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(54) Benævnelse: **Akustisk transmissionsfremgangsmåde og lytteanordning**

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DESCRIPTION

TECHNICAL FIELD

[0001] The application relates to an acoustic transmission method and a listening device.

BACKGROUND

[0002] It is known to provide vibrations to the skull bone directly or indirectly in order to exitate the cochlear whereby this excitation may be perceived as sound. This is done to provide a sensation of hearing to people who has a functioning cochlear, but have damaged or deformed ear structures.

[0003] It is known to provide hearing to these patients by attaching a magnetic means to the skull bone surface under the skin, and then excite the magnetic means with a magnetic field corresponding to a sound signal. Also a magnet provided subcutaneous may serve as an attachment point for a conventional vibrator which will be sitting exteriorly on the skin, attached thereto by the subcutaneous magnet. In both these instances, the skin between magnet and the exterior part may be subject to compression forces, and this may hamper blood circulation in this skin layer and serious negative effects such as irritation and necrosis may result from this.

[0004] Yet a further prior art example is to attach a vibrational transducer subcutaneously to the skull bone or cochlear and to energize the transducer by means of an electromagnetic signal provided by an externally mounted apparatus. In this kind of apparatus, a transcutaneous transmission of both energy and signal is necessary from the device on the outside to the transducer placed at the cochlear or under the skin, and a coil or similar device is needed to receive the energy and information signal.

[0005] In a prior art device disclosed in US patent 5,176,620 the transducer is provided under the skin behind the ear, and an acoustic wave guide is provided between the transducer and the cochlea. In this way, the skull bone is not used as transmission path, and the transducer may be made smaller and may consume less energy in order to vibrationally excite the cochlea. However, in this prior art device the power signal is still to be transmitted through the skin as an electromagnetic signal, and a complicated transducer with a multitude of electronic components must be provided in or at the skull bone.

[0006] Document DE102006026288 discloses a listening device having a magnetically operated compression parts including a subcutaneous part and a device part, and where further a vibrator is provided and adapted to vibrationally energize a skin portion through an output coupler, wherein the magnetic compression parts ensures compression between the

output coupler and the skin portion.

SUMMARY

[0007] A listening device is provided which has an ear hook adapted for carrying the device behind the ear of a user. The listening device has magnetically operated compression parts including subcutaneous parts and device parts, where further a vibrator is provided as part of the listening device and adapted to vibrationally energize a skin portion through an output coupler, wherein the ear hook carries the weight of the listening device and the magnetic compression parts ensures compression between the output coupler and the skin portion.

[0008] Instead of having strong magnets to hold the hearing aid system in place as is known in the prior art the proposed invention uses a hook around and above the ear to hold the hearing aid system in place. The hook is similar to hooks used in usual hearing aid systems for delivering a sound signal into the ear canal of the user. A system of magnetically operated parts are provided to compress the skin in order to make a good vibration transfer through the skin, but this new magnet system will need to generate a much smaller magnetic force than the magnet systems of prior art devices which needs to both carry the weight of a vibrator and ensure sufficient compression of the skin portion which is to receive the vibrations. Therefore skin irritation and the possible risk of necrosis can be avoided with the new system.

[0009] Because the magnet system can be made much weaker, due to the absence of a need for holding or carrying forces, the pressure on the skin will be smaller and therefore a relatively large area is not needed to distribute the holding force over the skin. The skin area, under which a magnetic device is present, can be made smaller and the risk of feedback will also be reduced. A system with a capsulated magnet that is just positioned in a small drilled recess in the skull bone is proposed. This implant is easy to surgically put in place without need for special surgical instrumentation. The implant can be removed easily in case a MRI scan of the user is needed.

[0010] It is further proposed to screw the capsulated magnets into the skull bone with osseointegration between threads of a capsulated magnet and skull bone.

[0011] The placement of the hearing aid closer to the ear canal also puts it closer to the cochlea with larger sensitivity as a result. This is possible because of the hook used for carrying the heavy vibrator and other parts of the hearing aid.

[0012] The hook also makes it possible to position the microphones in the hook as is known from a traditional BTE hearing aid. This facilitates a more favorable position of the hearing aid microphone as placement thereof in front of the ear of the user helps in generating a more natural directionality and sound, than what can be obtained with the traditional bone anchored hearing aid systems where the entire apparatus is mounted on the head behind the ear, and further to the back of the head..

[0013] It is intended that the structural features of the device described above, in the 'detailed description of embodiemnts' and in the claims can be combined with the method, when appropriately substituted by a corresponding process and vice versa. Embodiments of the method have the same advantages as the corresponding devices.

[0014] Further objects of the application are achieved by the embodiments defined in the dependent claims and in the detailed description of the invention.

[0015] As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well (i.e. to have the meaning "at least one"), unless expressly stated otherwise. It will be further understood that the terms "includes," "comprises," "including," and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. It will also be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present, unless expressly stated otherwise. Furthermore, "connected" or "coupled" as used herein may include wirelessly connected or coupled. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless expressly stated otherwise.

BRIEF DESCRIPTION OF DRAWINGS

[0016] The disclosure will be explained more fully below in connection with a preferred embodiment and with reference to the drawings in which:

Fig. 1 shows a schematic hearing aid according,

Fig. 2 shows the hearing aid of fig. 1 seen in a sideview,

Fig. 3 is a schematic drawing of a hearing aid according to the invention.

[0017] The figures are schematic and simplified for clarity, and they just show details which are essential to the understanding of the disclosure, while other details are left out. Throughout, the same reference numerals are used for identical or corresponding parts.

[0018] Further scope of applicability of the present disclosure will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the disclosure, are given by way of illustration only. Other embodiments may become apparent to those skilled

in the art from the following detailed description.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] In the following examples, the listening device is provided in the shape of a hearing aid adapted to be worn by individuals with reduced hearing. Other listening or communication devices such as headsets or radio communication devices may however also benefit from the general idea of the invention.

[0020] The listening device 1 in fig. 1 includes an ear hook 11 and magnetically operated compression parts 12,13 with a subcutaneous compression part 13 and a device compression part 12 forming part of the listening device 1. The two compression parts 12,13 are arranged to provide an attraction force between each other, when they are close to each other, such as by the one part being a permanent magnet and the other part an iron part, or by both parts including permanent magnet elements. The compression parts 12,13 may be titanium encapsulated samarium cobalt magnets. The compression part 13 provided subcutaneous may be fastened to the skull bone 2 underneath the skin 3 by suitable means such one or more screws, by suture or it may be provided in a recess formed in the skull bone for this purpose as is known in the art. The skull bone recess may also be threaded to allow the compression part to be screwed into the bone without the use of additional parts such as loose screws. Further, a vibrator 9 is provided and adapted to vibrationally energize a skin portion 15 through an output coupler 8. The output coupler 8 and the vibrator 9 are well known elements in bone conduction hearing aids and are thus not described in much further detail. The vibrator 9 is suspended from springs 18, and a further spring 19 is provided maintaining a distance between the vibrator 9 and the output coupler 8 as is known in the art. The output coupler 8 is coupled at its output end to the magnetic means 12 which serves to attract the subcutaneous magnetic part 13, when the hearing aid is set on the ear 20. The hearing aid 1 further includes a hook 11, which in use hooks over the top part of the connection between outer ear 20 and the side of the users head. In this way the hook 11 carries the weight of the listening device and the magnetic compression parts 12,13 ensures compression between the output coupler 8 and the said skin portion 15.

[0021] The output coupler 8 and the compression part 12 in the listening device 1 may be provided adjacent to each other, or as shown on top of each other. There are however many other ways of arranging these parts, and a further option is to integrate the compression part 12 into the output coupler.

[0022] The subcutaneous magnetic compression part 13 may cover an area which is larger than the area covered by the compression part 12 of the listening device. The area in question is best measured as the projection of the area of the compression parts onto a plane P between the two compression parts 12,13 whereby the plane P is oriented to extend perpendicular to the magnetic field lines between the respective compression parts 12,13 when the listening device is placed to operate on an individual.

[0023] In fig. 3 a different example of the hearing aid is shown, wherein the distance between the skin surface 17 and the compression part 12 within the listening device 1 is adjustable. This is possible in that the compression part 12 is a threaded cylindrical part mounted within a threaded house 14. By turning the compression part 12 it will move towards or away from the subcutaneus compression part 13 and skin surface 17, and the compression forces acting on the skin 15 below the output coupler 8 will become smaller or larger accordingly.

[0024] In the embodiment shown in fig. 3 also the output coupler 8 is connected to an adapter 7. The adapter has a shape matching the skin and underlying bone at this particular point of the users head, such that deformities or a singular shaped skull of the user at this place may be taken into account.

[0025] The listening device includes as seen in fig. 2 and 3 a battery 4, a signal processor 5 and a microphone 6, and as is usual in the art these components are interconnected by suitable electric leads. An array of microphones may be included in the device, and also wireless capability allowing the device to obtain audio signals from a remote point is possible. Further, a direct audio input or DAI connection may be part of the device.

[0026] As seen in fig. 2 the output coupler 8 is provided a distance D from the ear canal 21 behind the ear of the user. It is attempted to keep this distance below 30mm and preferably below 25mm and most preferably below 20mm. By keeping this distance small, the vibrations shall travel a shorter route from the adapter 7 and to the cochlear of the user where the vibrations will be perceived as sound.

[0027] The invention is defined by the features of the independent claim(s). Preferred embodiments are defined in the dependent claims. Any reference numerals in the claims are intended to be non-limiting for their scope.

[0028] Some preferred embodiments have been shown in the foregoing, but it should be stressed that the invention is not limited to these, but may be embodied in other ways within the subject-matter defined in the following claims.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US5176620A **[0005]**
- DE102006026288 **[0006]**

Patentkrav

1. Lytteanordning (1), der har en ørekrog (11), som er indrettet til at bære anordningen (1) bag øret (20) af en bruger, og magnetisk betjente kompressionsdele (13,12), der indbefatter en subkutan kompressionsdel (13) og en anordningskompressionsdel (12), og hvor en vibrator (9) yderligere er tilvejebragt og indrettet til ved vibration at aktivere en huddel (15,16) ved hjælp af en udgangskobling (8), hvor ørekrogen (11) er indrettet til at bære vægten af lytteanordningen (1), og den magnetiske kompressionsdel (13,12) sikrer kompression mellem udgangskoblingen (8) og huddelen (15, 16), kendetegnet ved, at lytteanordningen omfatter et middel, der er indrettet til at indstille en afstand mellem hudoverfladen (17) over den subkutane kompressionsdel (13) og anordningskompressionsdelen (12).

2. Lytteanordning ifølge krav 1, kendetegnet ved, at udgangskoblingen (8) og kompressionsdelen (12,13) i lytteanordningen (1) er konfigureret til at være tilvejebragt ved siden af hinanden.

3. Lytteanordning ifølge krav 1, kendetegnet ved, at anordningskompressionsdelen (12) indeni lytteanordningen er tilvejebragt som del af udgangskoblingen (8).

4. Lytteanordning ifølge krav 2 eller krav 3, kendetegnet ved, at den subkutane magnetiske kompressionsdel (13) dækker et område, der er større end området, der dækkes af kompressionsdelen (12) indeni lytteanordningen (1), hvor områderne måles i et plan (P) mellem de to kompressionsdele (12,13), og planet (P) er orienteret til at strække sig vinkelret på magnetfeltlinjerne mellem de respektive kompressionsdele (12,13), når lytteanordningen er placeret til at blive anvendt af et menneske.

5. Lytteanordning ifølge krav 4, kendetegnet ved, at lytteanordningen yderligere omfatter et batteri, en signalprocessor og en mikrofon.

6. Lytteanordning ifølge krav 5, kendetegnet ved, at udgangskoblingen er konfigureret til at være tilvejebragt ved en afstand, der er mindre end 30 mm fra øregangen (21) i et område bag det ydre øre, når lytteanordningen er arrangeret til at fungere ved øret af en bruger.

7. Lytteanordning ifølge hvilke som helst af de foregående krav, hvor lytteanordningen er et knogleledende høreapparat.

8. Akustisk transmissionsfremgangsmåde, der indbefatter

a. ophænge en vibrator (9) fra et ydre øre af en bruger ved hjælp af en ørekrog, hvor vibratoren (9) er indrettet til at tilvejebringe et vibrationssignal til en huddel (15),

b. generere tiltrækningskræfter mellem magnetisk betjente kompressionsdele, der omfatter en subkutan kompressionsdel og en ekstern kompressionsdel (12,13),

c. udsætte huddelen (15), der tilgrænser øregangen (21), for kompressionskræfter, som er genereret af kompressionsdelene,

d. transmittere vibrationssignalet fra den ophængte vibrator (9) ind i huddelen (15) og ind i kranieknoglen (2) under denne huddel (15), og

e. indstille en afstand mellem hudoverfladen (16) og den eksterne kompressionsdel (12).

9. Akustisk transmissionsfremgangsmåde ifølge krav 8, hvor lyd opfanges af en mikrofon (6), der bliver forstærket af en signalbehandlingsanordning (5), og tilvejebringes ved vibratoren (9) og omdannes til mekaniske vibrationer af vibratoren (9).

DRAWINGS

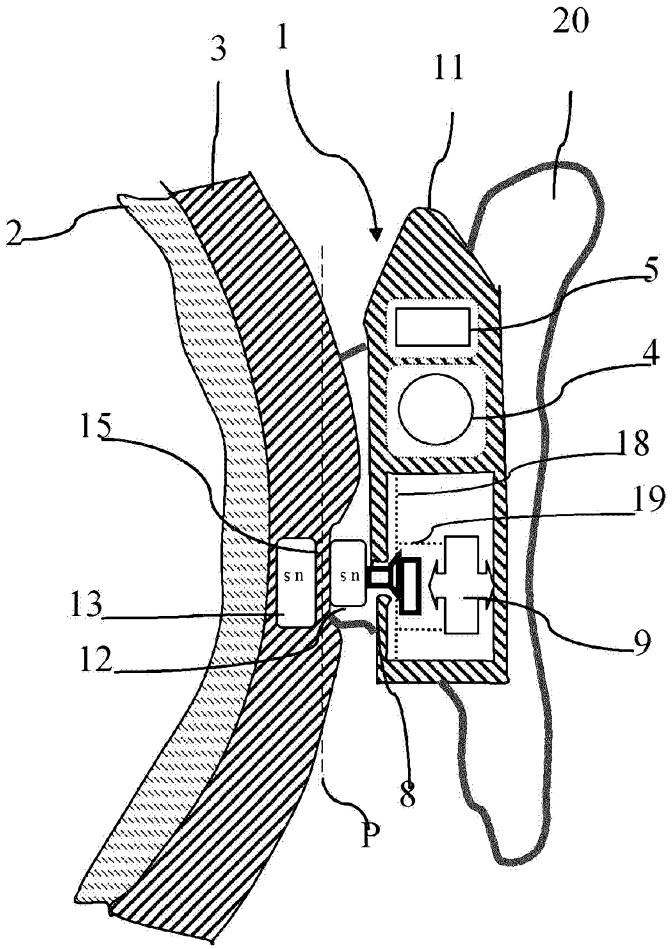


Fig. 1.

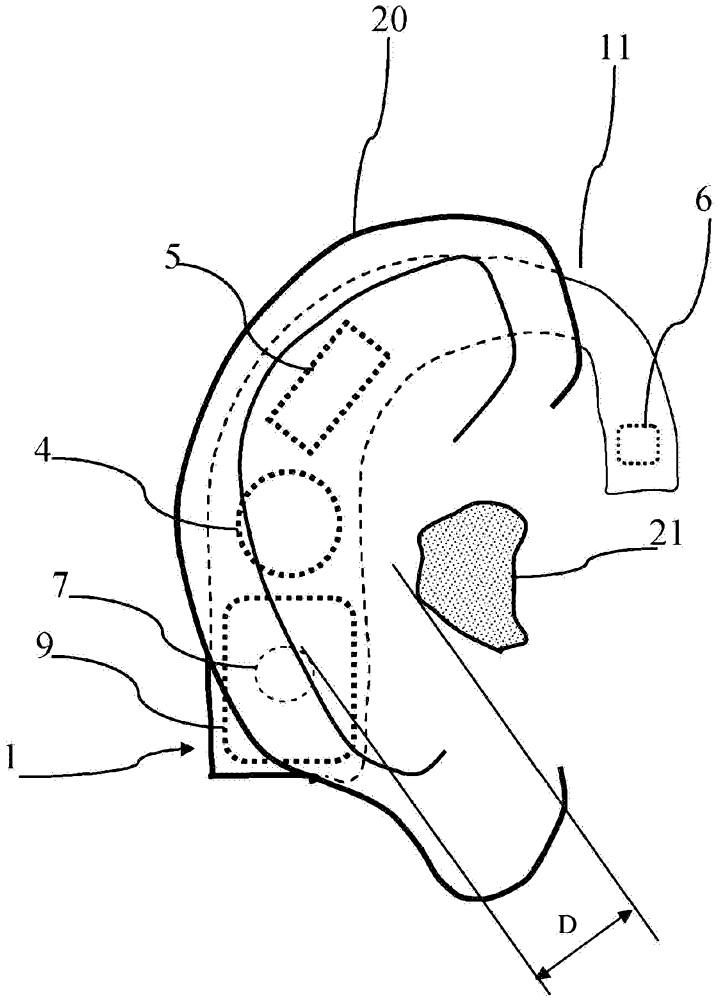


Fig. 2

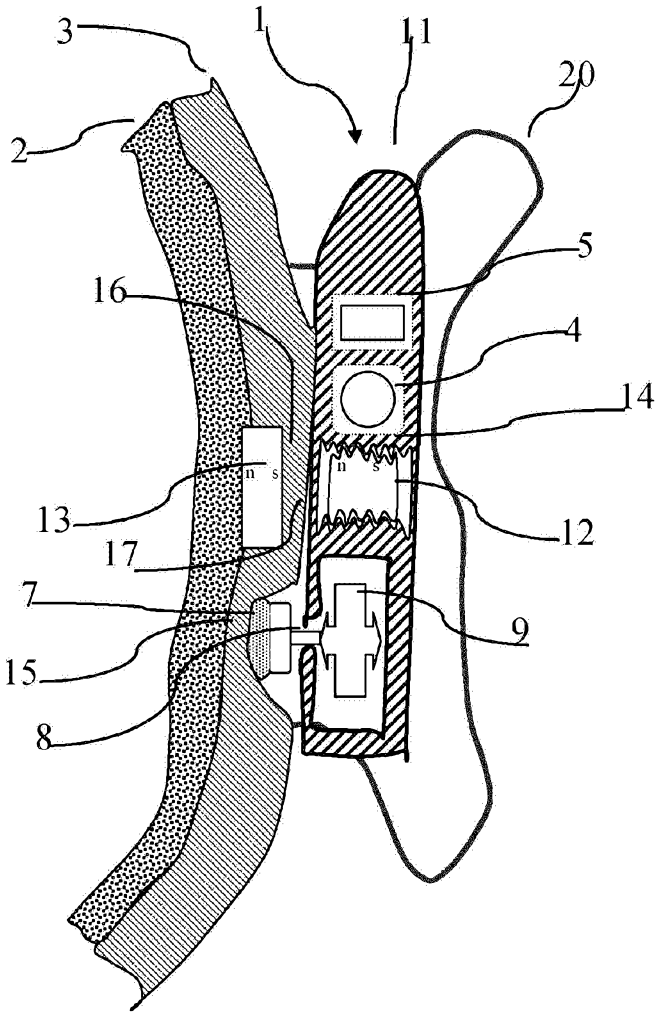


Fig. 3