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(54)

A dipole antenna for a hearing aid

(57)

A hearing aid having an attachment member and an antenna extending into the attachment element is provided. The hearing aid comprises a hearing aid housing having a microphone, a signal processor and a wireless communications unit connected to the signal processor for wireless data communication. The wireless communications unit is interconnected with an antenna having a first pole element and a second pole element for emission and reception of an electromagnetic field. The attachment member is connectable to the hearing aid housing and at least a part of the first pole element extends via the attachment member, and a second pole element of the dipole antenna extends in the hearing aid housing. Also disclosed is a set of attachment members wherein a first antenna element extending in a first attachment member has a first antenna length and a second antenna element has a second antenna length, and wherein the absolute relative difference of the first antenna length and the second antenna length is less than a first threshold, such as 10 %.

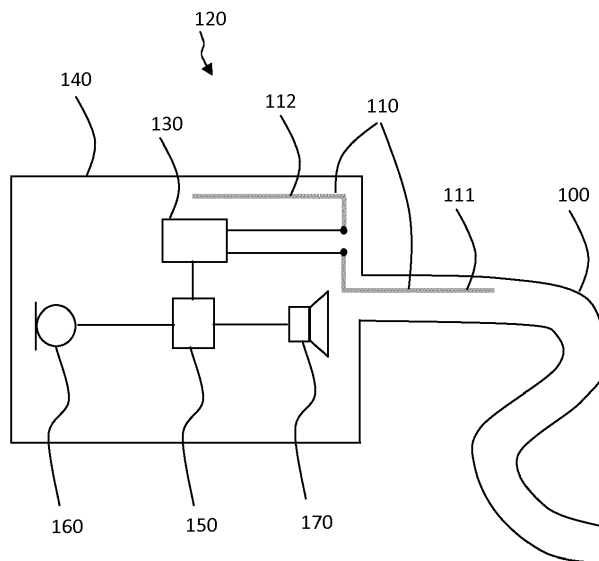


Fig. 1

Description

FIELD OF INVENTION

[0001] The invention relates to antennas for hearing aids, and especially for antennas extending in hearing aid housing attachment members or outside of a hearing aid housings, and particularly to antennas, such as dipole antennas, having a first pole element extending in an attachment member and a second pole element extending in the hearing aid housing.

BACKGROUND

[0002] Hearing aids are very small and delicate devices and comprise many electronic and metallic components contained in a housing small enough to fit in the ear canal of a human or behind the outer ear. The many electronic and metallic components in combination with the small size of the hearing aid housing impose high design constraints on radio frequency antennas to be used in hearing aids with wireless communication capabilities.

[0003] Conventionally, antennas in hearing aids have been used for receiving radio broadcasts or commands from a remote control. Typically, such antennas are designed to fit in the hearing aid housing without special concern with relation to the efficiency of the antenna.

[0004] A variety of hearing aids are known, including so called behind-the-ear hearing aids, in-the-ear hearing aids, receiver-in-the-ear hearing aids, etc. Some hearing aids have been designed with a cable or a sound tube connecting hearing aid elements positioned behind the ear of a user with hearing aid elements position in the ear of a user. It has been suggested to use such cables or sound tubes for accommodating antenna elements. For example in US 8,300,863, a hearing aid having a cable or a sound tube connecting the hearing aid to a receiver in the ear of a user or to a speaker in the ear, respectively, is configured for wireless communication via an antenna, and the cable or sound tube comprises a conducting element forming at least part of the antenna. Furthermore, EP 2 088 804 discloses a hearing aid having a cable comprising one or more conductors for connecting a hearing aid housing with a transducer in the ear of a user. To enable wireless communication, a wireless transceiver in the hearing aid may be connected to one of the transducer cables to provide a monopole antenna, or the wireless transceiver may be connected to two transducer cables to provide a dipole antenna for the wireless transceiver.

SUMMARY OF INVENTION

[0005] It is an object of the present invention to provide an improved antenna design for hearing aids.

[0006] According to a first aspect of the present invention the above and other objects are fulfilled by a hearing

aid comprising a hearing aid housing having a microphone for reception of sound and conversion of the received sound into a corresponding first audio signal, a signal processor for processing the first audio signal into a second audio signal compensating a hearing loss of a user of the hearing aid, and a wireless communications unit connected to the signal processor for wireless data communication, the wireless communications unit is interconnected with an antenna having a first pole element and a second pole element for emission and reception of an electromagnetic field. The hearing aid further comprises an attachment member connectable to the hearing aid housing and at least a part of the first pole element extends via the attachment member, and a second pole element of the dipole antenna extends in the hearing aid housing.

[0007] According to a second aspect of the present invention the above and other objects are fulfilled by a hearing aid comprising a hearing aid housing having a microphone for reception of sound and conversion of the received sound into a corresponding first audio signal, a signal processor for processing the first audio signal into a second audio signal compensating a hearing loss of a user of the hearing aid, and a wireless communications unit connected to the signal processor for wireless data communication, the wireless communications unit is interconnected with an antenna having a first pole element and a second pole element for emission and reception of an electromagnetic field wherein at least a part of the first pole element extends outside of the hearing aid housing, and the second pole element of the antenna extends within the hearing aid housing.

[0008] According to a third aspect of the present invention the above and other objects are fulfilled by a hearing instrument comprising a hearing instrument housing for reception of a sound signal and a speaker for providing the sound signal to the ear of a user, a wireless communications unit for wireless data communication, the wireless communications unit is interconnected with an antenna having a first pole element and a second pole element for emission and reception of an electromagnetic field. The hearing instrument further comprises an attachment member connectable to the hearing instrument housing and at least a part of the first pole element extends via the attachment member, and a second pole element of the dipole antenna extends in the hearing instrument housing.

[0009] According to a fourth aspect of the present invention, a set of attachment members is provided. The set of attachment members comprises a first attachment member configured to interconnect with a hearing aid housing, and a second attachment member configured to interconnect with a hearing aid housing, the first attachment member having a first length and the second attachment member having a second length, the first attachment member comprising a first antenna element and the second attachment member comprising a second antenna element, wherein the first antenna element

has a first antenna length and the second antenna element has a second antenna length and wherein the absolute relative difference of the first antenna length and the second antenna length is less than a first threshold, such as 10 %. Thus, it is envisaged that the first antenna length is equal to, or substantially equal to, the second antenna length. In one or more embodiments, the first length of the first attachment member is different from the second length of the second attachment member. Thereby, the field distribution of the antenna is substantially the same irrespective of the length of the attachment member. It is an advantage that a renewed matching of the antenna is not required when an attachment member is exchanged.

[0010] It is an advantage that the antenna is not connected to a ground plane in the hearing aid housing. Hereby, the radiation pattern of the antenna may be independent of e.g. circuit board radiation, and thereby the radiation pattern for the antenna may be more tightly controlled. It is a further advantage that the first pole element and the second pole element may be separated so that coupling between the first pole element and the second pole element is minimized.

[0011] The attachment member may be any attachment member configured to be attached to the hearing aid housing. The attachment member may be a holding member for holding the hearing aid in place during use, the attachment member may be configured to transmit the second audio signal from the hearing aid housing to the ear of a user, etc.

[0012] The length of the attachment member may be determined by the size of a user's ear to allow for a smooth fitting, and may for example be selected during fitting of the hearing aid. The length of an attachment member varies depending on the type of attachment member provided. For some attachment members, e.g. for attachment members for sound transmission, the length of the attachment members may typically range from about 50 mm to about 70 mm, and the attachment members are typically available in a number of predetermined lengths. As the attachment members are exposed to the environment, including the user's head, the material may degrade over time, and typically need to be exchanged at regular intervals.

[0013] The length of the antenna, such as the length of first pole element, may be a fixed or same length, such that the length of the antenna, such as the length of the first pole element, is the same for all attachment member lengths.

[0014] The first pole element and the second pole element may have a same length, such as a length of half a wavelength of an operating frequency for the antenna, such as a length corresponding to the length of the attachment member, such as a length corresponding to a smallest length of the attachment member.

[0015] Thus, by providing a fixed length of the antenna, such as of the first pole element, for all attachment member lengths, a properly matched antenna is ensured ir-

respective of attachment member changes. It is a further advantage of providing a fixed length of the first pole element irrespective of the length of the attachment member that the second pole element positioned in the hearing aid housing has a fixed length so that the frequency response of the antenna is not varied if an attachment member is exchanged.

[0016] Alternatively, the length of first pole element may extend over the length of the attachment member.

[0017] The required physical length of the antenna, whether the length is the same or is varied with attachment member length, may be decreased by interconnecting the antenna with an electronic component, a so-called antenna shortening component, having an impedance that modifies the standing wave pattern of the antenna thereby changing its effective length. The required physical length of the antenna may for example be shortened by connecting the antenna in series with an inductor or in shunt with a capacitor to obtain a desired length of the antenna, to e.g. obtain a desired frequency response for the antenna.

[0018] In some embodiments, the attachment member may be a sound transmission member for transmission of sound from the hearing aid housing to the ear of a user. The second sound signal may be transmitted electrically or acoustically to the ear of a user.

[0019] The attachment member may comprise a sound tube and in some embodiments, the second audio signal may be coupled to the ear of a user by transforming the second audio signal to an acoustic signal and transmitting the acoustic signal to the ear of a user via the sound tube. The sound tube may be a thin tube, and the acoustic signal may be transmitted via acoustic wave propagation in the thin tube. The second audio signal may be transformed to an acoustic signal via a transducer, such as a speaker. Typically, this configuration is used when a hearing aid housing of a behind-the-ear hearing aid is provided behind the ear of a user and a sound is transmitted from the hearing aid housing to the ear of a user. An ear mould may receive the transmitted signal and provide it to the inner ear of the user. The hearing aid housing of the behind-the-ear hearing aid may thus further comprise a transducer for transforming the second audio signal into a sound to be transmitted by the sound tube to the ear of a user.

[0020] The attachment member may comprise one or more conductors for conducting the second audio signal to a receiver positioned in the ear of a user. Typically, the conductors are electrically conducting conductors and the second audio signal is transmitted electrically to the ear of a user via the conductors. Typically, this configuration is used when a hearing aid housing of a receiver-in-the-ear hearing aid is provided behind the ear of a user and the second audio signal is electrically transmitted to a receiver positioned in the ear of a user. Thus, the electrical signal is transmitted to the ear and at this stage. An ear mould may receive the transmitted signal and provide it to the inner ear of the user. The hearing

aid housing of the behind-the-ear hearing aid may thus further comprise a transducer for transforming the second audio signal into a sound to be transmitted by the sound tube to the ear of a user.

[0021] The antenna has a first pole element and a second pole element for emission and reception of an electromagnetic field, and is fed in between the first and second pole elements. The antenna may be a dipole antenna.

[0022] The antenna including the first pole element and the second pole element may be confined within the hearing aid housing and the attachment member, so that no part of the antenna protrudes from the hearing aid housing or the attachment member.

[0023] Alternatively, the first pole element, or at least a part of the first pole element, such as substantially the entire first pole element, may extend in free air outside of the hearing aid housing, and outside any attachment member.

[0024] The attachment member may comprise a conducting element, particularly an electrically conductive element, and the conducting member may form at least a part of the first pole element. The conducting element may be an additional conducting element provided in the attachment member to form at least a part of the first pole element, for example, the conducting element may be provided specifically or exclusively to form a part of the first pole element.

[0025] The conducting element, particularly an electrically conductive element, may form part of a cable assembly configured to connect the hearing aid housing with the ear of a user, such as for example to electrically transmit the second audio signal from the hearing aid housing to the ear of a user, such as to a receiver in the ear of a user. The antenna may reuse the conducting element electrically transmitting the second audio signal from the hearing aid housing to the ear of a user to also act as antenna.

[0026] The second pole element may have any shape, and may have the shape of a patch antenna, a rod antenna, a meander line antenna, etc. or any combination thereof.

[0027] The second pole element is positioned in the hearing aid housing and may be at least primarily extending within the hearing aid housing. The positioning of the second pole element within the housing may be a determining factor for the radiation pattern for the antenna. In some embodiments, the second pole element may extend along a top surface of the hearing aid housing. It is an advantage of positioning the second pole element along a top surface of the hearing aid that the position of the head with respect to the second pole element is substantially unchanged irrespective of whether the hearing aid is positioned at the right ear of a user or the left ear of a user.

[0028] The second pole element may in some embodiments have a first section extending along a first side of the hearing aid housing and a second section extending

along a second side of the hearing aid housing. A length of the first section may correspond substantially to a length of the second section, and the length of the first section and the second section of the second pole element may be substantially the same, i.e. substantially equal. Furthermore, in some embodiments, the first section and the second section may have a substantially same shape, and the first section and the second section may be symmetrical. The first section and the second section may be symmetrical about an axis of the hearing aid housing, such as about a middle plane partitioning the hearing aid housing in two equal parts in a longitudinal direction, i.e. in a direction parallel to the surface of the head when the hearing aid is provided in its intended operational position.

[0029] In one or more embodiments, the first pole element may have a first section extending via the attachment member and a second section extending in the hearing aid housing. The second section of the first pole element extending in the hearing aid housing may have a same shape as the second pole element.

[0030] The second section of the first pole element may extend along one side of the hearing aid housing while the second pole element may extend along another side of the hearing aid housing.

[0031] The wireless communications unit is configured for wireless data communication, and in this respect interconnected with the antenna for emission and reception of an electromagnetic field. The wireless communications unit may comprise a transmitter, a receiver, a transmitter-receiver pair, such as a transceiver, a radio unit, etc. The wireless communications unit may be configured for communication using any protocol as known for a person skilled in the art, including Bluetooth, WLAN standards, manufacture specific protocols, such as tailored proximity antenna protocols, such as proprietary protocols, such as low-power wireless communication protocols, etc.

[0032] The wireless communications unit interconnected with the antenna may be configured for operation in the ISM frequency band. The wireless communications unit interconnected with the antenna may be configured for operation at a frequency of at least 100 MHz, such as at a frequency of at least 800 MHz, such as at at least 1 GHz, such as at a frequency between 1.5 GHz and 3 GHz, such as at a frequency of 2.4 GHz, such as at substantially 2.4 GHz.

[0033] The wireless communications unit may be configured for communication with external devices, such as hearing aid accessories, such as remote controls, telephones, such as mobile telephones, televisions, television boxes, television streamer boxes, spouse microphones, hearing aid fitting systems, etc.

[0034] The wireless communications unit may also be configured for communication with another hearing aid in a binaural hearing aid, so that data may be exchanged between the hearing aid positioned at the right ear of a user and the hearing aid positioned at the left ear of the

user. Such binaural communication may be used for example for binaural beam forming, for binaural noise reduction, etc.

[0035] The hearing aid may further comprise a variable matching circuit for electrically matching the antenna with the wireless communications unit.

[0036] The antenna may be a dipole antenna and may be fed in between the first pole element and the second pole element, such as in the center between the first pole element and the second pole element, such as substantially in the center between the first pole element and the second pole element. The dipole antenna may be a balanced dipole antenna. The antenna design may be inherently symmetric, so as to provide a balance antenna without the use of balun components, etc.

[0037] The hearing aid housing may comprise hearing aid electronics, such as hearing aid electronics provided on e.g. a printed circuit board. In the prior art, many hearing aid antennas have been using the printed circuit board as a ground plane for a hearing aid antenna, whereby the radiation pattern is dependent also on the (non-controlled) radiation from the printed circuit board.

[0038] It is an advantage of the present antenna that the antenna the printed circuit board is not used as a ground plane for the antenna.

[0039] It is envisaged that preferred features and characteristics of one aspect and/or embodiment of the invention are applicable to another aspect and/or embodiment, mutatis mutandis.

[0040] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. The invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like reference numerals refer to like elements throughout. Like elements will, thus, not be described in detail with respect to the description of each figure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041]

Fig. 1 shows schematically a behind the ear type hearing aid housing with a sound tube and having an antenna extending via the sound tube,

Figs. 2a and 2b show a receiver in the ear type hearing aid having a hearing aid housing with an attachment member comprising one or more conductors and having an antenna extending via the attachment member,

Fig. 3 shows a hearing aid housing with an attachment member wherein a first pole extends via the

attachment member and a second pole extend along a side of the hearing aid housing,

Fig. 4 shows a hearing aid housing with an attachment member wherein an antenna has a first pole extending via the attachment member and a second pole having a first and a second section, extending along a first and a second side of the hearing aid housing, respectively,

Fig. 5 shows a hearing aid housing with an attachment member wherein an antenna has a first pole extending via the attachment member and a second pole extend along a top side of the hearing aid housing,

Fig. 6 shows a hearing aid housing with an attachment member wherein an antenna has a first pole having a first section extending via the attachment member and a second section extending along a side of the hearing aid and a second pole extending along another side of the hearing aid housing,

Fig. 7 shows a hearing aid housing without an attachment member wherein an antenna has a first pole extending outside of the hearing aid, and a second pole extending within the hearing aid housing,

Fig. 8 shows a 3D drawing of a hearing aid housing with an attachment member and a receiver in the ear,

Fig. 9 shows the intended operational position of the hearing aid.

Figs. 10a-d show fixed lengths of antenna extending in attachment members of different lengths,

Figs. 11a-d show variable lengths of antennas extending in attachment members of different lengths.

DETAILED DESCRIPTION OF THE DRAWINGS

[0042] Fig. 1 shows schematically a behind the ear type hearing aid 120 having a hearing aid housing 140. The hearing aid housing comprises a microphone 160 for reception of sound and conversion of the received sound into a corresponding first audio signal, a signal processor 150 for processing the first audio signal into a second audio signal compensating a hearing loss of a user of the hearing aid 120, and a wireless communications unit 130 connected to the signal processor 150 for wireless data communication. The hearing aid has an attachment member 100 connectable to the hearing aid housing 140, and the wireless communications unit 130 is interconnected with an antenna 110 having a first pole element 111 and a second pole element 112 for emission and reception of an electromagnetic field. At least a part of the first pole element 111 extends via the attachment

member 100, and the second pole element 112 extends in the hearing aid housing 140. The signal processor 150 is connected to a speaker 170 for conversion of the second audio signal into a sound. The attachment member 100 is a sound tube, and the sound is acoustically transmitted to the ear of a user (not shown) via acoustic wave propagation in the thin tube 100.

[0043] It is seen that the antenna 110 having first and second poles 111, 112 may be longer than an antenna 110 extending only in the hearing aid housing. In that the hearing aid designers strive to minimize the size of the hearing aids, it is an advantage that a part of the antenna may extend outside of the housing.

[0044] It is a further advantage that the antenna 110 is not connected to a ground plane in the hearing aid housing. Hereby, the radiation pattern of the antenna 110 is independent of e.g. circuit board radiation, and thereby the radiation pattern may be more tightly controlled. It is a further advantage that the first pole element 111 and the second pole element 112 are separated so that coupling between the first pole element 111 and the second pole element 112 is minimized.

[0045] Fig. 2a shows schematically a receiver in the ear type hearing aid 220 having a hearing aid housing 240. The hearing aid housing 240 comprises a microphone 260 for reception of sound and conversion of the received sound into a corresponding first audio signal, a signal processor 250 for processing the first audio signal into a second audio signal compensating a hearing loss of a user of the hearing aid 220, and a wireless communications unit 230 connected to the signal processor 250 for wireless data communication. The hearing aid has an attachment member 200 connectable to the hearing aid housing 240, and the wireless communications unit 230 is interconnected with an antenna 210 having a first pole element 211 and a second pole element 212 for emission and reception of an electromagnetic field. At least a part of the first pole element 211 extends via the attachment member 200, and the second pole element 212 extends in the hearing aid housing 240. The antenna 210 having a first pole element 211 and a second pole element 212 is fed approximately in the center from the wireless communications unit thus implementing a dipole antenna.

[0046] Conducting element 280 connects the signal processor 250 to receiver in the ear 270, thereby electrically transmitting the second audio signal from the signal processor 250 in the hearing aid housing 240 to the receiver in the ear 270. It is seen that the attachment member 200 is a cable assembly comprising at least conducting element 280 and at least a part of the first pole element 211. It is envisaged that more conducting elements may be provided connecting the receiver in the ear with hearing aid electronics, such as with the signal processor 250.

[0047] Fig. 2b shows schematically a hearing aid of the receiver in the ear type, wherein the conducting element 280 is also used as at least a part of the first pole element 211. The wireless communications unit 230 is connected to conducting element 280 and the conducting

element 280 will act as the first pole element 211 of the antenna 210 for the wireless communications unit. In Fig. 2b it is seen that the first pole element extends over the entire length of the attachment member.

[0048] Fig. 3 shows schematically a hearing aid housing with an attachment member in 3D. The hearing aid 320 may be any hearing aid type including a behind the ear hearing aid, a receiver in the ear type, etc. The attachment member 300 may thus be any attachment member including a sound tube, a cable assembly comprising at least one conducting element, a hook, etc. The wireless communications unit 330 and the antenna 310 interconnected with the wireless communications unit 330 is shown schematically, for clarification further elements, including signal processor etc., are not shown. The first pole element 311 extends via the attachment member 300 and the second pole element 312 extends along a side 342 of the hearing aid housing 340. In this embodiment, the hearing aid is preferably positioned so that the side 342 of the hearing aid housing 340 along which the second pole element 312 is positioned is fronting the surroundings and not the side of the head of a user when the hearing aid is worn in its intended operational position. Hereby, the field distribution of transmitted and/or received signals is most powerful in free air and any damping effect of the head of the user is reduced.

[0049] In Fig. 4, a hearing aid 320 as in Fig. 3 is shown. The hearing aid housing 340 has an attachment member 300 wherein an antenna 310 has a first pole element 311 extending via the attachment member 300 and a second pole element 314, 316 extending in the hearing aid housing 340. The second pole element 314, 316 has a first section 314 extending along a first side 341 of the hearing aid housing 340 and a second section 316 extending along a second side 342 of the hearing aid housing 340. In the present example the first section 314 and the second section 316 are of the same shape, they are identical. This is an advantage as the hearing aid may then be optionally positioned at the right ear or the left ear of a user and still obtain a same or at least comparable field distribution of a field received or transmitted by the antenna 310 comprising first pole element 311, first section 314 of second pole element 314, 316 and second section 316 of the second pole element 314, 316. It can be seen that the first section 314 and second section 316 are distributed symmetrically about a longitudinal center axis of the hearing aid housing 340. It is an advantage of having a symmetric antenna in the hearing aid housing 340 in that the field distribution about the antenna is the same or substantially the same regardless of whether the hearing aid is positioned on a right hand side of the user or a left hand side of the user.

[0050] Fig. 5 shows a hearing aid 320 with a hearing aid housing 340 with an attachment member 300 wherein an antenna 311, 312 has a first pole element 311 extending via the attachment member 300 and a second pole element 312 extending along a top side 343 of the hearing aid housing 340. Hereby, the field distribution of a trans-

mitted and/or received signal may be substantially the same on both a right hand side and a left hand side of the hearing aid housing 340 in that the second pole element 312 of the antenna will experience a same, such as substantially a same, damping effect from the head of a user whether the hearing aid is provided on a left hand side or a right hand side of the hearing aid housing 340 in its intended operational position.

[0051] Fig. 6 shows a hearing aid housing 340 with an attachment member 300 wherein an antenna has a first pole element having a first section 311 extending via the attachment member 300 and a second section 313 extending along a side 342 of the hearing aid housing 340, and a second pole 314 extending along another side 341 of the hearing aid housing 340. In one or more embodiments, the length and/or shape of the second pole element 314 corresponds to the length and/or shape of the second section 313 of the first pole element to obtain a symmetric antenna in the hearing aid housing 340 as discussed above.

[0052] In Fig. 7, a further embodiment is shown, wherein a hearing aid 320 has wireless communications unit 330 and an antenna interconnected therewith. The antenna has a first pole element 317 extending outside of the hearing aid housing, and a second pole element 312 extending within the hearing aid housing 340. Regarding the electromagnetic properties of the antenna, it may be advantageous to provide the first pole element 317 in free space.

[0053] Fig. 8 shows schematically in 3D, a receiver in the ear type hearing aid 220 in more detail. The hearing aid 220 has a hearing aid housing 240 comprising a microphone 260, a signal processor 250, a wireless communications unit 230. An attachment member 200 comprises electrical conductor 280 transmitting the second audio signal from the signal processor 250 to the receiver in the ear 270. The receiver in the ear 270 is provided in an ear mould 290 configured to be positioned in the ear of a user. The wireless communications unit 230 is interconnected with an antenna having a first pole element 211 extending along the attachment member 200. The first pole element extends within the attachment member and an insulating material may be provided between the first pole element 211 and the electrical conductor 280, e.g. to avoid cross talk. A second pole element 212 extends within the hearing aid housing 240.

[0054] Fig. 9 shows the intended operational position of the hearing aid 320 behind the ear 900 of a user. The attachment member 300 is conveniently located at a face 344 of the hearing aid housing 320. The top side of the hearing aid is the side of the hearing aid housing 320 furthers away from the ear, the side 341 is the side of the hearing aid adjacent the head (not shown) of a user, and the side 342 is the side of the hearing aid exposed to the surroundings, i.e. exposed to the surroundings through the thin outer ear which is substantially less for the electromagnetic or RF radiation.

[0055] Figs. 10a-d show fixed lengths of antennas 311

extending in attachment members 301, 302, 303, 304 of different lengths. The fixed lengths antennas may be monopole antennas, or the fixed length antennas may be dipole antennas wherein only one pole element of the dipole antenna is shown.

[0056] Figs. 11a-d show variable lengths of antennas 321, 322, 323, 324 extending in attachment members 301, 302, 303, 304 of different lengths. Table 1 below shows exemplary lengths of the attachment members for an attachment member being a sound tube.

Tube name	length (mm)
-1B	52,1
0A	57,9
0B	55,0
1A	60,0
1B	57,9
2A	67,0
2B	64,0
3A	72,0
3B	69,0

[0057] Although particular embodiments of the present inventions have been shown and described, it will be understood that it is not intended to limit the claimed inventions to the preferred embodiments, and it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the claimed inventions. The specification and drawings are, accordingly, to be regarded in an illustrative rather than restrictive sense. The claimed inventions are intended to cover alternatives, modifications, and equivalents.

Claims

1. A hearing aid comprising
 - a hearing aid housing having
 - a microphone for reception of sound and conversion of the received sound into a corresponding first audio signal,
 - a signal processor for processing the first audio signal into a second audio signal compensating a hearing loss of a user of the hearing aid, and
 - a wireless communications unit connected to the signal processor for wireless data communication, and an attachment member connectable to the hearing aid housing,
 - the wireless communications unit being interconnected with an antenna having a first pole element and a second pole element for emission and reception of an electromagnetic field,

wherein at least a part of the first pole element extends via the attachment member, and the second pole element extends in the hearing aid housing.

2. A hearing aid according to claim 1, wherein the attachment member is configured to transmit the second audio signal from the hearing aid housing to the ear of a user. 5
3. A hearing aid according to any of claims 1 or 2, wherein the antenna is confined within the hearing aid housing and the attachment member. 10
4. A hearing aid according to any of the previous claims, wherein the attachment member comprises one or more conducting elements at least one of the one or more conducting elements forming at least a part of the first pole element of the antenna. 15
5. A hearing aid according to any of the previous claims, wherein the second pole element of the antenna extends along a top surface of the hearing aid housing. 20
6. A hearing aid according to any of claims 1-4, wherein the second pole element of the dipole antenna has a first section extending along a first side of the hearing aid housing and a second section extending along a second side of the hearing aid housing. 25
7. A hearing aid according to claim 6, wherein the first section and the second section are substantially symmetrical. 30
8. A hearing aid according to any of the previous claims, wherein the attachment member comprises a sound tube, and wherein the second audio signal is coupled to the ear of a user by transforming the second audio signal to an acoustic signal and transmitting the acoustic signal to the ear of a user via the sound tube. 35
9. A hearing aid according to any of claims 4-7, wherein at least one of the one or more conducting elements conduct the second audio signal to a receiver positioned in the ear of a user. 40
10. A hearing aid according to any of the previous claims, wherein the length of the first pole element of the antenna is fixed for all attachment member sizes. 45
11. A hearing aid according to any of claims 1-9, wherein the length of the first pole element of the antenna extends over the length of the attachment member. 50
12. A hearing aid according to claim 11, wherein the hearing aid further comprises a variable matching circuit for electrically matching the antenna with the wireless communications unit. 55

13. A hearing aid according to any of the previous claims, wherein the antenna is a balanced dipole antenna

14. A hearing aid according to any of the previous claims, wherein the first pole element of the antenna has a first section extending via the attachment member and a second section extending in the hearing aid housing, the second section of the first pole element extends along a first side of the hearing aid housing and the second pole element of the antenna extends along a second side of the hearing aid housing.

15. A set of attachment members comprises a first attachment member configured to interconnect with a hearing aid housing, and a second attachment member configured to interconnect with a hearing aid housing, the first attachment member having a first length and the second attachment member having a second length, the first attachment member comprising a first antenna element having a first length and the second attachment member comprising a second antenna element having a second length, wherein the absolute relative difference of the first antenna length and the second antenna length is less than a first threshold, such as 10 %.

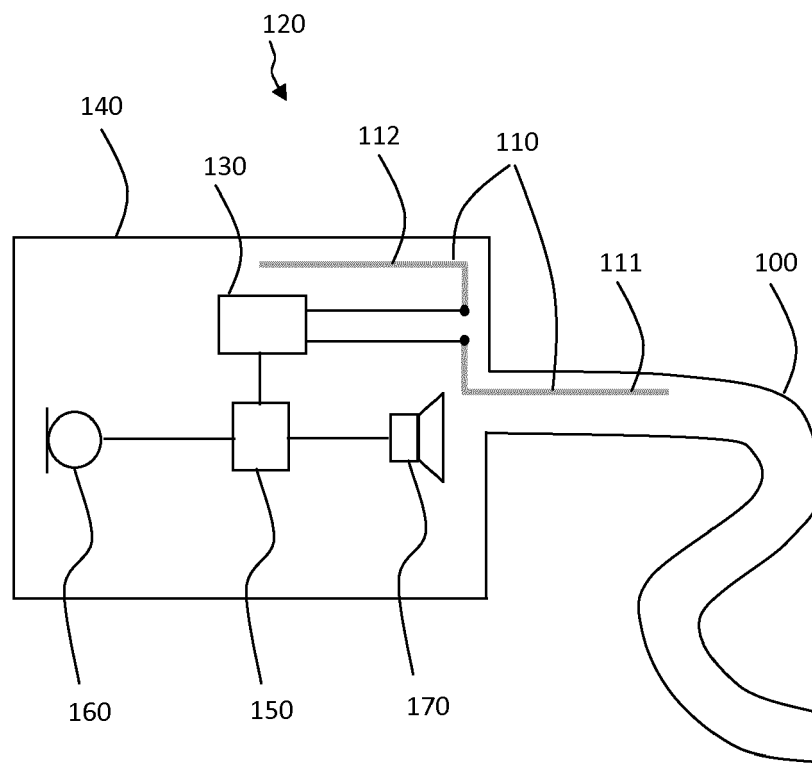


Fig. 1

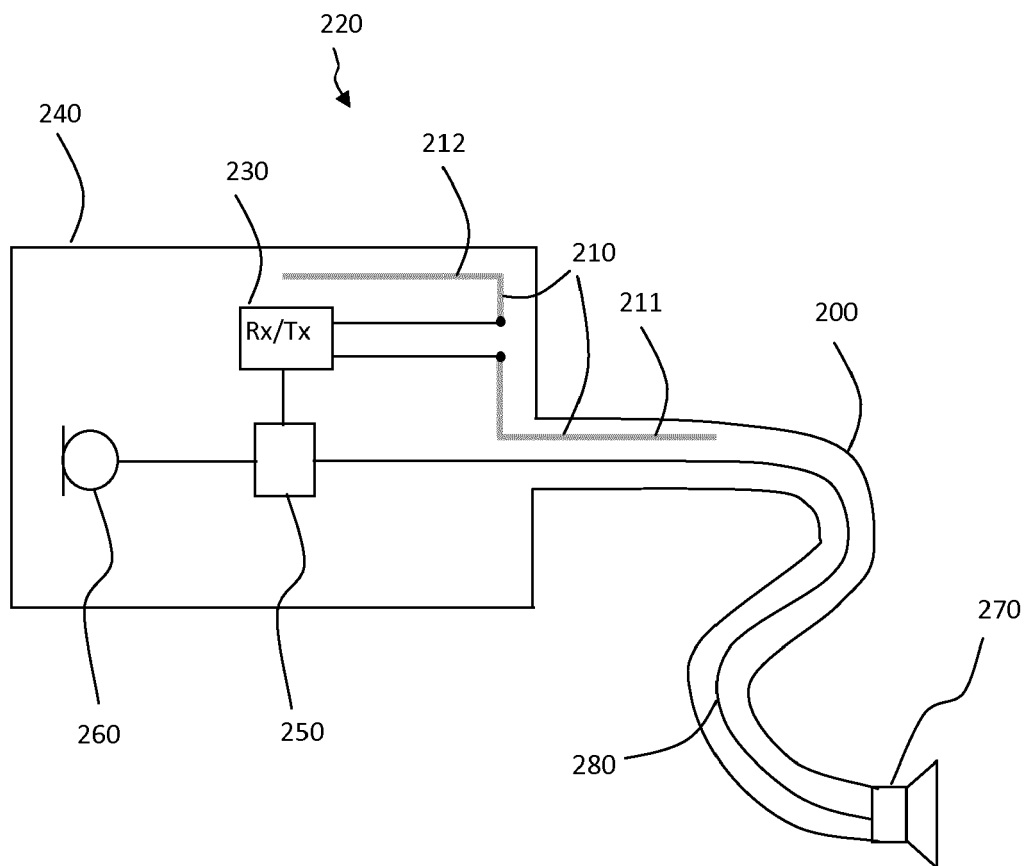


Fig. 2a

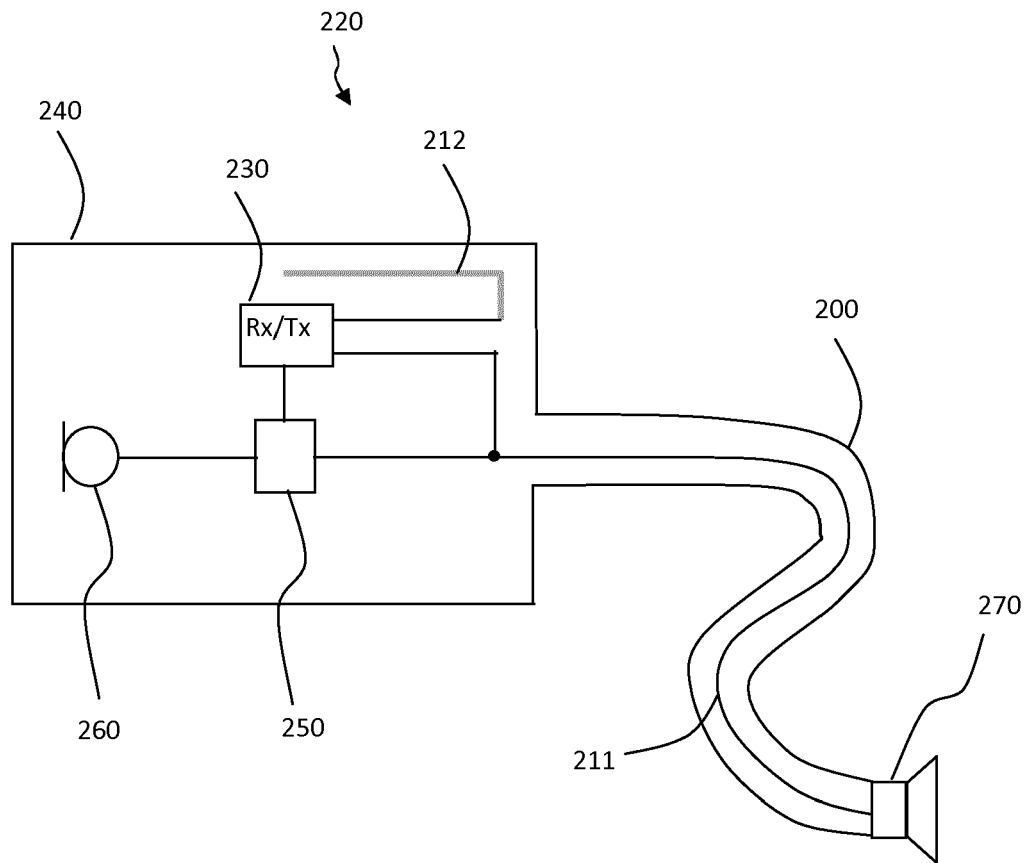


Fig. 2b

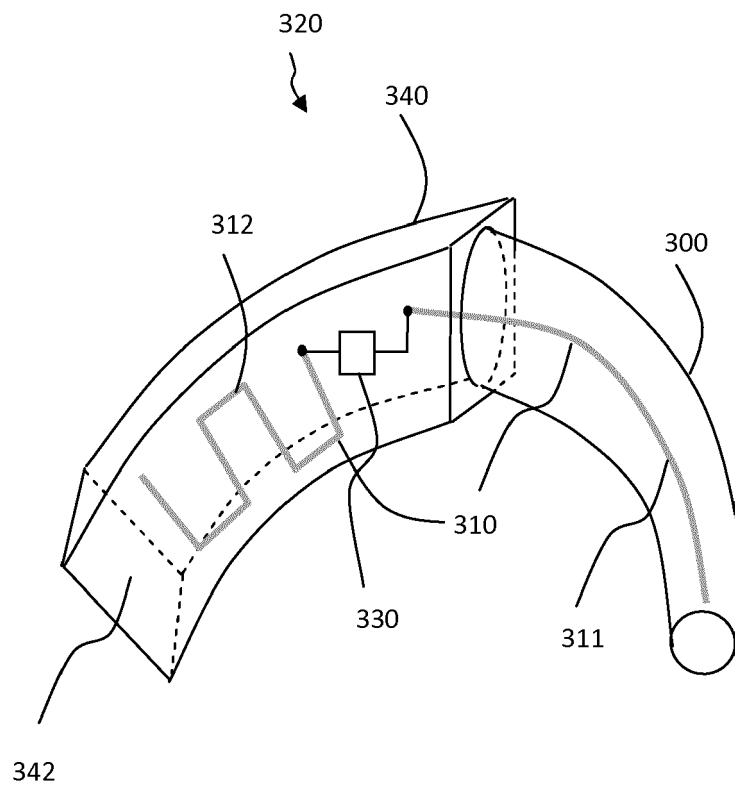


Fig. 3

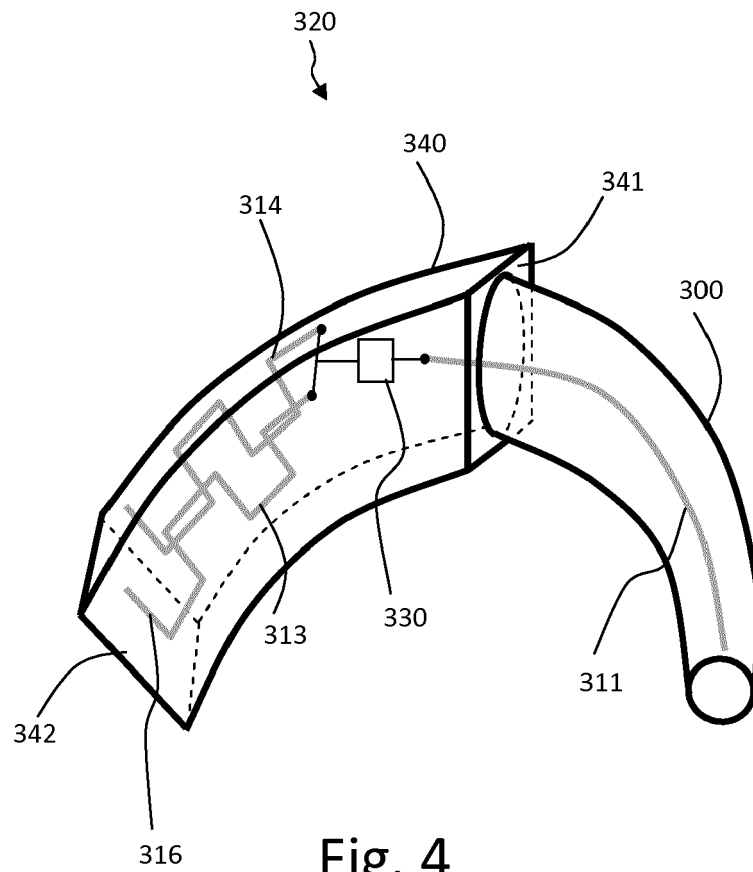


Fig. 4

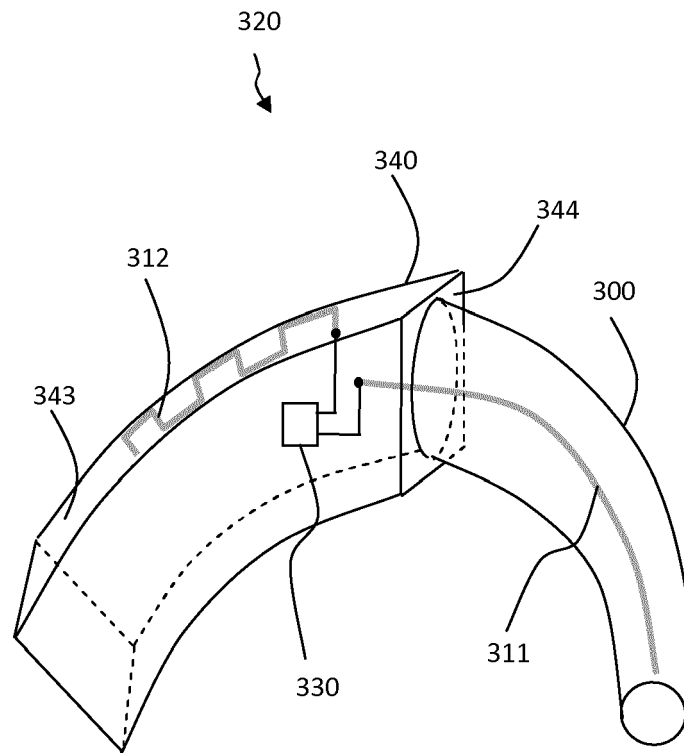


Fig. 5

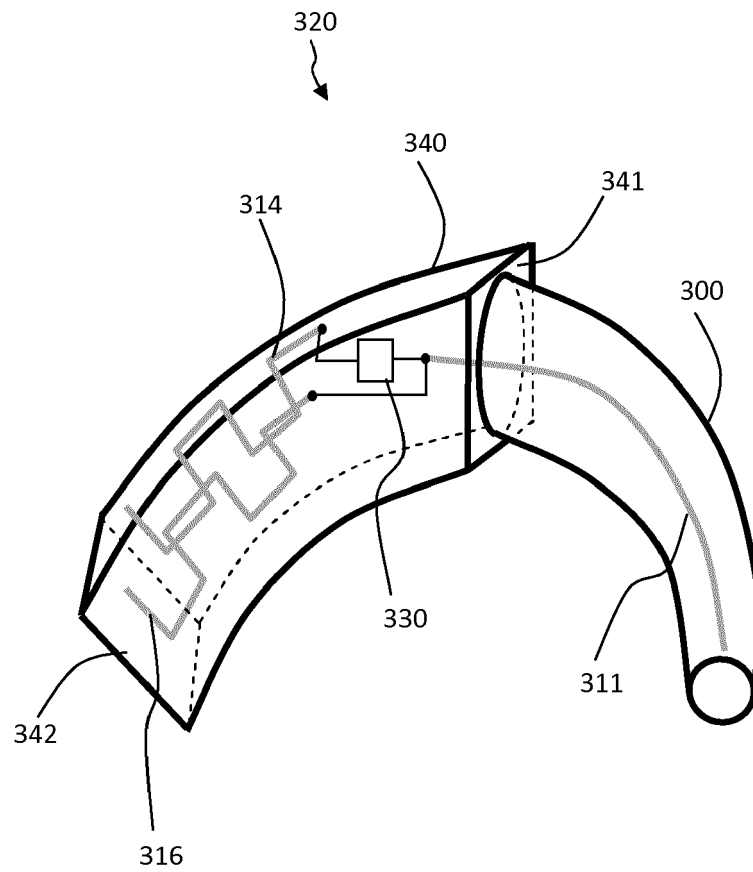


Fig. 6

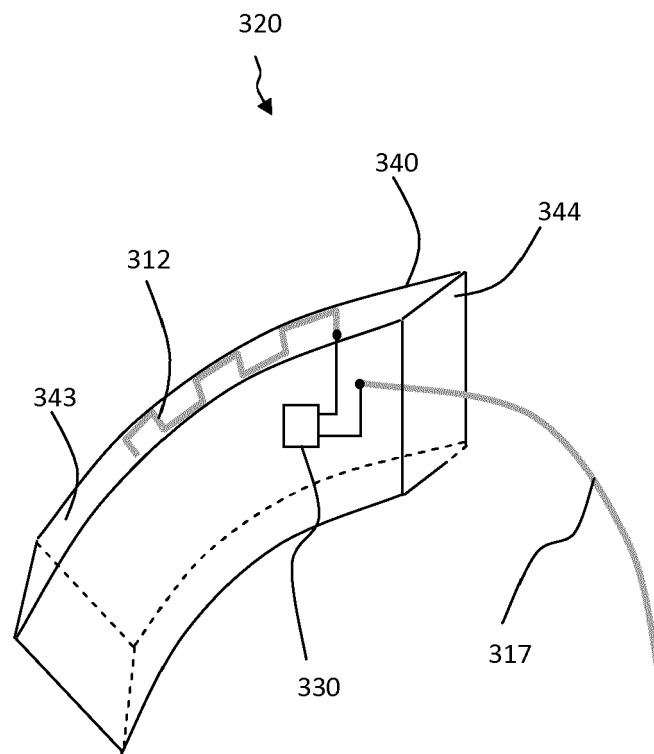


Fig. 7

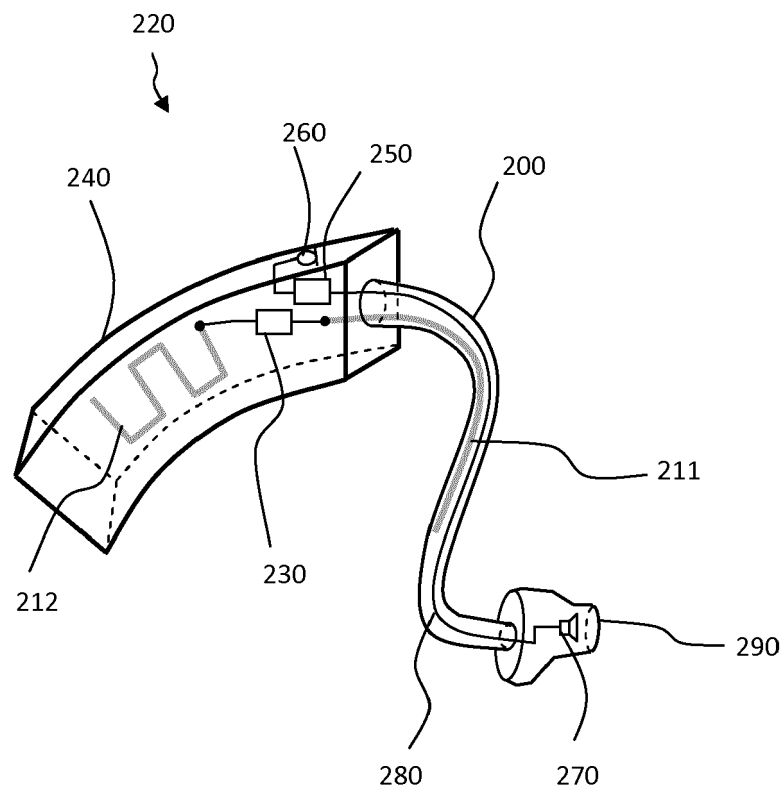


Fig. 8

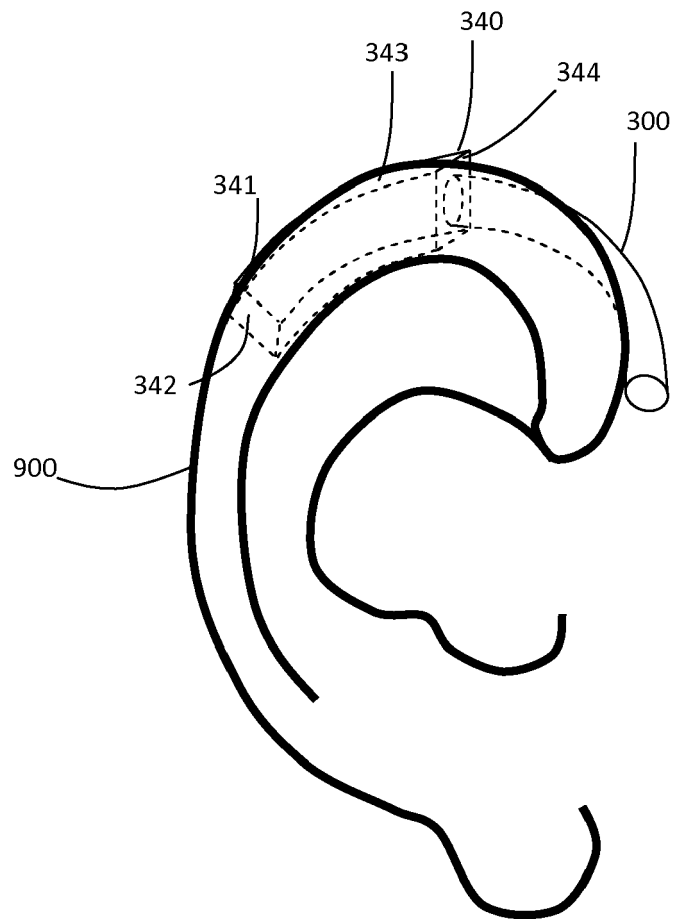


Fig. 9

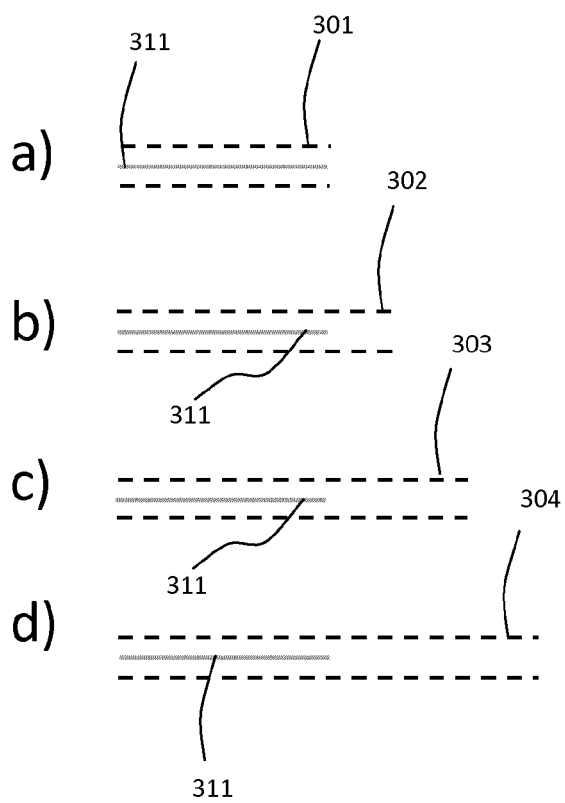


Fig. 10

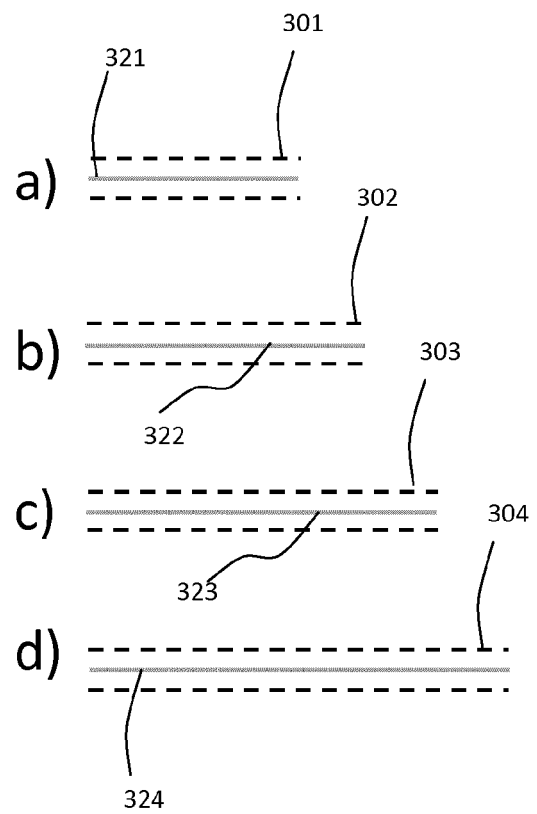


Fig. 11



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			H04R H01Q
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Munich		25 April 2013	Fülöp, István
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