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(54) **LISTENING DEVICE AND LISTENING SYSTEM**

(57) Listening device (2), comprising at least one audio input interface (3a, 3b, 3c, 3d), wherein said listening device (2) comprises a processing unit (9) configured to generate digital audio stream data (10) based on an audio signal from the at least one audio input interface (3a, 3b, 3c, 3d), and a wireless transmission unit (11) that is configured to wirelessly output the digital audio stream data (10) to be received by a receiving unit (12), wherein said listening device (2) comprises a charging case (23) with a holder (6) configured to hold at least one earphone (4) and a charging interface (7) that is configured to recharge a battery (8) of the at least one earphone (4) when the earphone (4) is held by the holder (6) .

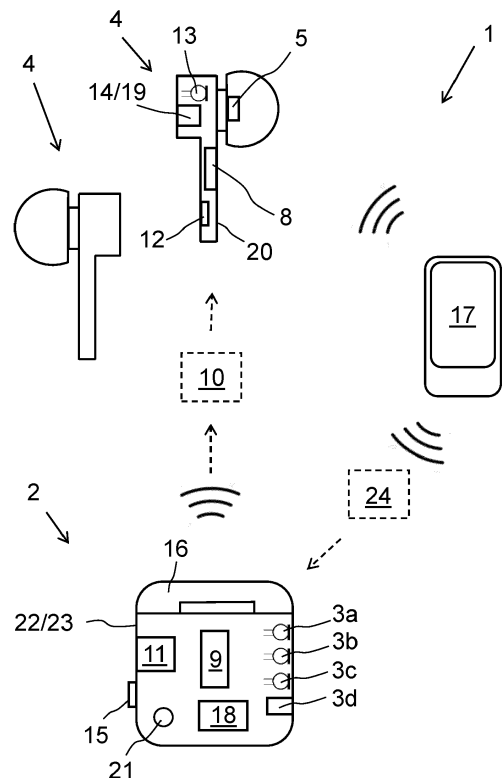


Fig. 1

Description

[0001] The invention relates to a listening system, comprising at least one audio input interface, wherein said listening device comprises a processing unit configured to generate digital audio stream data based on an audio signal from the at least one audio input interface, and a wireless transmission unit that is configured to wirelessly output the digital audio stream data to be received by a receiving unit. The invention also relates to a corresponding listening system.

[0002] Personal hearing systems are well known on the market. The main purpose of such systems is to amplify the sound in the environment for a hard of hearing person. Depending on the noise conditions and the specific use situation, different requirements of such a system have to be fulfilled. For example, in conference situation, it is important for a hard of hearing person to clearly understand each participant. Therefore, known personal hearing systems comprise a digital conversation amplifier that can be placed, for example, in the middle of a conference table. Microphones of the amplifier record the voice of a speaker or other sounds and amplifies it on an output socket. Thus, the amplified output signal can be played over a headphone or other hearing aid devices.

[0003] A further known example of such a personal hearing system is configured to transmit the recorded audio signal via a wireless broadband link to a receiver that is in turn connected to an earphone or to hearing aids. Such systems are known as personal audio amplifiers.

[0004] The disadvantage of common personal hearing systems is that their usage can be inconvenient due to the set up that has to be made each time before the system is ready to use. This requires various steps, including connecting the components and selecting the right operating mode. A further drawback of such systems is that they require a certain amount of space for transportation. However, in today's mobile working environment or during leisure activities there is a need for mobile hearing assistance solutions.

[0005] It is therefore an object of the invention to provide an improved listening device and a listening system that allows a convenient use in mobile situations.

[0006] The invention solves this objective with the features of the independent claims.

[0007] According to a first aspect of the invention, a listening device is proposed, comprising at least one audio input interface, wherein said listening device comprises a processing unit configured to generate digital audio stream data based on an audio signal from the at least one audio input interface, and a wireless transmission unit that is configured to wirelessly output the digital audio stream data to be received by a receiving unit, wherein said listening device comprises a charging case with a holder configured to hold at least one earphone, and a charging interface that is configured to recharge a

battery of the at least one earphone when the earphone is held by the holder.

[0008] If the listening device comprises two or more audio input interfaces, one or more of these audio input interfaces may be used as a source for the audio signal/signals on which the digital audio stream data is based.

[0009] First, some terms used in the context of this application will be explained here.

[0010] Audio stream data in the sense of this application is data that is transmitted for audio streaming. Audio streaming means that digital audio stream data is sent from a sending device to a receiving device where the audio signal represented by the digital audio stream data is reproduced. The corresponding audio stream data is deleted after the audio signal is played.

[0011] The transmission unit has the capability to send digital data. Of course, it may also be possible that the transmission unit is configured to receive data. In the same manner, a receiving unit in the sense of this application is configured to receive data, but may also be configured to send data.

[0012] The audio stream data can be transmitted using various technological standards, including a Bluetooth or WLAN standard; or optical transmission technologies, such as infrared data transmission.

[0013] The charging case as part of the listening device enables the user to carry the at least one earphone in a convenient manner. The earphone, preferably a pair of earphones, may be used to listen to an audio signal that is sent from the listening device to the receiving unit as audio stream data. Furthermore, the charging case ensures that the battery of the at least one earphone is sufficiently charged. Preferably, the at least one earphone can be charged wirelessly over a charging interface of the charging case; e.g., via an inductive charging interface or a charging interface comprising contact elements.

[0014] Preferably, the at least one earphone may comprise the transmission unit so that the audio stream data is directly sent from the listening device to the at least one earphone.

[0015] Alternatively, the receiving unit may be part of an external device that may be connected via a wireless or wired connection to the at least one earphone.

[0016] Furthermore, it is possible that the audio stream data is directly sent to the at least one earphone comprising a first receiving unit, and the audio data is sent to a second receiving unit, for example, as part of an external device.

[0017] The listening device is capable of wirelessly transmitting audio information to a distant receiving unit which can be worn or carried, for example, by a hard of hearing person. Therefore, the listening device can be used as a flexible external microphone that can be positioned and oriented in the best possible manner relative to an audio source. Thus, by using the listening device, the intelligibility during conversations can be increased.

[0018] The processing unit may be configured, in addition to generating the audio stream data, to perform further audio processing. Therefore, the processing unit may comprise a certain number, e.g., one to three, pre-set sound curves that can be chosen by a user. The parameters of the chosen sound curve are applied by the processing unit for processing the input audio signal. The processed audio is then transmitted as audio stream data to the receiving unit.

[0019] The processing unit of the listening device preferably has an automatic gain control (autogain) function.

[0020] Preferably, said listening device is a handheld-device. A handheld-device in the sense of this application is a device that can be held by a person with one hand. This allows to carry and use the listening device in a flexible manner.

[0021] In an advantageous embodiment, the holder is configured to support the at least one earphone in at least two spatial directions, preferably in three spatial directions. This kind of support allows retaining the at least one earphone in a predefined manner, even in transport situation. This ensures that the at least one earphone is aligned with respect to the holder such that the at least one earphone is reliably supplied with electrical energy when inserted. In a further preferred embodiment, the holder is configured to prevent a rotational movement of the at least one earphone when inserted into the holder.

[0022] Preferably, at least one audio input interface is a microphone. The microphone can be used to directly record sounds of the environment of the listening device. The listening device can be positioned independently from the hearing device that is used to play the recorded sound. This allows a flexible positioning of the microphone. For example, the listening device may be positioned on a conference table near the participants of a conference, wherein the user of the listening device stands in front of the table for holding a speech or presentation. The voice of the participants is recorded by the listening device and can, for example, be wirelessly transmitted to the at least one earphone of the user.

[0023] Preferably, at least one audio input interface is an omni-directional microphone and/or at least one audio input interface is a directional microphone. The use of a directional microphone and an omnidirectional microphone allows capturing various sound sources in the best possible manner. For example, if different speakers are positioned around the listening device, the omni-directional microphone can be used for capturing the sound of their voices. As a further example, in case there is a conversation with only one person, the directional microphone can be used.

[0024] A directional microphone may also comprise an array of at least two omnidirectional microphones, wherein a directional sensitivity is created by an algorithm based on the audio signals of the array of microphones.

[0025] In a further advantageous embodiment said listening device comprises at least two microphones, wherein one or more of the at least two microphones is

selectable as the main source for generating the digital audio stream data. A main source for generating the digital audio stream data in the context of this application is a sound source that is amplified compared to the other sources. The sound of the microphones which are not selected as the main source may either be completely muted or attenuated. This selection of microphones is preferably applied in a "zoom hearing mode" of the listening device. This mode can particularly improve the speech intelligibility in noisy environments. The selection of one microphone as the main source may be done automatically by an algorithm; this algorithm can, for example, be configured to detect the microphone, e.g., a directional or omnidirectional microphone, that creates the best audio signal of a person speaking. The algorithm can be implemented, for example, as a part of the processing unit of the listening device. The choice of the microphone may also be done manually via an application of a smart device connected to the listening device.

[0026] Preferably, at least one audio input interface is a connector that is configured to receive audio signals via an audio cable. The connector may be, for example, an AUX-connector. In principle, however, it may also be a connector according to an alternative standard. The connector allows to connect the listening device to an external audio signal source, for example, a television, a HiFi system, a radio, a smartphone or a personal computer. In a particularly preferred embodiment, the listening device comprises at least one microphone and at least one connector. This allows an even more flexible use of the listening device.

[0027] In an advantageous embodiment, the charging case comprises a lid that is movable relative to the holder from an opened position to a closed position, wherein in the opened position the holder is accessible, wherein in the closed position the holder is covered by the lid, wherein an operating mode of the listening device is settable depending on the position of the lid relative to the holder. It has been shown that the position of the lid is an intuitive user input interface. The main advantage is that the user feels the position of the lid and does not have to visually capture the listening device when setting the operational mode.

[0028] For example, one or more of the following operating modes of the listening device may be set by the position of the lid:

[0029] An "around me hearing mode" where the sound recorded by the omnidirectional microphone of the listening device is the input signal for the processing unit.

[0030] A "directional mode" where the sound recorded by a certain directional microphone of the listening device is the input signal for the processing unit. This mode is particularly advantageous during a conversation under noisy conditions. Since the user knows the working direction of the active directional microphone, the user can point with the directional microphone in the direction of the sound source that shall be amplified, for example a speaking person. In the "directional mode" the selected

directional microphone does not change.

[0031] A "zoom hearing mode" where one or more microphones of the listening device are selectable as the input signal for the processing unit. The direction and zoom characteristics of this mode may be based on the signal processing algorithm determining where the sound source comes from and consequently attenuate sound and/or noise from other directions. The zoom hearing mode requires a listening device comprising an array of at least two microphones.

[0032] An "external mode" where the sound received by the connector is the input signal for the processing unit.

[0033] Of course, it may also be possible to set these modes via another control interface of the listening device.

[0034] Additionally, or alternatively, the position of the lid may also be used to switch the listening device on or off.

[0035] In an advantageous embodiment, the listening device comprises an indication unit that is configured to display the operating mode and/or a status of the listening device. For example, the indication unit may be a LED that lights in different colors depending on the operating mode and/or status of the listening device.

[0036] In an advantageous embodiment, at least one intermediate position of the lid between the opened and closed position is predefined which is recognizable by the user through haptic feedback of the lid. The haptic feedback may, for example, be a vibration signal or a force that has to be overcome when moving the lid out of a predefined position.

[0037] Preferably, the listening device is connectable to a smart device, wherein the processing unit is configurable by receiving a configuration data set from the smart device. The wireless transmission unit may be configured to connect the listening device to the smart device. It may also be possible that the connection to the smart device is established via a separate interface of the listening device.

[0038] The smart device can be, for example, a smartphone, a smart-watch, a tablet computer, a laptop or a personal computer.

[0039] Furthermore, the listening device may be configured to wirelessly output audio stream data based on an audio stream received by the smart device. The audio stream received by the smart device, e.g., music or telephone call, may be processed by the processing unit of the listening device such that outputted audio stream data is adapted to the personal hearing capabilities of a user.

[0040] According to a second aspect of the invention, a listening system is proposed comprising a listening device according to one of the claims 1 to 10, and a receiving unit that is configured to receive the wireless audio stream data outputted by the listening device.

[0041] Preferably, said listening system comprises at least one earphone, wherein the at least one earphone comprises a loudspeaker, the receiving unit and an in-

ternal audio processing unit configured to play the received digital audio stream data on the loudspeaker.

[0042] Further preferably, the internal audio processing unit may also be configured to perform the audio processing that has been described above in connection with the listening device, for example, the adaption of audio signals based on sound curve parameters. In this case, the processing unit of the listening device generates the audio stream data without further audio processing.

[0043] Furthermore, the audio processing required for the selected operational mode, for example, the "zoom hearing" mode may also be done by the internal audio processing unit of the earphone. In this case, the audio stream data generated by the processing unit of the listening device may comprise data corresponding to audio signals from several available audio input interfaces. The received audio stream data is then processed according to the selected operational mode; this audio processing may comprise the selection of an audio channel and/or the attenuation of certain undesired sound sources.

[0044] It is advantageous that the listening system comprises two earphones to enable stereo playback of the input audio signal.

[0045] The advantage of the listening system is that the at least one earphone can be used for playing the audio stream data outputted by the listening device. Furthermore, in mobile situations, the at least one earphone can be retained in the charging case.

[0046] Preferably, said listening system is configured to automatically establish a wireless connection between the at least one earphone and the listening device. Thus, the listening system is immediately ready for use without the need of pairing these components.

[0047] Preferably, the at least one earphone comprises an internal microphone, wherein the internal audio processing unit uses the audio signal from the internal microphone as an input for audio processing.

[0048] Preferably, the listening device may be switched in an "earphone mode" where the sound recorded by the internal microphone of the at least one earphone is directly played on the loudspeaker of the at least one earphone.

[0049] The "earphone mode" allows an amplification of environmental sounds when it is inconvenient for the user to place the listening device in an appropriate position. Furthermore, the internal microphone of the earphone can, for example, be used as a data source for a noise cancellation algorithm. The use of the internal microphone can be controlled, for example, by the listening device or by a user interface of the at least one earphone.

[0050] The sound curve parameters selected in the listening device may also be transmitted to the internal audio processing unit so that the audio signals of the internal microphone can also be processed according to the personal hearing capabilities of the users in the "earphone mode". In case the sound curve parameters are already stored in the earphone, it may also be possible to send

a selection command of the chosen sound curve to the at least one earphone.

[0051] The internal microphone allows to operate the at least one earphone independently from the listening device, because the amplification can be done by the internal audio processing unit itself. The internal audio processing unit may be configured to play the amplified sound over the loudspeaker of the at least one earphone. Listening via the earphone directly is particularly advantageous, for example, when the user has a conversation while having a walk. It has been shown that the amplification performed by the earphones directly is sufficient in more quiet environments.

[0052] The internal microphone may be controlled by a control interface of the earphone, a control interface of the listening device and/or by the software of the smart device.

[0053] Preferably, said listening system further comprises the smart device that is configured to be connected with the listening device, wherein the smart device comprises a software configured to generate a configuration data set, and to send the configuration data set to the listening device. By using the smart device for the configuration of the listening device, especially for the generation of the sound curve by making a hearing test, a corresponding user interface is not required as part of the listening device. Thus, a compact and light design of the listening device can be achieved, which enables a convenient use in mobile situations.

[0054] Preferably, the configuration data set comprises one or more of the following information: personalized audio sound curve parameters; advanced setting parameters; microphone selection parameters.

[0055] The personalized audio sound curve parameters allow to adjust the algorithm of the processing unit in order to adapt the audio stream data according to the personal hearing capabilities of the user. The personalized audio sound curve may be generated manually or automatically by using the smart device. The automatic generation of the personalized audio sound curve is preferably made by using the results of a hearing test that may also be performed by the software of the smart device. The personalized audio curve resulting from the hearing test may be manually adjusted, for example, by dragging a visualized sound curve on a display of the smart device.

[0056] Advanced settings are settings that are usually not made on a daily basis; e.g., the configuration of operating modes.

[0057] Microphone selection parameters allows the selection of one or more microphone to be used as the main source for the audio signal that is processed by the processing unit.

[0058] In a further preferred embodiment, the listening device comprises a charger battery having a capacity that has at least five times, preferably at least ten times, the capacity of a battery of the at least one earphone. This allows several mobile recharge cycles of the battery

of the earphone. The charger battery of the listening device can be charged, for example, via an USB-connector. Furthermore, such a capacity of the battery of the listening device allows to provide enough energy for the processing unit. Since the energy consuming audio processing is performed in the listening device, the capacity of the battery of the at least one earphone can be smaller, leading to lighter and more compact earphone design.

[0059] In a preferred embodiment, the listening device and/or the at least one earphone comprises a control interface for controlling at least one function of the listening device and/or the at least one earphone. Preferably, the control interface is configured to control the volume of the earphones, the balance, the operating mode and/or a microphone mode. Preferably, a quiet mode and a noise mode that applies noise and echo cancellation may also be selected by the control interface of the listening device and/or the earphones.

[0060] According to a further embodiment, the control interface may be implemented in such a way that the volume is adjusted by shaking a right or a left earphone. For example, by shaking the left earphone, the volume decreases and by shaking the right earphone, the volume increases.

[0061] Furthermore, the listening system may comprise a cradle that can be configured to charge the listening device and to connect the listening device to an external audio source.

[0062] In the following, the invention shall be illustrated on the basis of preferred embodiments with reference to the accompanying drawings, wherein:

Fig. 1 shows a listening system according to a first embodiment;

Fig. 2 shows a listening device;

Fig. 3 shows a listening system according to a second embodiment;

Fig. 4 shows a listening system according to a third embodiment; and

Fig. 5 a method for operating a listening system.

[0063] Figure 1 shows a listening system 1 comprising a listening device 2, two earphones 4 and a smart device 17.

[0064] The listening device 2 comprises a charging case 23, wherein said charging case 23 comprises a holder 6 configured to hold both earphones 4 (see Figure 2) and a charging interface 7 configured to charge a battery 8 of each earphone 4 when the earphones 4 are inserted in the listening device 2. The charging case 23 further comprises a lid 16 that is pivot mounted relative to the holder 6. The lid 16 covers the interior of the charging case 23 in a closed position (see Figure 2, left), where-

in the interior of the charging case 23 is accessible in an opened position of the lid 16 (see Figure 2, right) .

[0065] The charging case 23 comprises a housing 22 that is also a housing for the whole listening device 2.

[0066] The listening system 1 of Figure 1 shows a configuration in which both earphones 4 are removed from the holder 6 of the listening device 2. This is typical use situation, where the earphones 4 are positioned at some distance from the listening device 2; e.g., 0,2 to 5 meters.

[0067] The basic configuration of the two earphones 4 is identical, and therefore only the functionality of one earphone 4 will be explained in more detail below.

[0068] The working principle of the listening system 1 is that digital audio stream data 10 is generated by the listening device 2 based on an audio input provided by one or more audio signal interfaces 3a-3d. The generated digital audio stream data 10 is wirelessly outputted by a transmission unit 11 of the listening device 2.

[0069] In this first embodiment of the listening system 1, the outputted audio stream data 10 is received by a receiving unit 12 of the earphone 4 where the corresponding sound is played subsequently by a loudspeaker 5 of the earphone 4. In other words: The sound detected by one or more of the audio input interfaces 3a-3d is streamed from the listening device 2 to the earphone 4. The played sound can be amplified to enable, for example, a hard of hearing person to clearly hear the sound recorded by the listening device 2 over the earphone 4.

[0070] The listening device 2 comprises four audio input interfaces 3a-3d, namely an omni directional microphone 3a, a first and a second directional microphone 3b, 3c and a connector 3d in the form of an AUX-connector. Of course, an embodiment with only one directional microphone 3b, an omni directional microphone 3a and a connector 3d would also be possible.

[0071] The audio signals received by one or more of the audio input interfaces 3a, 3b, 3c and 3d are processed by an processing unit 9 of the listening device 2. The processing unit 9 is configured to generate the digital audio stream data 10 that is transmitted immediately after being generated via a transmission unit 11 of the listening device 2 to the receiving unit 12 of the earphone 4.

[0072] The transmission unit 11 and the receiving unit 12 are configured to transmit the audio stream data 10 wirelessly via a Bluetooth standard from the listening device 2 to the earphone 4.

[0073] The listening device 2 further comprises a charger battery 18, in particular for providing energy to the charging interface 7 and to the processing unit 9. A control interface 15 is provided at the listening device 2 to adjust, for example, the volume of the earphones 4, the left-right balance of the earphones 4, the operating mode and/or a microphone mode of the listening device 1.

[0074] Depending on an operational mode of the listening device 2, different audio input interfaces 3a-3d are used as an input signal for the processing unit 9 to generate the digital audio stream data 10.

[0075] In an "around me mode", the omnidirectional microphone 3a provides the input signal. This mode is advantageous to amplify voices from different directions.

[0076] In a "directional mode", one of the directional microphones 3b or 3c provides the input signal. This mode is advantageous in noisy environments. The user can position the listening device 2 with the activated microphone 3b or 3c in the direction of the sound that shall be amplified, for example, in the direction of a speaking person.

[0077] In a "zoom hearing mode" one or more of the microphones 3a to 3c are alternately selectable as the main audio source for the processing unit 9 to generate the audio stream data 10. In this embodiment, one of the three microphones 3a, 3b or 3c can be selected as the main audio source. The non-selected directional microphone 3b or 3c is either muted or attenuated. The selection of the active directional microphone 3b or 3c may either be done manually or automatically by an algorithm that detects the most relevant sound source for the user. This selection may be performed by the listening device or by the software of a selected smart device.

[0078] Alternatively, the processing of audio signals for the "zoom hearing mode" can also be performed by an internal audio processing unit 14 of the earphone 4.

[0079] In an "external mode", the aux-connector 3d provides the input signal. The "external mode" can be used to connect an external device, for example, a HiFi system, a radio, a smartphone or a personal computer, to the listening device 2. In the "external mode", also one of the microphones 3a-3c may be used in certain situations. For example, the aux-connector 3d could primarily be used as an audio input source so that the user hears, for example, the amplified TV sound. In the case of a sound in the environment, for example, a person talking to the user, the external signal that is provided via the connector 3d is muted to some degree and the environmental sound provided by one of microphones 3a-3c (e.g., the omnidirectional microphone 3a) is amplified.

[0080] The position of the lid 16 of the charging case 13 is used to control the operational mode of the listening device 2. In Figure 2, left side, the lid 16 is in a closed position. In this position, the listening system 1 is switched off. In Figure 2, right side, the lid 16 is in an opened position that activates, for example, the around me mode in which the omni-directional microphone 3a provides the audio signal.

[0081] The further operational modes can be adjusted by positioning the lid 16 in predefined positions between the opened and closed position. Alternatively, the opened and/or closed position of the lid 16 may be programmable by a user so that corresponding operational mode can be set by using these two positions.

[0082] Figure 1 also shows that the earphone 4 comprises a data storage 19 that is used to temporarily store the received audio stream data 10 before playing the corresponding sound. The earphone 14 further comprises the internal audio processing unit 14 that is configured

to play the audio stream data 10 temporarily stored on the data storage 19 over the loudspeaker 5. Furthermore, the earphone 4 comprises an internal microphone 13 that can be used to amplify sound directly via the internal audio processing unit 14. This is possible in the so called "earphone mode"; this mode is advantageous in mobile situations. In this mode, the amplification of the sound can be done without the participation of the listening device 2. The earphone 4 further comprises a control interface 20, that can be used to control different functions of the listening system 1, such as the volume and the left-right balance of the earphones 4; the operating mode and/or a microphone mode of the listening device 1 or the earphone 4. In this embodiment, the control interface 20 is a touch sensitive surface of the earphone 4.

[0083] Furthermore, the listening system 1 comprises a smart device 17 which is, for example, a smartphone. The smart device 17 is connectable to the listening device 2 and may also be directly connectable to the earphone 4. The smart device 7 comprises a software that is configured to change the settings of the listening device 2. Particularly, the software is configured to adjust sound curve parameters that are used by the processing unit 9 and/or internal audio processing unit 14. The software is configured to adjust the sound curve on the basis of a hearing test and/or manually. The adjusted sound curve is wirelessly transmitted to the listening device 2 in the form of a configuration data set 24. The configuration data set is received by the transmission unit 11 that has also a receiver functionality.

[0084] The configuration data set generated by the software of the smart device 17 may also comprise information about advanced settings and/or microphone selection.

[0085] In order to display for a user, the status and/or the operating mode of the listening device 1, the listening device 2 comprises an indication unit 21 in the form of a LED that is configured to light in different colors depending on the operational mode.

[0086] Figure 3 shows a second embodiment of the listening system 1 that comprises the listening device 2, a receiver 25 that is connected to an earphone 4 and/or to a hearing aid device 26.

[0087] The main working principle of the listening device 2 is the same as in the embodiment shown in Figures 1 and 2. The listening device 2 comprises a connector (not shown) to receive an audio input signal 29 of, for example, a TV 27; a lid 16 to cover a holder (not shown) of the earphone 4; an omnidirectional microphone 3a and a directional microphone 3b to receive sound from a sound source 28; and a control interface 20.

[0088] Instead of transmitting the audio stream data 10 directly to the earphone 4, the audio stream data 10 is sent to the receiving unit 12 of the receiver 25 that is configured to provide an output audio signal 30 that can be played by the earphone 4 or by a hearing aid device 26 that is connected to the receiver 25.

[0089] The receiver 25 also comprises an omnidirectional

microphone 103a, a directional microphone 103b, a control interface 120 and a processing unit (not shown). The receiver 25 together with the earphone 4 or the hearing aid device 26 can be used as a hearing assistance system independently from the listening device 2. Since such a hearing assistance system is usually worn by the user, the listening device 2 may be used as a flexible add-on for such a system that increases the mobile usability.

[0090] The embodiment of Figure 4 shows that the listening device 2 can also be configured to output the audio stream data 10 to more than one receiving unit 12. The listening device 2 transmits the wireless audio stream data 10 to the receiving unit 12 of a receiver 25 (cf. embodiment shown in Figure 3) and additionally to the receiving unit 12 of the earphone 4 (cf. embodiment shown in Figure 1). Thus, the listening device 2 may comprise two or more of the wireless transmission units 11 shown in Figure 1. Such a listening device 2 allows to share the audio stream data 10 generated by the listening device 2 with other users.

[0091] Figure 5 illustrates a method for operating the listening system 1 according to the embodiment shown in Figure 1.

[0092] In step a), digital audio stream data 10 is generated based on the audio signal of the at least one audio input interface 3a, 3b, 3c, 3d of the listening device 2 by the processing unit 9 of the listening device 2. In this step, the processing of the digital audio stream data 10 is performed, so that no further processing of the audio stream data 10 has to be performed in the earphone 4, except the processing for playing the audio stream data 10 over the loudspeaker 5.

[0093] In step b), the digital audio stream data 10 is wirelessly transmitted from the listening device 2 to the at least one earphone 4.

[0094] In step c), the digital audio stream data 10 is stored on the data storage 19 of the earphone 4 and the audio stream data 10 is played by the loudspeaker 5 of the earphone 4 subsequently after storing it.

[0095] In step d) the audio stream data 10 stored on the data storage 19 of the earphone 4 is deleted after the corresponding audio stream data 10 has been played by the loudspeaker 5 of the earphone 4.

[0096] The adjustment of the personalized amplification is done prior to step a), for example, by using the smart device 17. The settings are saved in the processing unit 9 so that steps a) to d) can be performed independently from the smart device 17.

Claims

1. Listening device (2) comprising at least one audio input interface (3a, 3b, 3c, 3d), wherein said listening device (2) comprises a processing unit (9) configured to generate digital audio stream data (10) based on an audio signal from the at least one audio input in-

- terface (3a, 3b, 3c, 3d), and a wireless transmission unit (11) that is configured to wirelessly output the digital audio stream data (10) to be received by a receiving unit (12), **characterized in that** said listening device (2) comprises a charging case (23) with a holder (6) configured to hold at least one earphone (4) and a charging interface (7) that is configured to recharge a battery (8) of the at least one earphone (4) when the earphone (4) is held by the holder (6).
2. Listening device (2) as claimed in claim 1, **characterized in that** said listening device (2) is a handheld device.
 3. Listening device (2) as claimed in any one of the preceding claims, **characterized in that** the holder (6) is configured to support the at least one earphone (4) in at least two spatial directions, preferably in three spatial directions.
 4. Listening device (2) as claimed in any one of the preceding claims, **characterized in that** at least one audio input interface is a microphone (3a, 3b, 3c).
 5. Listening device (2) as claimed in claim 4, **characterized in that** at least one audio input interface is an omni-directional microphone (3a) and/or at least one audio input interface is a directional microphone (3b, 3c).
 6. Listening device (2) as claimed in claims 4 or 5, **characterized in that**
 - said listening device (2) comprises at least two microphones (3a, 3b, 3c), wherein
 - one or more of the at least two microphones (3a, 3b, 3c) is selectable as the main source for generating the digital audio stream data (10).
 7. Listening device (2) as claimed in any one of the preceding claims, **characterized in that** at least one audio input interface is a connector (3d) that is configured to receive audio signals via an audio cable.
 8. Listening device (2) as claimed in any one of the preceding claims, **characterized in that** the charging case (23) comprises a lid (16) that is movable relative to the holder (6) from an opened position to a closed position, wherein in the opened position the holder (6) is accessible, wherein in the closed position the holder (6) is covered by the lid (16), wherein an operating mode of the listening device (2) is settable depending on the position of the lid (16) relative to the holder (6).
 9. Listening device (2) as claimed in claim 8, **characterized in that** at least one intermediate position of
- the lid (16) between the opened and the closed position is predefined which is recognizable by the user through haptic feedback of the lid (16).
10. Listening device (2) as claimed in any one of the preceding claims, **characterized in that** the listening device (2) is connectable to a smart device (17), wherein the processing unit (9) is configurable by receiving a configuration data set (24) from the smart device (17).
 11. Listening system (1) comprising a listening device (2) according to any one of the preceding claims, and a receiving unit (12) that is configured to receive the wireless audio stream data (10) outputted by the listening device (2).
 12. Listening system (1) as claimed in claim 11, **characterized in that** said listening system (1) comprises at least one earphone (4), wherein the at least one earphone (4) comprises a loudspeaker (4), the receiving unit (12) and an internal audio processing unit (14) configured to play the received digital audio stream data (10) on the loudspeaker (5).
 13. Listening system (1) as claimed in claim 11 or 12, **characterized in that** the at least one earphone (4) comprises an internal microphone (13), wherein the internal audio processing unit (14) uses the audio signal from the internal microphone (13) as an input for audio processing.
 14. Listening system (1) as claimed in any one of the claim 11 to 13 in combination with claim 10, **characterized in that** said listening system (1) further comprises the smart device (17) that is configured to be connected with the listening device (2), wherein the smart device (17) comprises a software configured to generate a configuration data set (24), and to send the configuration data set (24) to the listening device (2).
 15. Listening system (1) as claimed in any one of the claims 11 to 14, **characterized in that** the listening device (2) comprises a charger battery (18) having a capacity that has at least five times, preferably at least ten times, the capacity of a battery (8) of the at least one earphone (4).

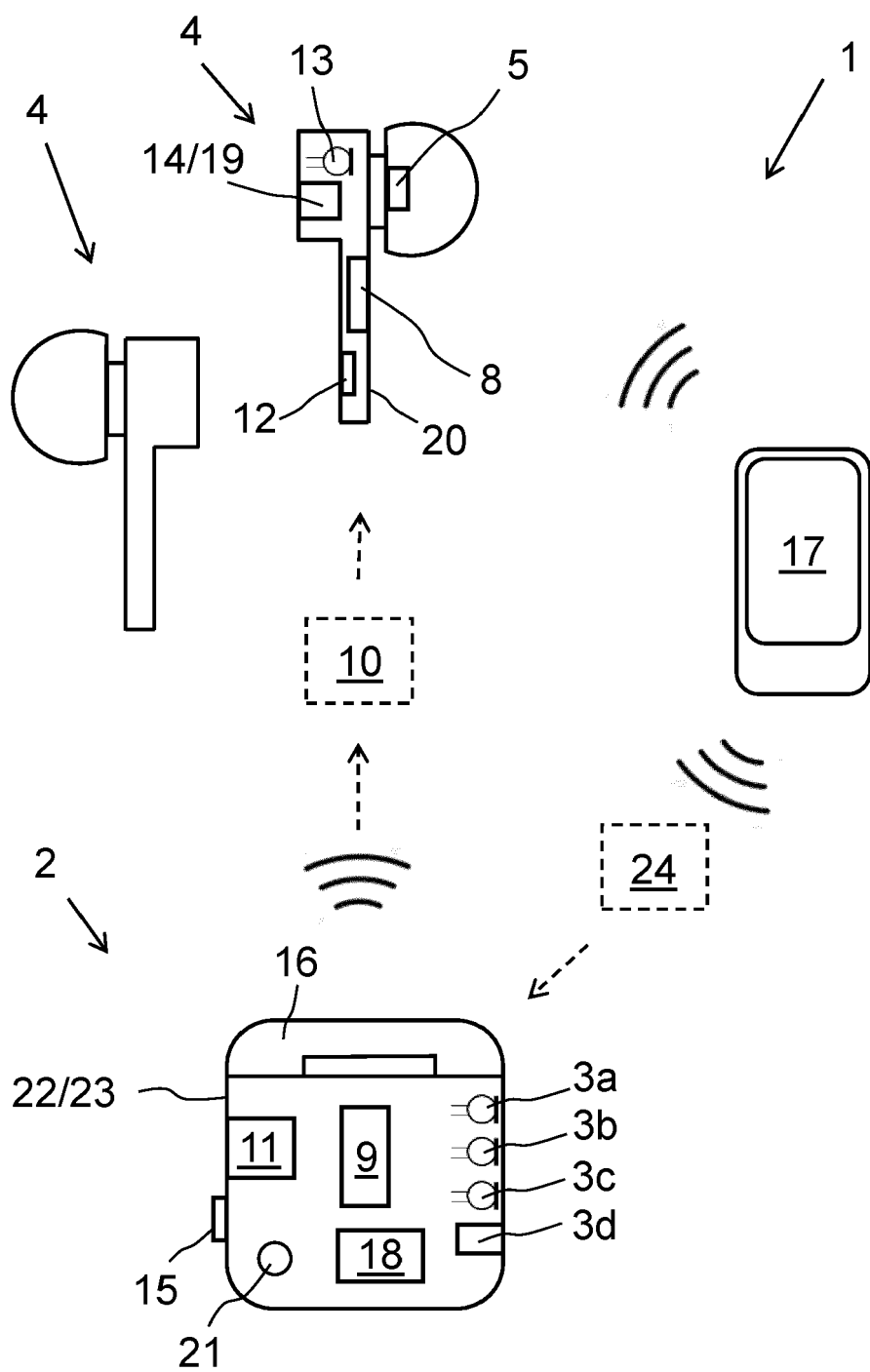


Fig. 1

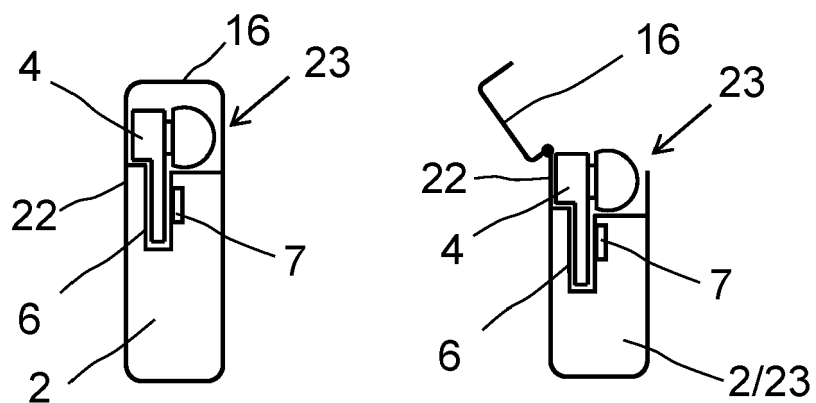


Fig. 2

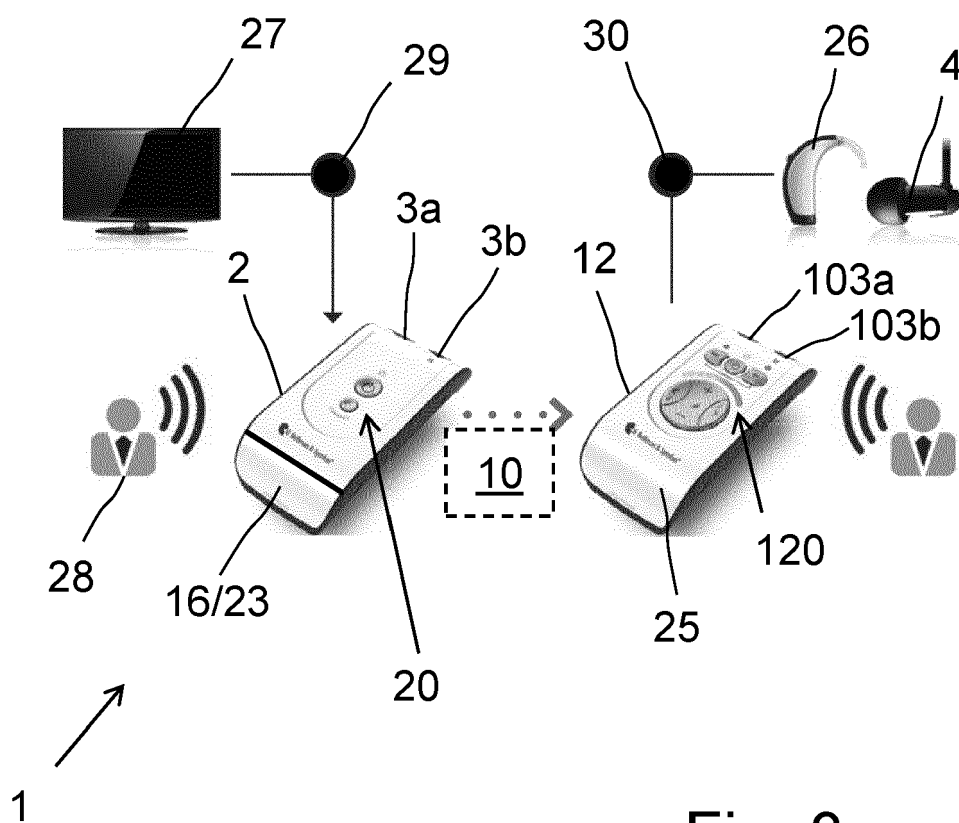


Fig. 3

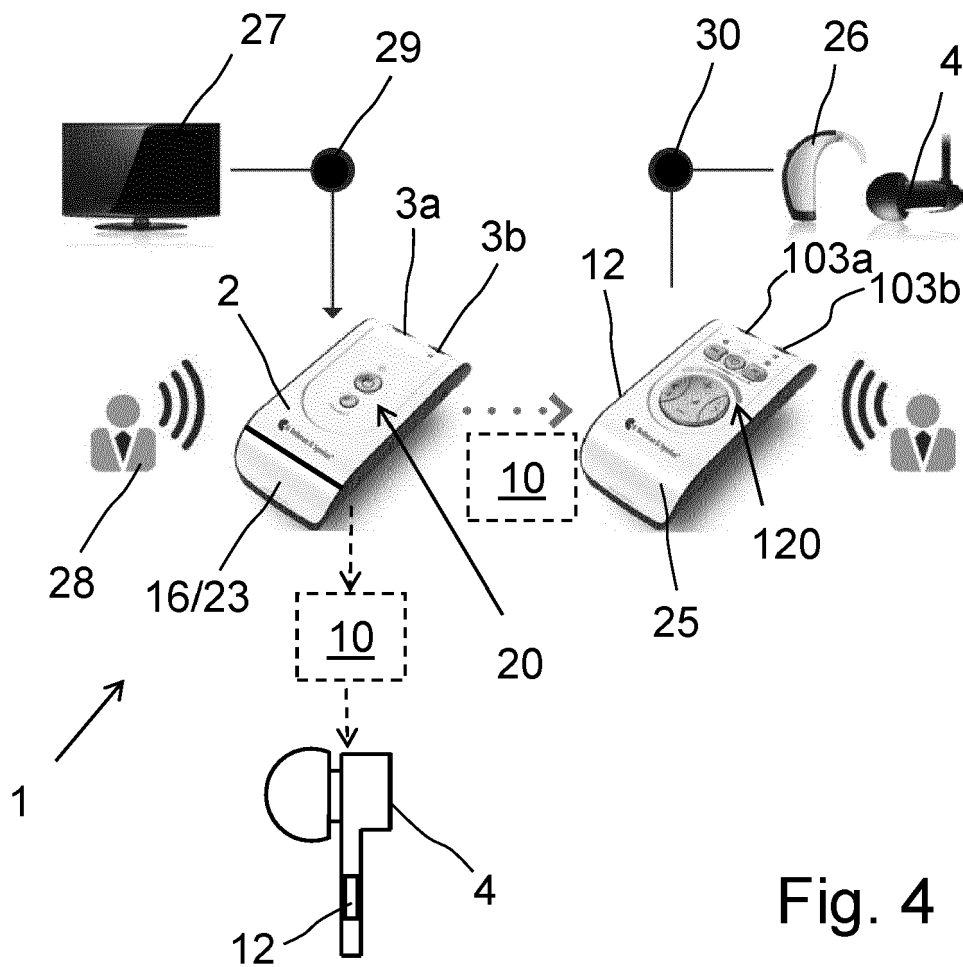


Fig. 4

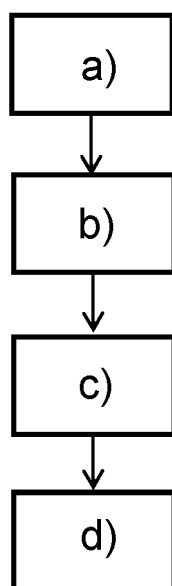


Fig. 5



EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	----- US 2008/261527 A1 (CHEN LU-CHENG [TW]) 23 October 2008 (2008-10-23) * paragraphs [0024] - [0031]; figures 3-5 *	4-6	
Y	----- US 2020/329134 A1 (KIM SEUNG JIN [US]) 15 October 2020 (2020-10-15) * paragraphs [0078], [0081], [0089], [0090], [0139], [0143], [0145]; figures 1-2, 4A-4B, 7 *	4-6,10, 14	
X	----- GB 2 461 477 A (LIN PI-FEN [TW]) 6 January 2010 (2010-01-06) * figures 4-6 *	1,7	
			TECHNICAL FIELDS SEARCHED (IPC)
			H04R
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		27 August 2021	Fachado Romano, A
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)



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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☒ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

1, 2, 4-7, 10-12, 14, 15(completely); 3(partially)

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



LACK OF UNITY OF INVENTION
SHEET B

Application Number

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The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1, 2, 11, 12, 15(completely); 3(partially)

Known/obvious listening device and system.

1.1. claims: 1, 2, 11, 12(completely); 3(partially)

Known listening device and system.

1.2. claim: 15

Listening system comprising selected battery capacity.

2. claim: 3(partially)

Listening device comprising means to support the earphone in at least three spatial directions.

3. claims: 4-7

Listening device comprising alternative means to receive audio.

4. claims: 8, 9

Listening device comprising means to control the operation mode of said listening device.

5. claims: 10, 14

Listening device and system comprising means to configure said listening device.

6. claim: 13

Listening system comprising means to process audio depending on the acoustic environment of the earphone.

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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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.

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