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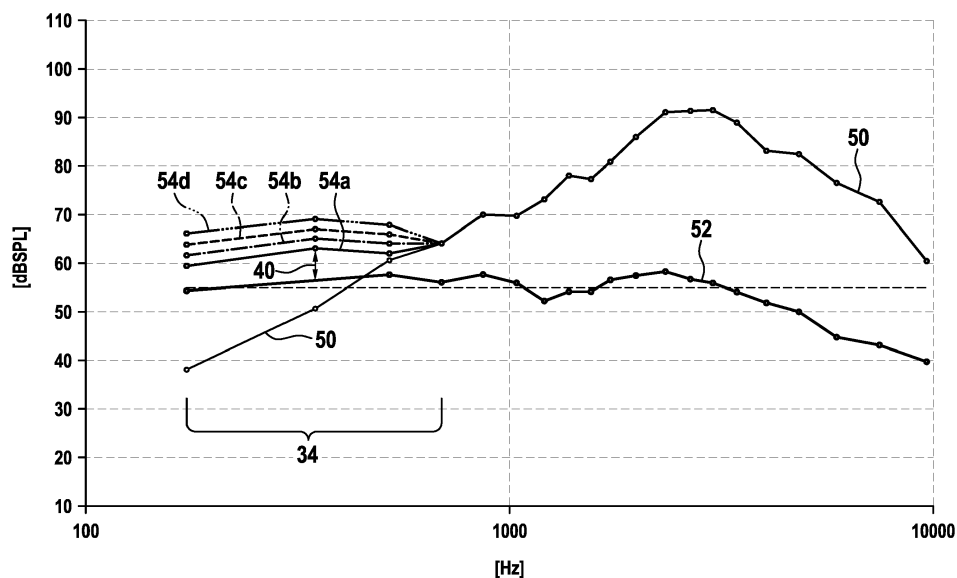
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(54) **ADJUSTING A FREQUENCY DEPENDENT GAIN OF A HEARING DEVICE**

(57) A method for adjusting a frequency dependent gain of a hearing device (10) comprises: receiving an amplification level (38) selected by a user of the hearing device (10); selecting offset gain values (40) for frequencies in a bass range (34) based on the amplification level (38); reading fitting gain values (30) for the frequencies stored in the hearing device (10), wherein the fitting gain values (30) have been selected to compensate a hearing loss of the user; determining direct sound indicator values (32) for the frequencies, wherein an direct sound indica-

tor value (32) for a frequency specifies a level of direct sound in front of an ear drum in an ear canal of the user at that frequency; setting an adjusted gain value (36) in each frequency depending on the offset gain value (40), the fitting gain value (30) and the direct sound indicator value (32); applying the adjusted gain values (36) to an amplifier (20) of the hearing device (10), such that a sound signal in each frequency is amplified with the corresponding adjusted gain value (36).

Fig. 2



Description

FIELD OF THE INVENTION

5 **[0001]** The invention relates to a method, a computer program and a computer-readable medium adjusting a frequency dependent gain of a hearing device. Furthermore, the invention relates to a hearing device.

BACKGROUND OF THE INVENTION

10 **[0002]** A hearing device may be used for compensating a hearing loss of a user. Hearing devices are generally small and complex devices. Hearing devices can include a processor, microphone, speaker, memory, housing, and other
 15 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
 20 budget.

25 **[0003]** Usually a hearing device comprises a part, called coupling, which partially or completely occludes the ear canal of a user. Electroacoustic amplified sound is emitted by a hearing device receiver in the ear canal via the coupling. Portions of the electroacoustic amplified sound may flow out of the ear canal through the coupling, especially at low frequencies. This may be called ventloss or leakage. Also, portions of environmental sound may pass the ear canal
 30 directly through the coupling, without electroacoustic amplification, especially at low frequencies, whereas environmental sound may be attenuated by the coupling more at high frequencies. The environmental sound, which passes the ear canal directly through the coupling, is called direct sound. In front of the ear drum, a superimposition of receiver sound and direct sound takes place, which may result in unwanted comb filter effects. Furthermore, if the emitted receiver
 35 sound is at lower levels than the direct sound in specific frequency ranges, it may get masked by the direct sound at these frequency ranges.

DESCRIPTION OF THE INVENTION

40 **[0004]** It is an objective of the invention to avoid comb filter effects and to increase perceived sound gain at low frequencies masked by direct sound.

[0005] This objective is achieved by the subject-matter of the independent claims. Further exemplary embodiments are evident from the dependent claims and the following description.

45 **[0006]** A first aspect of the invention relates to a method for adjusting a frequency dependent gain of a hearing device. A hearing device may be a device as described above. A hearing device may be a hearing aid adapted for compensating the hearing loss of a user.

50 **[0007]** A hearing device may comprise a microphone, a sound processor and a sound output device, such as a loudspeaker, which also may be called a receiver. The sound processor may receive a sound signal from the microphone and may frequency dependent amplifier and/or attenuate the sound signal. The sound signal then may be output by the sound output device to the ear of the user. The hearing device may comprise an in-the-ear part arranged in the ear canal
 of the user. The in-the ear part may contain or may be connected to the sound output device.

[0008] The method as described herein may be performed automatically by the hearing device.

55 **[0009]** According to an embodiment of the invention, the method comprises: receiving an amplification level selected by a user of the hearing device. A low frequency amplification level change request from the user may be received in the hearing device. For example, the hearing device may comprise a knob for selecting the amplification level. It also may be possible that the selection is performed with a mobile device of the user, which sends the selected amplification level to the hearing device. The amplification level may be numeric value. For, example, the amplification level is an integer number from a range of numbers.

[0010] According to an embodiment of the invention, the method further comprises: selecting offset gain values for frequencies in a bass range based on the amplification level. A bass range may comprise frequencies below 1 kHz. The frequency range may be divided into frequency bands and/or frequencies, wherein the hearing device is adapted for processing a sound signal in each frequency band separately. A frequency band may be represented by a frequency.

[0011] The offset gain values may be selected to specify a desired amplification. For example, the offset gain values may be equal in the frequency range. However, it also may be that the offset gain values increase from a border of the frequency range towards a middle of the frequency range.

60 **[0012]** For example, the offset gain values may be selected, such that the offset gain values from a lowest frequency to a highest frequency are decreasing. In this case it may be that, the offset gain value of the highest frequency is 0.

[0013] The offset gain values may be determined with a function stored in the hearing device, which calculates the offset gain values, when the amplification level is put in as input data. It also may be that the offset gain values are stored

in a table in the hearing device and/or in the mobile device in dependence of the amplification level.

[0014] According to an embodiment of the invention, the method further comprises: reading fitting gain values for the frequencies stored in the hearing device, wherein the fitting gain values have been selected to compensate a hearing loss of the user. The fitting gain values may have been determined during fitting of the hearing device, for example a hearing care specialist may have selected the fitting gain values and applied to the hearing device.

[0015] In general, the fitting gain values may be seen as a gain model for the hearing device. When the hearing device is operating, there may be a sound in front of an ear drum of an ear of the user, wherein the sound is a superimposition of a receiver sound, i.e. a sound from a receiver and/or loudspeaker of the hearing device and direct sound, which is environmental sound passing a coupling of the hearing device directly into the ear canal without electroacoustic amplification. The receiver sound may be generated based on the environment sound being picked up by a microphone of the hearing device, which is amplified by an amplifier according to the gain model and/or the fitting gain values. The receiver sound may then be emitted by the receiver into the ear.

[0016] The fitting gain values and/or the gain model may be defined such that the receiver sound is sufficiently below the direct sound within the bass range for avoiding comb filter effects; which may result if both sounds are at a similar level.

[0017] It may be that the hearing device comprises several sets of fitting gain values, which may be selected for different programs of the hearing device. The actually selected fitting gain values then may be used in the present method. It also may be that the fitting gain values are dependent on an input gain of the environmental sound to be amplified. Thus, the amplification of the hearing device may be frequency dependent and gain dependent.

[0018] According to an embodiment of the invention, the method further comprises: determining direct sound indicator values for the frequencies, wherein a direct sound indicator value for a frequency specifies and/or indicates a level of direct sound in front of an ear drum in the ear canal of the user at that frequency. As already mentioned, direct sound may be environmental sound directly entering the ear canal without electroacoustic amplification.

[0019] The direct sound, which is used for determining the direct sound indicator values, may be estimated based on the results of a feedback test. Such a feedback test may be performed with the ear of the user. The direct sound indicator values may directly encode the level of direct sound in front of the ear drum, as real ear occluded gain values or as 2cc occluded gain values. Also the fitting values may be encoded in this way.

[0020] As the offset gain values, the direct sound indicator values may be determined with a function stored in the hearing device and/or from a table stored in the hearing device. The function and/or table for the specific hearing device type and/or hearing device configuration of the hearing device then may be stored in the hearing device.

[0021] It may be that direct sound indicator values are determined by a hearing device manufacture for different hearing device types and/or hearing device configurations. The level of direct sound may depend on a leakage or vent in the coupling, in particular a diameter and/or length of the vent. In general, the level of direct sound may be estimated based on data in a fitting software. It also may be that the direct sound is directly measured.

[0022] According to an embodiment of the invention, the method further comprises: setting an adjusted gain value in each frequency depending on the offset gain value, the fitting gain value and the direct sound indicator value. For example, the method may comprise: setting an adjusted gain value in each frequency to the sum of the offset gain value and a maximum of the fitting gain value and the direct sound indicator value. In each frequency, a maximum of the fitting gain value and the direct sound indicator value may be determined to this maximum, the respective offset gain value may be added.

[0023] For example, an adjusted gain value in the frequency may be set to the sum of the direct sound indicator value and the offset gain value for a frequency, when the direct sound indicator value in the frequency is higher than the fitting gain value. When the direct sound indicator value in the frequency is lower (or equal) to the fitting gain value, the adjusted gain value in the frequency may be set to the sum of the fitting gain value and the offset gain value in the frequency.

[0024] For compensating the masking of the direct sound, the offset gain values are added to the higher value of the fitting gain value and the direct sound indicator value. When necessary, the amplification is performed with respect to the level of direct sound, which may be higher than the level of an unmodified fitting gain model, which has been selected to be below the direct sound level to avoid comb filter effects. Since the adjusted gain values may be above the level of direct sound, a comb filter effect also may be avoided with the adjusted gain values.

[0025] It has to be noted that in such a way the fitting gain values may be chosen device independent, while the direct sound indicator values solely may be based on the type and/or configuration of the hearing device.

[0026] According to an embodiment of the invention, the method further comprises: applying the adjusted gain values to an amplifier of the hearing device, such that a sound signal in each frequency is amplified with the corresponding adjusted gain value. The sound processor of the hearing device may be adapted for amplifying the sound signal from the microphone differently in each frequency. This frequency dependent amplification may be set with the adjusted gain values. A correspondingly amplified sound is then output by the sound output device.

[0027] According to an embodiment of the invention, the fitting gain values and/or the direct sound indicator values have been determined for an ear of the user. The fitting gain values and the direct sound indicator values may be obtained in a real ear representation.

[0028] According to an embodiment of the invention, the fitting gain values and/or the direct sound indicator values have been determined for a standardized ear model, such as for a 2cc coupler. The fitting gain values and the direct sound indicator values may be obtained in 2cc coupler values representation.

[0029] According to an embodiment of the invention, an adjusted gain value is set to a maximal gain value in the frequency, when it is higher than the maximal gain value. A maximal gain value may be provided for each frequency. A headroom for the amplification may be defined in this way.

[0030] According to an embodiment of the invention, margin gain values are added to the adjusted gain values or to the offset gain values, before the adjusted gain values are applied to the amplifier of the hearing device. The margin gain values in different frequencies all may be equal. Such margin gain values may help to suppress comb filter effects between the direct sound, which directly enters the ear of the user and processed sound output by the hearing device into the ear, i.e. receiver sound, which usually is delayed with respect to the direct environmental sound. With the margin gain values, the sound output by the hearing device may be made louder than the direct environmental sound.

[0031] According to an embodiment of the invention, an adjusted offset value is determined by subtracting the fitting gain value from the direct sound indicator value and adding the offset gain value for a frequency, when the direct sound indicator value in the frequency is higher than the fitting gain value. The adjusted gain value then may be determined by adding the adjusted offset value to the fitting gain value. This may be beneficial, when the adjusted gain value is determined in a different module and/or part of the hearing device as the adjusted gain value, which, for example, may be determined in the sound processor directly.

[0032] According to an embodiment of the invention, the direct sound indicator values are stored in the memory of the hearing device. It may be that the direct sound indicator values are calculated offline and stored in the hearing device in the form of a table.

[0033] According to an embodiment of the invention, the direct sound indicator values are determined from a function stored in the hearing device. It also may be that a function, such as a spline or a polynomial, is fitted to a curve, which is defined by the direct sound indicator values. The parameters of this function and/or curve may be stored in the hearing device.

[0034] According to an embodiment of the invention, when the amplification level increases, the offset gain values increase. For example, the offset gain values for a first amplification level may be multiplied with a factor, which increases with increasing amplification level.

[0035] Further aspects of the invention relate to a computer program for adjusting a frequency dependent gain of a hearing device, which, 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.

[0036] For example, the computer program may be executed in a processor of the hearing device, which, for example, may be carried by the user behind the ear and/or in the ear. The computer-readable medium may be a memory of the hearing device.

[0037] 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.

[0038] A further aspect of the invention relates to a hearing device adapted for performing the method as described in the above and in the following. The hearing device may comprise a processor and a memory, in which the computer program is stored. The hearing device may comprise a microphone for acquiring a sound signal, which is frequency dependent adjusted with the method. The hearing device also may comprise an in-the-ear part, which is either connected via a tube with the sound output device and/or which contains the sound output device.

[0039] 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 device as described in the above and in the following, and vice versa.

[0040] 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

[0041] Below, embodiments of the present invention are described in more detail with reference to the attached drawings.

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

Fig. 2 shows a diagram with sound curves produced in a method for adjusting a frequency dependent gain of a

hearing device according to an embodiment of the invention.

Fig. 3 shows a diagram with gain values used in a method for adjusting a frequency dependent gain of a hearing device according to an embodiment of the invention.

Fig. 4 shows a diagram indicating amplification levels used in a method according to an embodiment of the invention.

Fig. 5 shows a flow diagram for a method for adjusting a frequency dependent gain of a hearing device according to an embodiment of the invention.

[0042] The reference symbols used in the drawings, and their meanings, are listed in summary form in the list of reference symbols. In principle, identical parts are provided with the same reference symbols in the figures.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0043] Fig. 1 schematically shows a hearing device 10 in the form of a behind the ear device. It has to be noted that the hearing device 10 of Fig. 1 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.

[0044] The hearing device 10 comprises a part 12 behind the ear and a part or coupling 14 to be put in the ear canal of a user. The part 12 and the part 14 are connected by a tube 16. In the part 12, a microphone 18, a sound processor 20, which may comprise an amplifier, and a sound output device 22, such as a loudspeaker and/or receiver, are provided. The microphone 18 may acquire environmental sound of the user and may generate a sound signal, the sound processor and/or amplifier 20 may amplify the sound signal and the sound output device 22 may generate sound that is guided through the tube 16 and the in-the-ear part 14 into the each canal of the user.

[0045] The hearing device 10 may comprise a processor 24, which is adapted for adjusting the frequency dependent gain of the sound processor 20. For example, with a knob 26 of the hearing device 10, a user may select a specific program, which has been adjusted for him or by himself to compensate his hearing loss in a specific situation. Furthermore, with the knob, modifiers (such as bass, treble, noise suppression, etc.) and levels of these modifiers may be selected, which change the frequency and input level dependent gain of the sound processor 20. All these functions may be implemented as computer programs stored in a memory 28 of the hearing device 10, which computer programs may be executed by the processor 20.

[0046] Fig. 2 shows a diagram with sound pressure levels in front of the ear drum of a user, which may be present in a method as described herein. The sound pressure levels are depicted over frequency

In general, the sound in front of the ear drum is a superimposition of a receiver sound 50 produced by the sound output device 22 (which may be a loudspeaker 22 and/or receiver 22), and a direct sound 52, which results from environment sound passing directly without electroacoustic amplification by the amplifier/sound processor 20 into the ear canal. The unmodified receiver sound 50 may be determined by the hearing device 10 with a fitting curve, which was stored in the hearing device 10 during fitting of the hearing device 10.

[0047] The in-the-ear part 14 occludes the ear canal of the user partially or completely and influences a transmission of the direct sound 52 into the ear canal. Also, the transmission from the receiver sound 50 generated by the sound output device 22 into the ear canal may be influenced by the in-the-ear part 14, since sound produced in this way, may leave the ear canal through the in-the-ear part 14. In particular, sound with low frequencies, i.e. in a bass range 34, flows more out of the ear canal than sound with higher frequencies. Moreover, portions of environmental sound with low frequencies passes the ear canal directly through the opening in-the-ear part 14 more easily than portions of environmental sound with higher frequencies.

[0048] Since the receiver sound 50 is delayed with respect to direct sound, receiver sound of the same level as the direct sound may produce comb filter effects. Therefore the hearing device 10 may be fitted, such that sound in the bass range is much lesser amplified as sound with higher frequencies. In this case, it may be that a bass modifier increases the gain of low frequencies to a higher value, but that an increase in gain is not or nearly not perceptible by the user due to the effects described above. In the following a method will be described in detail, how these effects can be compensated.

[0049] As shown in Fig. 2, a possibly frequency dependent offset 40, which is determined based on the selection of an amplification level by the user, is added to the maximum of the direct sound level 52 and the unmodified receiver sound level 50. Fig. 2 shows different modified receiver sound curves 54a, 54b, 45c, 45d that are produced in this way for different amplification levels.

[0050] Fig. 3 shows a diagram with gains used with the hearing device 10. The diagram shows different curves with gains over frequency, which is depicted to the right. The overall frequency range, in which the hearing device 10 and/or the sound processor 20 is adapted for processing the sound signal is divided into frequencies and/or frequency bands, which are indicated by the dots on the curves in the diagram. For every frequency a different gain value can be selected

for the sound processor 20.

[0051] The fitting gain values 30, which are indicated by the fitting curve 30', may have been determined by an audiologist or hearing care specialist during the fitting of the hearing device 10. The fitting gain values 30 are selected to optimally compensate a hearing loss of the user. The fitting gain values 30 are stored in the memory 28. For example, the fitting gain values 30 are applied to the sound processor, when no special program has been selected and/or when all modifiers are on a neutral level.

[0052] Fig. 3 furthermore shows a direct sound indicator curve 32', from which direct sound indicator values 32 can be determined. The direct sound indicator curve 32' may have been determined from the manufacture of the hearing device 10 and/or may have been measured and/or may depend on the type/configuration of hearing device 10 and in particular the in-the-ear part 12. The direct sound indicator curve 32' indicates the level of direct sound in front of the ear drum in the ear canal. It can be seen that as the lower the frequency as higher the attenuation.

[0053] Fig. 3 also shows adjusted curves 36a', 36b', 36c', 36d', defined by adjusted gain values 36a, 36b, 36c, 36d, which have been determined with the method as described herein. The respective curves 36a', 36b', 36c', 36d' and gain values 36a, 36b, 36c, 36d belong to different positive amplification levels 38, which are indicated in Fig. 4.

[0054] Fig. 3 further indicates an offset gain value 40 for a specific frequency that has been determined for the amplification level 38 and an adjusted offset gain value 42, which is the sum of the difference 44 between the direct sound indicator value 32 and the fitting gain value 30 in this frequency. It has to be noted that the values 40, 42, 44 may be determined for every frequency or at least frequencies for a frequency range, such, as shown, a bass range 34.

[0055] Fig. 4 shows an example of amplification levels 38, which may be chosen by the user, for example with the aid of the knob 26 and/or with a mobile device, which is in data communication with the hearing device 10. For example, the amplification level 38 can be chosen with a slider element of a graphical user interface provided by the mobile device.

[0056] The amplification 0 belongs to the fitting curve 30 and/or the fitting gain values 30 as gain values, which are chosen for amplification. The amplification levels 38, i.e. 1, 2, 3, 4, correspond to the adjusted curves 36a', 36b', 36c', 36d' and/or the adjusted gain values 36a, 36b, 36c, 36d shown in Fig. 3.

[0057] In the following, the adjusted gain values 36a, 36b, 36c, 36d and the offset gain values 40a, 40b, 40c, 40d will be referred to with the numerals 36 and 40 for brevity.

[0058] The offset gain values 40 used for positive amplifications levels 38 may be determined by a function and/or table stored in the hearing device 10.

[0059] Fig. 5 shows a flow diagram for a method for adjusting a frequency dependent gain of the hearing device 10, which may be performed automatically by the hearing device 10.

[0060] In step S10, an amplification level 38 selected by a user of the hearing device 10 is received. For example, the amplification level 38 may have been selected with the knob 26 or with a graphical user interface of a mobile device in data communication with the hearing device 10.

[0061] In step S12, offset gain values 40 for frequencies in a frequency range 34, which may be a bass range, based on the amplification level 38 are selected. The offset gain values may be taken from a table stored in the memory 28 of the hearing device 10 and/or may be calculated with a function stored in the memory 28 of the hearing device 10.

[0062] When the amplification level 38 specifies a positive amplification, the offset gain values 40 are selected to be positive. The offset gain values 40 may be chosen such that the offset gain value 40 for a frequency increases (or at least stays the same), when the amplification level 38 increases.

[0063] When the amplification level 38 specifies an amplification, the offset gain values 40 may be selected, such that the offset gain values 40 decrease from a lowest frequency to a highest frequency of the frequency range 34. It may be possible that the offset gain value 40 of the highest frequency in the frequency range is 0.

[0064] In step S12, also fitting gain values 30 for the frequencies may be read, which have been stored in the hearing device 10.

[0065] Dependent on the amplification level 38, the method continuous in step S14 or step S16.

[0066] In step S14, when the amplification level 38 specifies a positive amplification, direct sound indicator values 32 are determined for the frequencies. The direct sound indicator values 32 also may have been stored in the memory 28 of the hearing device 10 and/or may be calculated with a function stored in the memory 28.

[0067] Then, an adjusted gain value 36 in each frequency is determined based on the offset gain value 40, the fitting gain value 30 and the direct sound indicator value 32 in the frequency.

[0068] When the direct sound indicator value 32 for a frequency is higher than the fitting gain value 30 in this frequency, the adjusted gain value 36 in this frequency is set to the sum of the direct sound indicator value 32 and the offset gain value 40 in this frequency.

[0069] When the direct sound indicator value 32 in the frequency is lower than the fitting gain value 30 in the frequency, the adjusted gain value 36 in the frequency is set to the sum of the fitting gain value 30 and the offset gain value 40 in the frequency.

[0070] It also possible that adjusted offset values 42 are firstly determined in a first module of the hearing device 10, which then may be added to the fitting gain values 30 in a second module of the hearing device 10. For example, this

may be beneficial, when the parameters implemented to the sound processor 20 are not the absolute gain values, but offset gain values with respect to a fitting curve. For example, the sound processor 20 may add the adjusted offset values 42 to the fitting gain values 30.

[0071] In this case, the adjusted offset values 42 may be determined by subtracting the fitting gain value 30 from the direct sound indicator value 32 and adding the offset gain value 40 for a frequency, when the direct sound indicator value 32 in the frequency is higher than the fitting gain value 30. Otherwise, the adjusted offset values 42 may be equal to the selected offset values 40.

[0072] It also is possible that margin gain values are added to the adjusted gain values 36 or to the adjusted offset values 42, before the adjusted gain values 36 are applied to the amplifier of the hearing device 10. As described above, this may be beneficial to compensate for interactions between the original sound and the amplified sound within the ear.

[0073] In step S16, when the amplification level 38 specifies a negative amplification, the direct sound indicator values 32 are not considered. The adjusted gain values 36 are determined by adding the selected negative offset gain values 40 to the fitting gain values 30.

[0074] In both steps S14 and/or S16, the adjusted gain value 36 may be restricted to a maximal gain value. An adjusted gain value 36 may be set to a maximal gain value in the frequency, when it is higher than the maximal gain value in this frequency. Also the maximal gain values for the frequency may be stored in the hearing device 20.

[0075] In step S18, the adjusted gain values 36 are applied to the sound processor and/or amplifier 20 of the hearing device 10, such that the sound signal in each frequency is amplified with the corresponding adjusted gain value 36. For example, the sound signal acquired with the microphone 18 may be amplified in this way and may be output by the sound output device 22.

[0076] 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 practising 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

[0077]

10	hearing device
12	part behind the ear
14	part in the ear
16	tube
18	microphone
20	sound processor
22	sound output device
24	processor
26	knob
28	memory
30	fitting gain value
30'	fitting curve
32	direct sound indicator values
32'	direct sound indicator curve
34	bass range
36a, 36b, 36c, 36d	adjusted gain value
36a', 36b', 36c', 36d'	adjusted curve
38	amplification level
40	offset gain value
40a, 40b, 40c, 40d	offset gain value
40a', 40b', 40c', 40d'	offset curve
42	adjusted offset gain value
44	difference direct sound indicator value and fitting gain value
50	unmodified receiver sound

52 direct sound
54a, 54b, 54c, 54d modified receiver sound

5 Claims

1. A method for adjusting a frequency dependent gain of a hearing device (10), the method comprising:

receiving an amplification level (38) selected by a user of the hearing device (10);
selecting offset gain values (40) for frequencies in a bass range (34) based on the amplification level (38);
reading fitting gain values (30) for the frequencies stored in the hearing device (10), wherein the fitting gain values (30) have been selected to compensate a hearing loss of the user;
determining direct sound indicator values (32) for the frequencies, wherein a direct sound indicator value (32) for a frequency specifies a level of direct sound in front of an ear drum in an ear canal of the user at that frequency;
setting an adjusted gain value (36) in each frequency depending on the offset gain value (40), the fitting gain value (30) and the direct sound indicator value (32);
applying the adjusted gain values (36) to an amplifier (20) of the hearing device (10), such that a sound signal in each frequency is amplified with the corresponding adjusted gain value (36).

2. The method of claim 1,
wherein the adjusted gain value (36) in each frequency band is set to the sum of the offset gain value (40) and a maximum of the fitting gain value and the direct sound indicator value (32).

3. The method of claim 1 or 2,
wherein the fitting gain values (30) and/or the direct sound indicator values (32) have been determined for an ear of the user.

4. The method of one of the previous claims,
wherein the fitting gain values (30) and/or the direct sound indicator values (32) have been determined for a standardized ear model

5. The method of one of the previous claims,
wherein the offset gain values (40) are selected, such that the offset gain values from a lowest frequency to a highest frequency are decreasing.

6. The method of one of the previous claims,
wherein the offset gain value (40) of the highest frequency in the frequency range is 0.

7. The method of one of the previous claims,
wherein an adjusted gain value (36) is set to a maximal gain value in the frequency, when it is higher than the maximal gain value.

8. The method of one of the previous claims,
wherein margin gain values are added to the adjusted gain values (36), before the adjusted gain values (36) are applied to the amplifier of the hearing device (10).

9. The method of one of the previous claims,
wherein an adjusted offset value (42) is determined by subtracting the fitting gain value (30) from the direct sound indicator value (32) and adding the offset gain value (40) for a frequency, when the direct sound indicator value (32) in the frequency is higher than the fitting gain value (30);
wherein the adjusted gain values (36) are determined by adding the adjusted offset values to the fitting gain values.

10. The method of one of the previous claims,
wherein the direct sound indicator values (32) are stored in the memory of the hearing device (10).

11. The method of one of the previous claims,
wherein the direct sound indicator values (32) are determined from a function stored in the hearing device (10).

12. The method of one of the previous claims,
wherein, when the amplification level (38) increases, the offset gain values (40) increase.
- 5 13. A computer program for adjusting a frequency dependent gain of a hearing device (10), which, when being executed
by a processor is adapted to carry out the steps of the method of one of the previous claims.
14. A computer-readable medium, in which a computer program according to claim 13 is stored.
- 10 15. A hearing device (10) adapted for performing the method of one of claims 1 to 12.

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Fig. 1

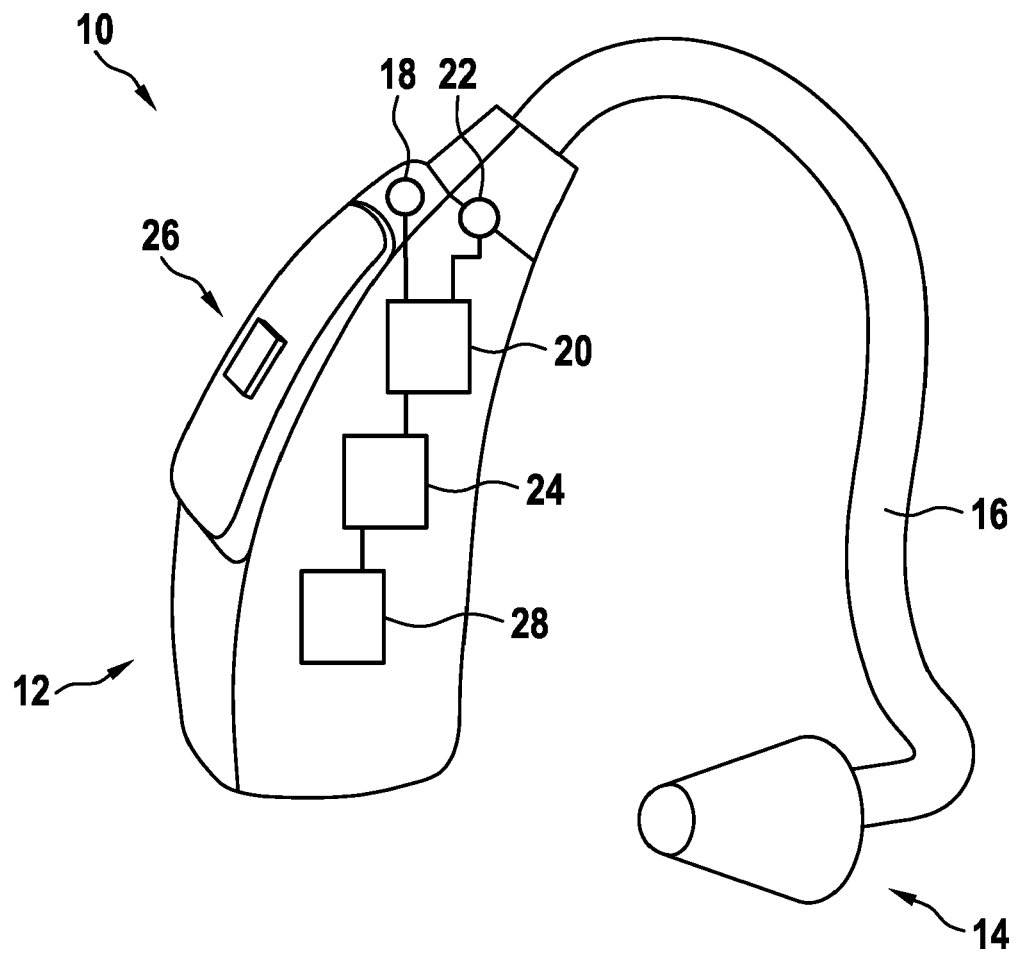


Fig. 2

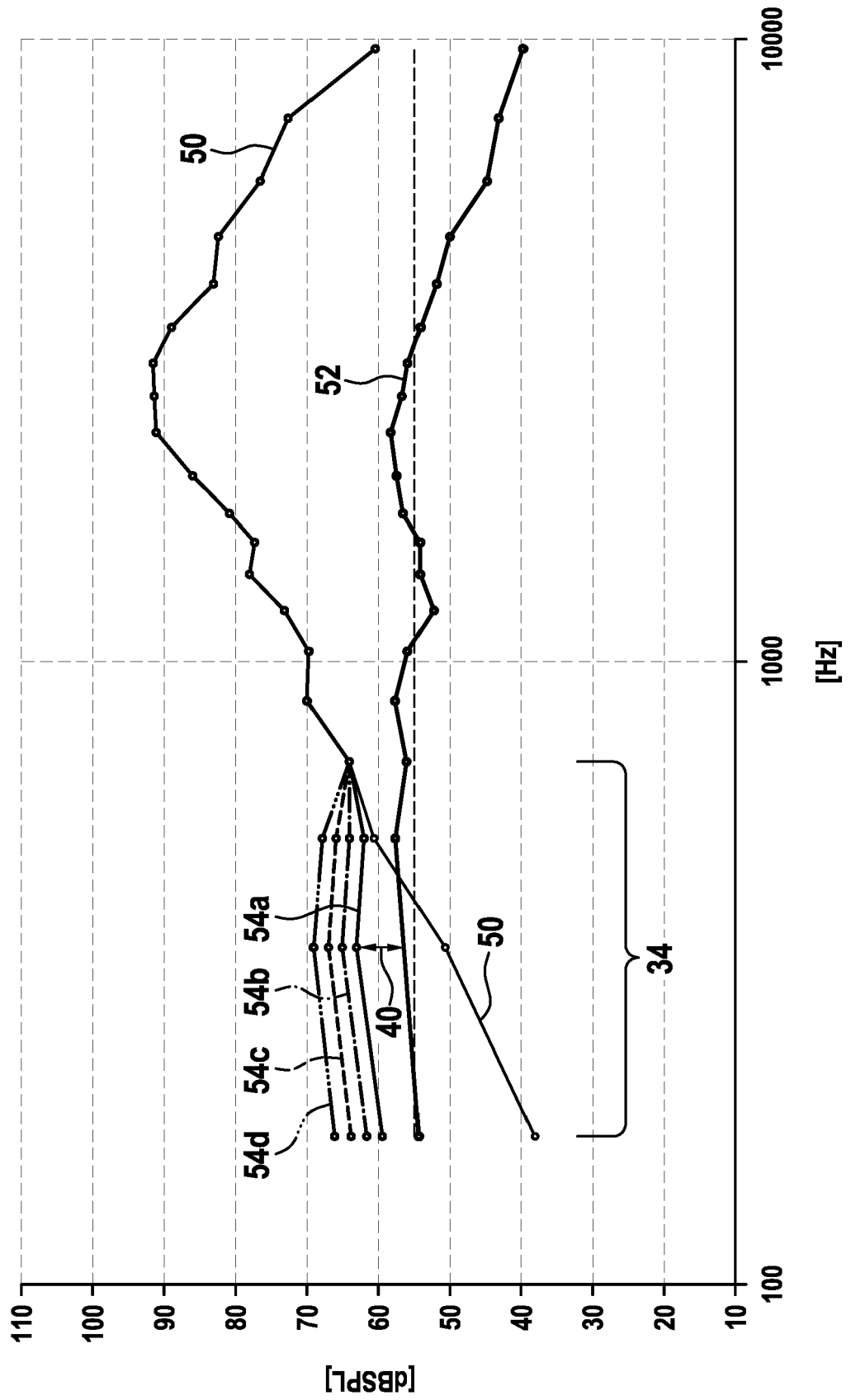


Fig. 3

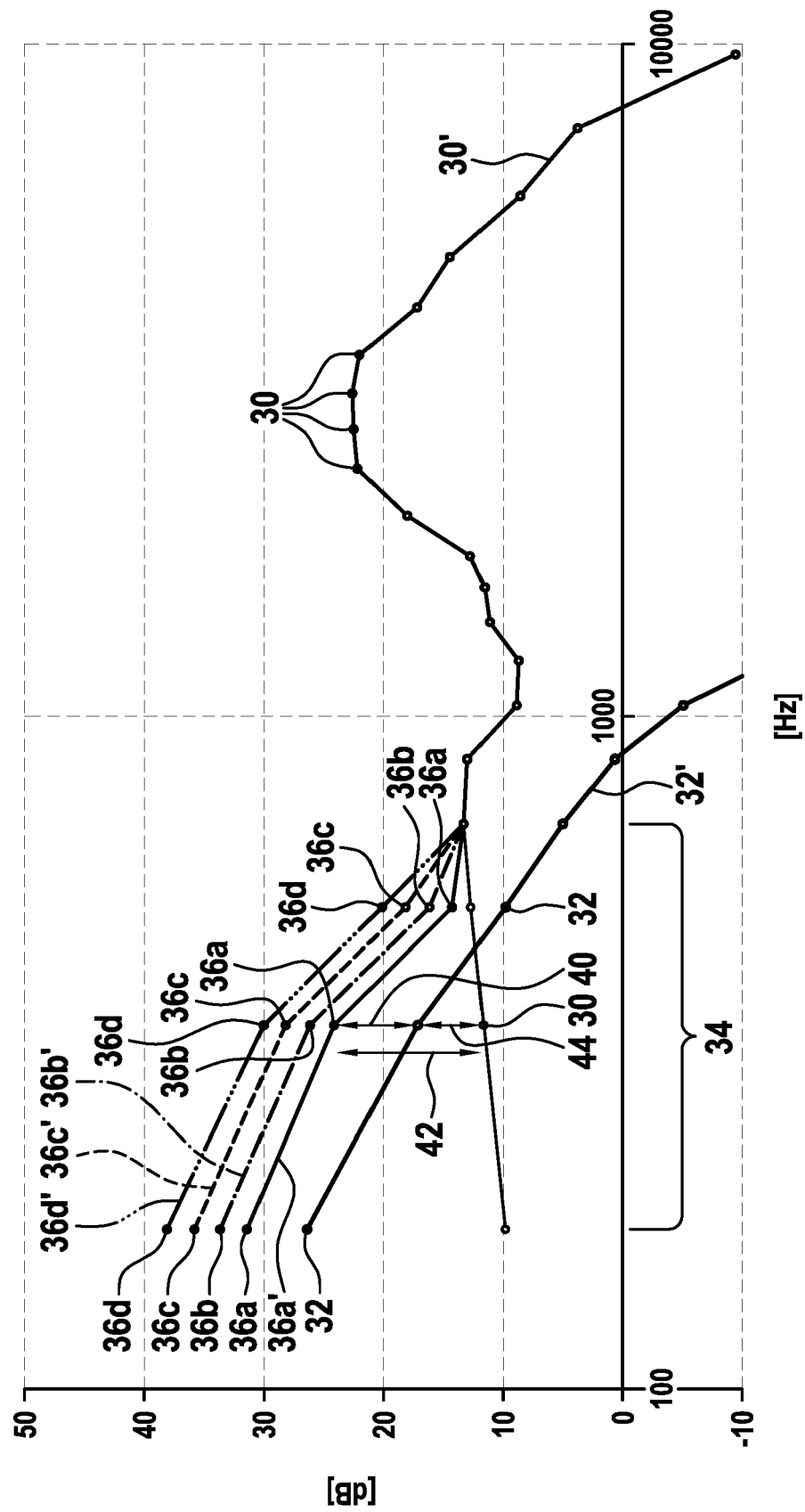


Fig. 4

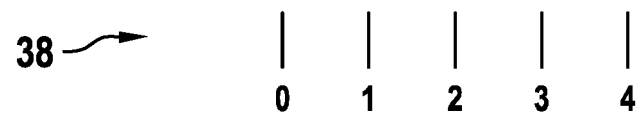
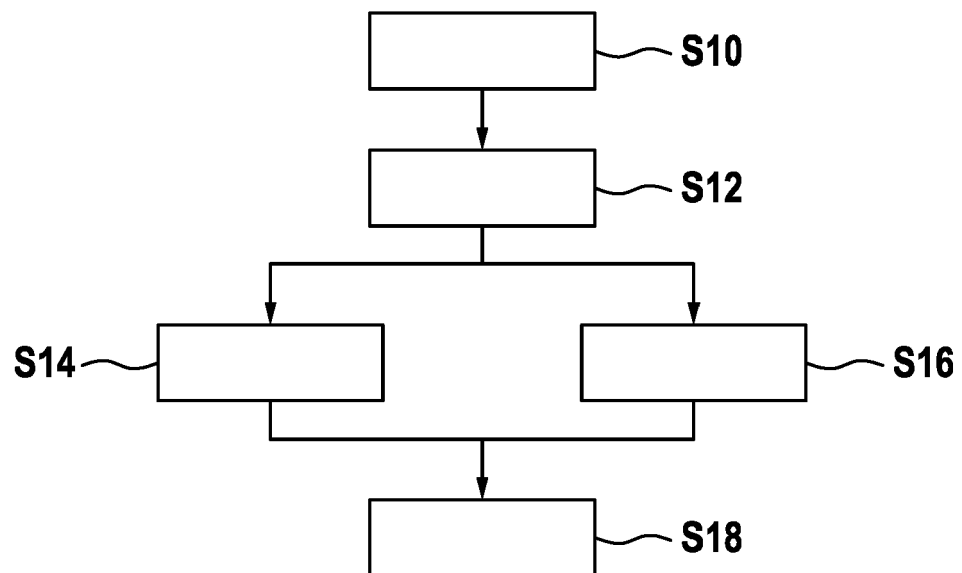


Fig. 5





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Place of search The Hague		Date of completion of the search 5 November 2019	Examiner Timms, Olegs
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			

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