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(54) System and method for personalizing a hearing aid

(57) The present invention relates to a system (100) for training a hearing aid (102). The hearing aid (102) comprises a microphone unit (106) converting a sound pressure to an electric signal; a speaker unit (110) converting a processed electric signal to a processed sound pressure; and a signal processing unit (108) interconnecting the microphone and speaker unit and generating the processed electric signal from the electric signal. The system (100) further comprises a personalizing means adjusting a setting of the signal processing unit (108) during a training phase according to a user reaction.

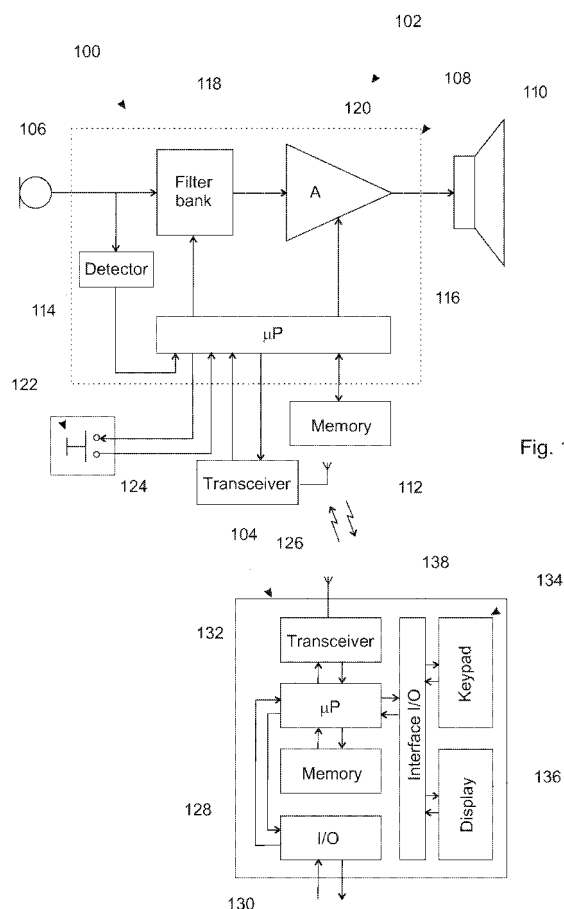


Fig. 1

Description

Field of invention

[0001] This invention relates to a system and method for personalizing a hearing device. In particular, this invention relates to a system and method for training a hearing assistive device such as a behind-the-ear (BTE), in-the-ear (ITE), or completely-in-canal (CIC) hearing aid to a user.

Background of invention

[0002] The adaptation of hearing devices to users has been widely discussed in the patent literature. For example, international patent application WO 01/20965 discloses a method for determining a current acoustic environment in a hearing aid by extracting environment characteristics from an acoustic signal. The environment characteristics are used by the hearing aid processor to select an appropriate hearing aid setting (program). The environment characteristics may be based on audiological features identified using "Auditory Scene Analysis" (ASA), as described in von A. Bregman in MIT Press 1990, during an identification phase prior to operation of the hearing aid.

[0003] Further, European patent application EP 1 432 282 discloses a system and method for adapting a hearing aid to a current acoustic environment identified by the hearing aid. The disclosed hearing aid comprises a signal processing unit for identifying the current acoustic environment and for controlling an amplifier unit in accordance with the identified current acoustic environment. A number of parameter settings are associated with different acoustic environments in a memory and the signal processing unit controls the amplifier by, firstly, identifying the current acoustic environment and, secondly, applying the parameter settings associated with said acoustic environment to the amplifier. The hearing aid further comprises an input unit through which the user of the hearing aid may adjust the parameter settings chosen by the signal processing unit.

[0004] In addition, international patent application WO 2004/098238 discloses a remote control unit for a hearing aid, which provides the user with the possibility for adapting the hearing aid settings to the surrounding acoustic environment and/or the user's desires. The remote control unit may be a module, which is integrated with or connected to a mobile or cellular phone. Hence the disclosed remote control provides controlling means for a user of the hearing aid, which comprises user interfaces simplifying the adaptation of the hearing aid to a specific acoustic environment.

[0005] However, none of the above documents, which hereby are incorporated by reference in the present specification, describe the problem of associating an acoustic environment with a specific setting or program. That is, describe how the hearing aid is trained or learns which

settings to associate with a particular acoustic environment.

[0006] Different acoustic environments may require different hearing aid settings. Generally the hearing aids select a setting in accordance with a specific acoustic environment detected by the hearing aid. However, the selection algorithm (signal identification) is typically given by the manufacturer based on hypothetical acoustic environments. Thus the selection may be suboptimal if a user is in acoustic environments unforeseen by the manufacturer.

Summary of the invention

[0007] An object of the present invention is to provide a system and method for personalizing a hearing aid to a user. That, is solving the above-described problem associated with prior art.

[0008] It is a further object of the present invention to provide a training device providing an interface for the user of a hearing aid to communicate adjustments to the hearing aid.

[0009] A particular advantage of the present invention is the system and method enable the user of the hearing aid to personalize the user's hearing aid in accordance with the actual acoustic environments the user operates in.

[0010] In addition, it is an advantage of the present invention that the system ensures the selection of setting during the process will be established on the basis of the user's perception rather than the audiologist, manufacturer or dispenser's general feel.

[0011] The above objects and advantages together with numerous other objects, advantages and features, which will become evident from below detailed description, are obtained according to a first aspect of the present invention by a system for training a hearing aid, and comprising a microphone unit adapted to convert a sound pressure to an electric signal; a speaker unit adapted to convert a processed electric signal to a processed sound pressure; and a signal processing unit interconnecting said microphone and speaker unit and adapted to generate said processed electric signal from said electric signal; wherein said signal processing unit comprising a detector element adapted to detect present acoustic environment of said hearing aid, said signal processing unit being adapted to process said electric signal according to a setting associated with said present acoustic environment, and said system further comprising a personalizing means adapted to adjust said setting during a training phase according to a user reaction.

[0012] The term "setting" is in this context to be construed as a mode of operation, program, or software, to be executed by a processor and comprising a gain transfer function, noise and feedback reduction schemes, and/or directionality calculations.

[0013] The term "a" or "an" is in this context to be construed as one or more, a multiplicity, or a plurality.

[0014] The term "present acoustic environment" is in this context to be construed as the acoustic environment presently being recorded by, firstly, the microphone unit and, secondly, the detector element, and involves data describing the surrounding acoustic environment of the hearing aid.

[0015] Finally, the term "training phase" is in this context to be construed as a period during which the signal processing unit is trained, i.e. the settings adjusted so as to match a user's operational preferences.

[0016] The system according to the first aspect of the present invention thus learns during the training phase the user's preferences continually or for a limited time and adapts the signal processing unit's settings to the user's acoustic environments. That is, the system learns the user's reactions to features such as noise reduction, directionality, expansion, compression, and any combination thereof.

[0017] The personalizing means according to the first aspect of the present invention may further comprise a first user interface positioned on the hearing aid and adapted to detect a user's reaction to the setting. The first user interface may be implemented by means of one or more buttons on the hearing aid in connection with the signal processing unit. Thus the first user interface enables the user to react to the signal processing unit's selection of setting by either changing the volume or changing the overall setting through a button unit placed on the hearing aid.

[0018] The hearing aid according to the first aspect of the present invention may further comprise a memory adapted for storing of one or more settings associated with one or more acoustic environments. The memory may further be adapted for storing a user's reaction to the setting during a training phase and associate the reaction with the present setting executed by the signal processing unit. Hence the user's reaction relating to the setting, which is selected by the signal processing unit, is recorded and the setting is adjusted accordingly so as to update the settings stored in the memory with the user's preferences.

[0019] The personalizing means according to the first aspect of the present invention may further comprise a trainer unit communicating with the hearing aid through a wireless communication channel and adapted to record a user's reaction. The trainer unit provides the user with the ability to react to the hearing aid's signal processing unit's selection of setting. The trainer unit may comprise a second user interface comprising a keypad adapted to receive the user's reaction and a display adapted to present a visual presentation for the user. Hence the user may advantageously utilise the trainer unit for adaptation of the hearing aid to the user, the trainer unit providing a larger user interface reducing the risk for erroneous reactions and simultaneously providing visual confirmation of the user's interactions on the display.

[0020] Psychologically it is of utmost importance to widen the user's influence of the operation of the hearing

aid and thereby personalize the hearing aid to the user. A training process as described above provides a fitting scenario that may be extended infinitely, since the user continuously may request a training phase during which the hearing aid is further fitted to the user. The user is not required to return to the hearing care professional for this further adaptation.

[0021] The trainer unit according to the first aspect of the present invention may comprise a processor adapted to control the second user interface and control communication with the hearing aid. The trainer unit may further comprise a memory adapted for storing the user's reaction. The processor may thus periodically download the user's reactions to the hearing aid. Alternatively or additionally, the processor may perform an immediate download of the user's reactions once the processor records these.

[0022] The second user interface according to the first aspect of the present invention may be adapted to enable switching between the training phase and a common phase. The second user interface may further be adapted to operate as a remote control for the hearing aid during the common phase. Hence the trainer unit may serve a first purpose during the training phase, namely training the hearing aid to the user, and a second purpose during the common phase, namely as a remote control for the hearing aid.

[0023] The system and the trainer unit according to the first aspect of the present invention therefore advantageously may adapt to environment changes and/or changing user preferences. In other words, the system and trainer evaluates the acoustic environment and user preferences when determining the optimum setting of the signal processing unit.

[0024] The training phase of the hearing aid may according to the first aspect of the present invention comprise a fine tuning of amplification associated with each acoustic environment. This results in one amplification frequency response for each setting, which may be manually or automatically selected. The system ensures that the physical acoustic environment in which the user generally operates is taken into account during this process, thereby further personalizing the hearing aid to a specific user.

[0025] Obviously, the system according to the first aspect of the present invention still allows for dialogue with a hearing care professional so as to enable user feedback to the manufacturer of the hearing aids may improve the initial settings when required. In addition, the hearing care professional may through dialogue with the user of the hearing aid and based on the data in memory of the trainer determine how to fine tune the amplification frequency response of each setting.

[0026] The trainer unit according to the first aspect of the present invention may further comprise an I/O element adapted to communicate with a computer. In particular, the I/O element enables the hearing care professional to download data from the memory of the trainer

unit and to import these data to fitting program thereby, for example, gaining threshold information of the user.

[0027] The I/O element of the trainer unit according to the first aspect of the present invention may further be adapted to connect with a communications device, such as a mobile telephone, a cellular telephone, a personal digital assistant, or any combination thereof. This advantageously enables the user for transmitting the information to the hearing care professional, who may assist the user directly without being physically with the user.

[0028] The above objects and advantages together with numerous other objects, advantages and features, which will become evident from below detailed description, are obtained according to a second aspect of the present invention by a trainer unit for training a hearing aid in a system according to the first aspect of the present invention.

[0029] The trainer unit according to the second aspect of the present invention may incorporate any features of the system according to the first aspect of the present invention.

Brief description of the drawings

[0030] The above, as well as additional objects, features and advantages of the present invention, will be better understood through the following illustrative and non-limiting detailed description of preferred embodiments of the present invention, with reference to the appended drawing, wherein:

figure 1, shows a system according to a first embodiment of the present invention.

Detailed description of preferred embodiments

[0031] In the following description of the various embodiments, reference is made to the accompanying figures, which show by way of illustration how the invention may be practiced. It is to be understood that other embodiments may be utilized and structural and functional modifications may be made without departing from the scope of the present invention.

[0032] Figure 1 shows a hearing aid system 100 according to the first embodiment of the present invention and comprising a hearing aid 102 and a training unit 104. The hearing aid 102 comprises a microphone unit 106, a signal processing unit 108, and a speaker unit 110. The microphone unit 106 converts sound to an electric sound-signal, which may be analogue or digital, and communicates the electric sound-signal to the signal processing unit 108. The signal processing unit 108 processes the electric sound-signal in accordance with a prescription of hearing loss and communicates a processed electric sound-signal to the speaker unit 110. The speaker unit 110 converts the processed electric sound-signal to a processed sound to be presented to the user of the hearing aid 102.

[0033] A hearing aid prescription is encoded into a memory 112 of the hearing aid 102 of the signal processing unit 108. That is, a hearing aid care professional, such as a medical doctor, audiologist, or a trained hearing aid dispenser, adapts the hearing aid 102 to the user's hearing impairment. During the process of adaptation the plurality of possible settings in the memory 112 are adjusted so as to fit the user.

[0034] The settings of the signal processing unit 108 may further be influenced by the surrounding acoustic environment, since the signal processing for a situation when the user of the hearing aid 102 is in a noisy acoustic environment, is entirely different from when the user of the hearing aid 102 is in a quiet acoustic environment. Hence the signal processing unit 108 comprises one or more acoustic environment detectors 114 communicating one or more environment signals to a processor 116 of the signal processing unit 108. The processor 116 utilises the one or more environment signals to classify which type of acoustic environment the user is in, and based thereon selects a specific setting from the memory 112 so as to provide the best setting for a particular user's hearing impairment in a particular acoustic environment. The processor 116 controls a filter bank 118 filtering the incoming electric sound signal into one or more frequency bands and controls an amplifier unit 120 receiving the divided electric sound signals and processing each of the divided electric sound signals. The amplifier unit 120 separately amplifies each frequency bands in accordance with the user's hearing impairment encoded into the settings while ensuring that the amplification does not exceed the user's maximum power output tolerance.

[0035] The hearing aid 102 further comprises means for communicating the user's reactions to the overall hearing aid setting (prescriptive and operational) selected by the processor 116 in a specific acoustic environment. As the processor 116 identifies an acoustic environment from the one or more environment signals and selects an appropriate overall setting from the memory 112 the user experiences the effect of the selection and possibly wishes to react by reducing the volume or changing operational setting. The changing of an operational setting includes changing frequency response of the amplification strategy e.g. changing the maximum power output for a particular frequency spectrum, changing the amplification from expansion to compression in the input-output relation in a particular frequency spectrum, changing directionality, or changing the noise reduction. The user may input his reaction directly on a button unit 122 on the hearing aid 102, which may be implemented as one or more buttons for increasing and decreasing volume and for changing program.

[0036] Alternatively, the user may input his reaction on the training unit 104 connecting wirelessly to a transceiver unit 124 in the hearing aid 102. The hearing aid system 100 not only adjusts the settings according to the user's wish but it also matches these settings with the acoustic environment and therefore, will be able to switch to the

correct settings without user intervention in the future.

[0037] The button unit 122 and the transceiver unit 124 connect to the processor 116, which processor 116 subsequently identifies the user's reactions. The processor 116 changes the actual overall settings and stores the reactions of the user in the memory 112 as data associated with the selected acoustic environment.

[0038] Thus the hearing aid system 100 according to the first embodiment of the present invention comprises a training phase, during which the user's reactions to various selections of settings are learned by the hearing aid system 100. The reactions are stored in the memory 112 associated with the actual setting so as to provide a user reflected frequency response function for amplification for each operational setting.

[0039] The training unit 104 comprises a transceiver unit 126 for transmitting and receiving data from the transceiver unit 124 of the hearing aid 102. The communication between the transceiver units 124, 126 may be in accordance with any electro-magnetic signal types, such as Bluetooth or a proprietary wireless protocol, and various modulation types. The training unit 104 further comprises a local memory 128 for additional storing the user's reactions. The reactions may, subsequently, be examined by, for example, a hearing care professional connecting to the training unit 104 through an I/O unit 130.

[0040] The training unit 104 is controlled by a processor 132 managing communication with the hearing aid 102, managing the local memory 128, and managing the communication through the I/O unit 130. The processor 132 further records the user's reactions on a local button unit 134. The button unit 134 may be implemented as a keypad or keyboard.

[0041] The training unit 104 may further comprise a display 136 for providing an interface through which the user may operate the training unit 104. The display 136 may in fact incorporate the button unit 134 as a touch screen. The button unit 124 and the display communicate with the processor 132 through an interface I/O unit 138.

[0042] In an alternative embodiment the button unit 124 enables the user to switch between the training phase and a common phase. During the common phase the training unit 104 may be operated as a remote control for controlling the hearing aid.

[0043] Hence the hearing care professional may during a fitting session access the training unit 104 so as to download information regarding the user's general acoustic environment as well as the reactions the user has had to the setting of the processor 116 during said setting. This is particularly advantageous since the hearing care professional as a complement of dialogue with the user may deduct how the hearing aid 102 is best fitted with the user.

[0044] A further advantage of the training unit 104 is the fact that the user of the hearing aid 102 is provided with further operational control of the hearing aid 102, thereby leaving the user in an improved situation since the discussion with the hearing care professional may be

on more equal terms.

[0045] The training device 104 may in a particular embodiment be implemented as an add-on to a mobile or cellular phone, a personal digital assistant, a personal computer, or any combination thereof.

[0046] The I/O unit 130 enables connection and communication of data to a computer either through wireless technology such as achieved by a wireless telecommunications network, Bluetooth network, or a wired or wireless dedicated line, local area network, metropolitan area network, inter-network (Internet), or any combinations thereof.

15 Claims

1. A system for training a hearing aid, and comprising a microphone unit adapted to convert a sound pressure to an electric signal; a speaker unit adapted to convert a processed electric signal to a processed sound pressure; and a signal processing unit interconnecting said microphone and speaker unit and adapted to generate said processed electric signal from said electric signal; wherein said signal processing unit comprising a detector element adapted to detect present acoustic environment of said hearing aid, said signal processing unit being adapted to process said electric signal according to a setting associated with said present acoustic environment, and said system further comprising a personalizing means adapted to adjust said setting during a training phase according to a user reaction.
2. A system according to claim 1, wherein said personalizing means further comprises a first user interface positioned on the hearing aid and adapted to detect a user's reaction to said setting.
3. A system according to claim 2, wherein said first user interface comprises one or more buttons on said hearing aid.
4. A system according to any of claims 1 to 3, wherein said hearing aid further comprises a memory adapted for storing of one or more settings associated with one or more acoustic environments.
5. A system according to claim 4, wherein said memory is further adapted for storing a user's reaction to the setting during a training phase and associate said reaction with the present setting executed by the signal processing unit.
6. A system according to any of claims 1 to 5, wherein said personalizing means further comprises a trainer unit communicating with said hearing aid through a wireless communication channel and adapted to record a user's reaction.

7. A system according to claim 6, wherein said trainer unit comprises a second interface comprising a keypad adapted to receive the user's reaction and a display adapted to present a visual presentation for the user. 5
8. A system according to any of claims 6 to 7, wherein said trainer unit comprises a processor adapted to control the second user interface and control communication with the hearing aid. 10
9. A system according to any of claims 6 to 8, wherein said trainer unit further comprises a memory adapted for storing said user's reaction. 15
10. A system according to any of claims 7 to 9, wherein said second user interface is adapted to enable switching between the training phase and a common phase. 20
11. A system according to claim 10, wherein said second user interface further is adapted to operate as a remote control for the hearing aid during the common phase. 25
12. A system according to any of claims 1 to 11, wherein said training phase comprises a fine tuning of amplification associated with each acoustic environment. 30
13. A system according to any of claims 6 to 12, wherein said trainer unit further comprises an I/O element adapted to communicate with a computer. 35
14. A system according to claim 13, wherein said I/O element is further adapted to connect with a communications device, such as a mobile telephone, a cellular telephone, a personal digital assistant, or any combination thereof. 40
15. A trainer unit for training a hearing aid in a system according to any of claims 1 to 14. 45

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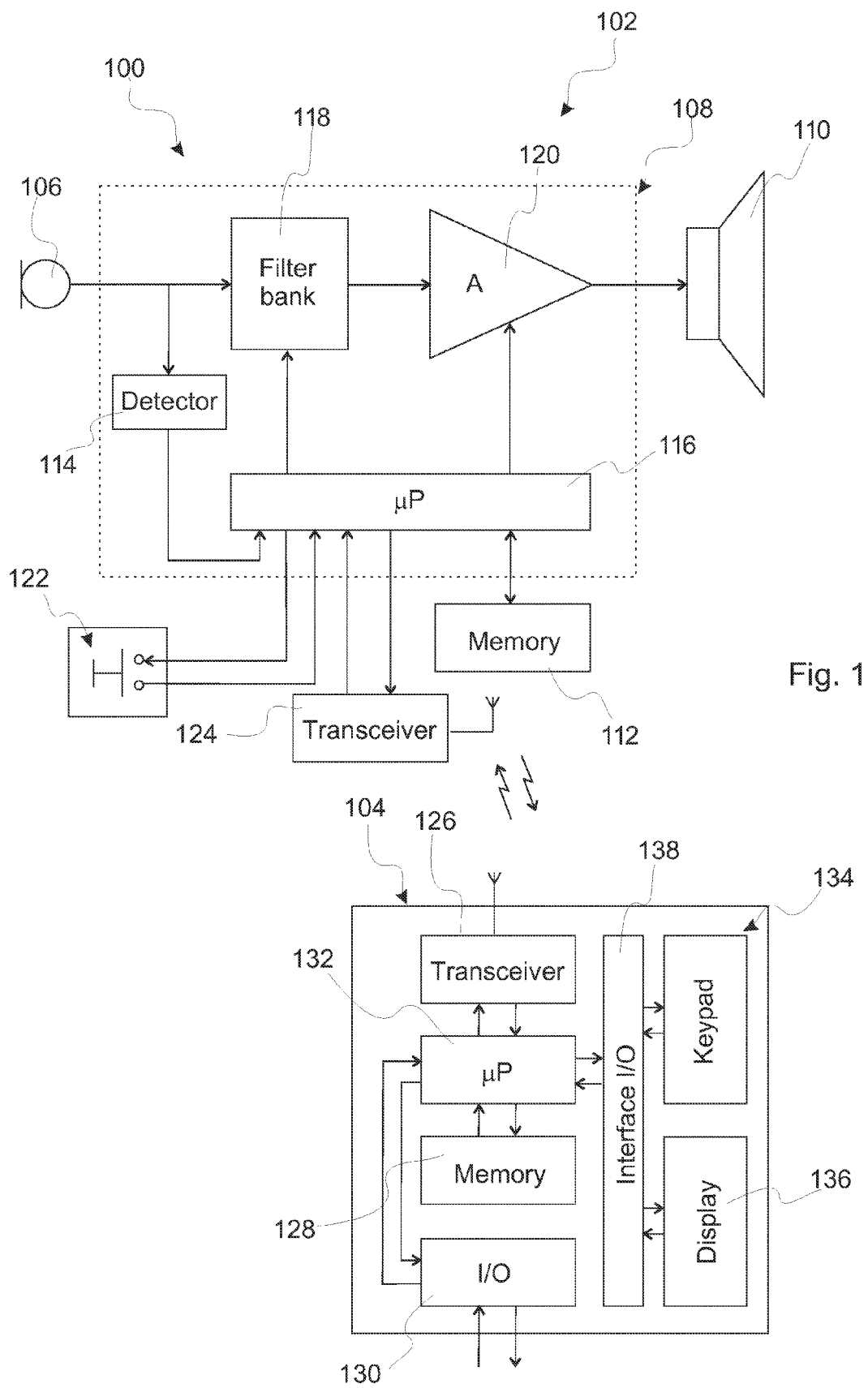


Fig. 1



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 10 2966

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X	US 6 035 050 A (WEINFURTNER ET AL) 7 March 2000 (2000-03-07) * column 1, lines 5-11 * * column 1, line 65 - column 2, line 47 * * column 2, lines 48-57 * * column 3, lines 2-17 * * column 4, line 60 - column 5, line 13 * * column 5, lines 50-65 * * column 6, lines 31-57 * * column 7, lines 53,54 * * column 8, lines 9-18 * * figures 1-6 *	1-15	H04R25/00
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 21 October 2005	Examiner 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			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 05 10 2966

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
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