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(54) **A hearing aid having an adaptive antenna matching mechanism and a method for adaptively matching a hearing aid antenna**

Hörgerät mit adaptivem Antennenanpassungsmechanismus und Verfahren zum adaptiven Anpassen einer Hörgerätantenne

Prothèse auditive comprenant un mécanisme de mise en correspondance d'antenne adaptative et procédé de mise en correspondance adaptative d'antenne de prothèse auditive

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EP 2 750 408 B1

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Description

FIELD OF INVENTION

[0001] The present invention relates to hearing aids, especially binaural hearing aids, configured for wireless communication and having wireless communication properties, and more specifically to binaural hearing aids capable of adaptively matching an antenna to the environment by detecting a signal strength of a received and/or transmitted signal and adjusting antenna properties accordingly.

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] It is known in the art to provide matching circuitry for antennas, and also for antennas used in hearing aids. The matching circuitry may match the impedance of the antenna to the applicable radio or transceiver used and may optimise the effective length of the antenna to the frequency of the radio or transceiver. The matching is typically performed upon initial fitting of the hearing aid, or as disclosed in US2009/0196444, upon replacement of antenna conductors which may vary in for example length from one to another.

[0005] WO 2009/156879 A1 describes method of tuning an antenna, wherein the method comprises receiving a first signal strength indicator indicating a signal strength of a first data signal transmitted by an antenna on a first frequency, receiving a second signal strength indicator indicating a signal strength of a second data signal transmitted by the antenna on a second frequency different to the first frequency, determining a tuning control signal based on the first signal strength indicator and the second signal strength indicator, and tuning the antenna based on the control signal.

[0006] US 2004/037442 A1 describes a wireless binaural hearing aid system that utilises direct sequence spread spectrum technology to synchronise operation between individual hearing prostheses is provided.

SUMMARY

[0007] It is an objective of the present invention to pro-

vide a hearing aid, such as a binaural hearing aid, providing an adaptive matching for a hearing aid antenna, such as providing an adaptive matching in response to detection of a received signal strength.

[0008] According to a first aspect of the present invention, a binaural hearing aid according to claim 1 is provided.

[0009] Alternatively, a hearing aid accessory may comprise the detector and information on the detected signal strength may be provided to the adjustable antenna matching mechanism for example via the wireless communications unit. Furthermore, a hearing aid fitting system may comprise the detector and information on the detected signal strength may be provided to the adjustable antenna matching mechanism for example via the wireless communications unit.

[0010] According to a further aspect of the present invention, a method of matching a hearing aid antenna in a binaural hearing aid according to claim 14 is provided.

[0011] The communications signal may be transmitted from the second hearing aid to the first hearing aid for detection, thus the communications signal received in one hearing aid of a binaural hearing aid may be received from another of the hearing aids of the binaural hearing aid.

[0012] In one or more embodiments the communications signal received through the wireless communications unit in one hearing aid is a signal transmitted from the other of the first and second hearing aids in a binaural hearing aid. Thus, the signal strength of a signal received from the second hearing aid may be detected.

[0013] It is envisaged that the adaptive adjustment may be performed during a fitting procedure fitting the hearing aid to a user, or the adaptive adjustment may be performed during use of the hearing aid.

[0014] The received signal strength may be an indication of the power level of the communications signal received by the antenna. The signal strength may be detected or measured according to any known methods, including for example measuring using a detector comprising received signal strength indicator (RSSI) circuitry, received channel power indicator (RCPI) circuitry, etc. Furthermore, also the signal noise ratio (SNR) may be measured.

[0015] The signal strength of the received signal may be detected or measured in the hearing aid, such as by a detector provided in the hearing aid, such as in the first hearing aid of a binaural hearing aid having a first and a second hearing aid. In some embodiments the detector may form part of the wireless communications unit, such as part of a radio.

[0016] A controller for controlling the matching circuit may be provided, such as provided in the wireless communications unit.

[0017] An adjustable antenna matching mechanism provided in the hearing aid, or in the first hearing aid and/or the second hearing aid of a binaural hearing aid, is configured to receive information on the detected sig-

nal strength and configured to adaptively adjust the matching mechanism to optimize antenna reception/emission according to the detected signal strength.

[0018] Alternatively, the signal strength of a signal transmitted from the hearing aid to e.g. an accessory device, or to a hearing aid fitting system, may be detected in the accessory device or in the hearing aid fitting system, respectively, and information on the transmitted signal strength may be provided to an adjustable antenna matching mechanism provided in the hearing aid, the adjustable antenna matching mechanism being configured to adaptively adjust the matching mechanism to optimize antenna reception/emission according to the detected signal strength.

[0019] The antenna matching mechanism may be configured to adjust an impedance of the antenna matching mechanism to optimize antenna reception.

[0020] The antenna matching mechanism may be a closed adaptive matching loop using a variable inductance in the matching circuitry. It is envisaged that the impedance may be adjusted according to a predetermined list of values, or that the impedance may be iteratively adjusted until an optimized antenna reception/transmission is obtained.

[0021] The adjustable antenna matching mechanism may be configured to iteratively adjust the antenna matching mechanism until an end-adjustment criteria is reached, and the adjustable antenna matching mechanism may be configured to adjust the antenna matching mechanism upon receiving a detected signal strength being less than a predetermined threshold. The adjustable antenna matching mechanism may be configured to iteratively adjust the antenna matching mechanism until an end-adjustment criteria being the reception of a detected signal strength above the predetermined threshold is reached.

[0022] It is an advantage of the present invention that it is possible to control the field distribution of the antenna by adaptively adjusting the antenna matching mechanism taking into account different antenna structures, different antenna environments, etc.

[0023] It is envisaged that the signal strength may be detected remotely, that is for example either in an accessory device, in a hearing aid fitting system, or in one of the first and second hearing aids of a binaural hearing aid, etc. Subsequently, either information on the detected signal strength, such as a received signal strength indicator may be transmitted to the hearing aid, such as to the other of the first and second hearing aids of a binaural hearing aid or adjustment parameters may be provided to the hearing aid, such as to the other of the first and second hearing aid of a binaural hearing aid. The adjustment parameters may comprise impedance values, such as capacitor values, conductance values, etc.

[0024] In one or more embodiments, the detector is configured to detect the signal strength upon triggering to adaptively adjust the matching mechanism to optimize antenna reception. The detector may be triggered by

hearing aid adjustments, such as program selections, environmental changes, etc.

[0025] The hearing aid adjustments may be performed automatically, without direct interaction from a user.

[0026] 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.

[0027] 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 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.

[0028] 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.

[0029] 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.

[0030] The hearing aid may further comprise an attachment member, such as an attachment member transmitting the second audio signal from the hearing aid housing to the ear of a user when the hearing aid is worn in its intended operational position and wherein at least a part of the antenna extends via the attachment member.

[0031] The antenna, or at least the part of the antenna extending via the attachment member, may have a length being correlated with a length of the attachment member. The antenna, or at least the part of the antenna extending via the attachment member, may have substantially a same length as the attachment member. Alternatively, the antenna, or at least the part of the antenna extending via the attachment member, may have substantially a same length irrespective of the length of the attachment member.

[0032] The attachment member may be an electrical connection to a receiver in the ear of a user, a sound tube, such as a thin tube configured for acoustic wave

propagation, or an ear hook, such as an ear hook for holding the hearing aid in a desired position around the ear of a user.

[0033] The attachment member may be any attachment member configured to be attached to the hearing aid, such as to a 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.

[0034] 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. As the length may vary from one attachment member to another attachment member, that is, either the length of the attachment member and/or the length of the part of the antenna extending via the attachment member may vary, an adaptively adjustable matching mechanism ensures that the field distribution of the antenna is substantially unchanged.

[0035] It is an advantage of being able to maintain a constant field distribution of the antenna especially to maintain a constant ear-to-ear performance of a binaural hearing aid.

[0036] Especially for binaural hearing aids, the performance of the ear-to-ear link, that is the wireless communication between a first hearing aid and a second hearing aid in a binaural hearing aid, is crucial for optimum operation, such as for synchronization between the first and second hearing aids to e.g. achieve sound localization, and for e.g. noise reduction.

[0037] To obtain the best possible ear-to-ear link, there are basically two methods, either to increase the power in the ear-to-ear link or increase the size of the antenna. It is not desirable to increase the power in the ear-to-ear link due to the conflicting need to increase battery lifetime, and the size of the antenna is typically limited by the hearing aid dimensions.

[0038] In one or more embodiments, the hearing aids have an attachment element and the antenna extend at least partly into the attachment element. The attachment element may have a variable length as discussed above depending on e.g. the size of a user's head. To optimize the performance of the ear-to-ear link, the antenna may be as long as possible, and thus for a user having a larger size, i.e. longer, attachment element also the size of the antenna may be increased. As the field distribution on the antenna is an important factor in ear-to-ear commu-

nication, there is a need to control the field distribution. The field distribution may be controlled in that the length of the antenna element extending at least partly into the attachment element is kept constant irrespective of the length of the attachment element. However, in order to take advantage of the longer attachment elements, the antenna element may extend further into a longer attachment element. The length of the antenna element extending into the attachment element may for example correspond to, such as correspond substantially to, the length of the attachment element.

[0039] To control the field distribution on antenna elements having different lengths, a matching mechanism may be provided, and the field distribution may be controlled by adjusting the matching mechanism according to the length of the attachment member or antenna used. To enable adaptive matching of the matching mechanism, the hearing aid may comprise a detector configured to detect a signal strength of a communications signal received through the wireless communications unit and adjust the matching mechanism in response hereto, e.g. by providing a closed adaptive matching loop. Thereby, the field distribution on the antenna may be controlled and the different lengths of the attachment members may be accounted for. Hereby, the binaural efficiency may be increased when the length of the attachment member used is increased.

[0040] It is envisaged that features and characteristics described in connection with one aspect of the invention are applicable to other aspects mutatis mutandis.

[0041] 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

[0042]

Fig. 1 shows schematically a hearing aid,

Fig 2 shows schematically a binaural hearing aid having a detector in one hearing aid of the binaural hearing aid and an adaptively adjustable antenna matching mechanism in another of the hearing aids of the binaural hearing aid,

Fig. 3a shows a hearing aid communicating with a hearing aid fitting system, wherein the hearing aid fitting system comprises a detector,

Fig. 3b shows a hearing aid communicating with a hearing aid accessory, wherein the hearing aid accessory comprises a detector,

Figs. 4a-d show schematically various attachment member lengths having different antenna lengths.

Fig. 5 shows a flow chart illustrating a method of adaptively adjusting an antenna matching mechanism in a hearing aid,

Fig. 6 shows a flow chart illustrating a method of adaptively adjusting an antenna matching mechanism in a binaural hearing aid.

DETAILED DESCRIPTION OF THE DRAWINGS

[0043] In Fig. 1, a hearing aid 100 is shown schematically. The hearing aid has 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, a speaker 170 for providing sound to a user, a wireless communications unit 130 connected to the signal processor 150 for wireless data communication and being interconnected with an antenna 110 for emission and/or reception of an electromagnetic field. The wireless communications unit may be a radio, such as a radio, such as a multi protocol radio, such as a radio supporting Bluetooth as well as proprietary wireless protocols. The hearing aid further has a detector 180 connected to the wireless communications unit 130. The detector is configured to detect a signal strength of a signal received through the wireless communications unit 130. An antenna matching mechanism 190 is configured to receive the detected signal strength from the detector 180 and adaptively control the matching mechanism 190 to optimize antenna reception according to the detected signal strength of the received signal. The detected signal strength may be provided to the antenna matching mechanism as a control signal. The hearing aid may have an attachment element 120 and the antenna 110 may extend into the attachment element 120.

[0044] In some embodiment, the antenna matching mechanism may comprise, or consist of, a variable capacitor. The variable capacitor may form part of a matching circuitry for the antenna, such as a matching circuitry configured to match the antenna impedance to the radio, typically at 50 Ω .

[0045] Fig. 2 shows a binaural hearing aid, each of the first and second hearing aids 121, 122 has a microphone 161, 162, a signal processor 151, 152, speaker 171, 172, a wireless communications unit 131, 132 connected to the signal processor 151, 152 for wireless data communication and being interconnected with antenna 111, 112 for emission and/or reception of an electromagnetic field.

[0046] The first and second hearing aids 121, 122 are

configured to communicate with each other via wireless link 200 established between wireless communications units 131, 132 via antennas 111, 112. The first hearing aid 121 further has a detector 181 connected to the wireless communications unit 130. The detector 181 may be an RSSI detector and is in the present example provided in the wireless communications unit 131. The detector is configured to detect a signal strength of a signal received through the wireless communications unit 131. The signal is in this embodiment received from the second hearing aid 122 via the wireless link 200. The antenna matching mechanism 192 is thereby adaptively controlled to optimize antenna transmission according to the detected signal strength of the signal as received in the first hearing aid 121. Thus, information of the received signal strength is communicated from the detector 181 to the antenna matching mechanism 192, such as to an antenna matching controller configured to control the matching parameters for the antenna matching mechanism. The matching parameters may comprise inductance and capacitance of a matching circuitry in the antenna matching mechanism.

[0047] Even though speakers 170, 171, 172 are exemplary shown in the figures, it is envisaged that the hearing aid also may be a receiver in the ear type hearing aid, wherein the second signal is provided via an electrical connector in attachment member 120 (not shown in Fig. 2) to the ear 201, 202. When the receiver is provided in the hearing aid, such as in a behind the ear type hearing aid, the sound is typically transmitted to the ear 201, 202 via an attachment member comprising at least a sound tube.

[0048] In Fig. 3a, a hearing aid 300 is shown schematically, and it is seen that the hearing aid 300 has an adjustable antenna matching mechanism 380 configured to receive information on a detected signal strength and being configured to adaptively adjust the matching mechanism 380 to optimize antenna reception/emission according to the detected signal strength. The detector 391 is in the present example provided in a hearing aid fitting apparatus 315, and information of the signal strength is provided to the hearing aid 300 and thus, the matching mechanism is adjusted during fitting of the hearing aid. The fitting apparatus 315 and the hearing aid may communicate wirelessly and/or via a wired connection 320.

[0049] Fig. 3b shows hearing aid 300 connected to a hearing aid remote control 325 and the hearing aid remote control 325 may comprise the detector 392. The hearing aid matching mechanism may be adjusted via the remote control 325.

[0050] It is envisaged that any other hearing aid accessory may comprise a wireless communications unit and a detector to enable feedback on the information of the signal strength to the hearing aid. Typically, the hearing aid accessory and the hearing aid communicates via a hearing aid protocol, such as a proprietary protocol, using a wired or a wireless connection.

[0051] Figs. 4a-d show variable lengths of antenna el-

elements 411, 412, 413, 414 extending in attachment members 421, 422, 423, 424 of different lengths.

[0052] The length of the attachment member is typically determined by the size of a user's head and/or 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 example, the length of attachment members for sound transmission typically range from about 50 mm to about 70 mm, and the attachment members may be 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. As the length may vary from one attachment member to another attachment member, that is, either the length of the attachment member and/or the length of the part of the antenna extending via the attachment member, an adaptively adjustable matching mechanism ensures that the field distribution of the antenna is substantially unchanged.

[0053] It is envisaged that the antenna elements 411, 412, 413, 414 extending into the attachment member may have a length being correlated with the attachment member length, and thus correlated with the size of a user's ear. The length of the antenna elements 411, 412, 413, 414 may substantially be corresponding to the attachment member length, however, the length of the antenna element 411, 412, 413, 414 may also be shorter than the attachment member, such as 30% shorter, such as 20 %, such as 10 % shorter, such as 5 % shorter than the attachment member.

[0054] 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

[0055] In Fig. 5, a flowchart illustrates a method of adaptively matching a hearing aid antenna to optimize a received communications signal strength. The method comprises detecting the signal strength of a received communications signal, provide the detected signal strength, such as a control signal comprising information

about the signal strength, to an antenna matching mechanism, and adaptively adjust a hearing aid antenna matching mechanism to optimize received communications signal strength.

[0056] In Fig. 6, a flowchart illustrates a method 600 of adaptively matching hearing aid antenna(s) in a binaural hearing aid. Especially for binaural hearing aids, the performance of the ear-to-ear link 200, that is the wireless communication between a first hearing aid 121 and a second hearing aid 122 in a binaural hearing aid, is crucial for optimum operation, such as for synchronization between the first and second hearing aids 121, 122 to e.g. achieve sound localization, and for e.g. noise reduction.

[0057] The method 600 matches a hearing aid antenna 111,112 in a binaural hearing aid in accordance with a detected signal strength of a received communications signal. The method 600 comprises the steps of in a binaural hearing aid 601, transmitting a communications signal from one hearing aid in step 602, receiving the transmitted communications signal by a wireless communications unit in the other hearing aid in step 603, detecting a signal strength of the received communications signal in step 604, for example using a detector, such as an RSSI detector and provide the detected signal strength to an antenna matching mechanism to optimize received communications strength, such as in the ear-to-ear communication.

[0058] It is from the current description and the drawings envisaged that the detector and the matching mechanism may be provided in a same hearing aid, in a same binaural hearing aid, each in one or the other hearing aid in a binaural hearing aid, providing the antenna matching mechanism in a hearing aid and the detector in an accessory, such as in an accessory device, and any combination thereof. In embodiments wherein the detector and the antenna matching mechanism are provided separately, information about the detected signal strength may be fed back to the antenna matching mechanism either via a wireless communication connection or via a wired connection. The information about the detected signal strength may be provided in the form of a control signal, or the received signal strength may be provided as an indication of the power level being received by the antenna in connection with the detector, as an "above" or "below" threshold indication, and in any other way as known to a person skilled in the art.

[0059] 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 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 binaural hearing aid comprising a first hearing aid (121) and a second hearing aid (122), each hearing aid (121, 122) comprising
 - a microphone (161, 162) for reception of sound and conversion of the received sound into a corresponding first audio signal,
 - a signal processor (151, 152) for processing the first audio signal into a second audio signal compensating a hearing loss of a user of the hearing aid,
 - a wireless communications unit (131, 132) connected to the signal processor (151, 152) for wireless communication and being interconnected with an antenna (111, 112) for emission and/or reception of an electromagnetic field, the antenna (111, 112) being configured for operation at a frequency of at least 800 MHz,
 - the first hearing aid (121) having a detector (181) connected to the wireless communications unit (131), the detector (181) being configured to detect a signal strength of a communications signal received through the wireless communications unit (131), and
 - the first hearing aid (121) and/or the second hearing aid (122) having an adjustable antenna matching mechanism (192) configured to receive information on the detected signal strength and adjust the matching mechanism (192) to optimize antenna (111, 112) reception/emission according to the detected signal strength of the received communications signal.
2. A binaural hearing aid according to claim 1, wherein the communications signal received through the wireless communications unit (131) in one hearing aid (121) is a signal transmitted from the other of the first and second hearing aids (122).
3. A binaural hearing aid according to any of the previous claims, wherein the signal strength is measured using a receive signal strength indicator (RSSI) circuit.
4. A binaural hearing aid according to any of the previous claims, wherein the hearing aid further comprises an attachment member (120) transmitting the second audio signal from the hearing aid housing to the ear of a user when the hearing aid is worn in its intended operational position and wherein at least a part of the antenna (111, 112) extends via the attachment member (120).
5. A binaural hearing aid according to claim 4, wherein a length of the antenna (111, 112) is correlated with a length of the attachment member (120).
6. A binaural hearing aid according to any of claims 4-5, wherein the attachment member (120) is an electrical connection to a receiver in the ear of a user, a sound tube or an ear hook.
7. A binaural hearing aid according to any of the previous claims, wherein the signal strength of the received signal is detected during a hearing aid fitting procedure.
8. A binaural hearing aid according to any of the previous claims, wherein the detector is configured to detect the signal strength upon triggering to adaptively adjust the matching mechanism to optimize antenna reception.
9. A binaural hearing aid according to claim 8, wherein the detector (181) is triggered by hearing aid adjustments, such as program selection.
10. A binaural hearing aid according to any of the previous claims, wherein an impedance of the antenna matching mechanism (192) is adjusted to optimize antenna reception.
11. A binaural hearing aid according to any of the previous claims, wherein the adjustable antenna matching mechanism (192) is configured to iteratively adjust the antenna matching mechanism (192) until an end-adjustment criteria is reached.
12. A binaural hearing aid according to any of the previous claims, wherein the adjustable antenna matching mechanism (192) is configured to adjust the antenna matching mechanism (192) upon receiving a detected signal strength being less than a predetermined threshold.
13. A binaural hearing aid according to claim 12, wherein the adjustable antenna matching mechanism (192) is configured to iteratively adjust the antenna matching mechanism (192) until an end-adjustment criteria being the reception of a detected signal strength above the predetermined threshold is reached.
14. A method of matching a hearing aid antenna in a binaural hearing aid in accordance with a detected signal strength of a received communications signal, the binaural hearing aid having a first hearing aid (121) to be positioned at one ear of a user and a second hearing aid (122) to be positioned at another ear of the user, the method comprising receiving the communications signal by a wireless communications unit (131) in the first hearing aid (121), detecting a signal strength of the received communications signal, control a matching mechanism positioned in the first hearing aid (121) and/or the second hearing aid

(122) to obtain optimized antenna reception and/or transmission according to the detected signal strength, wherein the antenna reception/transmission is configured for operation at a frequency of at least 800 MHz.

15. A method according to claim 14, wherein the communications signal is transmitted from the second hearing aid (122) to the first hearing aid (121).

Patentansprüche

1. Binaurales Hörgerät umfassend ein erstes Hörgerät (121) und ein zweites Hörgerät (122), wobei jedes Hörgerät (121, 122) Folgendes umfasst

ein Mikrofon (161, 162) zum Empfangen von Geräusch und Umwandeln des empfangenen Geräusches in ein entsprechendes erstes Audiosignal,

einen Signalprozessor (151, 152) zur Verarbeitung des ersten Audiosignals in ein zweites Audiosignal, das einen Hörverlust eines Benutzers des Hörgeräts kompensiert,

eine drahtlose Kommunikationseinheit (131, 132), die mit dem Signalprozessor (151, 152) zur drahtlosen Kommunikation verbunden ist und mit einer Antenne (111, 112) zum Aussenden und/oder Empfangen eines elektromagnetischen Feldes verbunden ist, wobei die Antenne (111, 112) zum Betrieb bei einer Frequenz von mindestens 800 MHz ausgelegt ist,

wobei das erste Hörgerät (121) einen Detektor (181) aufweist, der mit der drahtlosen Kommunikationseinheit (131) verbunden ist, wobei der Detektor (181) dafür ausgelegt ist, eine Signalstärke eines durch die drahtlose Kommunikationseinheit (131) empfangenen Kommunikationssignals zu detektieren, und wobei das erste Hörgerät (121) und/oder das zweite Hörgerät (122) einen einstellbaren Antennenanpassungsmechanismus (192) aufweist, der zum Empfangen von Information über die detektierte Signalstärke und Einstellen des Anpassungsmechanismus (192) ausgelegt ist, um Empfang/Aussendung durch die Antenne (111, 112) gemäß der detektierten Signalstärke des empfangenen Kommunikationssignals zu optimieren.

2. Binaurales Hörgerät nach Anspruch 1, wobei das durch die drahtlose Kommunikationseinheit (131) empfangene Kommunikationssignal in einem Hörgerät (121) ein Signal ist, das von dem anderen des ersten und zweiten Hörgeräts (122) übertragen wird.
3. Binaurales Hörgerät nach einem der vorgehenden Ansprüche, wobei die Signalstärke unter Verwen-

dung einer RSSI (receive signal strength indicator)-Schaltung gemessen wird.

4. Binaurales Hörgerät nach einem der vorgehenden Ansprüche, wobei das Hörgerät weiter ein Befestigungselement (120) umfasst, das das zweite Audiosignal vom Hörgerätgehäuse zum Ohr eines Benutzers überträgt, wenn das Hörgerät in der beabsichtigten Betriebsposition getragen wird, und wobei sich mindestens ein Teil der Antenne (111, 112) über das Befestigungselement (120) erstreckt.

5. Binaurales Hörgerät nach Anspruch 4, wobei eine Länge der Antenne (111, 112) mit einer Länge des Befestigungselements (120) korreliert wird.

6. Binaurales Hörgerät nach einem der Ansprüche 4-5, wobei das Befestigungselement (120) eine elektrische Verbindung mit einem Empfänger im Ohr eines Benutzers, ein Schallschlauch oder ein Ohrbügel ist.

7. Binaurales Hörgerät nach einem der vorgehenden Ansprüche, wobei die Signalstärke des empfangenen Signals während eines Hörgerätenbringungs Vorgangs detektiert wird.

8. Binaurales Hörgerät nach einem der vorgehenden Ansprüche, wobei der Detektor dafür ausgelegt ist, die Signalstärke beim Auslösen zu detektieren, um den Anpassungsmechanismus adaptiv einzustellen zur Optimierung des Antennenempfangs.

9. Binaurales Hörgerät nach Anspruch 8, wobei der Detektor (181) durch Hörgeräteinstellungen, wie beispielsweise Programmwahl, ausgelöst wird.

10. Binaurales Hörgerät nach einem der vorgehenden Ansprüche, wobei eine Impedanz des Antennenanpassungsmechanismus (192) eingestellt wird, um den Antennenempfang zu optimieren.

11. Binaurales Hörgerät nach einem der vorgehenden Ansprüche, wobei der einstellbare Antennenanpassungsmechanismus (192) dafür ausgelegt ist, den Antennenanpassungsmechanismus (192) iterativ einzustellen, bis ein Eindeinstellungskriterium erreicht ist.

12. Binaurales Hörgerät nach einem der vorgehenden Ansprüche, wobei der einstellbare Antennenanpassungsmechanismus (192) dafür ausgelegt ist, den Antennenanpassungsmechanismus (192) beim Empfangen einer detektierten Signalstärke einzustellen, die geringer als ein vorgegebener Schwellenwert ist.

13. Binaurales Hörgerät nach Anspruch 12, wobei der einstellbare Antennenanpassungsmechanismus

(192) dafür ausgelegt ist, den Antennenanpassungsmechanismus (192) iterativ einzustellen, bis ein Endeinstellungskriterium, das der Empfang einer detektierten Signalstärke oberhalb des vorgegebenen Schwellenwerts ist, erreicht ist.

14. Verfahren zum Anpassen einer Hörgerätantenne in einem binauralen Hörgerät gemäß einer detektierten Signalstärke eines empfangenen Kommunikationssignals, wobei das binaurale Hörgerät ein erstes Hörgerät (121) zur Positionierung an einem Ohr eines Benutzers und ein zweites Hörgerät (122) zur Positionierung am anderen Ohr des Benutzers aufweist, welches Verfahren Folgendes umfasst
- Empfangen des Kommunikationssignals durch eine drahtlose Kommunikationseinheit (131) im ersten Hörgerät (121),
- Detektieren einer Signalstärke des empfangenen Kommunikationssignals, Steuern eines Anpassungsmechanismus, der im ersten Hörgerät (121) und/oder im zweiten Hörgerät (122) positioniert ist, um einen optimierten Antennenempfang und/oder eine optimierte Antennenübertragung gemäß der detektierten Signalstärke zu erreichen, wobei der Antennenempfang/die Antennenübertragung zum Betrieb bei einer Frequenz von mindestens 800 MHz ausgelegt ist.
15. Verfahren nach Anspruch 14, wobei das Kommunikationssignal vom zweiten Hörgerät (122) zum ersten Hörgerät (121) übertragen wird.

Revendications

1. Prothèse auditive binaurale comprenant une première prothèse auditive (121) et une deuxième prothèse auditive (122), chaque prothèse auditive (121, 122) comprenant
- un microphone (161, 162) pour la réception du son et la conversion du son reçu en un premier signal audio correspondant,
- un processeur de signal (151, 152) pour traiter le premier signal audio en un deuxième signal audio en compensation d'une perte auditive d'un utilisateur de la prothèse auditive,
- une unité de communication sans fil (131, 132) connectée au processeur de signal (151, 152) pour une communication sans fil et étant interconnectée avec une antenne (111, 112) pour l'émission et / ou la réception d'un champ électromagnétique, l'antenne (111, 112) étant configurée pour le fonctionnement à une fréquence d'au moins 800 MHz,
- la première prothèse auditive (121) comportant un détecteur (181) connecté à l'unité de communication

sans fil (131), le détecteur (181) étant configuré pour détecter une intensité de signal d'un signal de communication reçu par l'intermédiaire de l'unité de communication sans fil (131), et

la première prothèse auditive (121) et / ou la deuxième prothèse auditive (122) ayant un mécanisme de mise en correspondance d'antenne réglable (192) configuré pour recevoir les informations sur l'intensité de signal détectée et ajuster le mécanisme de mise en correspondance (192) afin d'optimiser la réception / l'émission par l'antenne (111, 112) en fonction de l'intensité de signal détectée du signal de communication reçu.

2. Prothèse auditive binaurale selon la revendication 1, dans laquelle le signal de communication reçu par l'intermédiaire de l'unité de communication sans fil (131) dans l'une prothèse auditive (121) est un signal transmis par l'autre des première et deuxième prothèses auditives (122).
3. Prothèse auditive binaurale selon l'une quelconque des revendications précédentes, dans laquelle l'intensité de signal est mesurée en utilisant un circuit d'indicateur d'intensité du signal de réception (RSSI).
4. Prothèse auditive binaurale selon l'une quelconque des revendications précédentes, dans laquelle la prothèse auditive comprend en outre un élément de fixation (120) transmettant le deuxième signal audio du boîtier de la prothèse auditive à l'oreille d'un utilisateur lorsque la prothèse auditive est portée dans sa position d'utilisation prévue, et dans laquelle au moins une partie de l'antenne (111, 112) s'étend via l'élément de fixation (120).
5. Prothèse auditive binaurale selon la revendication 4, dans laquelle une longueur de l'antenne (111, 112) est corrélée à la longueur de l'élément de fixation (120).
6. Prothèse auditive binaurale selon l'une quelconque des revendications 4 à 5, dans laquelle l'élément de fixation (120) est une connexion électrique à un récepteur situé dans l'oreille d'un utilisateur, un tube de son ou un crochet auriculaire.
7. Prothèse auditive binaurale selon l'une quelconque des revendications précédentes, dans laquelle l'intensité du signal reçu est détectée au cours d'une procédure d'ajustement de prothèse auditive.
8. Prothèse auditive binaurale selon l'une quelconque des revendications précédentes, dans laquelle le détecteur est configuré pour détecter l'intensité du signal lors du déclenchement afin de régler de manière adaptative le mécanisme de mise en correspondan-

ce afin d'optimiser la réception par l'antenne.

9. Prothèse auditive binaurale selon la revendication 8, dans laquelle le détecteur (181) est déclenché par des réglages d'aides auditives, tels qu'une sélection de programme. 5
10. Prothèse auditive binaurale selon l'une quelconque des revendications précédentes, dans laquelle une impédance du mécanisme de mise en correspondance d'antenne (192) est réglée pour optimiser la réception par l'antenne. 10
11. Prothèse auditive binaurale selon l'une quelconque des revendications précédentes, dans laquelle le mécanisme de mise en correspondance d'antenne réglable (192) est configuré pour régler de manière itérative le mécanisme de mise en correspondance d'antenne (192) jusqu'à ce qu'un critère de réglage d'extrémité soit atteint. 20
12. Prothèse auditive binaurale selon l'une quelconque des revendications précédentes, dans laquelle le mécanisme de mise en correspondance d'antenne réglable (192) est configuré pour régler le mécanisme de mise en correspondance d'antenne (192) lors de la réception d'une intensité de signal détectée étant inférieure à un seuil prédéterminé. 25
13. Prothèse auditive binaurale selon la revendication 12, dans laquelle le mécanisme de mise en correspondance d'antenne réglable (192) est configuré pour régler de manière itérative le mécanisme de mise en correspondance d'antenne (192) jusqu'à ce qu'un critère de réglage d'extrémité étant la réception d'une intensité de signal détectée supérieure au seuil prédéterminé soit atteint. 30 35
14. Procédé de mise en correspondance d'une antenne d'une prothèse auditive dans une prothèse auditive binaurale en fonction d'une intensité de signal détectée d'un signal de communication reçu, la prothèse auditive binaurale comportant une première prothèse auditive (121) à positionner au niveau d'une oreille d'un utilisateur et une deuxième prothèse auditive (122) à une autre oreille de l'utilisateur, le procédé comprenant les étapes consistant à recevoir le signal de communication par une unité de communication sans fil (131) dans la première prothèse auditive (121), 40 45 50
détecter une intensité de signal du signal de communication reçu, commander un mécanisme de mise en correspondance positionné dans la première prothèse auditive (121) et / ou la deuxième prothèse auditive (122) pour obtenir la réception / l'émission 55
par l'antenne optimisée en fonction de l'intensité de signal détectée, dans lequel la réception / la transmission est configurée pour le fonctionnement à une

fréquence d'au moins 800 MHz.

15. Procédé selon la revendication 14, dans lequel le signal de communication est transmis à partir de la deuxième prothèse auditive (122) vers la première prothèse auditive (121).

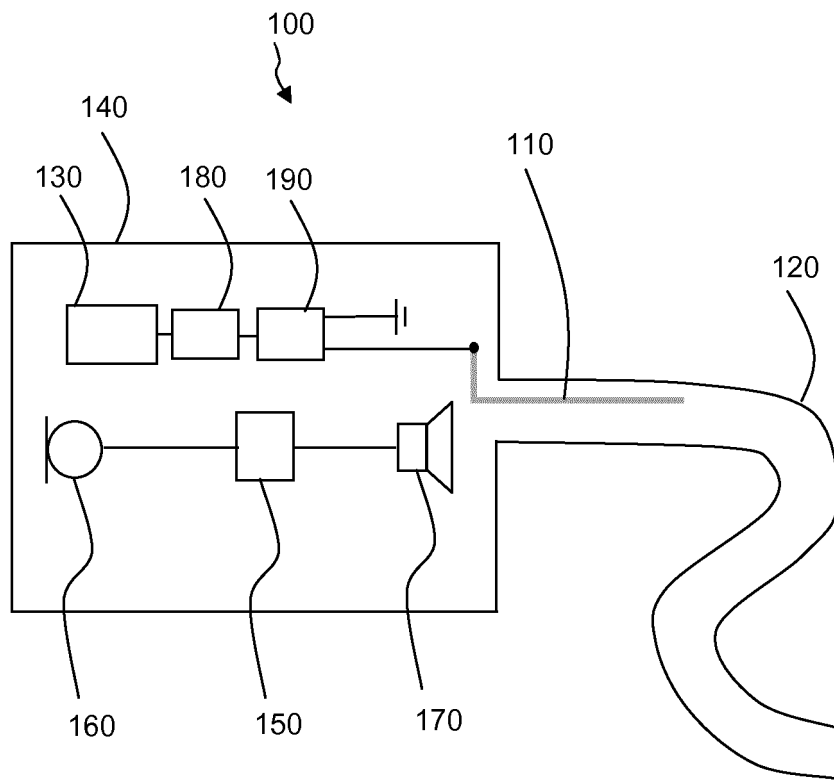


Fig. 1

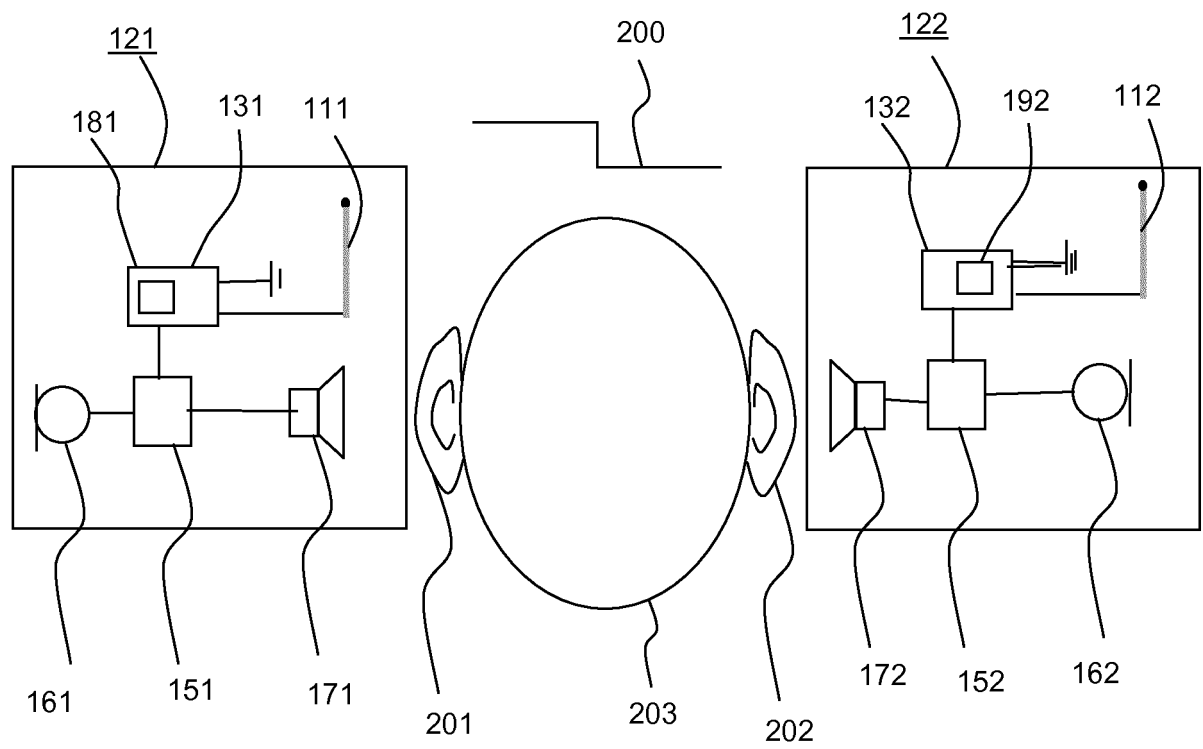


Fig. 2

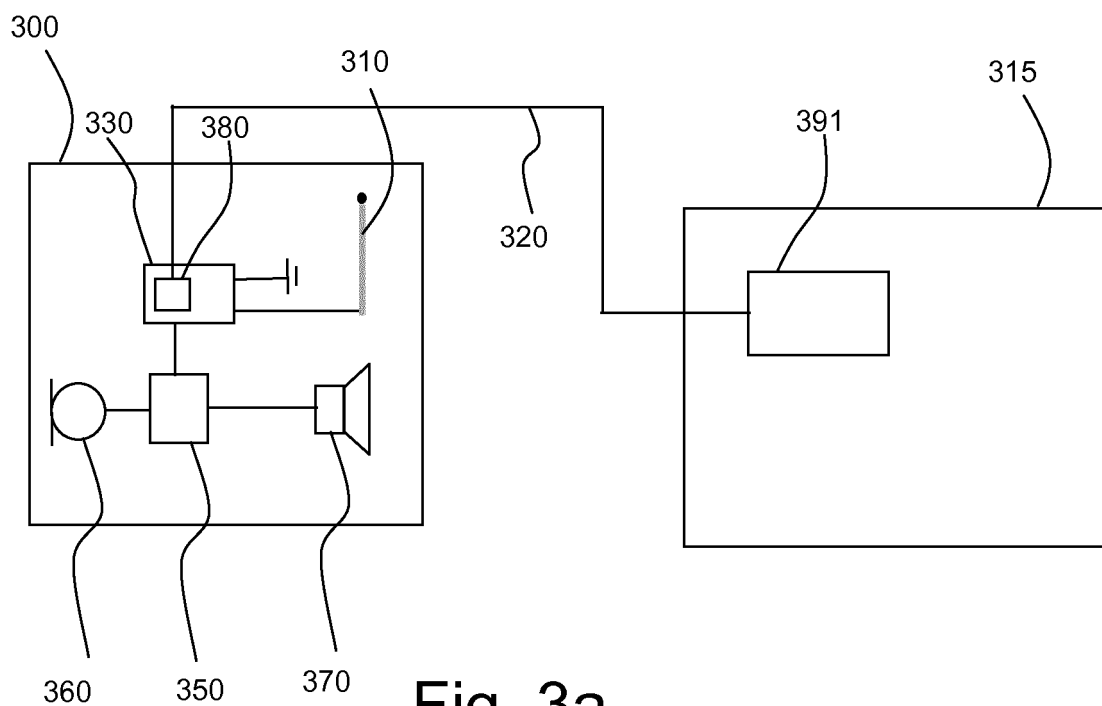


Fig. 3a

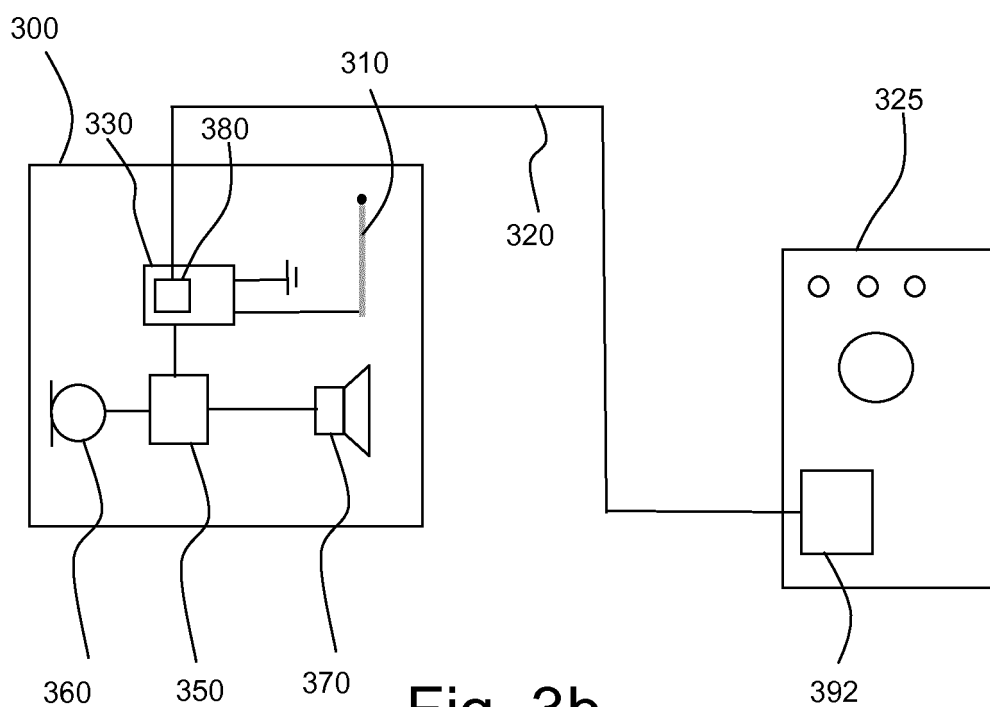


Fig. 3b

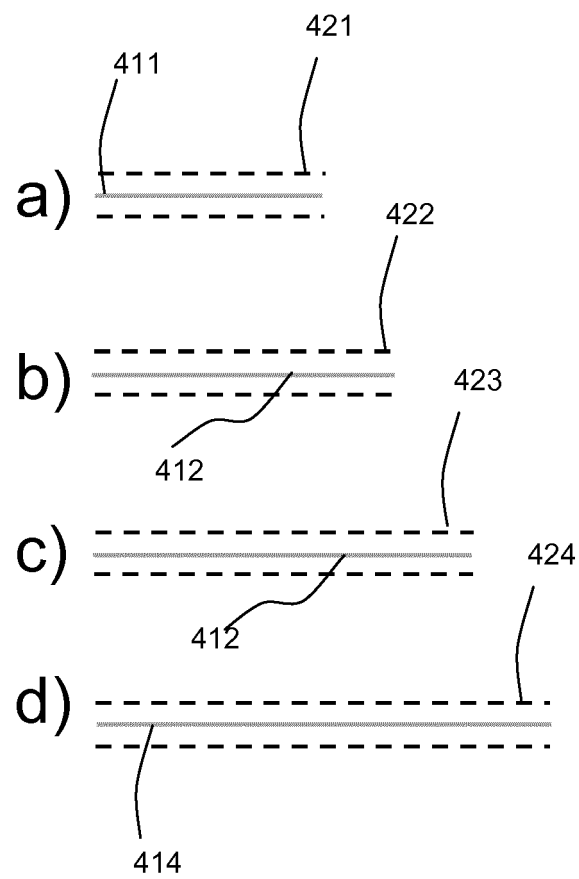


Fig. 4

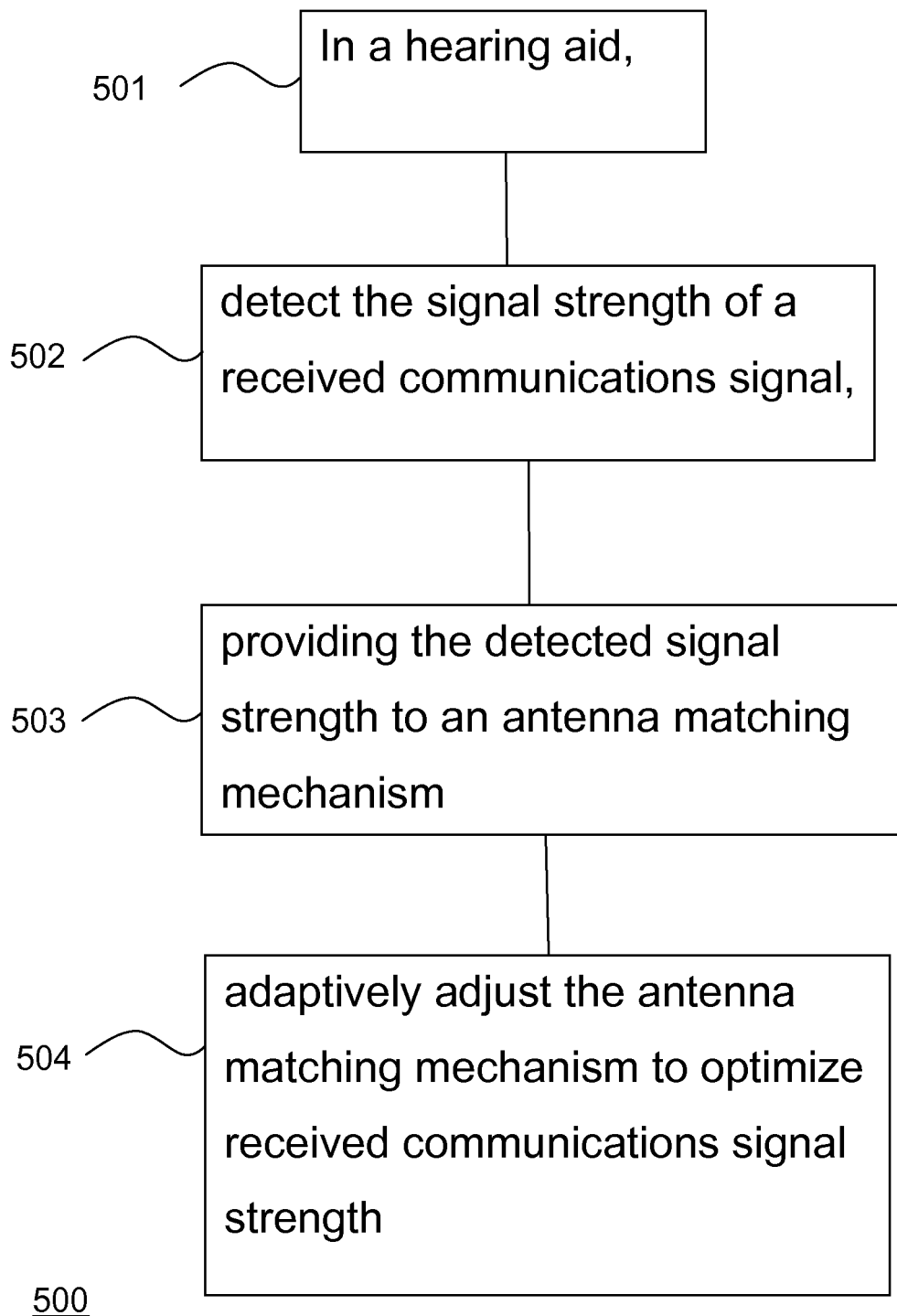


Fig. 5

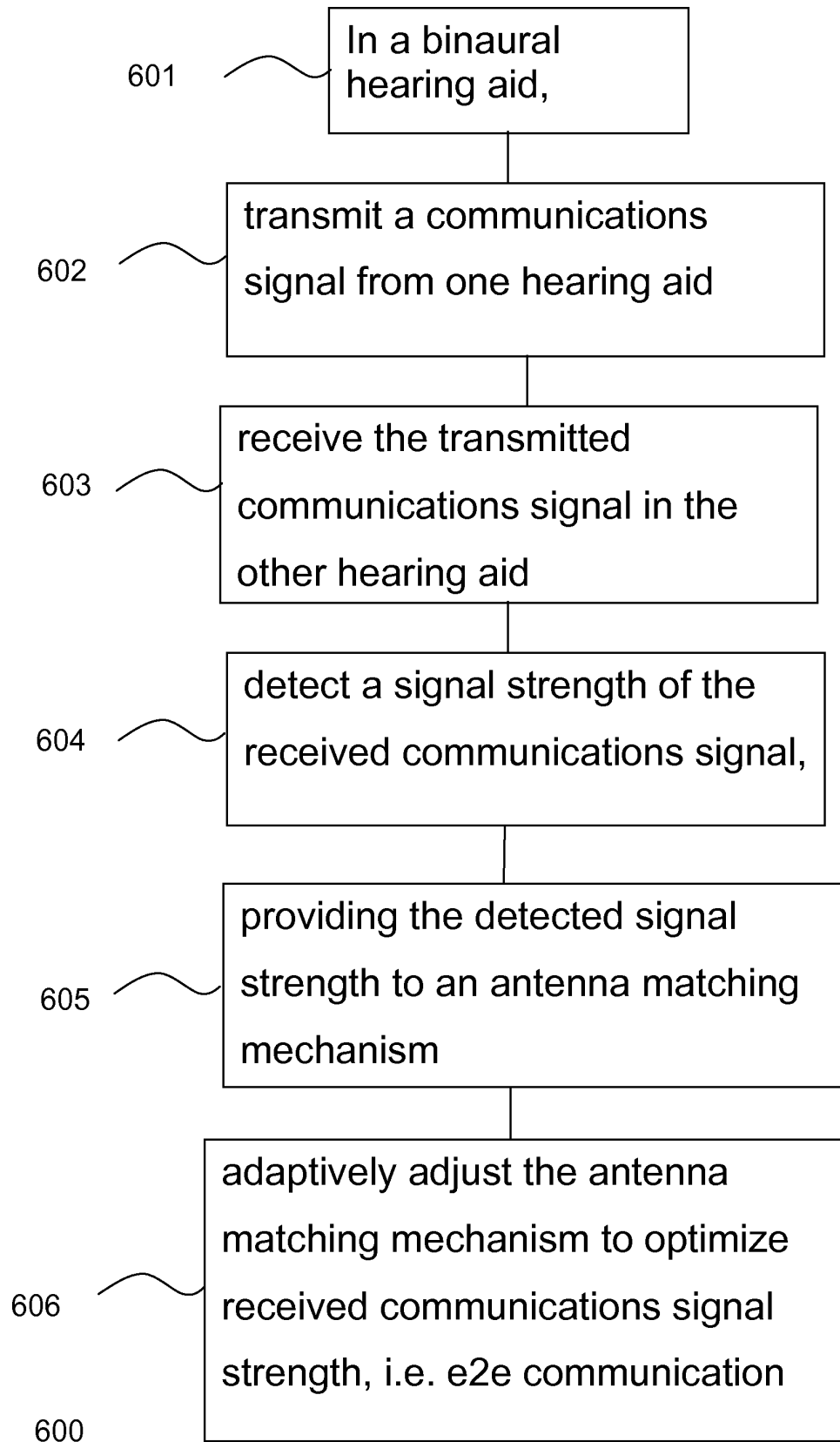


Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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