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(54) **HEARING AID**

(57) The present disclosure relates to hearing aids having self-test features. Still further, the present disclosure relates to chargers for hearing aids, where the

charger has an input and/or output transducer for emitting/receiving test signals for testing conditions of elements of a hearing aid.

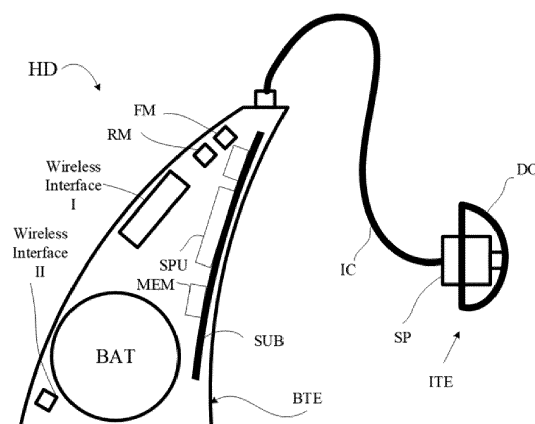


Fig. 1

Description

[0001] The present disclosure relates to hearing aids having speaker units. More particularly, the disclosure relates to different applications of hearing aids having speaker units, which speaker units have a housing configured to be positioned in the ear canal of a user. Even more particular, the present disclosure relates to hearing aids having speaker units with memory device, processor and/or sensors.

[0002] In the so-call RITE style hearing aid, the hearing aid most often comprises a housing configured to be positioned being the ear/pinna of the user, and a housing configured to be positioned in/at the ear canal of the user, most often termed an in-the-ear housing, and a member mechanically connecting the two. The member and the in-the-ear housing is often termed a speaker unit. If the in-the-ear housing comprises a mold, such as a custom-shaped ear mold, this is sometimes termed a power mold as this often allow the use of a higher power output transducer due to a more closed sealing with the ear canal.

[0003] When speaker units and/or (power) moulds are returned due to failure, there has been no way of knowing for how long the part has been used and how it has been handled. This makes it difficult to determine if the failure is covered by warranty and further to estimate if the producer is facing a quality issue.

[0004] In another aspect, for hearing aids, it is the cornerstone to deliver the correct gain and output for the end-user. This requires that the speaker unit is calibrated to the hearing aid and fitting software so that for a certain mV output the receiver/output transducer delivers the correct sound pressure level to the user.

[0005] Current speaker unit calibration is based on a nominal production sample and thus individual production variations is not calibrated for. This causes variations on the gain and sound pressure level on the client. With potential degraded sound quality and not optimal target match for the HCP as two key examples on non-optimal performance.

[0006] By storing sensitivity and output data SPL in the speaker unit, it is possible to make much better and precise hearing aids fittings and deliver better SQ for the client when the hearing fitting software and or the hearing read this data and apply the corresponding individual compensation.

[0007] It is further suggested to store the related key parameters in the hearing aid fitting: Vent response and RECD in the speaker unit as the vent, RECD is a coupled acoustics system with the receiver. This may be used to better calibrate the hearing aid fitting. The impedance of the receiver may be stored for future application implemented e.g. in software of the hearing aid processor.

[0008] Speaker units may comprise multiple sensors, such as one or more of temperature, pressure, pulse/heart rate, etc. Each sensor will require calibration. The speaker unit could store this calibration data so the hearing aid and/or speaker unit may easily access them.

[0009] A RITE hearing aid comprises (at least) two independent parts, an amplifier unit and a speaker Unit (SU).

[0010] When the HCP is fitting the hearing aid, only the amplifier information can be detected by the Fitting system. The SU is not specifically known by the fitting system, only cursory information about it is typed in by the fitter. This information carries risk of entering wrong information, with associated risk that the sound in the hearing aid being too loud or too soft for the user.

[0011] During the product lifetime, the SU typically needs replacement, which is sometimes done by the end user. When storing information in the SU, the Amplifier unit may automatically adapt to the replacement SU, even if there are differences. It can also prevent the application of a SU that doesn't suit the end user, such as a too low sound pressure level as maximum output.

[0012] When Speaker Units have other features than emitting sound, eg. Sensor features or microphones, it is important to check compatibility between Amplifier unit and Speaker Unit.

[0013] In an aspect, an RFID chip may be used for tracking hearing aids. This RFID chip may be readable when the hearing aid is lying on a table/surface, such as in a production line, hence the RFID chip needs to be placed somewhat parallel with the side of the hearing aid.

[0014] In a further aspect, when designing hearing aids one of the major challenges is achieving sufficient acoustical output while keeping the size of the instrument on an attractive level. The receiver/output transducer takes up a significant part of the instrument volume either behind the ear (in BTEs) or in the ear (such as Custom or RITE instruments). The maximum output a receiver can generate before it reaches an unacceptable distortion level is largely determined by the size.

[0015] Distortion is when the output contains new frequency components which are correlated to the input signal (If uncorrelated it is "noise" not distortion). This aspect aims at delivering higher output without increasing the size or reducing the size while maintaining the output, or something in between. Let us call this size vs distortion limited output, Output/size ratio.

[0016] Current and power consumption is a major issue in hearing aids. Some features such as sensors, like PPG-sensors, consume a lot of power which leads to shorter battery life as batteries in hearing aids are relatively small and have limited power storage.

[0017] In a further aspect, a hearing aid may stop performing as intended due to e.g. earwax blocking filters in front of the receiver/output transducer or microphone/input transducer or the receiver being damaged due to drop. The end-user may not notice a decline in performance especially if the decline is a gradual degradation of performance. Caretakers cannot always assess if the instrument is performing correctly. In some cases, the end-user is simply not communicating to them that the hearing instrument is no longer working correctly or sufficiently.

[0018] The result is that end-user is not getting the help

that is needed from the hearing aid leading to dis-satisfied customers. Another problem is the filters in many cases are not being replaced often enough which leads to the receiver itself being damaged by ingress of earwax.

[0019] In a still further aspect, it is herein disclosed that when designing chargers for a range of Hearing Aids or Wearables, there is usually a need to make specific mechanical modifications to each charger "pit/cradle" for each Style/Variant. The reason is that the outer shape of the HI/wearable and the location of the charge pads vary. Customers wearing 2 different hearing aids, that is, one specific type at each ear, will often need to carry two chargers.

[0020] The present aspect provides a solution where the HI is to be charged using a cable, where one cable could be used for multiple devices. A similar concept is known from consumer electronics where three different variants, micro-USB, USB-C and lightning cables, is able to connect to many different products.

[0021] Using a charge cable in a Hearing instrument has at least the following challenges.

- The weight of the HI is very low meaning the cable stiffness and weight will determine the position on the table and the HI could easily slide off a table.
- The socket in the HI will consume space inside and/or on the instrument.
- The circuit controlling the charging dissipate significant power which heats up the instrument. This is not only a challenge with cable chargers.

[0022] Therefore, there is a need to provide a solution that addresses at least some of the above-mentioned problems. Further, the present disclosure provides at least an alternative to the prior art.

[0023] One aspect of the present disclosure relates to a hearing instrument with a detachable speaker unit. A memory unit may be included in a housing of the hearing instrument or in the detachable speaker unit. Data may be written and/or updated in the memory unit during use of the hearing instrument. This could enable diagnostic information to be retrieved and analyzed after failure. Further, aggregating or analyzing data from multiple failures of individual devices could yield information on other

[0024] Further aspects are listed above. Individual and/or groups of features from the different aspects may be combined.

BRIEF DESCRIPTION OF DRAWINGS

[0025] The aspects of the disclosure may be best understood from the following detailed description taken in conjunction with the accompanying figures. The figures are schematic and simplified for clarity, and they just show details to improve the understanding of the claims, while other details are left out. Throughout, the same reference numerals are used for identical or corresponding parts. The individual features of each aspect may

each be combined with any or all features of the other aspects. These and other aspects, features and/or technical effect will be apparent from and elucidated with reference to the illustrations described hereinafter in which:

Fig. 1 schematically illustrates a hearing aid,
Figs. 2 and 3 schematically illustrates a hearing aid having an RFID chip,
Fig. 4 schematically illustrates a hearing aid receiving ambient noise,
Fig. 5 illustrates a cable charger for a set of hearing aids,
Fig. 6 illustrates a hearing aid for connecting to a charger of Fig. 5,
Fig. 7 illustrates a connector of a charger of Fig. 5,
Fig. 8 schematically illustrates a user wearing a set of hearing aids each connected to a charger of similar type as shown in Fig. 5 and connected to a power bank,
Fig. 9 schematically illustrates a hearing aid in a charger box having an output and an input transducer,
Fig. 10 schematically illustrates a set of hearing aids engaged in mutual testing,
Fig. 11 schematically illustrates a charger box having an input and an output transducer, where the input transducer and output transducer is engaged in testing of each other.

DETAILED DESCRIPTION

[0026] The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. Several aspects of the apparatus and methods are described by various blocks, functional units, modules, components, circuits, steps, processes, algorithms, etc. (collectively referred to as "elements"). Depending upon particular application, design constraints or other reasons, these elements may be implemented using electronic hardware, computer program, or any combination thereof.

[0027] The electronic hardware may include micro-electronic-mechanical systems (MEMS), integrated circuits (e.g. application specific), microprocessors, micro-controllers, digital signal processors (DSPs), field programmable gate arrays (FPGAs), programmable logic devices (PLDs), gated logic, discrete hardware circuits, printed circuit boards (PCB) (e.g. flexible PCBs), and other suitable hardware configured to perform the various functionality described throughout this disclosure, e.g. sensors, e.g. for sensing and/or registering physical properties of the environment, the device, the user, etc. Computer program shall be construed broadly to mean

instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

[0028] A hearing device (or hearing instrument, hearing assistance device) may be or include a hearing aid that is adapted to improve or augment the hearing capability of a user by receiving an acoustic signal from a user's surroundings, generating a corresponding audio signal, possibly modifying the audio signal and providing the possibly modified audio signal as an audible signal to at least one of the user's ears. 'Improving or augmenting the hearing capability of a user' may include compensating for an individual user's specific hearing loss. The "hearing device" may further refer to a device such as a hearable, an earphone or a headset adapted to receive an audio signal electronically, possibly modifying the audio signal and providing the possibly modified audio signals as an audible signal to at least one of the user's ears. Such audible signals may be provided in the form of an acoustic signal radiated into the user's outer ear, or an acoustic signal transferred as mechanical vibrations to the user's inner ears through bone structure of the user's head and/or through parts of the middle ear of the user.

[0029] The hearing device is adapted to be worn in any known way. This may include i) arranging a unit of the hearing device behind the ear with a tube leading airborne acoustic signals into the ear canal or with a receiver/ loudspeaker arranged close to or in the ear canal and connected by conductive wires (or wirelessly) to the unit behind the ear, such as in a Behind-the-Ear type hearing aid, and/ or ii) arranging the hearing device entirely or partly in the pinna and/ or in the ear canal of the user such as in an In-the-Ear type hearing aid or In-the-Canal/ Completely-in-Canal type hearing aid, or iii) arranging a unit of the hearing device attached to a fixture implanted into the skull bone such as in a Bone Anchored Hearing Aid, or iv) arranging a unit of the hearing device as an entirely or partly implanted unit such as in a Bone Anchored Hearing Aid. The hearing device may be implemented in one single unit (housing) or in a number of units individually connected to each other.

[0030] A "hearing system" refers to a system comprising one or two hearing devices, and a "binaural hearing system" refers to a system comprising two hearing devices where the devices are adapted to cooperatively provide audible signals to both of the user's ears. The hearing system or binaural hearing system may further include one or more auxiliary device(s) that communicates with at least one hearing device, the auxiliary device affecting the operation of the hearing devices and/or benefitting from the functioning of the hearing devices. A wired or wireless communication link between the at least one hearing device and the auxiliary device is es-

tablished that allows for exchanging information (e.g. control and status signals, possibly audio signals) between the at least one hearing device and the auxiliary device. Such auxiliary devices may include at least one of a remote control, a remote microphone, an audio gateway device, a wireless communication device, e.g. a mobile phone (such as a smartphone) or a tablet or another device, e.g. comprising a graphical interface, a public-address system, a car audio system or a music player, or a combination thereof. The audio gateway may be adapted to receive a multitude of audio signals such as from an entertainment device like a TV or a music player, a telephone apparatus like a mobile telephone or a computer, e.g. a PC. The auxiliary device may further be adapted to (e.g. allow a user to) select and/or combine an appropriate one of the received audio signals (or combination of signals) for transmission to the at least one hearing device. The remote control is adapted to control functionality and/or operation of the at least one hearing device. The function of the remote control may be implemented in a smartphone or other (e.g. portable) electronic device, the smartphone / electronic device possibly running an application (APP) that controls functionality of the at least one hearing device.

[0031] In general, a hearing device includes i) an input unit such as a microphone for receiving an acoustic signal from a user's surroundings and providing a corresponding input audio signal, and/or ii) a receiving unit for electronically receiving an input audio signal. The hearing device further includes a signal processing unit for processing the input audio signal and an output unit for providing an audible signal to the user in dependence on the processed audio signal.

[0032] The input unit may include multiple input microphones, e.g. for providing direction-dependent audio signal processing. Such directional microphone system is adapted to (relatively) enhance a target acoustic source among a multitude of acoustic sources in the user's environment and/or to attenuate other sources (e.g. noise). In one aspect, the directional system is adapted to detect (such as adaptively detect) from which direction a particular part of the microphone signal originates. This may be achieved by using conventionally known methods. The signal processing unit may include an amplifier that is adapted to apply a frequency dependent gain to the input audio signal. The signal processing unit may further be adapted to provide other relevant functionality such as compression, noise reduction, etc. The output unit may include an output transducer such as a loudspeaker/ receiver for providing an air-borne acoustic signal transcutaneously or percutaneously to the skull bone or a vibrator for providing a structure-borne or liquid-borne acoustic signal.

[0033] Fig. 1 schematically illustrates a hearing device HD comprising a behind-the-ear housing, BTE, which is configured to be positioned in the area between the pinna and the skull of a user.

[0034] The BTE comprises the majority of electronic

components of the hearing device, such as microphone system comprising first and second microphones, FM and RM, processor SPU, memory MEM, power source BAT, wireless interface(es) I and II, however, one or more of these components may be located in or distributed across other parts, such as an In-The-Ear housing/part ITE. The ITE part comprises an output transducer SP, which is configured to transform a processed electrical signal into a signal that the user may perceive as sound, such as air born audio. One or more of the electronic components may be arranged in connection with or on a substrate SUB. The power source BAT may be a primary or secondary battery, i.e. replaceable or rechargeable. The recharging may be contact charging or wireless charging.

[0035] The wireless interface may include an inductively-based system comprising a coil configured for reception and/or transmission of low frequency signals, such as magnetic induction signals, e.g. to/from a hearing device located contralaterally.

[0036] The wireless interface may include an RF-frequency based system, comprising a radio frequency antenna, e.g., an antenna configured for reception and/or transmission at around 2.4 GHz.

[0037] The speaker unit could include one or more sensors, such as temperature sensor, accelerometer, vibration sensor,

When a hearing instrument is provided with a writable memory, such as an NVRAM, EEPROM or the like, the hearing instrument will be able to store/modify/update information in that memory. If the memory device is positioned/arranged in a detachable speaker unit, an analysis of this data is also possible without the hearing instrument acting as an interface to the data. The data may be read out via a connector in the detachable speaker unit or may be wirelessly accessible. The wireless accessibility may also be used by the hearing aid.

[0038] Such data could be read out via a processor in the hearing instrument and, e.g., subsequently transmitted to an external device, such as a computer, tablet, smartphone or the like, via a communication interface in the hearing instrument, such as a wired or wireless interface. The data could be processed in some manner in the hearing aid and/or in the external device. The communication interface could be communicating via an intermediate device, such as a charger, such as a portable charger or table charger. The charger could be a charger using wireless charging or a charger using contact charging. The intermediate device could then also have a charger communications interface, which may be wired or wirelessly communicating with a computer, tablet or smart phone, or to a cloud-based service, such as via the Internet.

[0039] One example of data stored in the memory, which could be stored in the detachable speaker unit, such as a speaker unit with an earmold, is a date of when the speaker was first used, that is, used by the user for the first time. This could make it possible to

- Determine if replacement is covered by warranty
- Detect if the life-time of certain batches are usually low which should trigger an investigation by quality.

5 **[0040]** Another example could be storing information on extreme environmental conditions i.e. drop/accelerations, temperature, humidity etc. This would make it possible to

- 10
- Determine if replacement is covered by warranty
 - Gain knowledge of root causes for failures

[0041] Another example could be storing information on the settings used for the speaker unit. This would make it possible to

- 15
- Determine if there is a higher tendency for failures when receivers are driven to their limit

20 **[0042]** This could be achieved by storing e.g. sound level output at certain times, an average of output sound level over a given period or samples of output sound level at regular or irregular intervals.

[0043] In a larger system processing the data, such data may be aggregated from several speaker units so as to determine if problems to a specific speaker unit is a general problem or a user specific problem.

[0044] When updating/storing data in the memory, this data could include information as listed in the following.

- 30
- Sensitivity SPL / mV as function of frequency for 50 dB SPL input equivalent input signal in IEC 711 coupler,
 - OSPL90, the maximum output sound pressure level in IEC 711 coupler
 - Speaker model: Output SPL as function of frequency (1/24 octave resolution from 100 Hz to 10 kHz) vs input voltage stepped from 0 to 1 V in 1/100 V steps
 - Impedance: in ohm as function frequency in 1/24 octave
 - Vent or Dome response in dB SPL 1/24 octave from 100 to 10 kHz.
 - RECD: at the audiometric frequencies 125 to 8 kHz.
 - Sensor calibration data: Sensor temperature, pulse, pressure, etc
- 45

[0045] These data could be useful for the hearing aid, e.g. for adapting the output signal before supplying this to the output transducer. Further, a warning signal may be provided to the user if for some reasons a parameter is out of it's normal range. This could include warning the user that a speaker unit with a wrong maximum output sound pressure level is attached. A wrong SPL could lead to a distorted or potentially damaging signal being provided to the user.

[0046] How may the parameters determined?

- Sensitivity: In production,

- Speaker model: In production,
- Impedance: In production,
- Vent or Dome response: At the HCP on the client, or at boot time from hearing aid on the client, which could be done at each boot up or at different.
- RECD: at the HCP or using value from diagnostic instrument.
- Sensor calibration data: At production and or at HCP fitting

[0047] The parameter may be determined during production, and the parameter values stored in the specific speaker unit, where the hearing aid is then able to adapt the processed signal to specific characteristics of the specific speaker unit attached to the hearing aid. As mentioned, a speaker unit may need to be replaced, either by the user or at a hearing health care professional (HCP).

[0048] How are the parameters used:

- Sensitivity: Hearing aid or receiver is calibrated to sensitivity. Fitting software uses sensitivity in the simulation model to display correct graphs.
- OSPL90: hearing aid or receiver is set to never exceed OPSPL90. The fitting software uses the value in both graphs and MPO trimmer systems.
- Speaker model:

fitting software uses the speaker model to accurately model the receiver in the simulation model for display in graphs.

Apply anti-distortion parameters based on speaker model for better sound quality at high output levels

- Impedance: could be used to determine that the speaker unit is damaged or clogged,
- Vent or Dome: Used by fitting software to simulate hearing aid performance. Hearing aid compensates low-frequency loss - by applying a frequency dependent gain-correction.
- RECD: Used to compensate for non-standard residual volume of ear canal. Key use case is for pediatric fittings. Used by the fitting software and by the hearing aid.
- Sensor calibration data: Used to calibrate the sensor to measure correctly.

Key benefits:

[0049]

- Better safety - correct SPL for the client,
- Better target match - receiver variations are calibrated for,
- Better Signal Quality - more flat frequency response,
- Better localization - due to much less left & right imbalance is calibrate,

- Speaker Unit may be updated in market - when the hearing aid and fitting software can read calibration values from it.
- Supports easier use of second source products
- New sensor calibration data is stored in SU.

[0050] It may be beneficial for the user that a hearing aid supports remote fitting, i.e. fitting or adaptation of parameters at a location remote from a hearing care professional. In remote fitting situation, when no hearing health care professional is present to warrant patient safety, optimum fitting it is even more important that an automatic check ensures that the correct speaker unit is applied to the correct amplifier. A wrong fitting could result in undesirable fitting with HI being located uncomfortably and in worst case situations result in too loud or too low sound level. The need for automatic detection is even more evident for end-users who are visual impaired.

[0051] The present disclosure thus provides a hearing aid having a processor configured to detect identity of a speaker unit being attached to a hearing aid housing, and checking said identity of the speaker unit. The identity may be transmitted to a remote unit, such as a fitting device or computer. If said identity check results in a speaker unit not being identified as an allowed device, the hearing aid may be configured to provide an alarm signal.

[0052] Especially during production, an RFID chip could be used for tracking a hearing instrument. This could be useful in automated production facilities where an instrument may pass through different production stations or at the end of production and the instrument needs to be packaged and a final check of the instrument type or identity could be verified automatically or at least read out so an operator may verify prior to packaging. This RFID chip should be readable when the hearing instrument is lying on a table, hence the RFID chip needs to be placed somewhat parallel with the side of the hearing aid.

[0053] Until now, the RFID has been placed horizontally on a flap on the PCB. The flap with the RFID chip has then been bended down the side of the rack in the assembly process.

With this invention, we are planning to place the RFID chip vertically on the PCB instead. In this way, there is no flap that needs to be bended down the side.

[0054] This means that the PCB does not need to have a flap. By not having this flap, there are two advantages:

- It is easier to place the amplifiers close together in a panel, which might make it possible to have more amplifiers per panel and hence, less cost per amplifier.
- The bending that is needed in the existing solution will require a bending zone. And this bending zone will make the instrument wider compared to if it was not there.

[0055] Please also see the two drawings in Figs. 2 and 3.

[0056] The present disclosure thus provides a hearing aid having a housing having first and second sides and interconnecting top and bottom parts connecting the first and second sides so as to establish at least part of a housing. In the hearing aid, an RFID chip is arranged so as to be parallel with at least one of the first or second sides.

[0057] In hearing aids having one or more sensors, the operation of these sensors require power. Generally, current and power consumption is a major issue in hearing aids as battery power and capacity is limited. Some features like PPG-sensors and/or EEG sensors consume a lot of power which leads to shorter battery life.

[0058] The idea is switching between in which ear the sensor, such as PPG, EEG or IMU, is active based on e.g.

- Even split just to distribute the load. One HI only have to measure half of the time. This could be time based and a signal may be transmitted from one hearing aid instrument to the other when switching, or the activation/deactivation may simply be done based on a local timer with occasional synchronization between the two devices.
- Based on signal quality information i.e. SNR of the detected signal. Only measure in the ear which provides the highest quality signal. Coordination of which device is operational may be achieved via wireless communication between the two hearing aids.
- Include signals from both ears when sensor data quality is low.
- Power saving from single sided operation could also be converted to improved sensor data (e.g. allowing higher LED current or higher frequency of recording of measurements. Always or only when needed)
- Based on battery status e.g. if the hearing loss is higher on the right ear then right hearing aid instrument will use more power for audio processing and/or delivery and it would make sense to mainly use the left ear for sensors. If over time the "Active HI" get significantly lower battery level than the "Inactive HI" the two hearing aids could switch roles.
- The sensor data could be time stamped.
- A combination of the above

[0059] The idea could also be used for other power intensive features like Bluetooth LE (BLE).

Connection to e.g. mobile phone could be done by one HI and the "BLE active" HI could transmit to the other HI via a lower power path, such as via an inductive communication link.

Which HI should have the active connection could be determined by analysis of the transmission quality/transmitter power.

Based on battery level as mentioned in the PPG sec-

tion.

[0060] Acoustical self-test of a hearing aid may be done by the hearing aid playing a test signal through the receiver and the signal being picked up by the microphone subsequently being analyzed. If the received signal differs significantly from the reference signal emitted the HI performance is assumed degraded and the user may be warned. Unfortunately, when performing a self-test, the audio signals are easily disturbed/polluted by noise in the surroundings. Also, it is not always possible to detect/determine if the degradation is in the microphone or receiver path.

[0061] Fig. 4. illustrates ambient noise being mixed with sound from the output transducer at the microphone system of the hearing aid.

[0062] The present disclosure proposes to do a self-test when the HI is placed in a charger or similar box with a lid. When the lid is closed the ambient noise is reduced or even eliminated and the results become more reliable.

[0063] The self-test can be initiated automatically for instance when the charging is completed or at a certain level or even when charging is initiated. The result of the self-test may be conveyed to the user via displayed on a mobile phone in wireless communication with the hearing aid or the charger device, or visually by means of e.g. LEDs on either hearing aid or charger.

[0064] When the self-test is triggered by the charging device it may be safe to assume that the hearing aid is not placed on or in the ear of the user, and consequently it will be possible to test with full audio output without risk of injury to the user/wearer.

[0065] Manually starting the test could also be an option, e.g. from an app on a smartphone or from a software running on a computer in communication with the hearing aid.

[0066] Alternatively another enclosure e.g. a coffee mug could be used as enclosure.

[0067] As illustrated in Fig. 9, a charger box may be provided with a speaker and/or microphone in the inner space created in the charger when the lid is closed. Assuming these would be less exposed to the surroundings, it may be assumed that they are generally more reliable than those of the hearing aid and they thus will provide more accurate signals. Especially if combined with the microphones and speakers in the HI. As above, testing may be initiated at any point in the charging process, or after the charging process has been concluded.

[0068] As illustrated in Fig. 10, testing may be performed in pairs, advantageously in a charger with a closeable lid. Another way of increasing the accuracy of the self-test, possibly without adding additional components in the charger, is letting the hearing aids in a binaural set (Left and Right) test each other. A test signal may thus be emitted by one, or both, hearing aids, and the sound then be picked up by one or both of the hearing aids. The received audio signal may be compared to the reference (outputted) signal or the two received signals may be

compared in some manner. One assumption during the test could be that in the charger box, the output transducer of one hearing aid is closer to the input transducer of the other hearing aid.

[0069] In these self-tests, it would be preferable that there is no output of the sound recorded by the microphone system as that potentially could cause a feedback problem. The so-called forward path in the hearing aid may thus be disabled during the testing period.

[0070] The above methods could also be combined for improved accuracy of the self-test.

[0071] If speaker and microphone is included in the charger it would be possible to make a self-test of the charger box elements by rendering a test signal via the speaker which is then received by the microphone. By analyzing the signal, it can be detected if the microphone and speaker of the charger box are functioning as intended.

[0072] One test could be that a speaker in the charger renders sound that is then picked up by the microphone system of one or more hearing aids in the charger.

[0073] One test could be that the speaker of one hearing aid in the charger renders sound that is then picked up by the microphone system of the charger.

[0074] One test could be that the speaker of one hearing aid renders sound that is then picked up by the microphone system of another hearing aid in the charger.

[0075] Processing of the test signals may be performed by one or more of the hearing aids, a processor in the charger, a processor in an external device in wireless or wired communication with the charger and/or hearing aid(s).

[0076] Several combinations of sound sources and microphones has been proposed for conducting selftest in an enclosure. Notably a way of doing the self test in an enclosure without any additional hardware or complications to the hearing aid itself.

[0077] Self-test of the HI can reduce the risk of end-users not getting the help they need from the HI. Potentially warranty cost can be reduced because blocked filters are detected early.

[0078] Fig. 5 illustrates an alternative charger device of a set of hearing aids. The basic idea is a cable charger which is able to charge 2 instruments simultaneously. At the fork of the y-cable there is a "base" which serves different purposes including providing stability and housing electronics. The base could include a weight element to provide extra stability. A power converter may be included in the base. As illustrated, the base may be connected at one end via a USB connector to a power supply. Alternative interfaces may of course be provided.

[0079] The hearing aids are charged via a physical interface which could be reused across different hearing aid styles to enable using one charger for different type and styles of hearing aids.

[0080] This does not only reduce the number of different chargers but also enables using one charger even if the use is using different hearing aids at the left and right

ear, such as a so-called BTE at one ear and a custom or RITE device at the other ear.

[0081] To avoid the hearing aid moving around on the table or even sliding of the table a "Base" with significant weight(compared to the cable) and a non-slip bottom surface is placed at the fork. This could also include or be supplemented by a magnetic device.

[0082] Some of the electronics needed for charging the battery in the hearing aid could be placed in the "base". This could potentially save space in the hearing aid and reduce heating of the hearing aid during charging. Heating of a hearing aid is critical since it is a medical device which get in contact with the skin. Even if the hearing aid is not worn while charging it can be taken directly from the charger and placed on the ear/skin. Also, an increased heat may damage or reduce lifetime of the battery.

[0083] To ensure good usability it should be easy to connect to the charger. A rotational symmetric connector system is preferred, see Figs. 6 and 7. If possible the plugs should be guided towards each other using a combination of magnets and/or metal pieces, such as rings. With magnets there is however a risk of damaging the receiver/speaker so this will need to be considered in the design.

[0084] If the hearing aid is able to function while being charged, it may also be possible to charge the hearing aid via a Powerbank, a charging case, from a laptop, wallcharger etc. while on the move and wearing the hearing aids, see Figure 8. In this case, the base could feature a clip which could be attached to e.g. a shirt to relieve the stress in the charging connector. Another option would be not having the "Base" at the Y of the cable and place the electronics in either the Hearing Aid or by the USB-plug since this will reduce the need for a "clip".

[0085] It is intended that the structural features of the devices described above, either in the detailed description and/or in the claims, may be combined with steps of the method, when appropriately substituted by a corresponding process.

[0086] As used, 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, but an intervening element may also 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 disclosed method are not limited to the exact order stated herein, unless expressly stated otherwise.

[0087] It should be appreciated that reference throughout this specification to "one embodiment" or "an embodiment" or "an aspect" or features included as "may" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. Furthermore, the particular features, structures or characteristics may be combined as suitable in one or more embodiments of the disclosure. The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more.

[0088] Accordingly, the scope should be judged in terms of the claims that follow.

Claims

1. A system comprising a hearing aid and a charger box,

wherein the hearing aid comprises:

a first housing configured to be positioned behind the ear of a user,
a second housing configured to be positioned at the ear canal of the user,
an output transducer arranged in the second housing,
a rechargeable battery arranged in the first or second housing,
a hearing aid sound processor operationally connected to said output transducer and said input transducer,

wherein the charger box comprises:

a charger box housing having an openable lid, the lid and housing establishing a charger space,
an interface configured to deliver a charge current to a hearing aid placed in the charger box,
a charger output transducer arranged in communication with the charger space,
a charger processor operationally connected to said charger output transducer,

wherein the charger processor is configured to

provide an output signal via said charger output transducer and wherein the hearing aid processor is configured to process a signal representing a received signal from said input transducer, wherein said hearing aid sound processor is configured to, based on said signal representing a received signal and a signal relating to said output signal, determine a current state of said input transducer.

2. A system comprising a hearing aid and a charger box,

wherein the hearing aid comprises:

a first housing configured to be positioned behind the ear of a user,
a second housing configured to be positioned at the ear canal of the user,
an output transducer arranged in the second housing,
a rechargeable battery arranged in the first or second housing,
a hearing aid sound processor operationally connected to said output transducer and said input transducer,

wherein the charger box comprises:

a charger box housing having an openable lid, the lid and housing establishing a charger space,
an interface configured to deliver a charge current to a hearing aid placed in the charger box,
a charger input transducer arranged in communication with the charger space,
a charger processor operationally connected to said charger input transducer,

wherein the processor is configured to provide an output signal via said transducer and wherein the charger processor is configured to process a signal representing a received signal from said charger input transducer, wherein said charger processor is configured to, based on said signal representing a received signal and a signal relating to said output signal, determine a current state of said output transducer.

3. A system comprising a first hearing aid and a second hearing aid,

wherein each of the first hearing aid and the second hearing aid comprises:

a first housing configured to be positioned
 behind the ear of a user,
 a second housing configured to be posi-
 tioned at the ear canal of the user,
 an output transducer arranged in the sec- 5
 ond housing,
 a rechargeable battery arranged in the first
 or second housing,
 a hearing aid sound processor operationally
 connected to said output transducer and 10
 said input transducer,
 an input transducer,

wherein the processor of the first hearing aid is
 configured to, in response to a trigger event, out- 15
 put a test signal via said output transducer, and
 said second hearing aid is configured to receive
 a received audio signal via said input transducer,
 and said processor of said second hearing aid
 is configured to determine a state of said input 20
 transducer and/or said output transducer based
 on said received audio signal, wherein the trig-
 ger event is conditioned on the first and second
 hearing aid being arranged in a charger box.

- 25
4. The system according to claim 3, wherein the trigger
 event is further conditioned on the power source of
 the first and/or second hearing aid having a charged
 level above a first threshold.
- 30
5. The system according to claim 3 or 4, wherein the
 charger box is a charger box of one of claims 1 or 2.
- 35
6. A charger for a hearing aid having a rechargeable
 power source and a power reception connector, 35
 wherein the charger has a first circular connector
 mating the power reception connector, and wherein
 the circular connector and/or the power reception
 connector includes a magnet.
- 40
7. The charger according to claim 6, wherein the charg-
 er comprises a second circular connector, each of
 the first and second circular connector are arranged
 at the distal end of a respective first and second line,
 wherein said first and second line connect to a base, 45
 said base being connected to a supply line config-
 ured to be connected to a power source.

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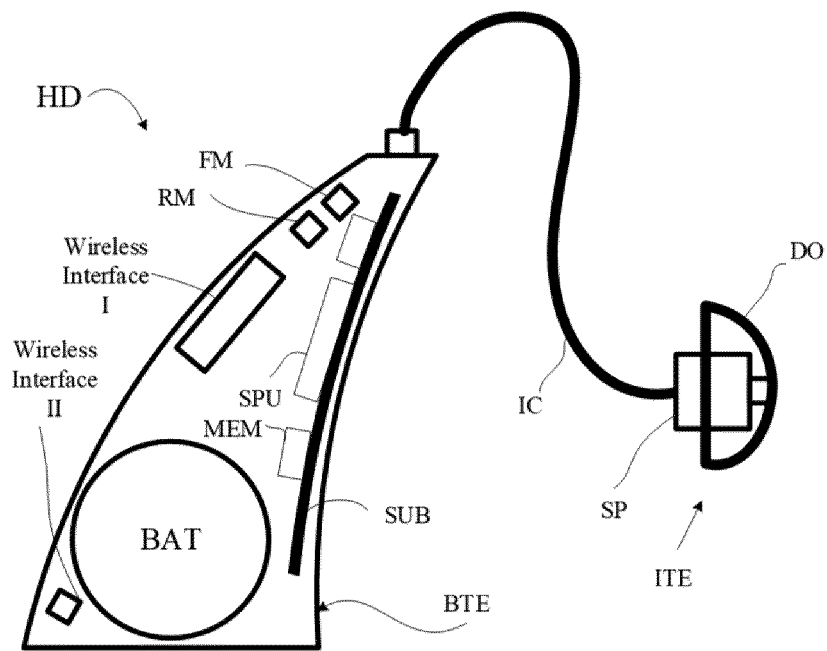


Fig. 1

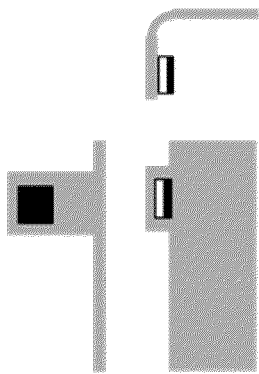


Fig. 2

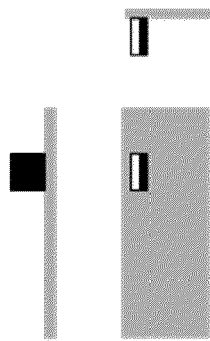


Fig. 3

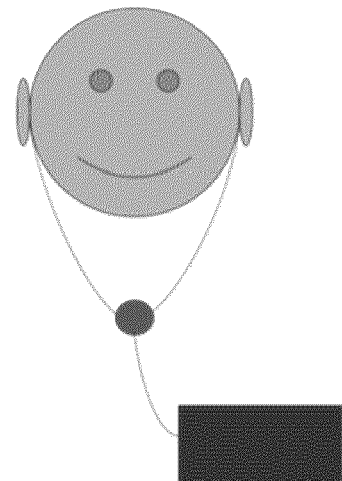


Fig. 8

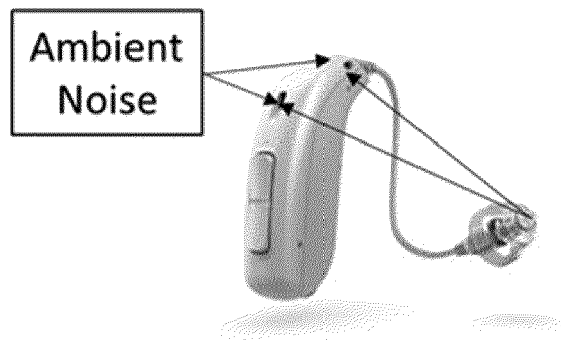


Fig. 4



Fig. 5

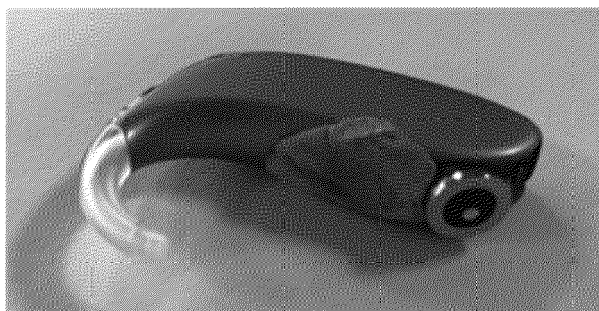


Fig. 6



Fig. 7

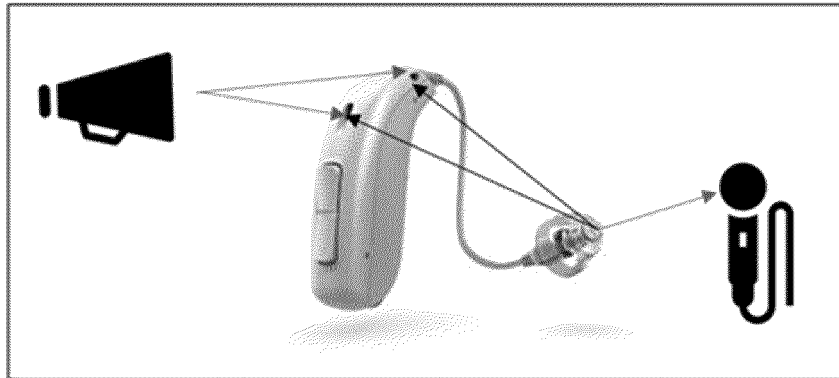


Fig. 9

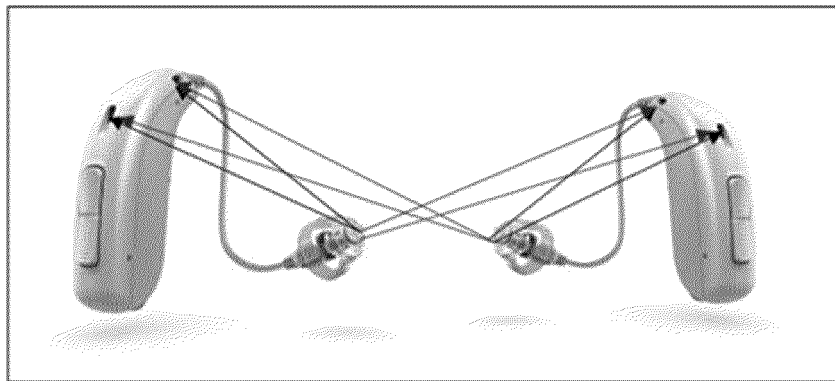


Fig. 10

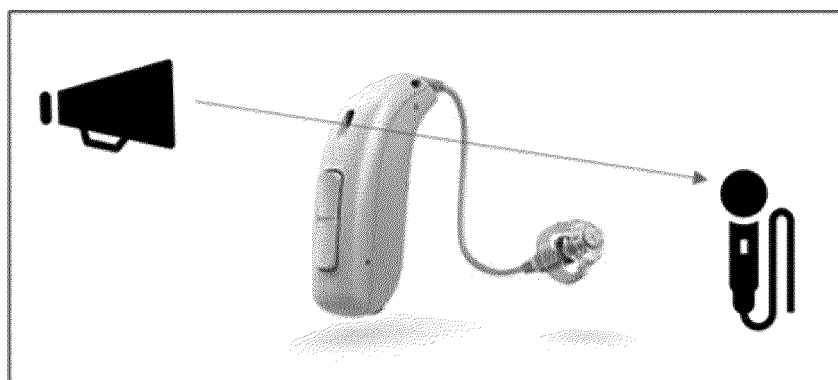


Fig. 11