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

(11) **EP 4 002 882 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.05.2022 Bulletin 2022/21

(21) Application number: **20208479.4**

(22) Date of filing: **18.11.2020**

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

(52) Cooperative Patent Classification (CPC):
H04R 25/505; H04R 25/552; H04R 2225/41; H04R 2460/03

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

(71) Applicant: **Sonova AG**
8712 Stäfa (CH)

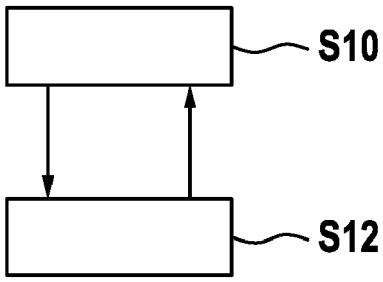
(72) Inventors:
- **Spieler, Ivo**
  8712 Stäfa (CH)
- **Breitenmoser, Andreas**
  8004 Zürich (CH)

(74) Representative: **Qip Patentanwälte**
Dr. Kuehn & Partner mbB
Goethestraße 8
80336 München (DE)

(54) **CUSTOMER SLEEP MODE OF A HEARING DEVICE**

(57) A method for providing a customer sleep mode of a hearing device (12) carried by a hearing device user and including at least one biometric sensor (48) configured to gather health data of the hearing device user. The method comprises: switching the hearing device (12) between a normal mode, configured for being used when the hearing device user is awake, and the customer sleep mode configured for being used when the hearing device user is asleep. When in the customer sleep mode, the hearing device (12) is operated at a reduced hearing aid functionality level, while at least one biometric sensor (48) is active and health data gathered thereby is used for monitoring and/or analyzing a health state of the hearing device user beyond simple detection of whether the hearing device user is asleep or awake.

Fig. 2



EP 4 002 882 A1

Description

TECHNICAL FIELD

[0001] The present technology relates to a method, a computer program, and a computer-readable medium for providing a customer sleep mode of a hearing device carried by a hearing device user. Furthermore, the present technology relates to a hearing system comprising at least one hearing device of this kind and optionally a connected user device, such as a smartphone.

BACKGROUND

[0002] Hearing devices are generally small and complex devices. Hearing devices can include a processor, microphone, speaker, memory, housing, and other electronical and mechanical components. Some example hearing devices are Behind-The-Ear (BTE), Receiver-In-Canal (RIC), In-The-Ear (ITE), Completely-In-Canal (CIC), and Invisible-In-The-Canal (IIC) devices. A user can prefer one of these hearing devices compared to another device based on hearing loss, aesthetic preferences, lifestyle needs, and budget.

[0003] Most hearing devices are usually not carried (i.e. worn) at night for several reasons such as: needs to be charged at night due to a use of battery and/or a rechargeable duration; not enough audiological comfort due to e.g. risk of feedbacks for side sleepers when the hearing device is on the pillow side; not enough wearing comfort, particularly when the hearing device is on the pillow side of a side sleeper etc.

[0004] As a result of not wearing a hearing device in sleep, hearing device users might, for example, not hear safety relevant sounds such as fire alarms, might miss relevant phone calls, or might not even hear the alarm clock in the morning.

[0005] To wake up the hearing device user in the morning, EP 3 021 599 A1 suggests a hearing device equipped with a wake-up member configured to determine when to wake up the hearing device user based on one or more signals representing acceleration, speed, orientation or electroencephalography (ECG) activity received from a detection member of the hearing device. Specifically, the hearing device comprises a processor adapted to (based on a predefined criterion) automatically detect when the hearing device user is awake and hereafter shift the hearing device into a "day time mode". The "night time mode" according to EP 3 021 599 A1 may involve application of a special setting with a lower gain setting than in "day time mode" to more particularly focus on picking up e.g. alarm sounds or speech.

[0006] On the other hand, EP 3 021 599 A1 suggests a hearing aid system which enables hearing impaired persons to hear their loved ones, such as a baby, at a distance when not using hearing aids at night. Here, during a night scenario, the hearing device user has removed the hearing device from his ear and, thus, is sleeping without any hearing device. Accordingly, an external device - a speaker unit integrated in a pillow or provided in another suitable manner close to the user - is required to generate the sound that is needed to alert the hearing device user in case of e.g. a crying baby.

DESCRIPTION OF THE INVENTION

[0007] It is an objective of the invention to address the above problems and to provide an alternative and/or improved hearing system and method of operation of a hearing device which provides a customer sleep mode suitable to be active when the user is asleep.

[0008] These objectives are achieved by the subject-matter of the independent claims. Further exemplary embodiments are evident from the dependent claims and the following description.

[0009] A first aspect of the invention relates to a method of providing a customer sleep mode in a hearing device carried by a hearing device user and including at least one biometric sensor configured to gather health data of the hearing device user. Herein, the term "carried" may be understood not only in the sense of a "worn" or "attached" hearing device but also in the sense of an "implanted" hearing device, in contrast to those hearing devices which are taken off at night.

[0010] The method may be a computer-implemented method, which may be performed automatically by a hearing system as described herein below. The hearing system may, for instance, comprise one or two hearing devices used by the same user. One or both hearing devices may be worn on and/or in an ear of the user. A hearing device may be a hearing aid, which may be adapted for compensating a hearing loss of the user. Also, a cochlear implant may be a hearing device. The hearing system may optionally further comprise at least one connected user device, such as a smartphone, smartwatch or other devices carried by the user and/or a personal computer etc.

[0011] According to an embodiment of the invention, the method comprises providing a possibility of switching the hearing device between a normal mode configured for being used when the hearing device user is awake (e.g. at daytime and/or when he/she stays active at night for travelling or working etc.), and the customer sleep mode configured for being used when the hearing device user is asleep.

[0012] In the customer sleep mode, the hearing device is operated at a reduced hearing aid functionality level as compared to the normal mode. Thereby, power consumption of the hearing device may be reduced and/or the user can be protected from being disturbed by less relevant signals in the sleep. In general, the customer sleep mode also may be called simply sleep mode, however it has be named in this ways to distinguish it from a hardware sleep mode, in which hardware components are switched off to save energy.

[0013] At the same time, at least one biometric sensor

may be fully active in the customer sleep mode, and health data of the hearing device user gathered thereby is used for monitoring and/or analyzing a health state of the hearing device user, which may go beyond simple detection of whether the hearing device user is asleep or awake.

[0014] Thus, providing the customer sleep mode according to the invention makes it possible to exploit sleep time to gather additional health data of the hearing device user. For example, a gain of additional 8 h (average sleep duration) may result in a non-stop health monitoring, i.e. full 24 h a day, and not only 16 h (average daytime) as with the known hearing devices, which are taken off at night by their users.

[0015] Furthermore, gathering health data by a hearing device with said customer sleep mode may have an additional advantage compared to gathering health data only during daytime or active time of the user, since night or sleep time is ideal for many health-relevant measurements. Firstly, the health state of the person, i.e. of the hearing device user, may be particularly well defined in the sleep. Secondly, accurate measurements of a resting heart rate or other resting body functions are possible when the user is asleep. Thirdly, monitoring and analysis of sleep related body functions, such as wake and sleep phases during the sleeping time, is made possible by the present method.

[0016] According to an embodiment of the invention, the hearing device provides a customer sleep mode which can be active at night or power naps or whenever the hearing device user chooses that such a mode is active. The customer sleep mode can be, for instance, entered and left by either user interaction on hearing device or any connected device or by a timer and/or sensor based user activity detection.

[0017] The customer sleep mode of the present invention may provide any one or any combination of the following features/embodiments:

According to an embodiment of the invention, the monitoring and/or analyzing of the health state of the hearing device user is performed directly during the customer sleep mode to detect a serious health issue and/or to detect if some of the gathered health data lies beyond a predetermined acceptable range. With this embodiment, immediate triggering of emergency measures in case of detected health issues of the hearing device user is possible, also when he/she is sleeping. To this end, an emergency signal is generated and/or transmitted to an emergency service in case of detecting a serious health issue and/or in case of detecting that some of the gathered health data lies beyond the predetermined acceptable range.

[0018] The emergency signal may, for example, be a waking-up signal perceivable by the hearing device user, such as a vibrational and/or sound signal generated by the hearing device or a further connected device. The emergency signal transmitted to an emergency service may e.g. include automatically starting an emergency call by a connected user device, such as a smartphone.

[0019] According to an embodiment of the invention, the monitoring and/or analyzing of the health state of the hearing device user is performed directly during the customer sleep mode and/or subsequently and comprises one or more of the following: monitoring and/or analyzing blood oxygen level and/or saturation; monitoring and/or analyzing body temperature; monitoring and/or analyzing EEG, ECG, EOG, or EMG data; monitoring and/or analyzing heart rate and heart rate variability, including accurate measurements of resting heart rate; monitoring and/or analyzing body movement; analysis of respiratory rates; and/or analysis of sleep and wake phases of the hearing device user.

[0020] Blood oxygen levels and saturation, particularly peripheral oxygen saturation (Sp02, CO2), may be monitored and/or analyzed, e.g. as indication for breathing issues. This may be, for example, done using a pulse oximetry sensor in the hearing device.

[0021] Body temperature measurements, e.g. performed in or around the ear by a sensor in the hearing device, may provide further relevant data for health monitoring and/or analyzing the health state.

[0022] Electroencephalography (EEG) may be used to monitor and/or analyze the neural function, e.g. as indication for associated information of sleep quality, sleep disruptions and time spent in various sleep stages. This may be, for example, done using in-ear EEG measurements performed by a sensor in the hearing device.

[0023] Similarly, Electrocardiography (ECG), Electrooculography (EOG) or Electromyography (EMG) measurements (e.g. measurements of muscle activities in mouth or jaw area) may be further sources of valuable information, indicative of the health state, which may be monitored and/or analyzed.

[0024] Heart rate and heart rate variability may be monitored and/or analyzed. This may be, for example, done using in-ear photoplethysmogram (PPG) measurements performed by a sensor in the hearing device. Accurate measurements of resting heart rate may be performed while the user is sleeping. This may be accompanied by subsequently analyzing and/or displaying the measurement results to a medical professional and/or to the hearing device user, e.g. by the help of a connected device.

[0025] Measurements of physical activities, such as body movements, during sleep may also provide health-relevant data from which further indications, including vital signs, stress, breathing rates or sleep patterns can be derived. This may be, for example, done using a motion sensor, such as an accelerometer, in the hearing device. Analysis of respiratory rates as well as sleep and wake phases of the hearing device user may be performed. This may also be accompanied by subsequently displaying analysis results to a medical professional and/or to the hearing device user, e.g. by the help of a connected device.

[0026] For example, a mobile app on a smartphone may show resulting sleep patterns, or other inferred

sleep-related behaviors and metrics, such as the evolution of heart rate data, to a user.

[0027] Analysis results may further trigger medical recommendations and/or suggestions for behavior changes that are presented to a medical professional and/or to the hearing device user.

[0028] According to an embodiment of the invention, the hearing device comprises a sound output device and/or a further output device for outputting a sound and/or a further (e.g. vibrational) signal to an ear of a hearing device user. In this embodiment, operating the hearing device at a reduced hearing aid functionality level comprises muting sound and/or further signals from the sound and/or further output device, except for relevant signals which are to be perceivable for the hearing device user when the hearing device is in the customer sleep mode.

[0029] In other words, sound output is muted in this embodiment, except a signal is detected that the hearing device user needs to hear at night as well. Muting can mean cancelling sounds, as well as restricting or inactivating parts of the sound delivery system, and thus the sound output, of the hearing device. As needed upon detection, restrictions may be lifted, and parts of the sound delivery system may be activated again. The detection can either be done by a hearing device itself and/or by a connected device and/or by logic of a connected device that might use further resources (e.g. cloud or artificial intelligence based logic).

[0030] This embodiment makes it possible that no output is generated by the hearing device at night, unless needed. In this manner, power consumption of the hearing device may be reduced and, at the same time, the user can be protected from being disturbed by less relevant signals in the sleep.

[0031] The relevant signals, which are to be perceivable for the hearing device user when the hearing device is in the customer sleep mode, may, for example, comprise one or more of the following: an alarm clock signal, so as not to disturb another person like a significant other such as a spouse or a close relative sleeping in the same room; a signal to mask specific ambient noise such as snoring or breathing sounds, a signal adapted for suppressing tinnitus of the hearing device user (especially during the stage of falling asleep); signals individually predefined by the user of the hearing device as relevant; signals otherwise predefined in the hearing device as relevant. These may be soothing signals or signals of further health relevance, such as audible or inaudible sounds emitted to the ear with attributed desirable clinical effects for the hearing device user (e.g. sleep modulation interventions). Such signals may be applied in response to feedback received by a sensor, such as the biometric sensor, of the hearing device. Alternatively, these may be predetermined alarm signals such as an earthquake, fire, baby crying and/or further alarm signals, which might be transmitted from external devices, such as a connected user device of the hearing system, to the hearing device. It may, for instance, be that the user and/or a hearing care professional can choose which signals are relevant enough to trigger that the output is unmuted.

[0032] In general, it may be that the monitored and/or analyzed data is used directly during the customer sleep mode in terms of a feedback signal that steers/controls the hearing device functionality directly, such as triggering/applying a specific signal, among others, for example a soothing signal or signals with medicinal effects based on this direct feedback from the biometric sensor(s).

[0033] According to an embodiment of the invention, the hearing device is a binaurally fitted hearing device, i.e. a left hearing device for the left ear or a right hearing device for the right ear, wherein the two hearing devices are adapted for exchanging data wirelessly, e.g. via Bluetooth, so as to constitute a binaural hearing system. For example, it may be that an audio signal received and/or processed by the left hearing device and/or sensor data collected by its sensors may be transmitted to the right hearing device, and vice versa.

[0034] In this embodiment, the customer sleep mode includes a monaural mode of the hearing device. The monaural mode enables it to work without communication with the second hearing device. The monaural mode may, for instance, be optionally selectable by the user to be automatically activated whenever the hearing device is switched to the customer sleep mode, to allow the user to take off the second hearing device. The monaural mode for binaurally fitted hearing devices may be useful, e.g. when the user only wants to use the side which is opposite to the pillow in case of a side sleeper. This embodiment, for instance, enables side sleepers to choose a side opposite the pillow flexibly and to wear the hearing device in a monaural mode on this side. Also, this allows for re-charging the other hearing device of the binaural system at night.

[0035] According to an embodiment of the invention, switching the hearing device between the normal mode and the customer sleep mode may be manually triggered by the hearing device user via a user interface provided on the hearing device, such as an activation/deactivation knob, or provided on a connected user device, such as a touch screen of a smartphone or PC. Additionally or alternatively, switching the hearing device between the normal mode and the customer sleep mode may be automatically triggered by a user activity sensor and/or a situation detection sensor and/or a timer provided in the hearing device or in a connected user device, such as a smartphone or PC. The automatic triggering may be implemented to depend on predetermined switching conditions measurable by these sensors or timers and suited to distinguish whether the user is awake or asleep. Automatic triggering may be performed depending on biometric measurements, e.g. indicating that user is asleep/falling asleep soon, depending on activity detection, e.g., decreased physical activity, indicating that user is going to rest/sleep, and/or depending on environment measurements, such as daylight, time, e.g. indicating

that it is sleep time.

[0036] According to an embodiment of the invention, the hearing device is configured for monitoring the environment, e.g. for detecting and processing sound signals, measuring environmental temperature, lighting conditions etc. In this embodiment, when the hearing device is in the customer sleep mode, its functionality of monitoring the environment is swapped out into a connected user device provided within a predetermined distance from the hearing device user, such as a smartphone located in the same room, in order to save energy of the hearing device.

[0037] For instance, to avoid undesirable feedbacks from a microphone of a hearing device carried on the sleeping side of the user, the microphone may be disabled in the customer sleeping mode, whereas the monitoring of the environment for relevant sounds may be swapped to the connected user device, from which recognized relevant signals might be transmitted directly to a transceiver of the hearing device so that an output signal perceivable by the user may be generated by the hearing device.

[0038] According to an embodiment of the invention, one or more features of the customer sleep mode and/or of switching the hearing device between the normal mode and the customer sleep mode are customizable via fitting at a hearing care professional's office and/or at another predetermined institution and/or by the hearing device user using a user interface on the hearing device or on a connected user device, such as a smartphone or PC.

[0039] Further aspects of the invention relate to a computer program for providing a customer sleep mode with a hearing device carried by a hearing device user and including at least one biometric sensor configured to gather health data of the hearing device user, which program, when being executed by a processor, is adapted to carry out the steps of the method as described in the above and in the following as well as to a computer-readable medium, in which such a computer program is stored.

[0040] For example, the computer program may be executed in a processor of a hearing device, which hearing device, for example, may be carried by the person behind the ear. The computer-readable medium may be a memory of this hearing device. The computer program also may be executed by a processor of a connected user device such as a smartphone or any other type of mobile device, which may be a part of the hearing system, and the computer-readable medium may be a memory of the connected user device. It also may be that steps of the method are performed by the hearing device and other steps of the method are performed by the connected user device.

[0041] In general, a computer-readable medium may be a floppy disk, a hard disk, an USB (Universal Serial Bus) storage device, a RAM (Random Access Memory), a ROM (Read Only Memory), an EPROM (Erasable Programmable Read Only Memory) or a FLASH memory. A computer-readable medium may also be a data communication network, e.g. the Internet, which allows downloading a program code. The computer-readable medium may be a non-transitory or transitory medium.

[0042] A further aspect of the invention relates to a hearing system comprising a hearing device carried by a hearing device user, as described herein above and below, wherein the hearing system is adapted for performing the method described herein above and below. The hearing system may further include, by way of example, a second hearing device used by the same user and/or a connected user device, such as a smartphone or other mobile device or personal computer, used by the same user.

[0043] According to an embodiment of the invention, the hearing device comprises: a microphone; a processor for processing a signal from the microphone; a sound output device for outputting the processed signal to an ear of the hearing device user; a transceiver for exchanging data with the connected user device and optionally with another hearing device; and at least one biometric sensor configured to gather health data of the hearing device user.

[0044] According to an embodiment of the invention, the shape of the hearing device and/or an arrangement of the microphone and/or of the sound output device are adapted so as to enable the hearing device user to carry the hearing device in sleep without disturbing its function in the customer sleep mode and/or without disturbing the hearing device user.

[0045] It has to be understood that features of the method as described in the above and in the following may be features of the computer program, the computer-readable medium and the hearing system as described in the above and in the following, and vice versa.

[0046] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0047] Below, embodiments of the present invention are described in more detail with reference to the attached drawings.

Fig. 1 schematically shows a hearing system according to an embodiment of the invention.

Fig. 2 shows a flow diagram for a method according to an embodiment of the invention for providing a customer sleep mode in a hearing device carried by a hearing device user and being a part of the hearing system of Fig. 1.

[0048] The reference symbols used in the drawings, and their meanings, are listed in summary form in the list of reference symbols.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0049] Fig. 1 schematically shows a hearing system 10 with a hearing device 12 in the form of a behind-the-ear device carried by a hearing device user (not shown) and a connected user device 14, such as a smartphone or a tablet computer. It should be noted that the hearing device 12 is a specific embodiment and that the method described herein also may be performed by other types of hearing devices, such as in-the-ear devices.

[0050] The hearing device 12 comprises a part 15 behind the ear and a part 16 to be put in the ear channel of the user. The part 15 and the part 16 are connected by a tube 18. In the part 15, a microphone 20, a sound processor 22 and a sound output device 24, such as a loudspeaker, are provided. The microphone 20 may acquire environmental sound of the user and may generate a sound signal, the sound processor 22 may amplify the sound signal and the sound output device 24 may generate sound that is guided through the tube 18 and the in-the-ear part 16 into the ear channel of the user.

[0051] The hearing device 12 may comprise a processor 26, which is adapted for adjusting parameters of the sound processor 22, such that an output volume of the sound signal is adjusted based on an input volume. These parameters may be determined by a computer program run in the processor 26. For example, with a knob 28 of the hearing device 12, a user may select a modifier (such as bass, treble, noise suppression, dynamic volume, etc.) and levels and/or values of these modifiers may be selected, from this modifier, an adjustment command may be created and processed as described above and below. In particular, processing parameters may be determined based on the adjustment command and based on this, for example, the frequency dependent gain and the dynamic volume of the sound processor 22 may be changed. All these functions may be implemented as computer programs stored in a memory 30 of the hearing device 12, which computer programs may be executed by the processor 22.

[0052] The hearing device 12 may comprise a sender/receiver 32 for (for example wireless) data communication with a sender/receiver 34 of the connected user device 14, which may be a smartphone or tablet computer. It is also possible that the above-mentioned modifiers and their levels and/or values are adjusted with the connected user device 14 and/or that the adjustment command is generated with the connected user device 14. This may be performed with a computer program run in a processor 36 of the connected user device 14 and stored in a memory 38 of the connected user device 14. The computer program may provide a graphical user interface 40 on a display 42 of the connected user device 14.

[0053] For example, for adjusting the modifier, such as volume, the graphical user interface 40 may comprise a control element 44, such as a slider. When the user adjusts the slider, an adjustment command may be generated, which will change the sound processing of the hearing device 12 as described above and below. Alternatively or additionally, the user may adjust the modifier with the hearing device 12 itself, for example via the knob 28.

[0054] The user interface 40 also may comprise an indicator element 46, which, for example, displays a currently determined listening situation.

[0055] The hearing device 12 further comprises one or several biometric sensors 48 (only schematically indicated in Fig. 1), such as a pulse oximetry sensor, temperature sensor, EEG-sensor, EOG-sensor, EMG-sensor, PPG sensor, accelerometer and/or any other kind of biometric sensors configured to gather health data of the hearing device user while he/she is carrying the hearing device 12. The biometric sensor 48 may, for example, communicate by wired or wireless communication with the processor 26 of the hearing device 12.

[0056] The hearing system 10 is adapted for performing a method for providing a customer sleep mode of the hearing device 12. To this end, the hearing device 12 is adapted to be switchable between a normal mode configured for being used when the hearing device user is awake (e.g. at daytime and/or when he/she stays active at night for travelling or working etc.), and a customer sleep mode configured for being used when the hearing device user is asleep and continues carrying his hearing device 12.

[0057] For example, switching the hearing device 12 between the normal mode and the customer sleep mode may be manually triggered by the hearing device user via a user interface provided on the hearing device 12, such as the knob 28, or on the connected user device 14, e.g. as the graphical user interface 40 on its display 42. Additionally or alternatively, switching the hearing device 12 between the normal mode and the customer sleep mode may be automatically triggered by a user activity sensor and/or a situation detection sensor and/or a timer provided in the hearing device 12 or in the connected user device 14. The automatic triggering may be implemented to depend on predetermined switching conditions detectable by these sensors or timers and suited to distinguish whether the user is awake or asleep.

[0058] Fig. 2 shows an example of a flow diagram for a method of providing a customer sleep mode in the hearing device 12 of the hearing system 10 as shown in Fig. 1. The method may be a computer-implemented method, which may be performed automatically in the hearing system 10 of Fig. 1.

[0059] In a first step S10 of the method, the hearing device 12 is switched from its normal mode to the customer sleep mode, or vice versa, as described above.

[0060] When in the customer sleep mode (step S12 in Fig. 2), the hearing device 12 is operated at a reduced hearing aid functionality level as compared to its normal mode. This may, for example, be implemented in that sound output of the sound output device 24 is muted,

except a signal is detected that the hearing device user needs to hear at night as well. This detection can either be done by the hearing device 12 itself and/or by the connected device 14 and/or by logic of the connected device 14 that might use further resources (e.g. cloud or artificial intelligence based logic). Thereby, power consumption of the hearing device 12 may be reduced and/or the user can be protected from being disturbed by less relevant signals during sleep.

[0061] At the same time, the at least one biometric sensor 48 is active in the customer sleep mode in step S12, and health data of the hearing device user gathered thereby is used for monitoring and/or analyzing a health state of the hearing device user which goes beyond simple detection of whether the hearing device user is asleep or awake.

[0062] In this manner, it is possible to exploit sleep time to gather additional health data of the hearing device user. For example, a gain of additional 8 h of average sleep duration may be used for a non-stop health monitoring, i.e. full 24 h a day, and not only 16 h of average daytime as with the known hearing devices, which are switched off for the night and/or taken off at night by their users.

[0063] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art and practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or controller or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

LIST OF REFERENCE SYMBOLS

[0064]

10 hearing system
12 hearing device
14 connected user device
15 part behind the ear
16 part in the ear
18 tube
20 microphone
22 sound processor
24 sound output device
26 processor
28 knob
30 memory
32 sender/receiver
34 sender/receiver
36 processor
38 memory
40 graphical user interface
42 display
44 control element, slider
46 indicator element
48 biometric sensor(s)

Claims

1. A method for providing a customer sleep mode of a hearing device (12) carried by a hearing device user and including at least one biometric sensor (48) configured to gather health data of the hearing device user, the method comprising:

   switching the hearing device (12) between a normal mode, configured for use when the hearing device user is awake, and the customer sleep mode, configured for use when the hearing device user is asleep;
   wherein, in the customer sleep mode, the hearing device (12) is operated at a reduced hearing aid functionality level, while the at least one biometric sensor (48) is active and health data gathered thereby is used for monitoring and/or analyzing a health state of the hearing device user beyond simple detection of whether the hearing device user is asleep or awake.

2. The method of claim 1, wherein
   the monitoring and/or analyzing of the health state of the hearing device user is performed directly during the customer sleep mode so as to detect a serious health issue and/or so as to detect if some of the gathered health data lies beyond a predetermined acceptable range; and
   an emergency signal is generated and/or transmitted to an emergency service in case of detecting a serious health issue and/or in case of detecting that some of the gathered health data lies beyond the predetermined acceptable range.

3. The method of claim 1 or 2, wherein the monitoring and/or analyzing of the health state of the hearing device user is performed directly during the customer sleep mode and/or subsequently and comprises one or more of the following:

   monitoring and/or analyzing blood oxygen level and/or saturation;
   monitoring and/or analyzing body temperature;
   monitoring and/or analyzing EEG, ECG, EOG, or EMG data;
   monitoring and/or analyzing heart rate and heart

rate variability, including accurate measurements of resting heart rate;
monitoring and/or analyzing body movement;
analysis of respiratory rates;
analysis of sleep and wake phases of the hearing device user.

4. The method of one of the previous claims, wherein the hearing device comprises a sound output device (24) and/or a further output device for outputting a sound and/or a further signal to an ear of a hearing device user; and
operating the hearing device (12) at a reduced hearing aid functionality level comprises muting sound and/or further signals from the sound and/or further output device (24), except for relevant signals which are to be perceivable for the hearing device user when the hearing device (12) is in the customer sleep mode.

5. The method of claim 4, wherein the relevant signals, which are to be perceivable for the hearing device user when the hearing device (12) is in the customer sleep mode, comprise one or more of the following:

an alarm clock signal;
a signal to mask ambient sound or noise;
a signal adapted for suppressing tinnitus of the hearing device user;
signals individually predefined by the user of the hearing device (12) as relevant;
signals otherwise predefined in the hearing device (12) and/or in a connected user device (14) as relevant.

6. The method of one of the previous claims, wherein the hearing device (12) is a binaurally fitted hearing device; and
the customer sleep mode includes operation in a monaural mode of the hearing device (12).

7. The method of one of the previous claims, wherein switching the hearing device (12) between the normal mode and the customer sleep mode is
manually triggered by the hearing device user via a user interface provided on the hearing device (12) or on a connected user device (14); and/or
automatically triggered by a user activity sensor and/or a situation detection sensor and/or a timer provided in the hearing device (12) or in a connected user device (14).

8. The method of one of the previous claims, wherein the hearing device (12) is configured for monitoring the environment; and
in the customer sleep mode, this functionality of monitoring the environment is shifted into a connected user device (14) provided within a predetermined distance from the hearing device user.

9. The method of one of the previous claims,
wherein one or more features of the customer sleep mode and/or of switching the hearing device (12) between the normal mode and the customer sleep mode are customizable via fitting at a hearing care professional office and/or at another predetermined institution and/or by the hearing device user.

10. A computer program for providing a customer sleep mode with a hearing device (12) carried by a hearing device user and including at least one biometric sensor (48) configured to gather health data of the hearing device user, which program, when being executed by a processor, is adapted to carry out the steps of the method of one of the previous claims.

11. A computer-readable medium, in which a computer program according to claim 10 is stored.

12. A hearing system (10) comprising a hearing device (12) carried by a hearing device user and a connected user device (14), wherein the hearing device (12) comprises:

a microphone (20);
a processor (26) for processing a signal from the microphone;
a sound output device (24) for outputting the processed signal to an ear of a hearing device user;
a transceiver (32) for exchanging data with the connected user device (14); and
at least one biometric sensor (48) configured to gather health data of the hearing device user;
wherein the hearing system (10) is adapted for performing the method of one of claims 1 to 9.

13. The hearing system (10) of claim 12,
wherein the shape of the hearing device (12) and/or an arrangement of the microphone (20) and/or of the sound output device (24) are adapted so as to enable the hearing device user to carry the hearing device (12) in sleep without disturbing its function in the customer sleep mode and/or the hearing device user.

Fig. 1

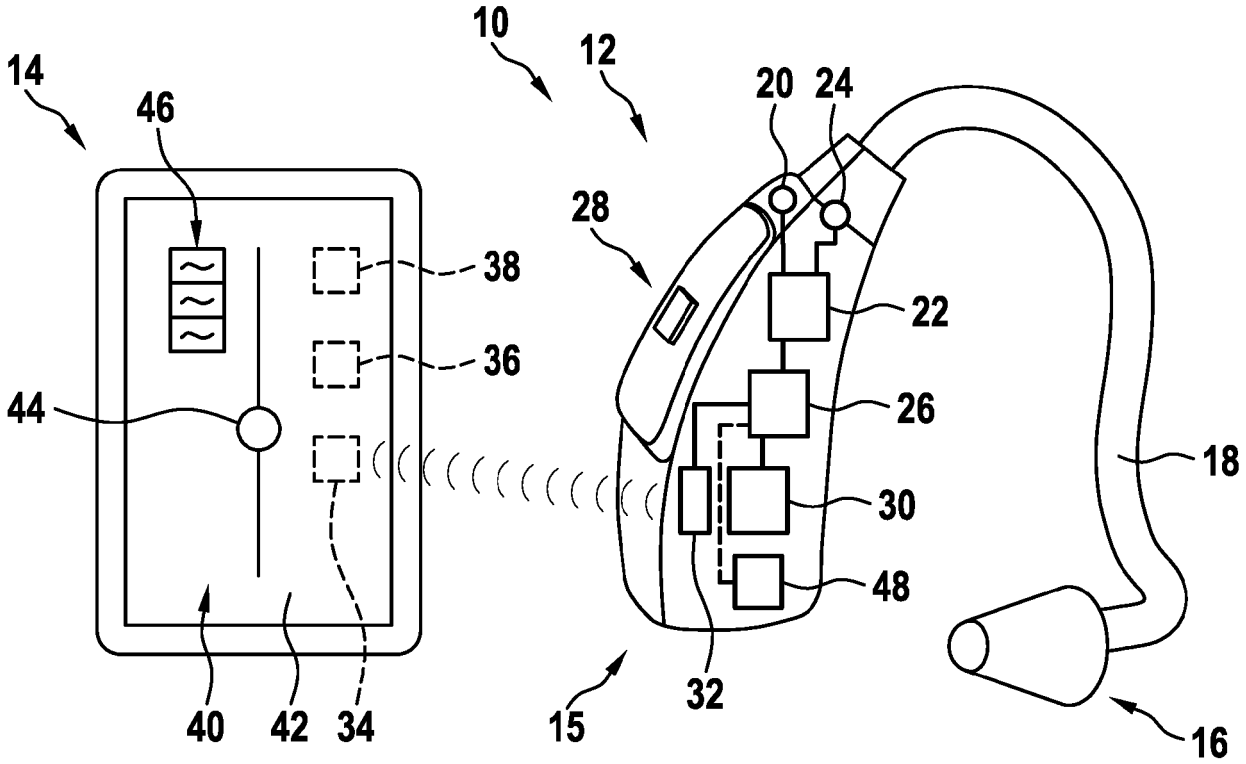
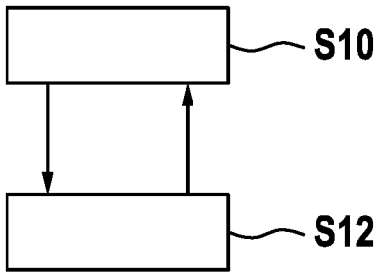


Fig. 2



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 20 8479

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2018/063624 A1 (BOESEN PETER VINCENT [DE]) 1 March 2018 (2018-03-01) * paragraphs [0019], [0021], [0023], [0026], [0029], [0031], [0069], [0094]; figure 1 * * paragraph [0044] - paragraph [0052] * -----	1,3,6,7, 9-13 2-5,8,13	INV. H04R25/00
Y	US 10 334 345 B2 (BRAGI GMBH [DE]) 25 June 2019 (2019-06-25) * column 3, line 41 - line 62 * * column 10, line 19 - line 25 * * column 11, line 3 - line 12 * * column 12, line 54 - column 13, line 17 * -----	2,3,8	
Y	US 2019/098395 A1 (KEELING ADAM [CA]) 28 March 2019 (2019-03-28) * paragraph [0058] - paragraph [0060] * * paragraph [0069] * -----	3,4	
Y	DE 35 45 088 A1 (SIEMENS AG [DE]) 25 June 1987 (1987-06-25) * claims 1, 2 * -----	5,13	TECHNICAL FIELDS SEARCHED (IPC) H04R H04S

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 April 2021	De Haan, Aldert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 20 8479

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-04-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2018063624 A1	01-03-2018	NONE	
US 10334345 B2	25-06-2019	NONE	
US 2019098395 A1	28-03-2019	CA 3001677 A1	09-03-2017
		US 2019098395 A1	28-03-2019
		WO 2017035636 A1	09-03-2017
DE 3545088 A1	25-06-1987	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- EP 3021599 A1 **[0005] [0006]**