, desirable noise is retained in the ear canal.

[0019] Turning now to the drawings and referring now to FIG. 1, an exploded view of an exemplary earphone 100 is described. The earphone 100 includes a damper plug 102, a bushing member 108, at least one transducer 118, a pair of wire 126, a housing 130, a circuit assembly 146, a cable 154, a handle 162 (see FIG. 2), and a coupling member 182.

[0020] The transducer 118 may be a single device or multiple devices. For example, the transducer 118 may be a receiver, a conjoined receiver and microphone, or a dual receiver. The transducer 118 comprises a sound outlet tube 120 and an electrical input terminal 122 and is operative for generating an acoustic output signal at the sound outlet tube 120 as a function of an electrical signal applied to the input terminal 122.

[0021] The circuit assembly 146 may process the electrical signals received. The damper plug 102 is attached to the sound outlet tube 120 of the receiver 118 and the input terminal 122 of the receiver 118 is electrically coupled through the wire 126 to the cable 154. Once the receiver 118 is held in contact with the bushing member 108, the damper plug 102, and the wire 126, the receiver 118 is positioned within the housing 130.

[0022] The housing 130 includes an opening 132, a body portion 134, a tubular portion 136, and an annular member 138. The annular member 138 of the housing 130 is sized to receive the circuit assembly 146. One end of the wire 126 is electrically coupled to the cable 154 via the circuit assembly 146. The handle 162 is

formed of two handle components 164 and 166 that snap fit against the housing 130. However, it will be understood that the components 164 and 166 may be joined together by mechanical fastening, crimping or any other suitable attachment arrangement. The coupling member 182 mates with the housing 130.

[0023] FIG. 2 illustrates a perspective view of the earphone 100. The housing 130 is flexible and may be molded from plastic in one piece and serves the functions of retaining the receiver 118 mounted to the bushing member 108 and the wire 126 (see FIG. 1), supporting the circuit assembly 146 for connection to the cable 154, and supporting the coupling member 182. The coupling member 182 is arranged to conform to the shape of the walls of the ear canal of the user in order to provide an acoustic seal in the ear canal. The coupling member 182 also provides the main support or the entire support for the earphone 100 within the ear canal. The coupling member 182 comprises a soft compliant material such as polyurethane foam, polymer, silicone or a similar material and may be molded from the above-mentioned material in one piece. The coupling member 182 is disposable after use thereby eliminating the accumulation of ear wax or debris on the coupling member 182.

[0024] The handle 162 includes at least two holders 168 and 170 to provide for removal and replacement of the internal components (e.g., the circuit assembly 146 or capacitors (not shown)). The handle 162 is pressed or molded into a shape having a hollow section (not shown) to accommodate the internal components (not shown). The handle 162 is preferably located at the annular member 138 of the housing 132. In some of these embodiments, the handle 162 can provide a second seal in addition to the seal provided by the coupling member 182. Alternatively, the coupling member 182 may be omitted and a single seal provided by the handle 162.

[0025] The handle 162 can be manufactured in a variety of configurations with any desired geometry. More specifically, the handle 162 includes a first opening 174 that mates with the tubular portion 136 of the housing 130 such that the annular member 138 of the housing 130 is securely retained within the handle 162 by a flange (not shown) and a second opening 176 to receive the cable 154. The handle 162 comprises a rigid and durable material such as polypropylene (pp) or a similar material (e.g., a polymer) and may be molded in one piece or more pieces.

[0026] FIG. 3 illustrates a cross-sectional view of the exemplary earphone 100 in conjunction with an exemplary method of assembling the earphone 100. As discussed earlier, the receiver 118 is mounted against the bushing member 108 and a filler 124

such as cement or a similar material is applied to fill the gap of the hollow section of the bushing member 108 and around the sound outlet tube 120 of the receiver 118. In one example, the bushing member 108 is pressed or molded from plastic in one piece. The damper plug 102 in the form of a tube shape may be made of stainless steel and is oriented according to the side wall of the bushing member 108, until the sound outlet tube 120 of the receiver 118 butts up against the side wall of the damper plug 102 to allow the acoustic signal travel to the ear canal.

[0027] A dust guard or acoustic resistor may be made of cloth or felt is attached within the damper plug 102 by any suitable method of attachment provides an acoustical resistance to the receiver 118 and prevents debris or ear wax from entering the receiver, which may damage the working components contained within the receiver 118. The damper plug 102 is preferably disposable and replaceable when clogged with ear wax or otherwise defective. The receiver 118 that is mounted to the bushing member 108 is retained in a first chamber 140 of the housing 130.

[0028] One end of the wire 126 is electrically coupled to the input terminal 122 of the receiver 118 and the other end of the wire 126 is electrically coupled to the connections 150 of the circuit assembly 146. A slack of wire (not shown) may be provided to prevent tension in the wire. As shown, the wire 126 is retained in a second chamber 142 of the housing 130 wherein the second chamber 142 is formed in the tubular portion 136 of the housing 130. The dimensions of the second chamber 142 are preferably smaller than or equal to the dimensions of the first chamber 140. The circuit assembly 146 includes a circuit board 152, a hole 148, and a plurality of connections 150. Optional components (not shown) such as capacitors may be mounted to the circuit board 152 serve to reduce RF interference.

[0029] The circuit board 152 may be formed in various shapes and sizes corresponding to the annular member 138 of the housing 130 or otherwise according to the requirements of specific applications. The front surface of the circuit board 152 may have printed wiring traces.

[0030] As mentioned earlier, the second end of the wire 126 is mounted to the front surface of the circuit board 152 via the hole 148. The cable 154 is electrically coupled to the front surface of the circuit board 152 to provide connection to the receiver 118 via the wire 126.

[0031] Electrical signals representative of sound are transmitted by cable 154, a wire 158, circuit assembly 146, and the wire 126 to the receiver 118 from an audio

signal device (not shown). The audio signal devices may be cellular phones, MP3 players or any other type of device that provides audio signals in electrical form. A strain relief (not shown) is affixed to the cable 154 with glue or any other suitable means for anchoring the cable 154 within the handle 162.

[0032] In the embodiment shown, a cable knot 156 is provided to anchor the cable 154 within the handle 162. The front surface of the circuit assembly 146 is held in contact with a plurality of flanges 172 formed within the inner surface of the handle 162 by any suitable form of attachments.

[0033] As shown in FIG. 3, the hole 148 is aligned with the second chamber 142 of the housing 130. When all the components are placed in final or closed position, the first and second handles 164, 166 are snap fit against the housing 130 and the cable 154. More specifically, the opening 174 of the handle 162 engages the annular member 138 of the housing 130 and the second opening 176 of the handle 162 engages the strain relief 156 of the cable 154. The coupling member 182 is provided on the outer portion of the housing 130. More specifically, an inner portion 186 of the coupling member 182 is affixed to the outer portion of the tubular portion 136 or the body portion 134 or both the body and tubular portions 134, 136 with glue or any other suitable means. An outer portion 184 of the coupling member 182 is positioned to come into contact with the walls of the ear canal of the user.

[0034] FIGs. 4-5 illustrate examples of full insertion of the exemplary earphone 100 into an ear canal 190 of a user. The earphone 100 (connected to the cable 154) is fully inserted into the ear canal 190 of a user, in close proximity to the user's eardrum 192, such that the coupling member 182 conforms to the inner walls of the ear canal 190. The coupling member 182 is supported entirely or substantially entirely by the ear canal 190 to provide a seal limiting transmission of sound to the ear canal 190. The earphone 100 (including the coupling member 182) is inserted and positioned in the ear canal 190 such that the eardrum 192 can easily receive acoustic energy from the earphone 100.

[0035] In FIG. 4, the coupling member 182 is coupled to the tubular portion 136. The earphone 100 provides a comfortable fit in the user's ear canal 190 and yet provides a good seal to reduce or eliminate noise from outside the ear from reaching the ear canal 190 and/or the transducer within the earphone 100. In addition, desirable sounds are prevented from escaping from the ear canal 190. The seal that is formed may be airtight or substantially airtight.

[0036] In an alternate embodiment shown in FIG. 5, the coupling member 182 conforms to the inner wall of the ear canal 190 and is affixed to the outer portion of the body portion 134. The coupling member 182 provides an airtight seal or substantially airtight seal in the ear canal 190. The seal limits the transmission of sound into the ear canal from outside the ear canal 190. In this example, a second seal is provided by the handle 164 as the handle fits snugly against the end of the ear canal 190. Consequently, the outside sounds do not reach the transducer thereby eliminating or substantially eliminating background noise. Furthermore, desirable sounds are prevented from escaping from the ear canal 190. In addition, the earphone 100 is comfortable to wear, provides high audio fidelity, and can be worn by the user over extended periods of time.

[0037] The examples of FIGs. 4 and 5 show the coupling member 182 either coupled to the tubular portion 136 or the body portion 134. However, it will be understood that the coupling member 182 may be coupled to both portions 134 and 136. Furthermore, the coupling member 182 may take any form, and, for example, may be comprised of multiple portions or segments. Moreover, while some of the above-mentioned examples may use both a coupling member and a handle to provide a seal, one of these components may be omitted.

[0038] In addition, while the earphone 100 is positioned in close proximity to the eardrum 192 (such that the eardrum 192 can easily receive acoustic energy from the earphone 100), the exact dimensions of the ear canal 190 and ear drum 192 of a particular user may affect the exact positioning of the earphone 100, the coupling member 182, and the seal (or seals) formed by the coupling member 182 (and any handle or other sealing component).

[0039] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. It should be understood that the illustrated embodiments are exemplary only, and should not be taken as limiting the scope of the invention.

WHAT IS CLAIMED IS:

1. An insert earphone adapted to be in close proximity to the eardrum of a user comprising:

a housing, the housing adapted to being positioned within an ear canal of a user;

at least one transducer positioned within the housing, the at least one transducer adapted to receive electrical energy and to responsively convert the electrical energy into acoustic energy for presentation to an eardrum of a user, the at least one transducer being positioned within the housing so as to be in close proximity to the eardrum of the user when the housing is inserted into the ear canal; and

at least one sealing member coupled to the housing, the at least one sealing member adapted to provide an acoustic seal within the ear canal of the user.

2. The insert earphone of claim 1 wherein the at least one sealing member comprises a coupling member that is coupled to an outer wall of the housing.

3. The insert earphone of claim 1 wherein the coupling member comprises a soft compliant material selected from the group of materials comprising a polyurethane foam; a polymer; and a silicone.

4. The insert earphone of claim 1 wherein the at least one sealing member comprises a handle positioned at an end of the housing.

5. The insert earphone of claim 4 wherein the housing comprises a body portion defining a first chamber, a tubular portion defining a second chamber, and an annular member and wherein the handle is coupled between the tubular portion and the annular member.

6. The insert earphone of claim 1 wherein the at least one sealing member comprises a coupling member that is coupled to an outer wall of the housing and a handle positioned at an end of the housing.

7. The insert earphone of claim 1 wherein the at least one transducer is selected from a group comprising a receiver; a conjoined receiver and microphone; and a dual receiver.
8. The insert earphone of claim 1 wherein the housing comprises a body portion defining a first chamber, a tubular portion defining a second chamber, and an annular member.
9. The insert earphone of claim 8 wherein the sealing member is coupled to a portion of the earphone selected from a group comprising the body portion; the tubular portion; and both the body and tubular portions of the housing.
10. The insert earphone of claim 8 wherein a wire is disposed within the second chamber of the tubular portion.
11. The insert earphone of claim 8 wherein the at least one transducer is disposed within the first chamber of the body portion.
12. A method of providing acoustic energy to an eardrum of a user comprising:
 - inserting at least one transducer into the ear canal of a user, the at least one transducer being positioned within the ear canal so as to be in close proximity to an eardrum of the user, the at least one transducer converting electrical energy into acoustic energy for presentation to the ear drum of the user; and
 - positioning at least one acoustic sealing member outward from the at least one transducer so as to provide an acoustic seal that substantially prevents noise originating outside of the ear canal from entering the ear canal of the user.
13. The method of claim 12 wherein positioning the at least one acoustic sealing member comprises positioning a coupling member that is attached to an outer wall of a housing that houses the transducer.

14. The method of claim 13 wherein the coupling member comprises a soft compliant material selected from the group of materials comprising a polyurethane foam; a polymer; and a silicone.

15. The method of claim 12 wherein positioning the at least one acoustic sealing member comprises attaching a handle at an end of a housing that comprises the transducer.

16. The method of claim 12 wherein positioning the at least one acoustic sealing member comprises attaching a coupling member to an outer wall of a housing that comprises the transducer and a handle at the end of the housing.

17. The method of claim 12 wherein the at least one transducer is selected from a group comprising a receiver; a conjoined receiver and microphone; and a dual receiver.

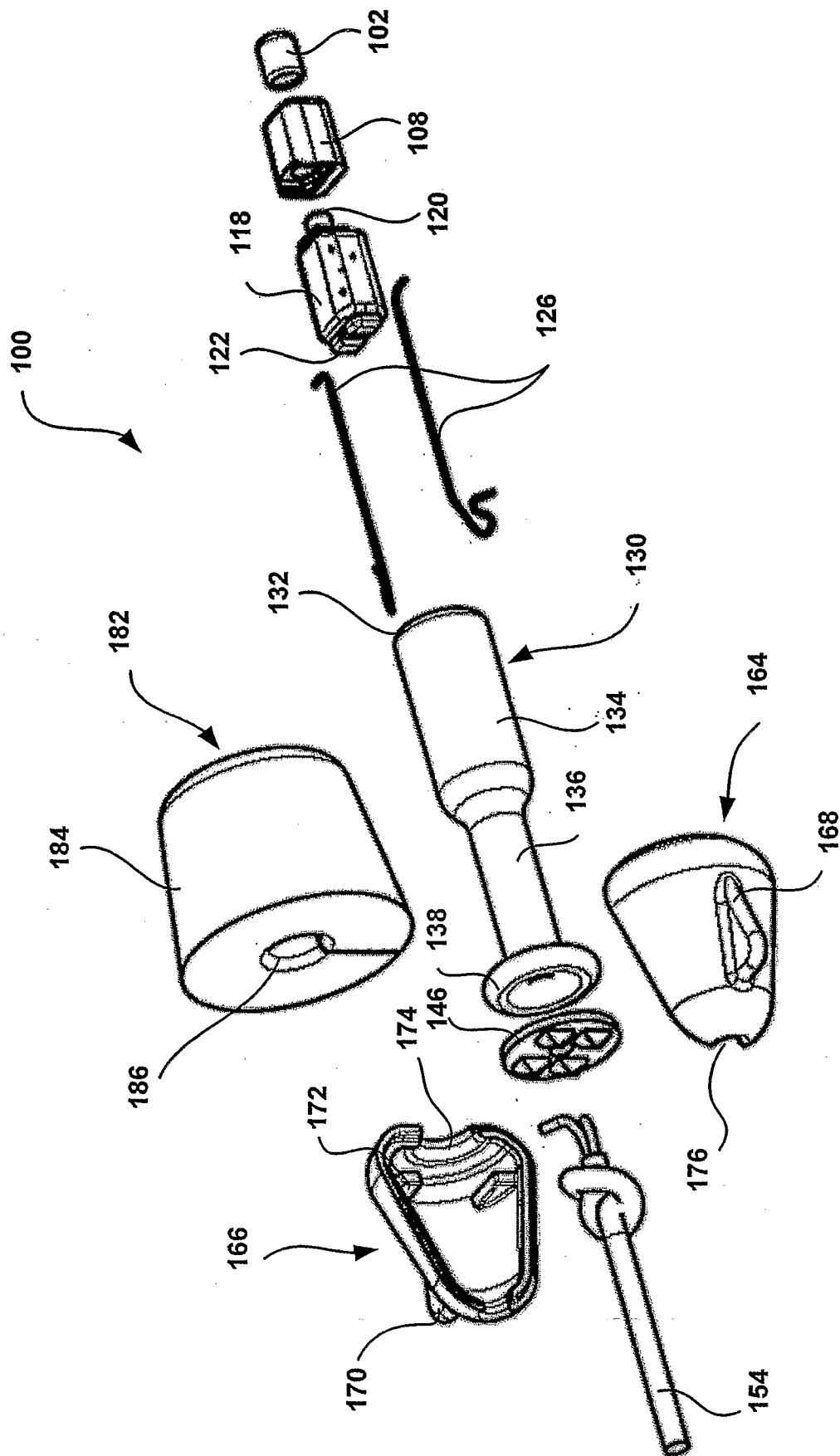


FIGURE 1

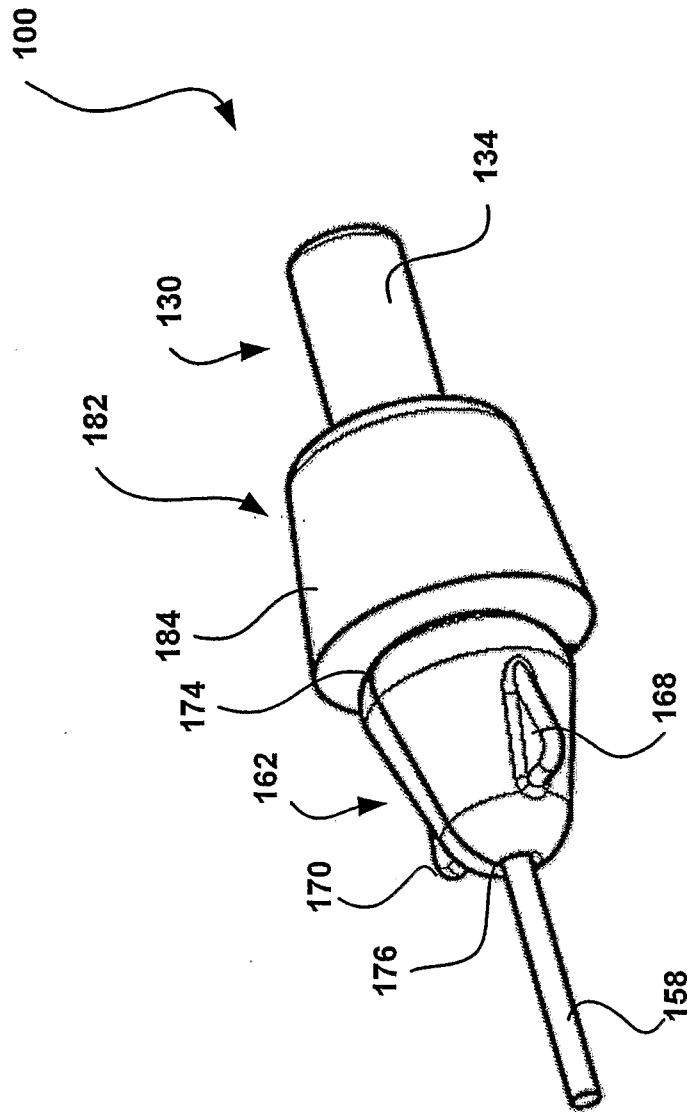


FIGURE 2

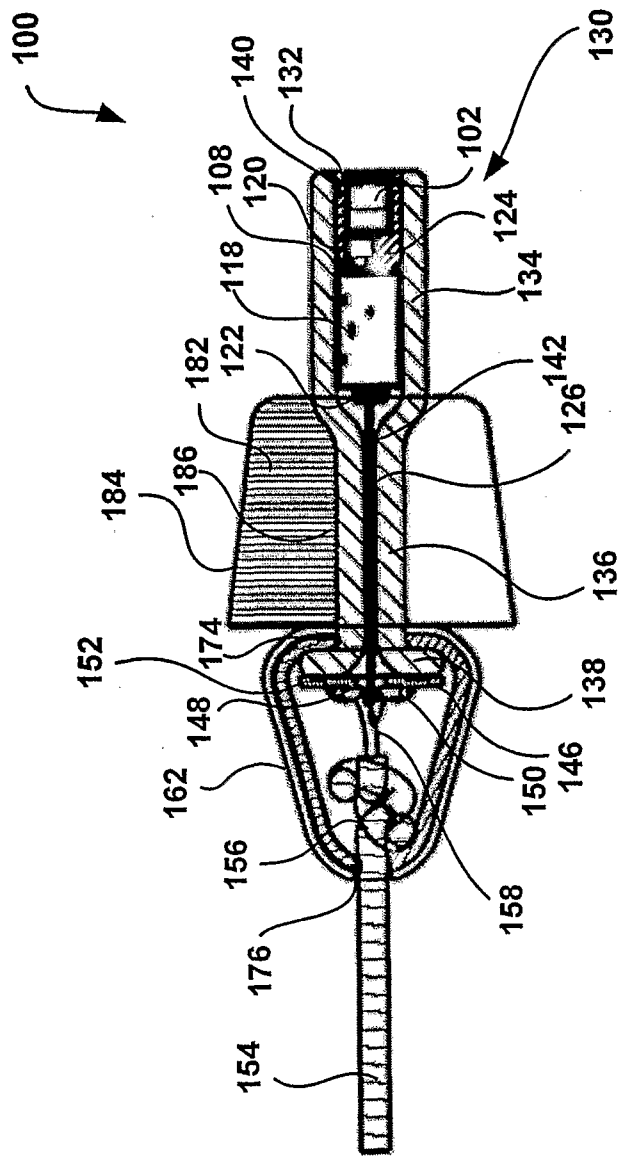


FIGURE 3

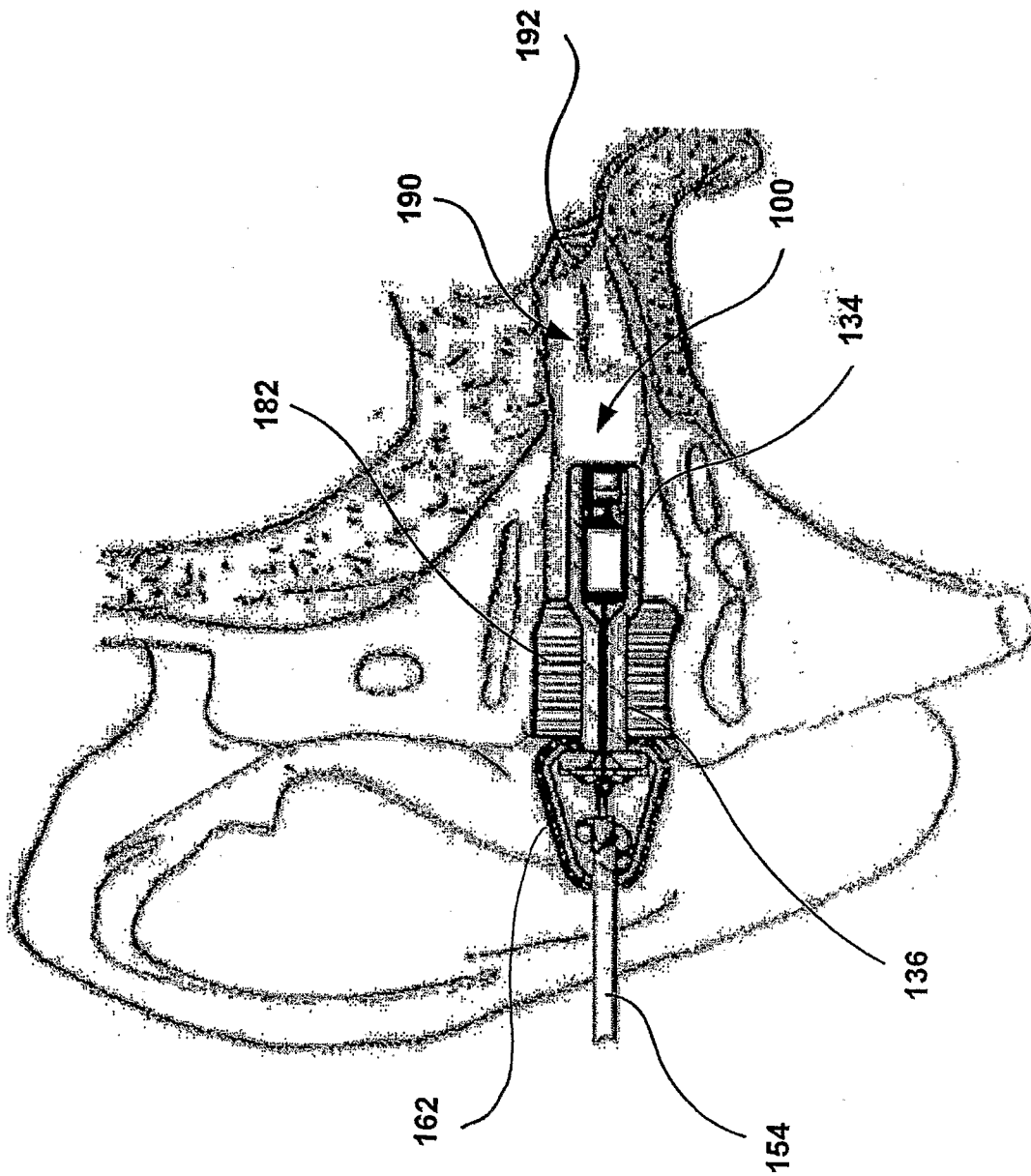


FIGURE 4

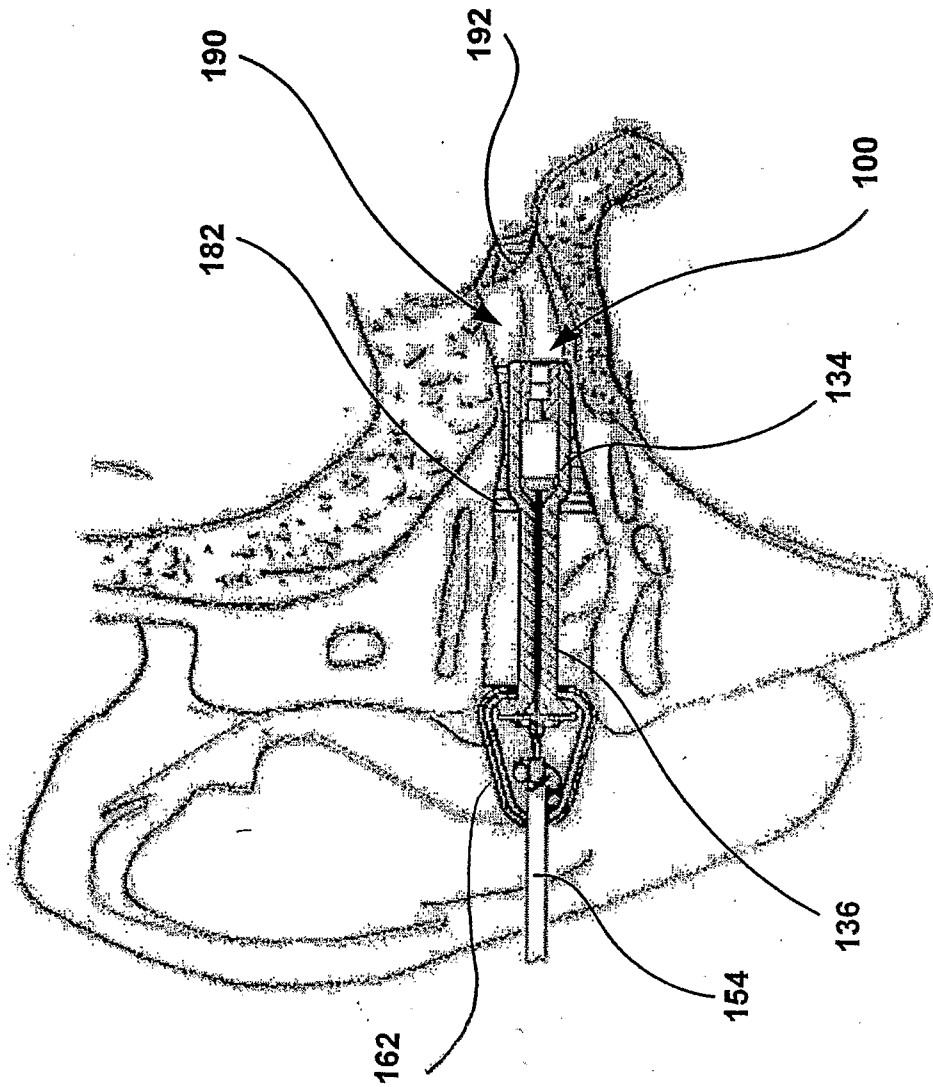


FIGURE 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US06/07835

A. CLASSIFICATION OF SUBJECT MATTER IPC: H04R 25/00 (2006.01) H04R 1/02 (2006.01), 25/00 (2006.01); A61B 7/02 (2006.01) USPC: 381/328,370,374,3801,384,395;181/129,135 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) U.S. : 381/328,370,374,380,384,395; 181/129,135 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 practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,701,348 A (SHENNIB et al.) 23 December 1997 (23.12.1997) Figures 3 and 20, column 4, lines 45-49, line 63 to column 5, line 7, column 5, line 60 to column 6, line 12, column 9, lines 61-63, column 11, lines 12-24.	1-17
☐ 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	"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
"E"	earlier application or patent published on or after the international filing date	"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
"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)	"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
"O"	document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed	
Date of the actual completion of the international search 17 October 2006 (17.10.2006)		Date of mailing of the international search report 21 NOV 2006
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201		Authorized officer Brian Ensey Telephone No. 571-272-7496 