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(56) Related Art
US 5604812 A (MEYER) 18 February 1997
US 4947432 A (TOPHOLM) 7 August 1990

HEARING DEVICE AND METHOD FOR MONITORING THE HEARING ABILITY OF A PERSON WITH IMPAIRED HEARING

Abstract

Changes of the hearing ability specifically of a person wearing a hearing aid are to be better able to be registered and taken into account. For this purpose, it is proposed to sense the setting of an operating element (LS), which serves for setting an output sound level of a hearing device. Furthermore, the ambient sound level (3) in the vicinity of the hearing device is to be measured. After that, the current setting (2) is compared with the current, measured ambient sound level (3) and a corresponding control signal is output in dependence on the result of the comparison. This control signal serves for example for signaling to the wearer of a hearing aid the loss of hearing or the automatic adjustment of the hearing aid.

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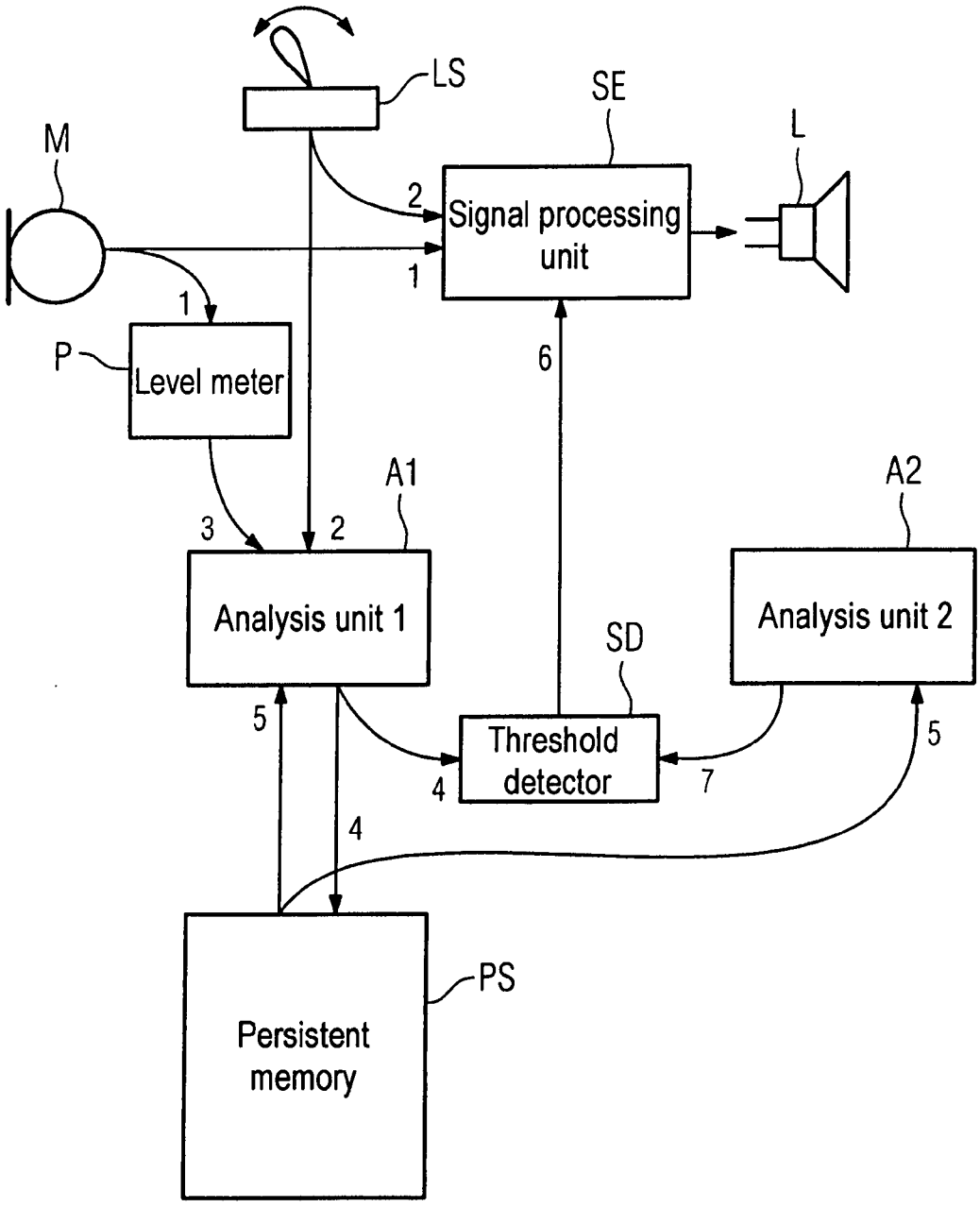

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FOR A STANDARD PATENT

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Invention Title:	Hearing device and method for monitoring the hearing ability of a person with impaired hearing

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

HEARING DEVICE AND METHOD FOR MONITORING THE HEARING ABILITY OF A PERSON WITH IMPAIRED HEARING

The present invention relates to a hearing device, in particular a hearing aid, with at least one operating element for setting an output sound level of the hearing device, in that the operating element can be adjusted to a number of settings. In addition, the present invention relates to a method for monitoring the hearing ability of a person with impaired hearing.

The hearing ability of a person with impaired hearing is not constant, but a variable that changes as a result of learning, aging and other processes. If a person with impaired hearing is already fitted with a hearing system, such a change should lead to readjustment of the hearing system.

Two typical situations may be mentioned in particular in this respect:

a) a hearing ability that has changed over the course of weeks or months, which occurs as a result of a learning effect as the user becomes accustomed to the hearing system (so-called acclimatization).
b) a deterioration in the hearing ability occurring over the course of months or years.

A "hearing system" refers here to one or two hearing aids, which may optionally also be equipped with a remote control. In this case, the remote control may also have functions which assist the signal processing of the hearing aid/hearing aids.

According to the current state of the art, the person with impaired hearing must take responsibility himself for dealing with the aforementioned situations a) and b) as follows:

With a): In the case of acclimatization, the person with impaired hearing goes at regular intervals of weeks or months to the acoustician, who, on the basis of an examination or questioning of his patient, possibly changes the set of parameters of the hearing system. The software used for this has usually been prepared already to the extent that the acoustician activates the next of a small number of setting stages (so-called "acclimatization stages").

With b): In the case of a deteriorating hearing ability, usually taking place slowly, the person with impaired hearing has the responsibility for reducing the setting possibilities available to him on the device. Here it is possible that the person with impaired hearing is not aware of the deterioration in his hearing ability, therefore also does not take the opportunity of newly optimizing his hearing aid setting and gradually arrives ultimately at a point where he is not getting the most from his hearing aid.

In this connection, it is also known from the document EP 1 351 552 A2 to classify the acoustic input signal and use the result as an input criterion for the determination of a set of hearing aid parameters. For this purpose, the classification result is fed to a complex application logic.

Furthermore, there are numerous proposals for storing data in a hearing aid. This may be data transferred to the hearing

aid from the outside (for example DE 40 20 154 A: storage of device- and customer-specific data). Similarly, it may be data representing the adjusting position of an operating element of the hearing aid and data taken from the set of parameters controlling the signal processing. In addition, the document EP 1 367 857 A1 proposes storing the input signal for further evaluation.

The document CH 672 215 A5 discloses a programmable hearing aid which has an amplifier and transmission section that can be controlled in its transmission characteristics. A detector-amplifier connected downstream of the microphone determines an ambient or background noise, compares it with stored noise level patterns and, by means of a control circuit, brings about an automatic selection of one of the stored groups of parameters that come closest to the determined noise level pattern. The detector-amplifier thereby controls the emission of the signals corresponding to the parameters to the actual hearing aid.

Thus, a need exists to provide a hearing device with which the current hearing ability of the user is automatically taken into account in the signal processing.

Disclosed herein is a hearing device, with at least one operating element for setting an output sound level of the hearing device, by the operating element being adjustable to a number of settings, a level measuring means for measuring an ambient sound level in the vicinity of the hearing device and an evaluation means for comparing a current setting position of the operating element with a current, measured ambient sound level and for outputting a control signal in dependence on the result of the comparison. In one embodiment, the hearing device is a hearing aid.

In addition, a method for monitoring the hearing ability of a person with impaired hearing is provided according to the invention, by sensing a setting of an operating element which serves for setting an output sound level of a hearing device, measuring an ambient sound level in the vicinity of the hearing device, comparing a current setting position of the operating element with a current, measured ambient sound level and outputting a control signal in dependence on the result of the comparison.

In an advantageous way, the hearing system or the hearing device consequently automatically detects on the basis of the settings chosen by the wearer a change of the hearing ability and can either automatically perform corrections or else indicate this situation to the person with impaired hearing. Consequently, a change of the hearing ability of the person with impaired hearing, and with it less than optimum use by him of the aid, does not go unnoticed. It should also be considered as particularly advantageous that the number of visits to the acoustician is reduced.

The control signal which the evaluation means of the hearing device according to the invention generates can preferably be used for readjusting an amplification of the hearing device. This leaves the user with a setting range that is as wide as possible, without him constantly having to operate his device at a limit of the settings.

In a way corresponding to a preferred embodiment, the hearing device according to the invention may have a signaling means, in order to inform the user of the hearing device in dependence on the control signal by means of an information signal. For this purpose, it is possible for example for an acoustic or optical signal to be output from a hearing aid.

In addition, the hearing device may have a signal transmission means for transmitting the control signal or a corresponding signal to an external device. In the case of a particular further development, the external device has a text output unit. In this way, a text message can reach the user via a remote control, a smart phone and the like.

In the hearing device according to the invention, a storage means may also be provided for recording a history of comparison results, the control signal being generated by the evaluation means in dependence on the history. This also allows the time factor which characterizes the changing of the hearing ability to be taken into account in the information provided to the user or in the automatic readjustment.

It is favorable for one or more average values to be continuously determined by the level measuring means. In this way, better account can be taken of certain ambient situations.

When processing the setting of an operating element of the hearing device, it is favorable for each setting to be assigned a setting level by the evaluation means and for this to be used to produce a difference between the setting level and the ambient sound level for further processing. It is then only necessary to store the difference to monitor the hearing ability.

The present invention is explained in more detail on the basis of the accompanying drawing, which represents a block diagram of a hearing device according to the invention.

The exemplary embodiments described in more detail below represent preferred embodiments of the present invention.

In a way corresponding to the basic idea of the present invention, a hearing system is provided with the capability of measuring the ambient sound level and bringing this measured value into a relationship with preferred settings of operating elements, which for their part regulate the output sound level of the hearing system. In this case, an evaluation unit analyzes a measured level value and a setting, stores a corresponding comparison value and activates a special function if the comparison value indicates a changed hearing ability. This allows the following response to the situations a) and b) presented at the beginning:

To a): When a user is becoming accustomed to a hearing system, the corresponding, preprogrammed acclimatization stage can be automatically activated as soon as the aforementioned evaluation unit initiates it. Alternatively, however, the corresponding hearing aid may also readjust the amplification of the hearing aid, so that the person with impaired hearing will always keep the volume adjuster in the same setting range.

To b): With hearing ability deteriorating in the long term, an acoustic detection signal is output, for example at the initiation of the evaluation unit, or a message is sent to an intelligent remote control, a smart phone or other system, which in response uses a text or other audio and/or visual feedback to draw the attention of the person with impaired hearing to his deteriorating hearing ability or recommend visiting a specialist.

The actual configuration of a hearing aid according to the invention is schematically reproduced in the figure. The hearing aid is provided with a microphone M and a level meter

P connected to said microphone, the level meter P measuring the level of the input signal or microphone signal 1. As a result, the level of the ambient sound is registered. The microphone signal 1 is also fed in a customary way to a signal processing unit SE, which for its part generates an output signal for a loudspeaker L.

The level meter P generates a level signal 3 of the output signal 1 and supplies it to an analysis unit A1. Furthermore, the analysis unit A1 also receives a position signal 2 of an operating element, here a loudspeaker adjuster LS. The position signal 2 of the loudspeaker adjuster LS is also used in an accustomed way in the signal processing unit SE.

The analysis unit A1 establishes a relationship between the position signal 2 of the loudspeaker adjuster LS and the level signal 3 of the level meter P and supplies a corresponding analysis value 4. This is fed to a threshold detector SD and a persistent memory PS. Optionally, one or more analysis values 5, which have previously been stored in the persistent memory PS, are provided by the persistent memory for the analysis unit A1, possibly including additional parameters. The output signal 4 of the analysis unit A1 is then correspondingly calculated, including these analysis values 5 and possibly other parameters.

The threshold detector SD receives for example a difference level, which the analysis unit A1 has determined from the ambient sound level 3 and an adjuster level assigned to the adjuster position 2. If the difference level exceeds a predetermined threshold value, the threshold detector SD triggers an activation signal 6 for a special function. In the present example, a change of the set of parameters of the

signal processing unit SE is initiated by the activation signal 6.

Furthermore, the hearing aid according to the invention may have a second analysis unit A2, to which the data 5 of the persistent memory PS are made available. The second analysis unit A2 analyzes these data on the basis of specific, predetermined criteria and performs one or more special functions, such as for example a warning function or self-adjustment. In the present example, an analysis value 7 is fed to the threshold detector SD for this purpose. The analysis unit A2 preferably serves the purpose of also analyzing the data stored in the persistent memory PS on a time basis and possibly making corresponding average values or other statistical data available.

In practice, the level meter P is preferably configured in such a way that it averages the ambient sound level over a predeterminable time interval and feeds the average value to the first analysis unit A1. In another embodiment, the level meter P is designed in such a way that it continuously carries out an averaging over a short time interval, for example 30 s, and over a long time interval, for example 5 min. In this case, for improved analysis two sliding values are available for the analysis unit A1 as a result.

An alternative embodiment is to use two level meters, upstream of which there is respectively a frequency filter, for example a high-pass filter and a low-pass filter. In this case too, two values are fed to the first analysis unit A1.

The first analysis unit A1 is preferably designed in such a way that it is activated in response to specific actuations of operating elements. After that, it stores the data

described above, and possibly also a time and/or date stamp, in the nonvolatile or persistent memory PS. It is also possible, furthermore, to store there the number of the chosen hearing program and the current result of a classifier, which usually investigates the incoming signal in the signal processing path of the hearing aid and assigns it to one of a number of possible classes.

In addition, as already indicated, the analysis unit A1 may be developed in such a way that it forms a difference value between the input signal level 3 and a setting level which has been assigned to the setting of the operating element. This difference value is then stored in the memory PS. If the difference value exceeds a predetermined threshold value, the amplification adjuster of the signal processing unit SE is adjusted.

According to a simplified exemplary embodiment, the analysis unit A1 firstly calculates the difference between the input signal level 3 and the setting 2, then calculates from this difference value and a number of last-stored difference values a sliding average value and only activates a special function if the sliding average value exceeds a threshold value.

One particular benefit of the type of signal processing according to the invention is that, when handling the incoming audio signals and settings of operating elements, only the processing result is sent for storage. This reduces the volume of data to be stored, so that the hearing aid according to the invention can manage with a chip of a smaller area. Therefore, extensive data preprocessing is carried out before the data storage. In this preprocessing, an analysis and feature extraction is performed, so that the

volume of data of the result values is significantly reduced in comparison with the original input signals.

The claims defining the invention are as follows:

1. A hearing device, comprising:
   at least one operating element for setting an output sound level of the hearing device, in that the operating element can be adjusted to a number of settings;
   a level measuring means for measuring an ambient sound level in the vicinity of the hearing device; and
   an evaluation means for comparing a current setting position of said operating element with a current, measured ambient sound level and for outputting a control signal in dependence on the result of the comparison.

2. The hearing device as claimed in claim 1, it being possible for the control signal to be used for readjusting an amplification of the hearing device.

3. The hearing device as claimed in either one of claims 1 and 2, which has a signaling means in order to inform the user of the hearing device in dependence on the control signal by means of an information signal.

4. The hearing device as claimed in any one of the preceding claims, which has a signal transmission means for transmitting the control signal or a corresponding signal to an external device.

5. The hearing device as claimed in claim 4, the external device having a text output unit.

6. The hearing device as claimed in any one of the preceding claims, which has a storage means for recording a history of comparison results, it being possible for the control

signal to be generated by the evaluation means in dependence on the history.

7. The hearing device as claimed in any one of the preceding claims, it being possible for one or more average values to be continuously determined by the level measuring means.

8. The hearing device as claimed in any one of the preceding claims, it being possible for each setting of the at least one operating element to be assigned a setting level by the evaluation means and for this to be used to produce a difference between the setting level and the ambient sound level for further processing.

9. The hearing device as claimed in any one of claims 1 to 8, wherein said hearing device is a hearing aid.

10. A method for monitoring the hearing ability of a person with impaired hearing, said method comprising the steps of:

sensing a setting of an operating element which serves for setting an output sound level of a hearing device;

measuring an ambient sound level in the vicinity of the hearing device;

comparing a current setting position of said operating element with a current, measured ambient sound level; and

outputting a control signal in dependence on the result of the comparison.

11. The method as claimed in claim 10, the control signal being used for automatically readjusting an amplification of the hearing device.

12. The method as claimed in either one of claims 10 and 11, the user being directly informed about the result of the comparison.

13. A hearing device substantially as described herein with reference to the accompanying drawing.

14. A method for monitoring the hearing ability of a person with impaired hearing, said method being substantially as described herein with reference to the accompanying drawing.

DATED this twenty-fifth Day of February, 2008

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