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

(11) EP 3 011 761 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
10.04.2024 Bulletin 2024/15

(21) Application number: **14813177.4**

(22) Date of filing: **18.06.2014**

(51) International Patent Classification (IPC):
H04R 25/02 (2006.01) ***H04R 25/00*** (2006.01)
H04R 9/04 (2006.01)

(52) Cooperative Patent Classification (CPC):
H04R 25/554; H04R 25/606; H04R 25/65; H04R 25/659; H04R 2225/51; H04R 2225/67

(86) International application number:
PCT/US2014/042928

(87) International publication number:
WO 2014/205069 (24.12.2014 Gazette 2014/52)

(54) IMPROVED METHOD AND APPARATUS FOR COIL ALIGNMENT IN ELECTROMAGNETIC HEARING IMPLANT

VERBESSERTES VERFAHREN UND VORRICHTUNG ZUR SPULENAUSRICHTUNG IN EINEM ELEKTROMAGNETISCHEN HÖRIMPLANTAT

PROCÉDÉ ET APPAREIL AMÉLIORÉS POUR UN ALIGNEMENT DE BOBINE DANS UN IMPLANT AUDITIF ÉLECTROMAGNÉTIQUE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **19.06.2013 US 201361836991 P**

(43) Date of publication of application:
27.04.2016 Bulletin 2016/17

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(56) References cited:

EP-A2- 0 242 038	**EP-A2- 0 354 698**
WO-A1-00/25551	**WO-A1-00/42817**
WO-A1-2004/045245	**WO-A1-2007/000160**
WO-A1-2010/000028	**WO-A1-2010/000028**
GB-A- 2 458 225	**US-A- 5 800 336**
US-A1- 2003 161 481	**US-A1- 2007 100 197**
US-A1- 2008 063 231	**US-A1- 2008 063 231**
US-A1- 2011 144 414	**US-A1- 2011 144 414**

Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to the field of hearing. More particularly, the present invention relates to devices to improve hearing. Most particularly, the present invention relates to an improved method and apparatus for alignment of an energy or signal transmission device, such as an electromagnetic coil, and a transducer or driver, such as a magnet, in middle ear hearing systems.

BACKGROUND OF THE INVENTION

[0002] Many different reasons exist why some people have hearing impairment. As a general proposition, sound entering the outer ear canal does not get transmitted to the inner ear and/or transmitted to the auditory nerve. In many cases a middle ear device that creates vibrations is used to improve the hearing of such persons. One class of these middle ear devices are known as magnetic middle ear implant devices.

[0003] The solution to hearing problems caused by middle ear deficiencies may involve implanting a magnet in the middle ear or placing it on the eardrum and causing the magnet to vibrate in response to environmental sounds. The magnet is connected, for example, such that it provides mechanical vibrations to the oval window, either through an adequately functioning portion of the middle ear's ossicular chain to which the magnet is attached, or through an implanted prosthesis carrying the magnet and communicating with the oval window, round window, or other vibration conducting surface.

[0004] The magnet is usually caused to vibrate by placing it near to a coil of wire which is energized by the flow of electricity. Once such a coil of wire is energized by the flow of electricity, it becomes an "electromagnet" whose magnetic strength and polarity are based on the direction and strength of the electric current energizing it. If a permanent magnet is placed near this electromagnetic coil, the magnet will be attracted to, or repelled from, the coil.

[0005] However, if the implanted magnet is not optimally aligned with the external coil from which the electromagnetic signal propagates, the implanted magnet might not respond adequately. This is very important, as better patient outcomes will result with optimal magnet and coil alignment.

[0006] Even with advanced imaging technology, the final coil alignment may not end up in the optimal position. This results in reduced energy transmission to the magnet. In these cases, a new external sound processor may be made with the coil in a different position to try to achieve optimal alignment. In some cases, it may be necessary to make several external processors with different coil positions before the best coil location is finally achieved. This process of making multiple processor assemblies to arrive at the optimal alignment is expensive and requires many visits between the patient and clinician.

[0007] What is needed is a means for adjusting the position of the coil in the same device. One way to do this would be to be able to move the coil to a different position. However, the thermoset polymers which are used in ear mold shells are rigid and do not soften when heated. Consequently, they do not deform even when heat is applied and will ultimately crack if attempts are made to move the coil.

[0008] One consideration would be to make the shell out of a thermosoftening plastic, also known as a thermoplastic. Thermoplastics are polymers that become pliable or moldable above a specific temperature, and return to a solid state upon cooling. Most thermoplastics have a high molecular weight, whose chains associate through intermolecular forces; this property allows thermoplastics to be remolded because the intermolecular interactions spontaneously reform upon cooling. In this way, thermoplastics differ from thermosetting polymers, which form irreversible chemical bonds during the curing process; thermoset bonds break down upon melting and do not reform upon cooling. Examples of well-known thermoplastics are nylon (polyamide), polyethylene, polypropylene, acrylics, polystyrene, polyvinyl chloride, and Teflon. Thermoplastics are commonly used in well-known processes such as injection molding, blow molding, rotational molding, extrusion and thermoforming.

[0009] An advantage of using a thermoplastic for the shell would allow the shell material to soften when heated, which would allow for moving the coil to a new position. When the thermoplastic cools, it would once again regain a rigid state. However, the use of a thermoplastic shell is problematic for two reasons. First, even when heated, the material is very viscous and will not flow into a reverse mold without a significant amount of pressure. This would necessitate the use of much more expensive manufacturing processes to make the shell. The second problem with thermoplastics is that if the shell is heated to allow movement of the coil, then the shell itself would also be heated which would soften it and could result in deforming its shape such that it would not fit properly in the ear canal.

[0010] Because of the critical nature of the alignment, there continues to be a need in the art for a better method of aligning the magnet and coil.

[0011] Document EP 0 354 698 A2 relates to a hearing aid employing a viscoelastic material to adhere components to a casing. Document WO 00/25551 A1 provides a deformable, multi-material hearing aid housing. Further, document WO 2004/045245 A1 provides a hearing aid comprising a shaped body that is adapted to an individual auditory canal.

[0012] Document US2011/144414 A1 disclose a method of attachment for a middle ear implant, comprising the steps of: positioning a magnet in optimal alignment with an electromagnetic coil or extra-coil electromagnetic transducer; and attaching said magnet to at least a portion of an ossicle in the middle ear.

[0013] Document US5800336 A is disclosing an apparatus for improving hearing, comprising: a housing; at least one coil coupled to the housing; and a magnet within the housing, the magnet vibrating in direct response to an externally generated electrical signal through the at least one coil; whereby vibration of the magnet causes inertial vibration of the housing in order to improve hearing.

[0014] Document US2008/063231 A1 is disclosing a completely in-the-ear hearing device for a patient, the device comprising: (a) a solid polymeric hearing device body that is shaped to fit the patient's ear canal; and (b) a hearing circuit that includes a plurality of electronic hearing components, including at least transducers and a volume control forming an amplifier network, the body including a supporting interface portion comprised of soft-solid polymeric material that is of sufficient thickness to closely conform to both the ear canal and at least the amplifier network that is embedded into the body; c) wherein the body is made of a soft polymeric elastomer and the body has a Durometer Hardness, Shore A, of less than 40 points.

SUMMARY OF THE INVENTION

[0015] The present invention is defined by the appended claims and provides, inter alia, for a sound processor assembly having a coil support device which allows for the coil to be moved without damaging the plastic components or deforming the shell body. This is done by making the shell of the sound processor assembly out of two separate polymers: a first polymer that does not soften when heat is applied, and a second polymer which does. Alternatively, the first polymer may soften at a higher temperature than the second polymer. The first polymer is used for the first polymer zone of the shell which is shaped to the ear canal, while the second polymer is used for the section of the shell which supports the coil. This allows the shell to be heated thereby softening the second polymer but not the first, and allows the coil to be repositioned to a new location. Once moved, the coil 48 is held in that position until the polymer cools back to a rigid state.

[0016] The second polymer portion may be connected with the shell by means of an adhesive, an overmolding process, a mechanical process such as a plug or screw connection, or any other process typically used in securing dissimilar plastic materials.

[0017] This sound processor assembly sends electromagnetic signals which are picked up by the magnet which cause it to vibrate. Typically, the coil is located in the ear canal near the eardrum. In one embodiment, it may be an integrated part of the sound processor which resides in the ear canal. In another embodiment, the sound processor may be located behind the ear of the patient, and a connector link communicates to the coil located in the ear canal. In both cases, the coil must be held in a fixed position in the canal to communicate with the implant.

[0018] Once the magnetic implant has been attached to the ossicles in the middle ear, or on the eardrum, the external device must be made in such a way that the coil is aligned with the magnet. Ideally, the coil and the magnet should be aligned and as close together as possible. One method to do this provides for imaging the external ear canal, and then imaging the implant using imaging techniques well known in the art. Once this is done, the ear canal and implant images may be combined, and the external device may be built to fit in the ear canal with the coil being in optimal alignment with the implanted magnet.

[0019] After combining the ear canal and implant images, the coil placement may take place. Using the combined ear canal and implant model, the coil position is determined in 3D with respect to the implant axis for optimal axial alignment and distance within the ear canal space.

[0020] This may involve such steps as identifying the implant axis, locating the coil axis to the implant axis, adjusting the coil position along the axis to the optimal distance from the implant and insuring an acceptable clearance from the ear canal wall and the tympanic membrane or eardrum.

[0021] After the coil location is determined, the coil support device, which will fit in the ear canal and hold the coil in proper alignment, may be manufactured. This involves first manufacturing the in-the-canal ear mold shell which supports the coil. These may be of two types. The first type would be an integrated type having the sound processor, microphone and coil and any other electronics located within the shell.

[0022] The second type would be to have an in-the canal-mold shell with the coil. This is attached to a sound processor assembly located behind the ear, by a connecting link. The link may be a wire which transmits the electric signals from the sound processor to the electromagnetic coil. The link may also be a wireless design which transmits the signals from the processor to the coil.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The above, as well as other advantages of the present invention will become readily apparent to those skilled in the art from the following detailed description when considered in the light of the accompanying drawings in which like numerals designate corresponding parts in the several views.

Fig. 1A is an illustration of the currently available prior art standard shell with a coil.

Fig. 1B is a sectional view, taken in the direction of the arrows, along the section line 1B-1B of Fig. 1A.

Fig. 2A shows an embodiment of the present invention wherein an improved IPC type sound processor assembly has a shell which is constructed of dual plastic zones having a first polymer and a second polymer.

Fig. 2B is a sectional view, taken in the direction of the arrows, along the section line 2B-2B of Fig. 2A.

Fig. 3 shows a currently available integrated processor and coil (IPC).

Fig. 4 shows an embodiment of the present invention having an improved IPC type sound processor assembly with a first polymer and a second polymer.

Fig. 5 shows a currently available linked processor and coil (LPC)

wherein the processor is linked to the coil support device by a wire.

Fig. 6 shows an embodiment of the present invention having an improved LPC type sound processor assembly wherein the coil support device has a shell having a first polymer portion and a second polymer portion.

Fig. 7 shows a modification of the invention, similar in part to that shown in Fig. 6, but where the link is a wireless link.

Fig.8 illustrates the improved IPC type sound processor assembly of the present invention in the ear canal of a hearing aid user, and the coil activating a magnet on the ossicles of the user.

Fig. 9 is a view in large part similar to Fig. 8, but showing a magnet on the eardrum of the user.

Fig. 10 is a partially cut away view of the improved IPC type sound processor assembly of the present invention wherein the first polymer zone has an electrical socket molded therein, and the second polymer zone has an electrical plug molded therein.

Fig. 11 shows the device of Fig. 10 with the first polymer zone plugged into the second polymer zone.

Fig. 12 shows a not claimed modification of the device wherein the device shown in Fig. 9 is shown in the ear canal of the user, with a laser replacing the coil, and the laser activating a photovoltaic receptor and driver.

[0024] Throughout the drawings, like elements are referred to by like numerals.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] Referring to Figs. 1A and 1B, there is shown a currently available integrated processor and coil (IPC) sound processor assembly, generally designated by the numeral 30. The shell 37 is made entirely of a first polymer 32 which does not deform when heated, and has a coil 48 embedded therein.

[0026] Referring to Fig. 2 there is shown an embodiment of the present invention in the form of an improved IPC type sound processor assembly, generally designated by the numeral 130, and having an in the ear shell 137 having two polymer zones, a first polymer zone 132, and a second polymer zone 134, the second polymer zone acting as a coil support for the coil148.

[0027] A second type of device would involve an integrated sound processor and coil (IPC) 30 being held in the ear canal by an in-the-canal mold shell 37 with a first polymer zone only designated by the numeral 32. An example of a currently available integrated processor and coil is shown in Fig. 3.

[0028] Fig. 4 is similar to Fig. 3, but showing an embodiment of the present invention with the improved sound processor assembly 130 having a first polymer zone 132 and a second polymer zone 134. A coil 148 is embedded in in the second polymer zone 134.

[0029] A third type of prior art device is the linked processor and coil (LPC) shown in Fig. 5, where the processor 38 is contained in a behind the ear (BTE) device 40 which is connected by a link 42, such as wire 44, to IPC 37.

[0030] Another embodiment of the present invention is shown in Fig. 6. The improved sound processor assembly 300 has a shell 137 comprising a first polymer portion132 and a second polymer portion 134. The coil 148 is contained in the second polymer portion of the shell 137. A behind the ear device 138, containing the sound processor 148 is connected by a link 142, such as wire 144, to the shell 137.

[0031] A further embodiment of the present invention is shown in Fig. 7, wherein the improved sound processor assembly 400 has a behind the ear device (BTE) 140 containing the processor 138 connected by a wireless link 146 to the shell 137, which has a first polymer portion132, and a second polymer portion 134.

[0032] With reference to Fig. 8, the IPC type sound processor assembly 136 is shown placed in the ear canal 156 of the user. The coil 148 is made in the position to give optimum placement for aiming at the magnet 158 mounted to the ossicles 160 of the user of the device.

[0033] In Fig. 9, the sound processor assembly 136 is shown placed in the ear canal 156 of the user. The coil 148 is made in the position to give optimum placement for aiming at the magnet 158, which in this embodiment of the invention is placed on the eardrum 162 of the user of the device.

[0034] Referring to Figs. 10 and 11, an electrical connection socket 164 may be secured in the first polymer zone 132 of shell 137, with the second polymer zone 134 of the shell 137 having a mating electrical connection or plug 166 which can be "plugged" into the socket 164.

[0035] With reference to Fig. 12, a not claimed modification illustrated. The sound processor assembly 136 is shown in the ear canal 156. The coil 148 has been replaced with a laser 170 which is directed toward a photovoltaic cell 172 and driver 174 mounted to the eardrum of the user of the device.

[0036] As described above, all of these types of devices use an ear mold or shell 137 to fit in the ear canal 156 and support the coil 148. The ear mold shell 137 is shaped to fit exactly in the ear canal and hold the coil 148 in the predetermined design location. The manufacturing process used for making shells is similar to that used for manufacturing in-the-canal hearing aids.

[0037] One technique is to make an ear mold of the ear canal using a soft impression material. A reverse impression of this mold is then made by casting the ear mold in silicone and removing it once the silicone has hardened. The void which is left is the reverse impression of the ear mold. It is then filled with a biocompatible polymer which is liquid when poured into the mold, but becomes hard and rigid after curing in the mold. This is known as a casting process.

[0038] Two component acrylic polymers are typically used since they are flowable liquids when first mixed together, and then cure at room temperature to a rigid state. Other biocompatible polymers may be also used. Single component biocompatible polymers that cure to a rigid form at elevated temperatures or when exposed to UV light or other techniques known to those skilled in the art may also be used. These polymers fall under the class of thermosetting plastics.

[0039] A thermosetting plastic, also known as a thermoset, is a polymer material that irreversibly cures. The cure may be done through heat, through a chemical reaction (two-part epoxy, for example), or irradiation such as electron beam processing. Thermoset materials are usually liquid or malleable prior to curing and designed to be molded into their final form. Once hardened, a thermoset resin cannot be reheated and melted back to a liquid form. The curing process transforms the resin into a plastic or rubber by a cross-linking process. The cross-linking process forms a molecule with a larger molecular weight, resulting in a material with a higher melting point. Uncontrolled reheating of the material results in reaching the decomposition temperature before the melting point is obtained. Therefore, a thermoset material cannot be melted and re-shaped after it is cured. Common thermosets include epoxies, polyesters, and vinylesters.

[0040] The result of this cast process is a rigid mold of the ear canal which is then used to make the in the ear shell 137. Since the cast mold is solid, material must be removed from it to create space for the electronics, coil and other desirable features such as vents. Because of the removal of material from the cast mold, this is known as a subtractive manufacturing process. The center of the mold is drilled or machined out to form a cavity which will house the electronics. This is now a shell. In addition, a hole is drilled in the shell which will hold the coil 148 in the desired location. The coil is inserted and secured in this hole. The shell137 is then ground, polished and shaped to a smooth finish to fit comfortably in the patient's ear canal. If optimum alignment is not achieved, the second polymer portion 134 will be heated and moved, thereby moving the coil 148, until optimum alignment is achieved.

[0041] In one form, the coil 148 is connected to the external sound processor assembly by a connecting link142, such as wire 144 or wireless link146. In another embodiment, a faceplate 150 which has a microphone 152, switch154, processor 138, and other electronic components attached to it, is connected to the coil 148 and then mated to the shell 137, typically by adhesive, to form the finished sound processor assembly (See Fig. 4).

[0042] A more modern technique to manufacture the shells is the use of stereolithography (SLA). Stereolithography is an additive manufacturing process. Additive manufacturing takes virtual blueprints from computer aided design (CAD) and "slices" them into digital cross-sections for the machine to successively use as a guideline for printing. Photopolymerization is primarily used in SLA to produce a solid part from a liquid. A vat of liquid photopolymer is exposed to light from an appropriate light source (i.e. DLP projector, ultraviolet laser). The exposed liquid polymer hardens. The build plate then moves down in small increments and the liquid polymer is again exposed to light. The process repeats until the model has been built. The liquid polymer is then drained from the vat, leaving the solid model. The EnvisionTec Ultra is an example of a DLP rapid prototyping system. The SLA process is well known and is used widely in rapid prototyping and low volume production, in addition to tooling applications and post-production customization.

[0043] In the SLA process, the earmold impression is digitally scanned and with the use of CAD programs and 3D printers which are well known in SLA manufacturing, a custom, rigid shell is produced of a biocompatible photopolymer. These are typically thermoset polymers which are built layer by layer such that only the material that is desired is in the final shell. This has the advantage of leaving the internal cavity open for electronics, creating desired vents and features, and producing the cylindrical hole for supporting the coil in its desired position. It also reduces manufacturing time and costs.

[0044] Methods for heating the coil support device to bend the second polymer zone 134 (if needed) include methods well known for softening thermoplastics such as heating device with hot air blower, heating device in an oven, placing the device in a heated bed of granules, heating device in a heated liquid, as well as other commonly used methods. The temperature should be selected such that the second polymer will soften and allow the coil to be moved, while the first polymer is not affected. Methods of manufacturing the coil supporting device include plastic injection molding, machining thermoplastic material, casting thermoplastic materials into a mold, and other processes typically used for shaping/molding plastics. Methods of assembling the transceiver coil or other components to the coil supporting device include insert plastic injection molding, gluing, ultrasonic welding, friction welding, solvent bonding, and other processes typically used for the assembly of small components to plastic.

[0045] Thus, by carefully studying the problems present in the field of magnetic ear devices, we have developed a new and novel method of magnet and coil alignment.

Claims

1. A sound processor assembly (300) with an electromagnetic coil (148) with an adjustable orientation adapted for an electromagnetic hearing implant comprising:

a) a rigid shell (137) made from a first polymer (132) which is formed to the shape of an ear canal (156) of an intended user to support the sound processor assembly and which is not deformed when heated to a temperature which softens and deforms a second polymer;
b) a coil support material made from the second polymer which will deform when heated and is rigid at room temperature, the coil support material defining a second polymer portion (134) connected to the rigid shell (137); and
c) the electromagnetic coil (148) which is supported by and contained within the second polymer portion (134).

2. A sound processor assembly according to claim 1 where the electromagnetic coil is configured to be located in the ear canal (156) and configured to be attached to a sound processor (138) by a link (142).

3. A sound processor assembly according to claim 2 wherein the link (142) is a wire (144).

4. A sound processor assembly according to claim 2 wherein the link (146) is wireless.

5. A sound processor assembly according to claim 1 where the shell (137) contains the electronics for the sound processor.

6. A method of manufacturing a sound processor assembly (300) comprising the steps of:

a) manufacturing a rigid shell (137) from a first polymer (132) which conforms to the shape of the ear canal (156) of an intended user of the sound processor assembly (300), and which is not deformed when heated to a temperature which softens and deforms a second polymer;
b) manufacturing an transmission device support from the second polymer which defines a second polymer portion, does deform when heated and is rigid at room temperature, wherein an electromagnetic transmission device (148, 170) is supported by and contained within the second polymer portion (134);
wherein the shell (137) and the electromagnetic transmission device support are manufactured as a single unit or
wherein the shell (137) and the electromagnetic transmission device support are manufactured as two separate units and joined together.

Patentansprüche

1. Klangprozessoranordnung (300) mit einer elektromagnetischen Spule (148) mit einer einstellbaren Ausrichtung, die für ein elektromagnetisches Hörimplantat geeignet ist, umfassend:

a) ein starres Gehäuse (137), das aus einem ersten Polymer (132) hergestellt ist, das an die Form eines Gehörgangs (156) eines vorgesehenen Benutzers angepasst ist, um die Klangprozessoranordnung zu tragen, und das nicht verformt wird, wenn es auf eine Temperatur erhitzt wird, die ein zweites Polymer erweicht und verformt;
b) ein Spulenträgermaterial hergestellt aus dem zweiten Polymer, das sich bei Erwärmung verformt und bei Raumtemperatur starr ist, wobei das Spulenträgermaterial einen zweiten Polymerabschnitt (134) definiert, der mit dem starren Gehäuse (137) verbunden ist; und
c) die elektromagnetische Spule (148), die von dem zweiten Polymerabschnitt (134) getragen wird und darin enthalten ist.

2. Klangprozessoranordnung nach Anspruch 1, wobei die elektromagnetische Spule dazu konfiguriert ist, im Gehörgang (156) angeordnet zu sein und dazu konfiguriert ist, über eine Verbindung (142) an einem Klangprozessor (138) angebracht zu sein.

3. Klangprozessoranordnung nach Anspruch 2, wobei die Verbindung (142) ein Draht (144) ist.

4. Klangprozessoranordnung nach Anspruch 2, wobei die Verbindung (146) drahtlos ist.

5. Klangprozessoranordnung nach Anspruch 1, wobei das Gehäuse (137) die Elektronik für den Klangprozessor enthält.

6. Verfahren zur Herstellung einer Klangprozessoranordnung (300), das die folgenden Schritte umfasst:

a) Herstellen eines starren Gehäuses (137) aus einem ersten Polymer (132), das sich an die Form eines Gehörgangs (156) eines vorgesehenen Benutzers der Klangprozessoranordnung (300) anpasst, und das nicht verformt wird, wenn es auf eine Temperatur erhitzt wird, die ein zweites Polymer erweicht und verformt;
b) Herstellen eines Trägers für eine elektromagnetische Übertragungsvorrichtung aus dem zweiten Polymer, der einen zweiten Polymerabschnitt definiert, sich bei Erwärmung verformt

und bei Raumtemperatur starr ist, wobei eine elektromagnetische Übertragungsvorrichtung (148, 170) von dem zweiten Polymerabschnitt (134) getragen wird und darin enthalten ist;
wobei das Gehäuse (137) und der Träger der elektromagnetischen Übertragungsvorrichtung als eine einzige Einheit hergestellt sind oder
wobei das Gehäuse (137) und der Träger der Übertragungsvorrichtung als zwei separate Einheiten hergestellt und miteinander verbunden werden.

Revendications

1. Ensemble de processeur de son (300) muni d'une bobine électromagnétique (148) présentant une orientation réglable adaptée pour un implant auditif électromagnétique, comprenant :

a) une coque rigide (137) réalisée à partir d'un premier polymère (132), laquelle est formée selon la forme d'un conduit auditif (156) d'un utilisateur envisagé pour porter l'ensemble de processeur de son, et laquelle n'est pas déformée lorsqu'elle est chauffée jusqu'à une température qui ramollit et déforme un second polymère ;
b) un matériau de support de bobine réalisé à partir du second polymère, lequel est déformé lorsqu'il est chauffé et est rigide à température ambiante, le matériau de support de bobine définissant une partie en second polymère (134) qui est connectée à la coque rigide (137) ; et
c) la bobine électromagnétique (148) qui est supportée par la partie en second polymère (134) et qui est contenue à l'intérieur de celle-ci.

2. Ensemble de processeur de son selon la revendication 1, dans lequel la bobine électromagnétique est configurée pour être localisée à l'intérieur du conduit auditif (156) et est configurée pour être liée à un processeur de son (138) par une liaison (142).

3. Ensemble de processeur de son selon la revendication 2, dans lequel la liaison (142) est un fil (144).

4. Ensemble de processeur de son selon la revendication 2, dans lequel la liaison (146) est sans fil.

5. Ensemble de processeur de son selon la revendication 1, dans lequel la coque (137) contient de l'électronique pour le processeur de son.

6. Procédé de fabrication d'un ensemble de processeur de son (300) comprenant les étapes suivantes :

a) la fabrication d'une coque rigide (137) à partir d'un premier polymère (132), laquelle est conforme à la forme du conduit auditif (156) d'un utilisateur envisagé de l'ensemble de processeur de son (300), et laquelle n'est pas déformée lorsqu'elle est chauffée jusqu'à une température qui ramollit et déforme un second polymère ; et
b) la fabrication d'un support de dispositif de transmission électromagnétique à partir du second polymère, lequel définit une partie en second polymère, est déformé lorsqu'il est chauffé et est rigide à température ambiante, dans lequel un dispositif de transmission électromagnétique (148, 170) est supporté par la partie en second polymère (134) et est contenu à l'intérieur de celle-ci ;
dans lequel la coque (137) et le support du dispositif de transmission électromagnétique sont fabriqués en une seule unité ou
dans lequel la coque (137) et le support du dispositif de transmission sont fabriqués comme deux unités séparées et assemblées.

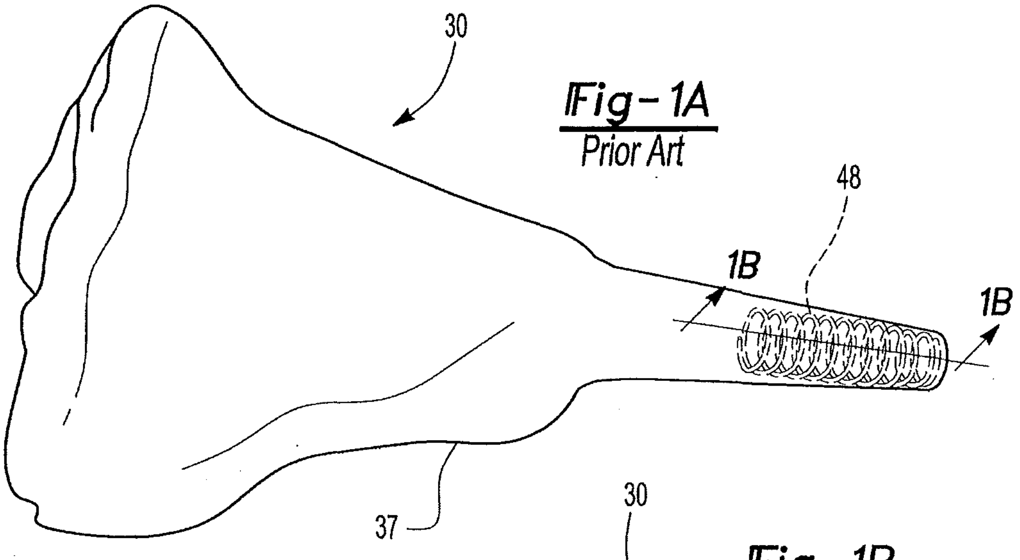


Fig-1A
Prior Art

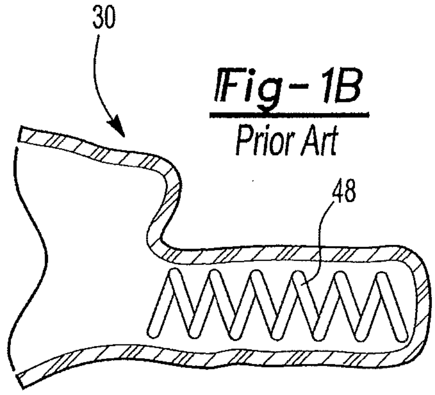
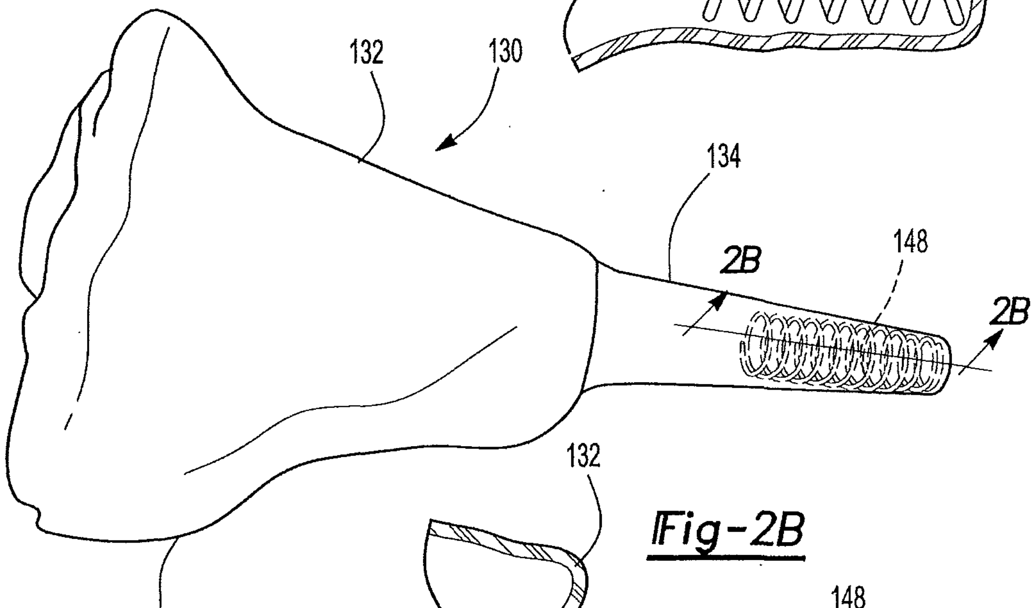


Fig-1B
Prior Art

Fig-2A



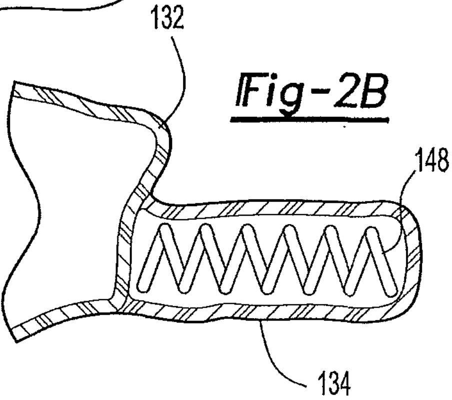


Fig-2B

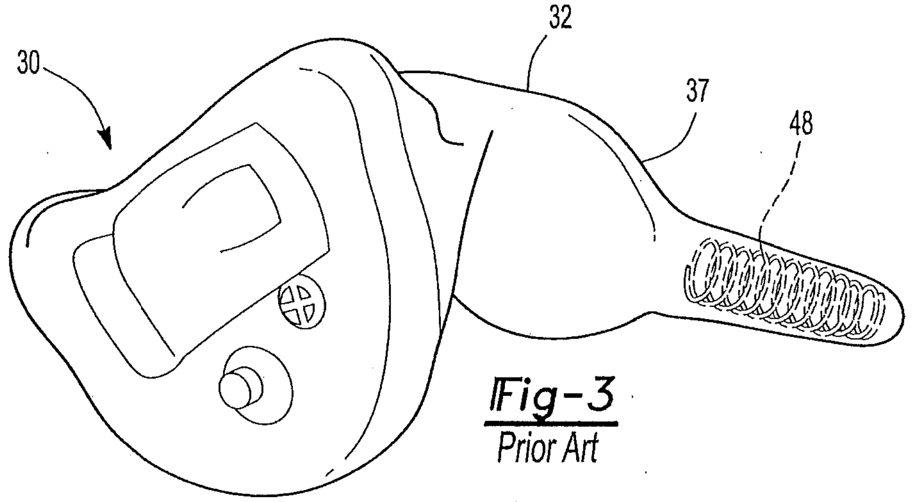


Fig-3
Prior Art

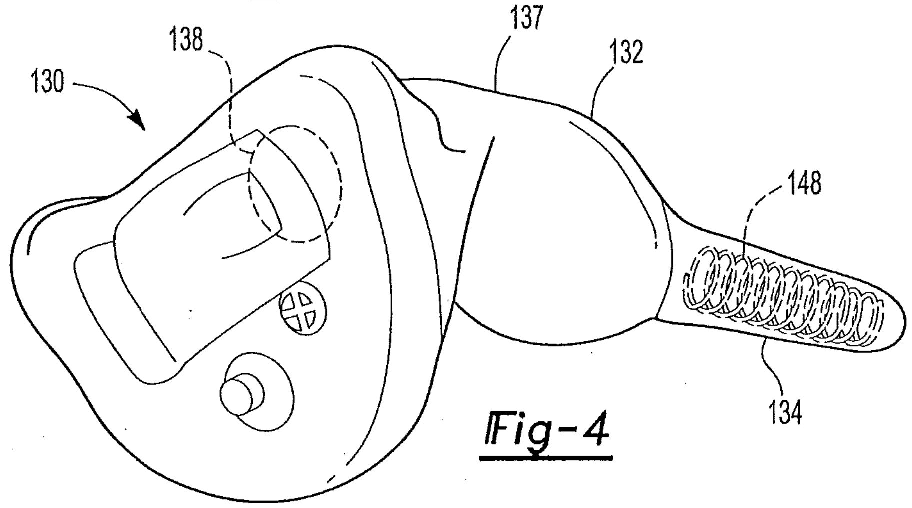


Fig-4

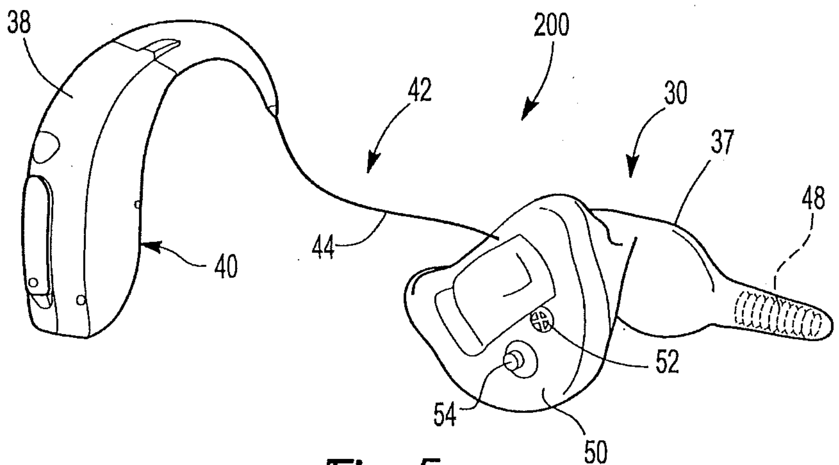


Fig-5
Prior Art

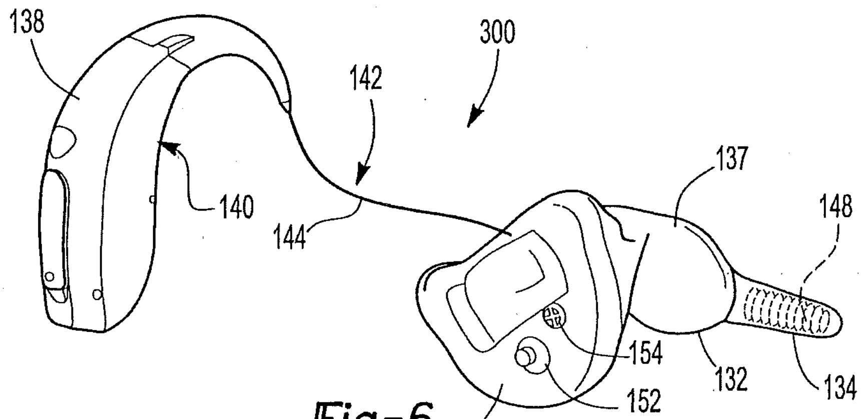


Fig-6

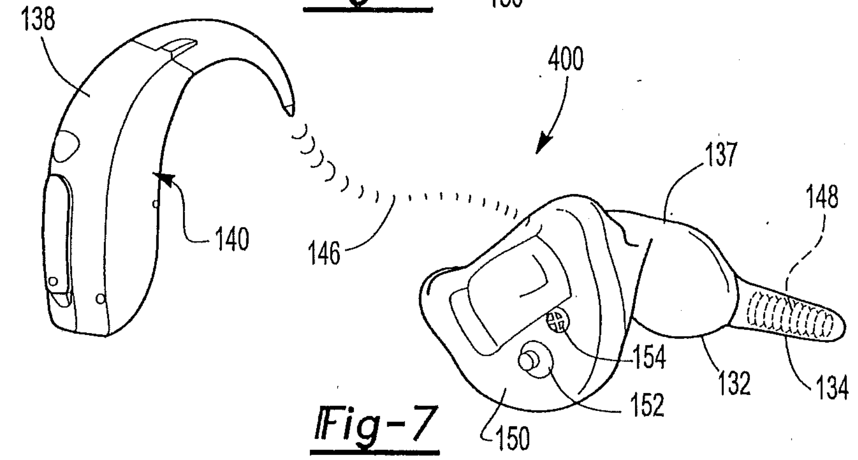


Fig-7

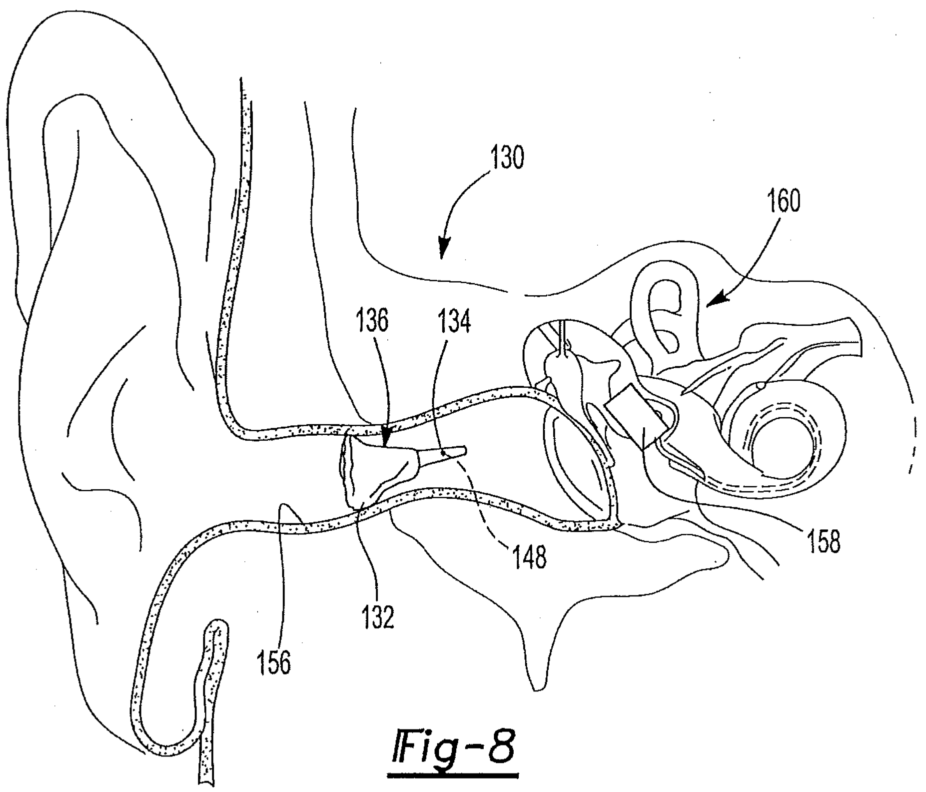


Fig-8

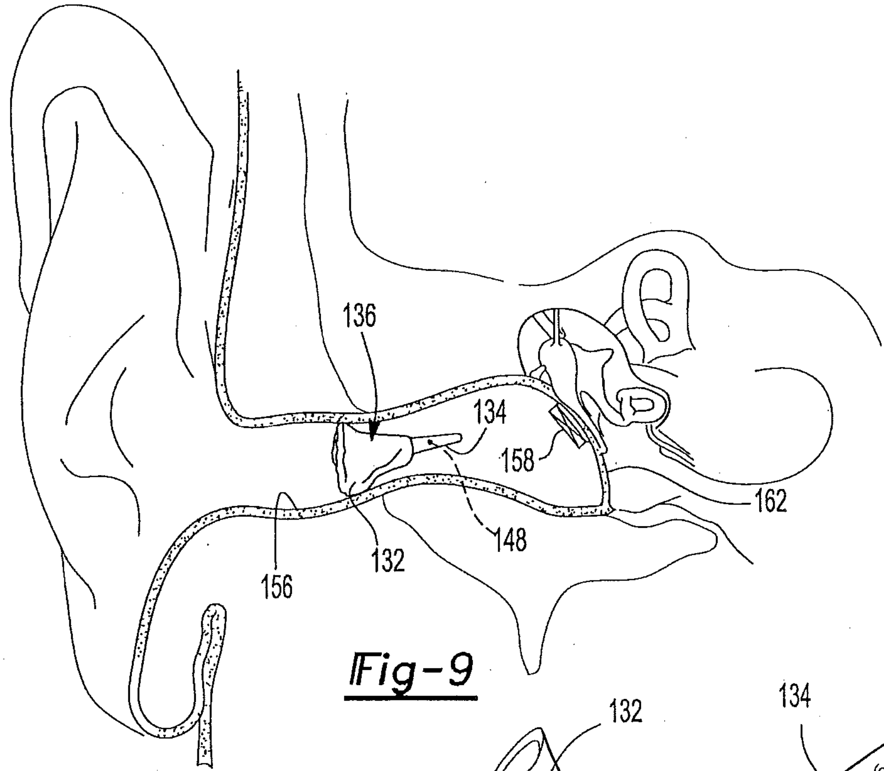


Fig-9

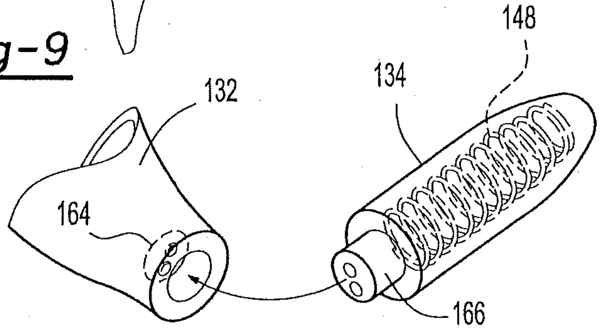


Fig-10

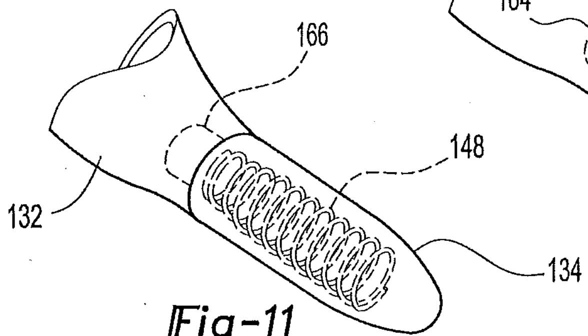


Fig-11

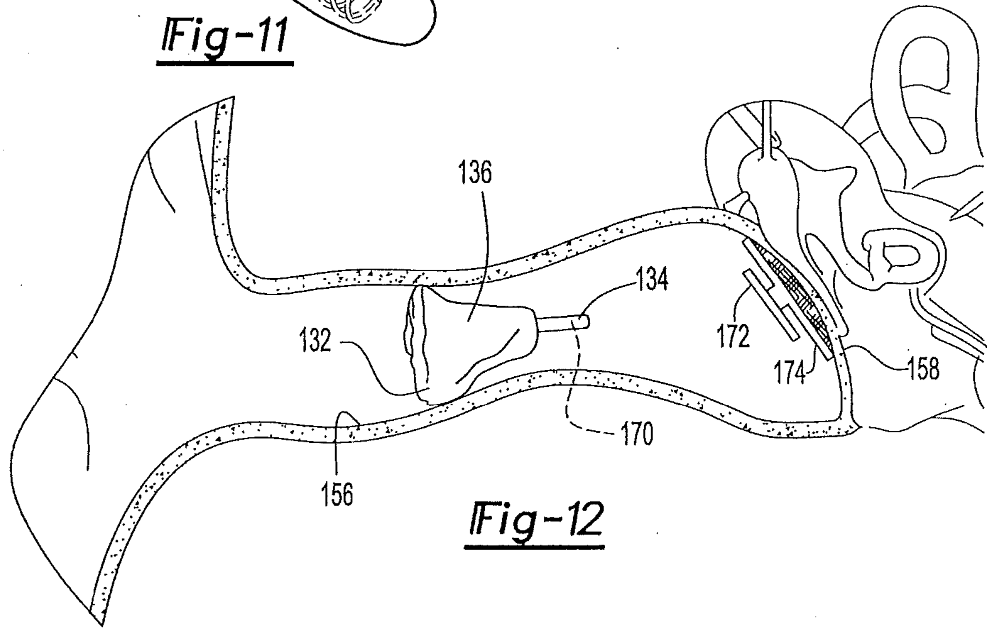


Fig-12

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0354698 A2 **[0011]**
- WO 0025551 A1 **[0011]**
- WO 2004045245 A1 **[0011]**
- US 2011144414 A1 **[0012]**
- US 5800336 A **[0013]**
- US 2008063231 A1 **[0014]**