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Entitled
***ADVANCED COMMUNICATION EARPIECE
DEVICE AND METHOD***

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ADVANCED COMMUNICATION EARPIECE DEVICE AND METHOD

FIELD OF THE INVENTION

The present invention relates to earpiece devices and is more particularly concerned with an earpiece device providing advanced communication to the user thereof, and method of operation thereof.

BACKGROUND OF THE INVENTION

MDL

The noisy environment in our industrial society is a health hazard to numerous workers as well as to people engaged in recreational activities generating loud noises, or simply listening to music with varying volume settings from individual digital music players such as an Ipod™, MP3 players or the like, via a set of earphones or the like.

Many documents such as US patent No. 3,789,952 granted to Widegren et al., US patent No. 7,151,835 granted to Yonovitz et al., US patent publication No. 2009/0208024 A1 to Farver and European patent No. EP 1,816,892 B2 to Ruwisch aim at limiting the harm produced by the continuous estimated noise/sound reaching the user's ear which could induce permanent partial hearing loss. These methods and devices typically integrate by estimation the total noise dose received by the user's ear, considering a sound generation via the speaker inside the headset of the user, as well as the estimated added noise contribution of the user surroundings or environmental noise as measured by and external microphone located on the headset. Upon the calculated total dose reaching a pre-determined threshold, an action or protective measure is taken by the processor.

These integrated total doses are estimated depending on the type of earpiece or headset being worn by the users, and considering their partial occlusion of the ear canals, the estimated cumulative total doses are only estimations and

not real measures of the ear exposures. These estimations do not take into account the actual positioning of the earpieces inside the user's ears, which may vary considerably from one user to another, as opposed to constant and known occlusion occurring when using custom-fitted in-ear devices, as
5 disclosed in US Patent No. 6,754,357 granted to McIntosh et al., No 6,687,377 granted to Voix et al., and No. 7,688,983 granted to Voix et al. Furthermore, these estimated integrations do not take into consideration the fact that the human ear rests, or recuperates from auditory fatigue over time, especially when the sound pressure level or the ambient noise is relatively low.

10 PTH

With the always increasing popularity of personal music players (PMP) or the like, users tend to constantly wear the headphones to listen music or the like. In such cases, the users essentially become acoustically disconnected, at least partially, from surrounding ambient sounds and/or noises, which could cause
15 dangerous situations. In order to be in hearing contact with the environment, the users need to either significantly reduce the sound or playback volume of the PMP or remove at least one of the two headphones, which might become annoying, especially if that kind of situation occurs frequently.

IEM

20 Many documents such as US patent No. 3,819,860 granted to Miller, US patent No. 6,754,359 granted to Svean et al., and US patent No. 7,502,484 granted to Ngia et al. teach an ear terminal with an internal microphone for clean voice pickup from the user. This measured voice signal, although clean (essentially noiseless), is not a natural speech voice since the higher frequencies have
25 essentially been transformed, by the surrounding body parts, into lower frequencies, giving the impression of an occlusion effect in that the voice is muffled or captured from inside a box, or closed cavity or the like, such that it is not preferred for transmission via a telecommunication network or the like.

Accordingly, there is a need for an improved earpiece device and method.

SUMMARY OF THE INVENTION

It is therefore a general object of the present invention to provide an improved earpiece device and method that obviate the above-mentioned disadvantages.

MDL

- 5 An advantage of the present invention is that the earpiece device provides for a more accurate calculation of the total noise dose reaching a specific ear, by taking advantage of using a custom-fitted in-ear device (with improved occlusion of the ear canal), which allows evaluation of occurring sound bursts, and measuring the actual impact thereof inside the occluded ear canal, behind the
10 earpiece.

Another advantage of the present invention is that the earpiece device considers a relative ear fatigue recuperation over time when continuously calculating the cumulated total noise dose.

- 15 A further advantage of the present invention is that the earpiece device can detect if the earpiece is actually being worn by the user or not, and reflect this situation into the calculation of the cumulated total noise dose.

Yet another advantage of the present invention is that the earpiece device provides for a more accurate calculation of the total sound dose reaching a specific ear.

- 20 PTH

- Another advantage of the present invention is that the earpiece device provides for the user to selectively disable the audio signal reaching the speaker of the headphone(s) temporarily, permanently or for a predetermined time duration, and allow the user to hear, via the headphone speaker, the external ambient
25 noise measured by an external microphone located on the corresponding headphone.

A further advantage of the present invention is that the earpiece device provides to the user the capability of varying the sound volume playing in the background

while receiving the external ambient noise measured by the corresponding external microphone.

Yet a further advantage of the present invention is that the earpiece device provides for ambient sound noise gating (ASNG) to allow the external ambient noise measured by the corresponding external microphone to be gated in removing the excessive ambient noise therefrom and keep only noise emerging signals.

Yet another advantage of the present invention is that the earpiece device allows the user to select a desired gate threshold for the ASNG, thereby adjusting the sensitivity level of the ambient noise to be transferred to the speaker of the corresponding headphone speaker.

Still another advantage of the present invention is that the earpiece device, in transmitting the ambient noise measured by the corresponding external microphone, ensures an unaltered localization of the incoming noise that enables the user to detect the source direction of that ambient noise because of the localization of the external microphone in close proximity of the corresponding user's ear.

IEM

Another advantage of the present invention is that the earpiece device provides for user's voice pickup from the user's ear for transmission thereof, via an earpiece internal microphone.

Still another advantage of the present invention is that the earpiece device provides for simultaneous user's voice pickup from an earpiece external microphone, which allows for a combination of the two internal and external microphone signals for clearer and more acoustically natural voice, which combination depends on the comparison between the two signals to prevent ambient noise perturbations, whenever applicable.



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Other objects and advantages of the present invention will become apparent from a careful reading of the detailed description provided herein, with appropriate reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Further aspects and advantages of the present invention will become better understood with reference to the description in association with the following Figures, in which similar references used in different Figures denote similar components, wherein:

Figure 1 is a simplified schematic bloc diagram of an advanced communication earpiece device in accordance with an embodiment of the present invention, referring to a noise and music dose limiter (MDL) device, and a push-to-hear (PTH) device, and an in-ear microphone (IEM) device;

Figure 2 is a simplified flow chart of an advanced communication earpiece method in accordance with an embodiment of the present invention, referring to a method of operation of the noise and music dose limiter (MDL) device of Figure 1;

Figure 3 is a simplified flow chart of an advanced communication earpiece method in accordance with an embodiment of the present invention, referring to a method of operation of the push-to-hear (PTH) device of Figure 1; and

20 **Figure 4** is a simplified flow chart of an advanced communication earpiece method in accordance with an embodiment of the present invention, referring to a method of operation of the in-ear microphone (IEM) device of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 With reference to the annexed drawings the preferred embodiments of the present invention will be herein described for indicative purpose and by no means as of limitation.

MDL

Referring now in more detail to Figures 1 and 2, there is shown simplified schematic bloc diagram of an embodiment 10 of an advanced communication earpiece device, as a sound or music dose limiter device, in accordance with the present invention. The noise and music dose limiter (MDL) 10 typically includes a controller unit 12 connected to at least one, preferably a pair of custom-fitted in-ear devices 14 (only one being shown), such that the respective outer ear canal 15 of the user is essentially occluded thereby (snugly fit), for connection to an audio output of a personal music player (PMP) 16 or the like, or any electronic device adapted to send an audio signal to the speaker 18 of the each in-ear device 14, typically left and right devices.

In addition to the speaker 18, each in-ear device 14 includes an internal microphone 20 (Min) for measuring the sound/noise level inside the ear occluded canal 15, between the in-ear device 14 and the tympanic membrane, and an external microphone 22 (Mout) for measuring the external ambient sound/noise level reaching the corresponding outer ear of the user. These internal and external measured sound pressure levels, from internal 20 and external 22 microphones, of each in-ear device 14, as well as the corresponding (left or right) audio signal coming from the PMP 16 are input signals of the controller unit 12. Based on these inputs, the controller unit 12 calculates the total noise dose (TND) reaching each user's ear, and provides for a remaining time estimate for listening to the input signal (such as music or the like) before the TND reaches the maximum acceptable sound dose (MASD) value or threshold considered to be harmful to the user, based on the most recent measured average sound level reaching each ear as well as on the user's own susceptibility, including physical characteristics (age, etc.), beyond which there might be some permanent hearing losses for the user. Upon the TND approaching, reaching or exceeding the MASD value, the controlled unit 12 typically sends an audio warning signal to the user, such as an audible repeated appropriate beep, or simply starts, at least intermittently, reducing the volume of the sound signal, or ultimately stops the audio signal sent to the speaker 18, or any other warning code as required.

More specifically, the controller unit 12 performs the following steps in calculating the TND, for each ear, based on the internal (Min) and external (Mout) microphone measured sound pressure levels and the audio input from the PMP 16. The calculation being done at regular time intervals ΔT , and the different sound pressure levels measured from the microphones 20, 22 and received from the PMP 16 are typically averaged via an RMS (Root Mean Square) estimator. For each time interval ΔT , the measured sounds from both internal and external microphones 20, 22 are compared to find out if they correlate (essentially follow the same magnitude or amplitude profile over time on specific frequency sub-bands) and/or are coherent (essentially follow the same magnitude profile over frequency in specific time frames) with one another. If not, this means that there is significantly less external sound that reaches inside the occluded ear canal other than the one coming from the speaker 18, such that both measured sounds are different, and the estimated acoustic pressure that reaches the tympanic area is primarily due to the signal reaching the speaker 18, which is estimated taking into account the in-ear device loudspeaker sensitivity. If yes, the controller unit 12 then verifies if the measured sound from the external microphone 22 is significantly stronger, by at least a few decibels (dBs), than the one measured by the internal microphone 20. If not, it essentially means that the in-ear device 12 is not worn by the user (since both measurements are considered to have similar measurands), and, in such a case, the estimated acoustic pressure that reaches the tympanic area is essentially the one reaching either microphone 20, or 22. If yes, it means that an external sound burst (disturbance) or the like reached inside the occluded ear canal 15 after passing through the in-ear device 14, in which case, the estimated acoustic pressure that reaches the tympanic area is due to both the sound measured by the internal microphone 20 that is distinct from the signal reaching the speaker 18 added to the signal reaching the speaker 18.

Based on the above estimated acoustic pressure level reaching the tympanic area, for the specified time interval ΔT , a sound dose is calculated which is then added to the cumulative noise and music dose. Furthermore, an estimated dose decrease is calculated for that same time interval ΔT to account for a certain 'ear fatigue recuperation' of the ear, based on an estimated Noise Dose

Decrease Rate (NDDR), which could be either linear or non-linear (logarithmic or the like) over time, and subtracted from the cumulative sound dose to obtain the estimated cumulative TND.

5 The NDDR could, for example assume that the human ear totally recuperates from the MASD threshold in a few hours, such as 16 hours or the like, in the absence of any harmful noise, such as any noise above a predetermined safe level of 70 decibels or the like.

10 As mentioned hereinabove, upon the estimated TND, the controller unit typically estimates, assuming a sound volume similar to the latest measured volume (over the last time interval, or the last few time intervals), the remaining time (RT) for the user to listen to the music or the like from the PMP 16, and displays that estimated time on a display 24. Such a display 24 could be either in the form of a bar meter, of multiple leds (light emitting diodes), or a digital display. Similarly, upon the estimated TND approaching the MASD threshold, 15 the controller unit 12 typically further sends an audible warning signal to the speaker 18, such a warning signal varying depending on the value of the estimated RT according to a predetermined warning code or the like. Ultimately, upon the estimated TND reaching and/or exceeding the MASD threshold, the controller unit 12 typically further simply starts, at least 20 intermittently, reducing the volume of the sound signal, or ultimately stops the audio signal sent to the speaker 18, and also typically displays the corresponding situation of the display 24.

When both in-ear devices 14 are used, the controller unit 12 typically calculates only one TND, taking into consideration the worst (highest) estimated TND of 25 the two devices 14 for each time interval ΔT .

PTH

Now referring more specifically to Figures 1 and 3, there is shown simplified schematic bloc diagram of an embodiment 110 of an advanced communication earpiece device, as a push-to-hear device, in accordance with the present 30 invention. The push-to-hear (PTH) device 110 typically includes a controller unit

112 connected to at least one, preferably a pair of custom-fitted in-ear devices 14 (only one being shown), such that the respective ear canal 15 of the user is essentially occluded thereby, for connection to an audio output of a personal music player (PMP) 16 or the like, or any electronic device adapted to send an audio signal to the speaker 18 of the each in-ear device 14, typically left and right devices.

In addition to the speaker 18, each in-ear device 14 of the PTH device 110 includes at least an external microphone 22 (Mout) for measuring the external ambient sound/noise reaching the corresponding ear or the user. The controller unit 112 typically includes an on/off switch to activate/deactivate the controller 112. When activated, the controller 112 disconnects the audio input from the PMP 16 from the headphone speakers 18 and connects the ambient sound measured by the corresponding external microphone 22 to the speakers 18, as represented by toggle switch 126, to enable the user to selectively and temporarily hear the ambient sound rather than the music or the like. Although not illustrated, when activated, the controller unit 112 could alternatively automatically switch back the device 110 to reconnect the audio signal from the PMP 16 instead of the ambient sound from the external microphone 22 after a predetermined lapse of time has occurred, such as 30 seconds, one minute or the like.

Alternatively, the PTH device 110 has a second activation/deactivation command, such as by simultaneously pressing two buttons or the like, as the two up ('+') and down ('-') volume buttons 128, during a predetermined time duration (such as 2 second or the like) for the controller unit 112 to allow both the audio signal from the PMP 16 and the ambient sound from the external microphone 22 to be simultaneously connected to the headphone speaker 18, and also press either the up and/or down volume buttons 128 to increase or decrease the sound volume ratio (SVR), or blending ratio, of the ambient sound over the audio signal.

The PTH device 110 typically provides for automatic adjustment of the ambient noise measured from the external microphone 22 and transmitted to the headphone speaker 18 for a natural sounding thereof, the gain and frequency

response adjustments depending on the actual type of headphone speaker and in-ear device.

Additionally, the PTH device 110 typically includes a user activatable electronic filter 130 of the ambient sound/noise signal measured by the external microphone 22. The ambient sound noise gating (ASNG) filter 130 essentially eliminates the noise portion of the ambient signal to keep only the noise emerging-type signals having an acoustic pressure larger than or above a gating threshold (GT). Preferably, the gating threshold GT, or microphone sensitivity threshold, is also adjustable by the user via up ('+') and down ('-') volume buttons 132 or the like. Alternatively, as an example, instead of using specific buttons 132, the same two buttons 128 could also be used for the GT adjustment, as long as the two buttons are simultaneously pressed during a second predetermined time duration, typically longer than the first one, for activation/deactivation of the ASNG filter 130.

Typically, the ASNG filter 130 can be used at any time during the operation of the PTH device 110, whichever option is selected by the user.

IEM

Now referring more specifically to Figures 1 and 4, there is shown simplified schematic bloc diagram of an embodiment 210 of an advanced communication earpiece device, as an inside-the-ear microphone device, in accordance with the present invention. The in-ear microphone (IEM) device 210 typically includes a controller unit 212 connected to at least one custom-fitted in-ear device 14, such that the corresponding outer ear canal 15 of the user is essentially occluded thereby (snugly fit).

In addition, the in-ear device 14 includes an internal microphone 20 (Min) for measuring the sound/noise, and also the user's voice inside the ear canal 15, between the in-ear device 14 and the tympanic membrane, and an external microphone 22 (Mout) for measuring the external ambient sound/noise reaching the corresponding ear or the user. These internal and external measured noises, from internal 20 and external 22 microphones, of the in-ear device 14

are input signals of the controller unit 212. Based on these inputs, the controller unit 212 evaluates if the RMS value of the external noise is smaller or equal to a first noise threshold (NT). If not, this means that the external ambient noise is too loud and disturbs any sound voice that would be simultaneously measured by the external microphone 22. The user's voice is therefore captured by the internal microphone 20 before it is sent by the controller unit 212 of the IEM device 210 to a telecommunication transmission link (TTL), such as a Bluetooth™ system wireless link, a telephone or the like. In such a case, since the speech voice measured from the ear canal of the user is acoustically deformed, the controller unit 212 typically and digitally transforms the deformed speech voice into a partially synthetic speech voice (especially into the higher frequencies) which sound more like a natural speech voice (NSV) from one's mouth.

In the case the RMS value of the external noise is smaller or equal to NT, the measured sounds from both internal and external microphones 20, 22 are compared to find out if they correlate (essentially follow the same magnitude or amplitude profile over time on specific frequency sub-bands) and/or are coherent (essentially follow the same magnitude profile over frequency in specific time frames) with one another, by being above a second correlation threshold CT. If not, this means that the external noise, although not too loud, is significant enough inside the speech frequency band to alter the user's voice measured by the external microphone 22, and as above, only the signal captured by the internal microphone 20 is considered and preferably transformed by the controller unit 212 of the IEM device 210 into a NSV to be sent to the TTL. If yes, the controller unit 12 generates a combination of both the internal signal for preferably lower frequencies and external signal for preferably higher frequencies, over the typical human voice frequency band to generate the best user's speech voice as the NSV signal to be sent to the TTL.

Although the present method and apparatus for objective assessment of in-ear device acoustical performance have been described with a certain degree of particularity, it is to be understood that the disclosure has been made by way of example only and that the present invention is not limited to the features of the

embodiments described and illustrated herein, but includes all variations and modifications within the scope and spirit of the invention as hereinabove described.

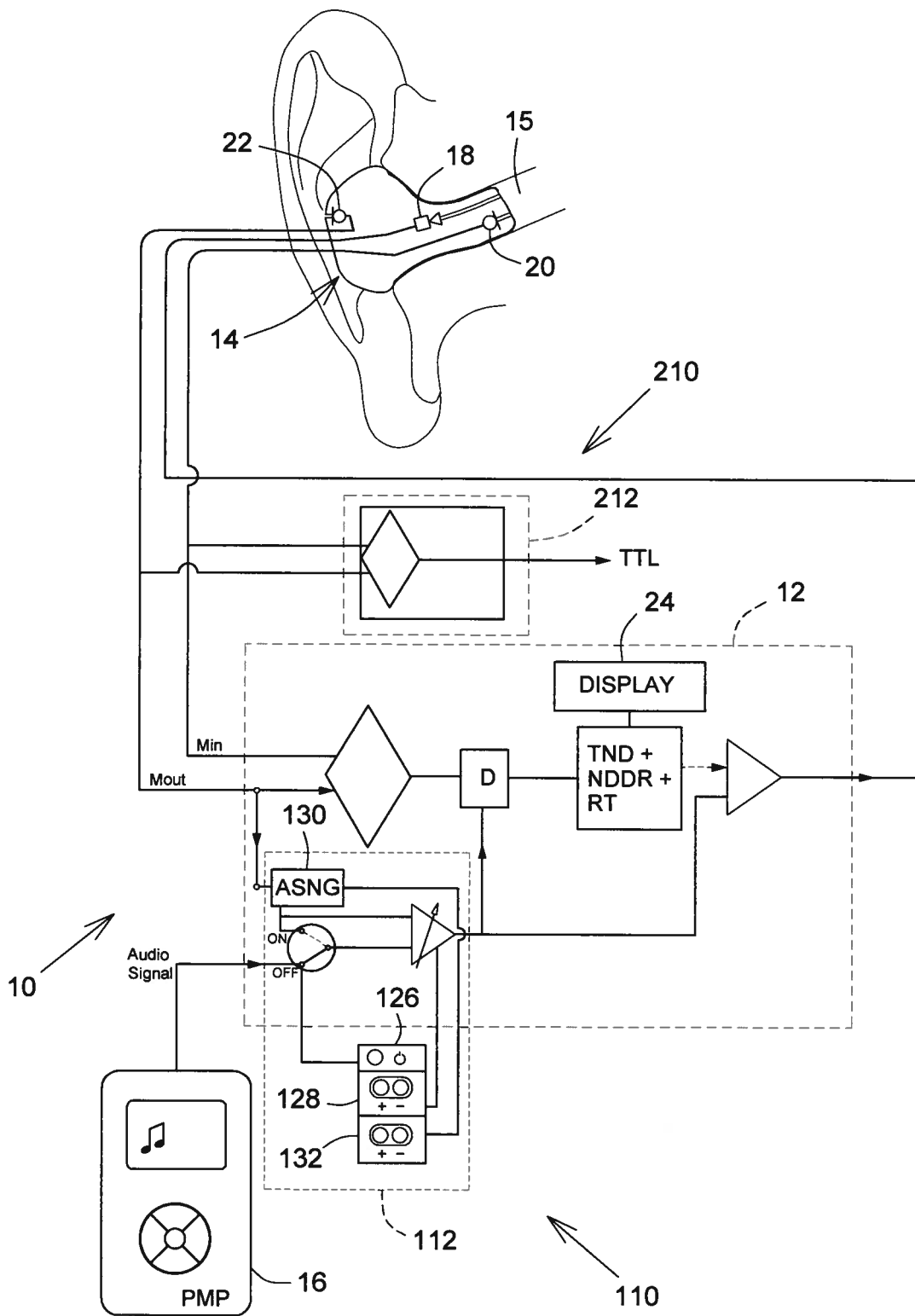


FIG.1

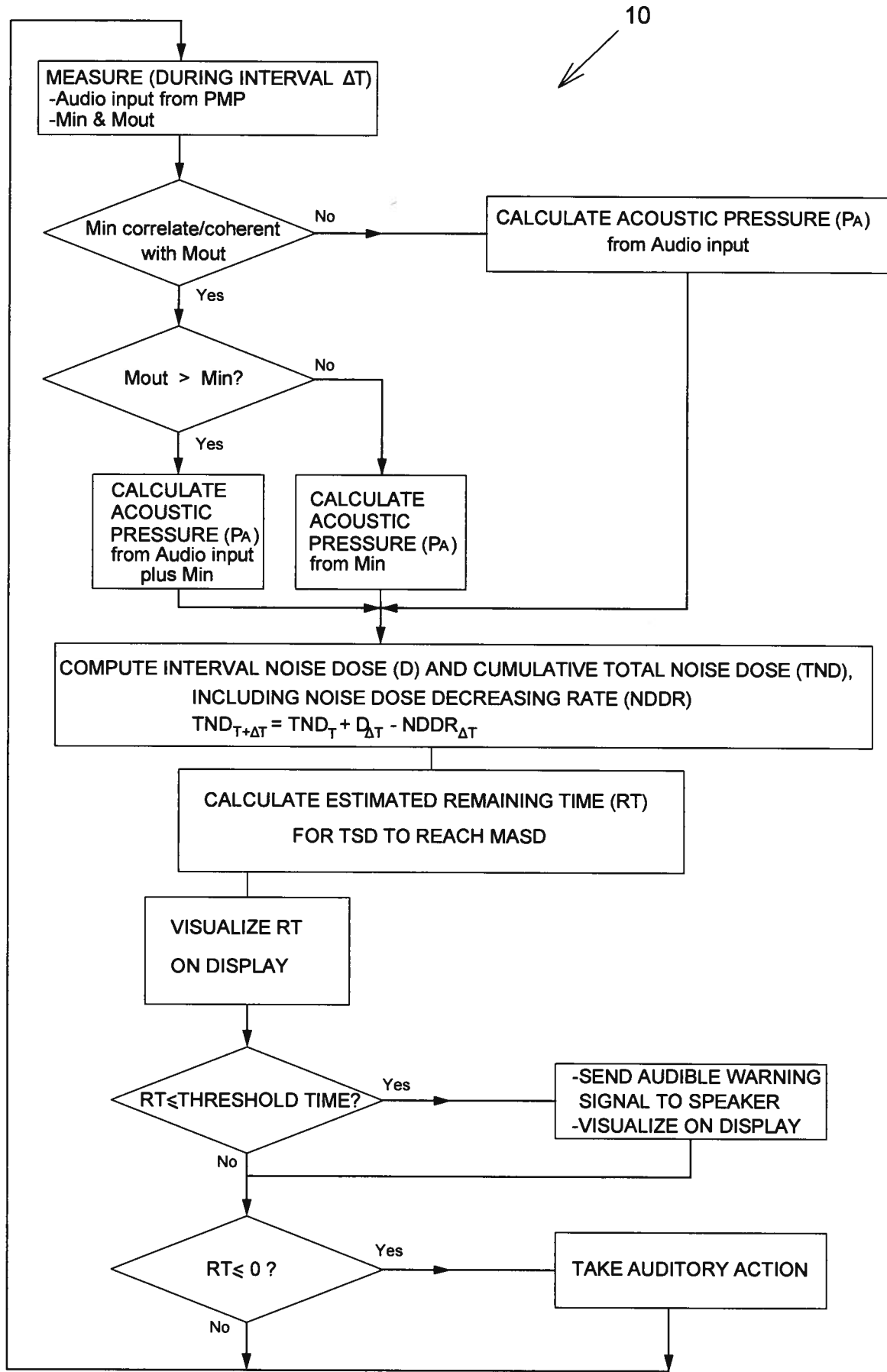


FIG.2

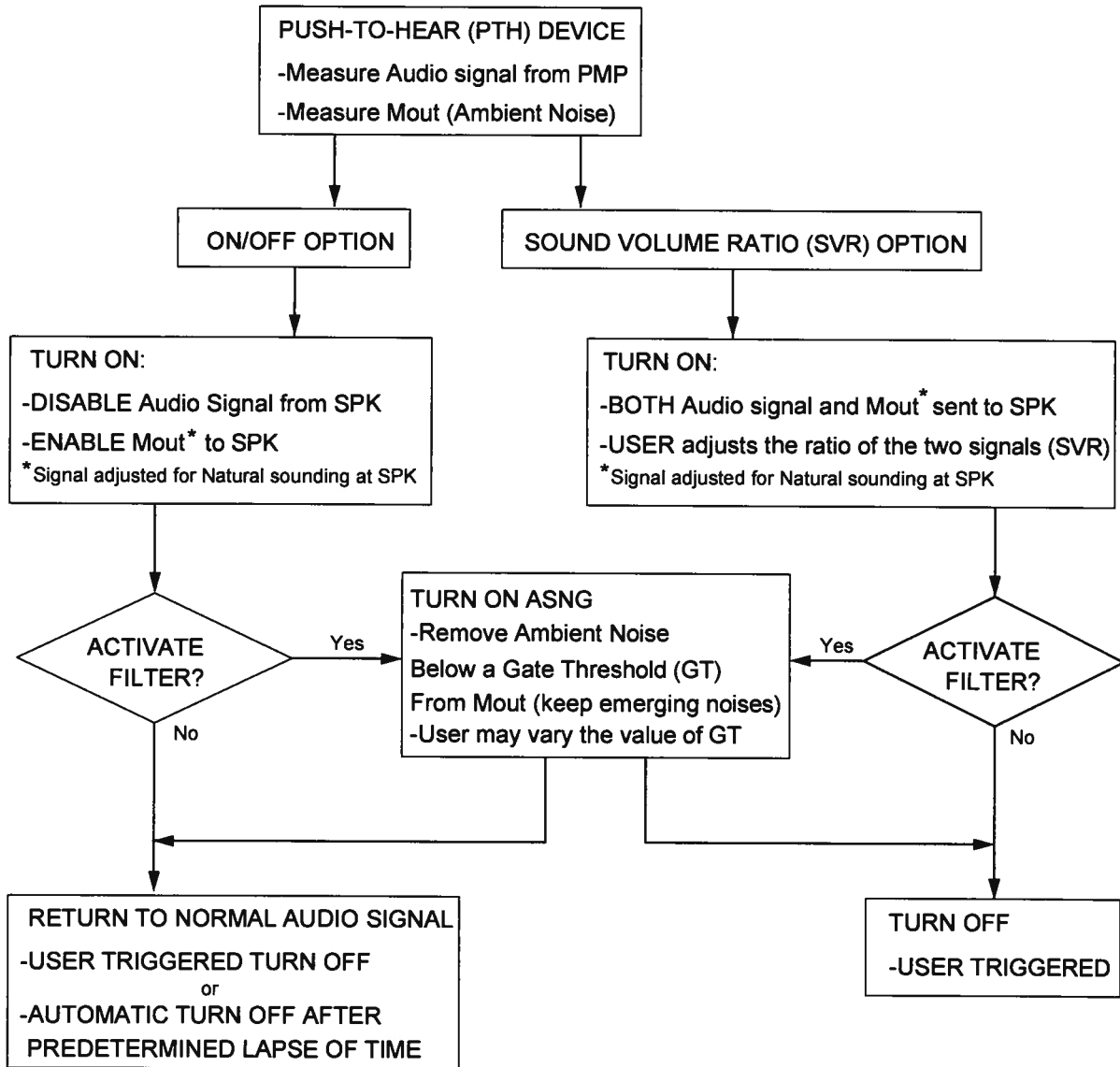
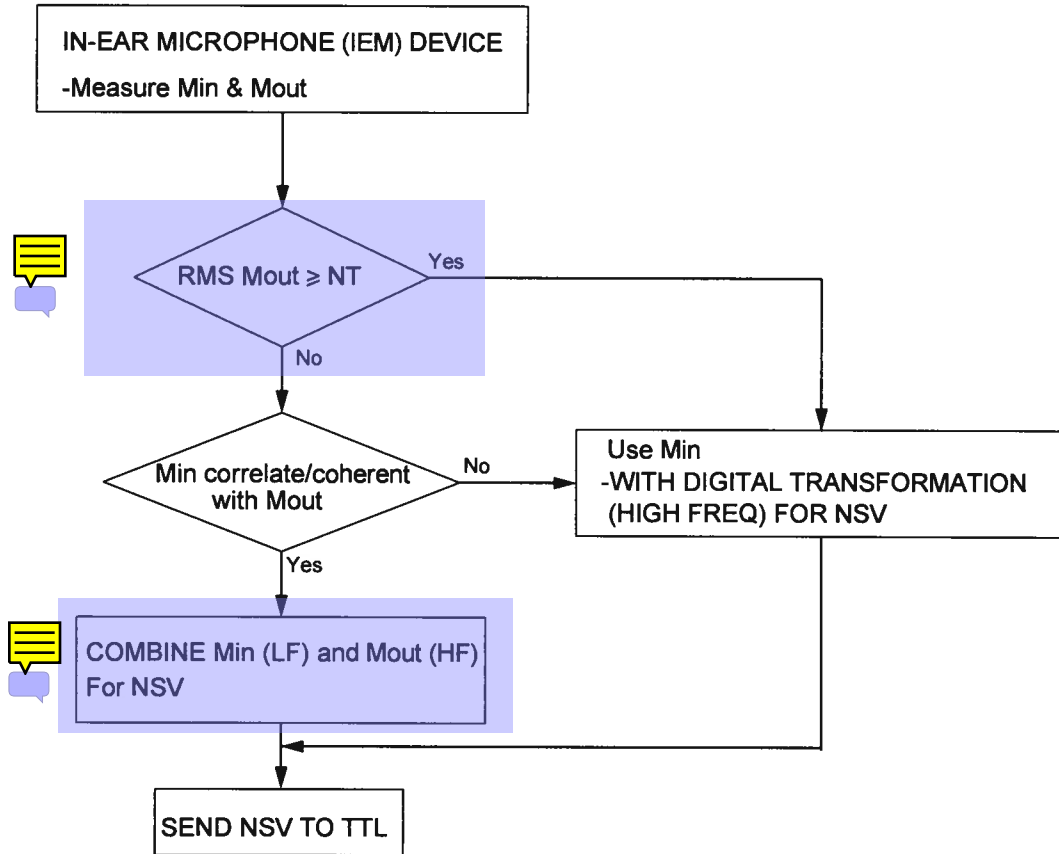


FIG.3

210



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FIG.4

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

Express Mail Label No.

INVENTOR(S)					
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<input type="checkbox"/> Additional inventors are being named on the _____ separately numbered sheets attached hereto					
TITLE OF THE INVENTION (280 characters max)					
ADVANCED COMMUNICATION EARPIECE DEVICE AND METHOD					
CORRESPONDENCE ADDRESS					
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<input type="checkbox"/> Customer Number				Place Customer Number Bar Code Label here	
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ENCLOSED APPLICATION PARTS (check all that apply)					
<input checked="" type="checkbox"/> Specification Number of Pages	12	<input type="checkbox"/> CD(s), Number			
<input checked="" type="checkbox"/> Drawing(s) Number of Sheets	4	<input type="checkbox"/> Other (specify)			
<input type="checkbox"/> Application Data Sheet. See 37 CFR 1.76					
METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)					
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27.					
<input type="checkbox"/> A check or money order is enclosed to cover the filing fees					
<input type="checkbox"/> The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number:				FILING FEE AMOUNT(\$) \$ 110.00	
<input checked="" type="checkbox"/> Payment by credit card. Form PTO-2038 is attached.					
The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.					
<input checked="" type="checkbox"/> No.					
<input type="checkbox"/> Yes, the name of the U.S. Government agency and the Government contract number are: _____					
Respectfully submitted,					
SIGNATURE				Date	Nov. 30, 2010
TYPED or PRINTED NAME	Franz BONSANG, Patent Agent			REGISTRATION NO.	56638
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This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

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- 01** **Antoine Bernier** Page no. **5**
- 2/6/2011 16:04
- Contribution 1 : voir fig.4 pour explications et commentaires
-
- 02** **Antoine Bernier** Page no. **12**
- 2/6/2011 16:14
- Contribution 2: Voir fig. 4 pour explication et commentaires.
-
- 03** **Antoine Bernier** Page no. **17**
- 2/6/2011 16:17
- Contribution 2 : Utilisation de la valeur RMS du signal comme facteur dans la prise de décision de la configuration de microphones à utiliser pour capter la voix de l'utilisateur. Idée née lors d'une discussion avec Jérémie Voix chez Sonomax. Ajout de ce facteur de prise de décision à son idée de cohérence
-
- 04** **Antoine Bernier** Page no. **17**
- 2/6/2011 16:18
- Contribution 1 : La combinaison des deux micros permet une différence perceptuelle moins grande lorsque le système passe d'un état à l'autre, de deux micros à seulement 1. L'intelligibilité semble également accrue. typically 50% Min + 50% Mout. Idée née de la manipulation des fichiers audios obtenus à l'intérieur sur les employés Sonomax, lors du travail sur le filtrage de la voix Min