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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2021-05-17
First Named Inventor	GOLDSTEIN, Steven Wayne
Art Unit	
Examiner Name	unknown
Attorney Docket Number	CONT-16987396

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8577052		2013-11-05	Michael W. Silber, et al.	
	2	5541359		1996-07-30	Young-Man Lee	
	3	5774567		1998-06-30	Lawrence F. Heyl	
	4	7421084		2008-09-02	Christopher Michael Jubien, et al.	
	5	7903826		2011-03-08	Johan Boersma	
	6	7986802		2011-07-26	Carl R. Ziller	
	7	8199942		2012-06-12	Xiadong Mao	
	8	10361673		2019-07-23	Takeo Matsukawa	

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Samsung v. Techiya
IPR2024-01004
Exhibit 1006

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	Application Number	
	Filing Date	2021-05-17
	First Named Inventor	GOLDSTEIN, Steven Wayne
	Art Unit	
	Examiner Name	unknown
	Attorney Docket Number	CONT-16987396

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	1	20050207597		2005-09-22	Takahisa Kageyama	
	2	20030035551		2003-02-20	John Light, et al.	
	3	20080165988		2008-07-10	Jeffrey J. Terlizzi, et al.	
	4	20030151678		2003-08-14	Moo-Soon Lee, et al.	
	5	20060222185		2006-10-05	Medford Dyer, et al.	
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	1	JP5299030	JP		2013-09-25	千智 劒持志朗 鈴木恭輔 松本		
	2	CN101401399	CN		2009-04-01	约翰娜·布尔斯马		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	
	Filing Date	2021-05-17
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	
	Filing Date	2021-05-17
	First Named Inventor	GOLDSTEIN, Steven Wayne
	Art Unit	
	Examiner Name	unknown
	Attorney Docket Number	CONT-16987396

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/John P. Keady/	Date (YYYY-MM-DD)	2021-05-17
Name/Print	John P. Keady	Registration Number	56389

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

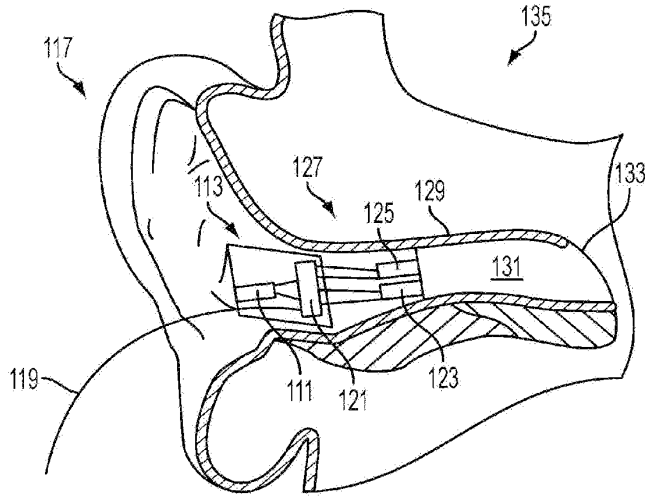

135
117
127
113
129
125
133
131
119
111
121
123

FIG. 1

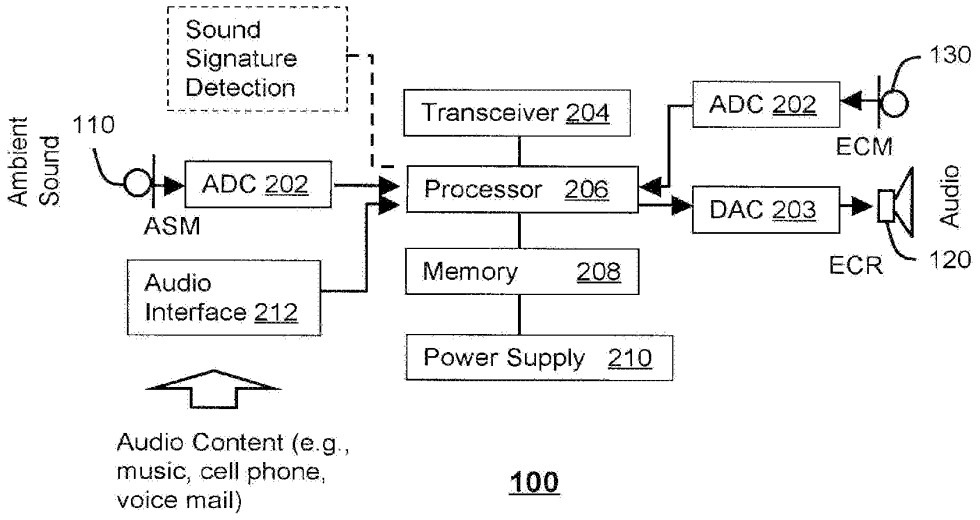
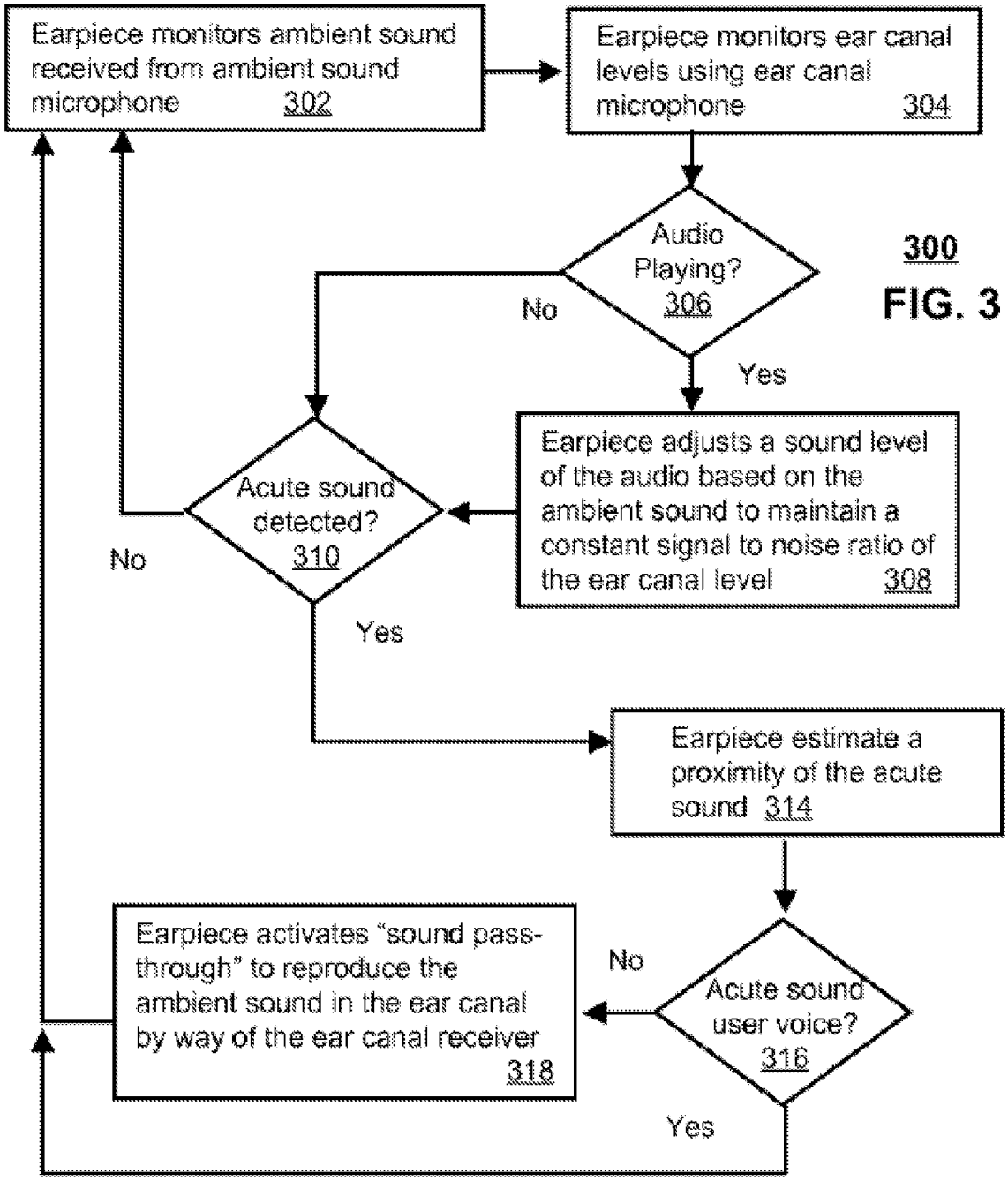

Sound Signature Detection
Ambient Sound
110
ASM
ADC 202
Audio Interface 212
Transceiver 204
Processor 206
Memory 208
Power Supply 210
ADC 202
130
ECM
DAC 203
Audio
ECR
120
Audio Content (e.g., music, cell phone, voice mail)
100

FIG. 2


Earpiece monitors ambient sound received from ambient sound microphone 302
Earpiece monitors ear canal levels using ear canal microphone 304
Audio Playing? 306
No
Yes
300
FIG. 3
Earpiece adjusts a sound level of the audio based on the ambient sound to maintain a constant signal to noise ratio of the ear canal level 308
Acute sound detected? 310
No
Yes
Earpiece estimate a proximity of the acute sound 314
Acute sound user voice? 316
No
Yes
Earpiece activates "sound pass-through" to reproduce the ambient sound in the ear canal by way of the ear canal receiver 318

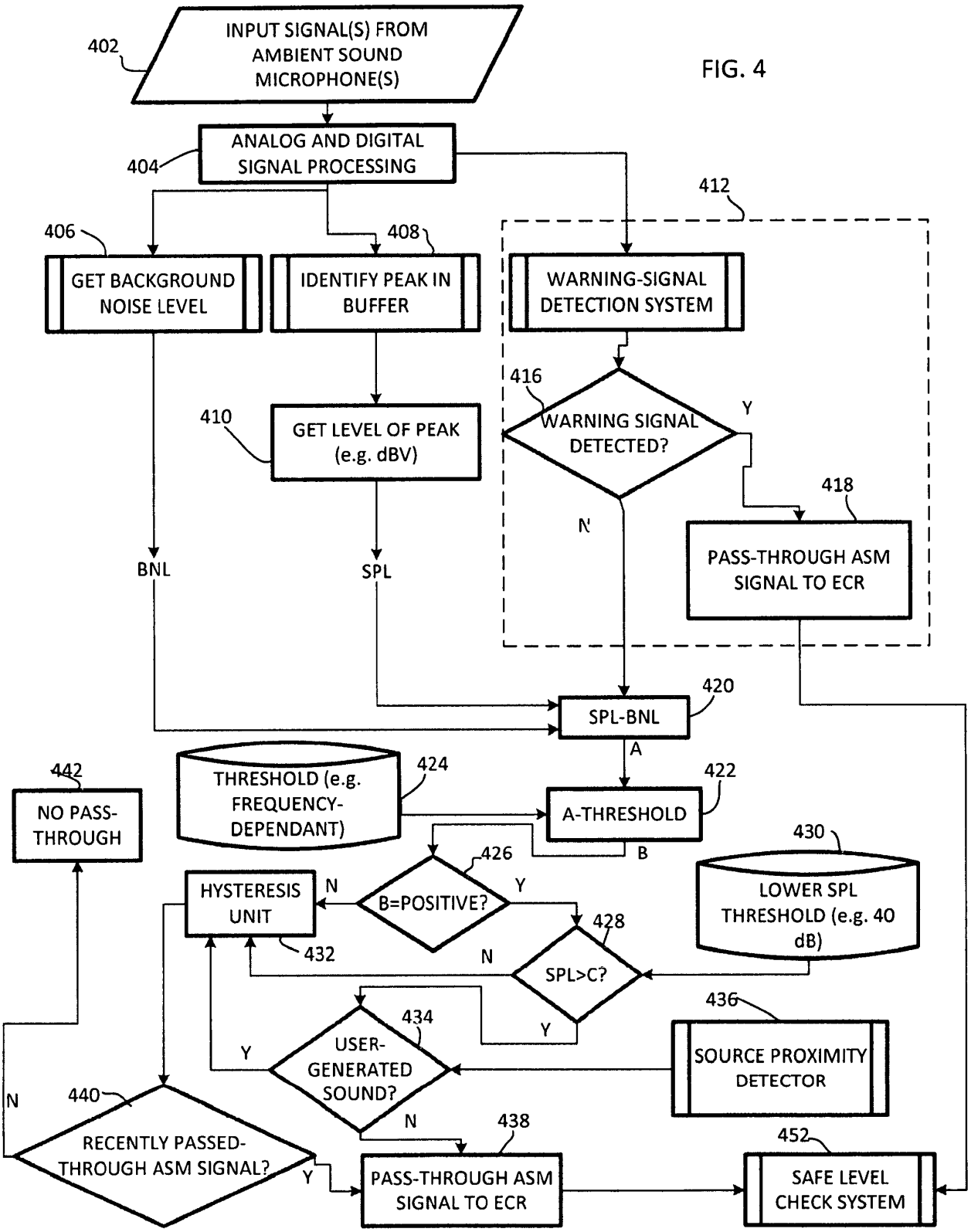
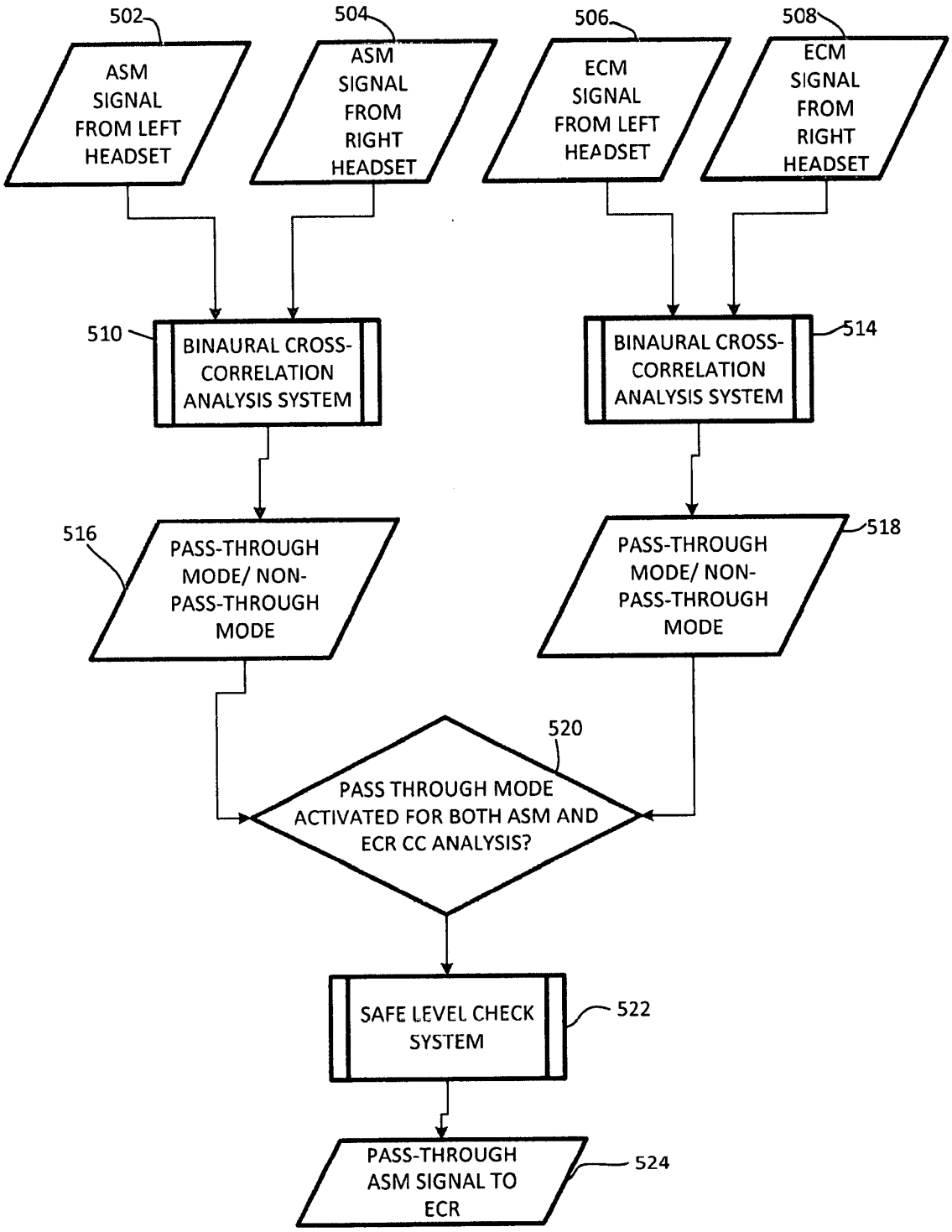

402
INPUT SIGNAL(S) FROM AMBIENT SOUND MICROPHONE(S)
404
ANALOG AND DIGITAL SIGNAL PROCESSING
406
GET BACKGROUND NOISE LEVEL
408
IDENTIFY PEAK IN BUFFER
412
WARNING-SIGNAL DETECTION SYSTEM
416
WARNING SIGNAL DETECTED?
Y
N
410
GET LEVEL OF PEAK (e.g. dBV)
418
PASS-THROUGH ASM SIGNAL TO ECR
BNL
SPL
420
SPL-BNL
A
B
442
NO PASS-THROUGH
424
THRESHOLD (e.g. FREQUENCY-DEPENDANT)
422
A-THRESHOLD
430
LOWER SPL THRESHOLD (e.g. 40 dB)
426
B=POSITIVE?
HYSTERESIS UNIT
432
428
SPL>C?
436
SOURCE PROXIMITY DETECTOR
434
USER-GENERATED SOUND?
440
RECENTLY PASSED-THROUGH ASM SIGNAL?
438
PASS-THROUGH ASM SIGNAL TO ECR
452
SAFE LEVEL CHECK SYSTEM

FIG. 4

FIG. 5


502
ASM SIGNAL FROM LEFT HEADSET
504
ASM SIGNAL FROM RIGHT HEADSET
506
ECM SIGNAL FROM LEFT HEADSET
508
ECM SIGNAL FROM RIGHT HEADSET
510
BINAURAL CROSS-CORRELATION ANALYSIS SYSTEM
514
BINAURAL CROSS-CORRELATION ANALYSIS SYSTEM
516
PASS-THROUGH MODE/ NON-PASS-THROUGH MODE
518
PASS-THROUGH MODE/ NON-PASS-THROUGH MODE
520
PASS THROUGH MODE ACTIVATED FOR BOTH ASM AND ECR CC ANALYSIS?
SAFE LEVEL CHECK SYSTEM
522
PASS-THROUGH ASM SIGNAL TO ECR
524

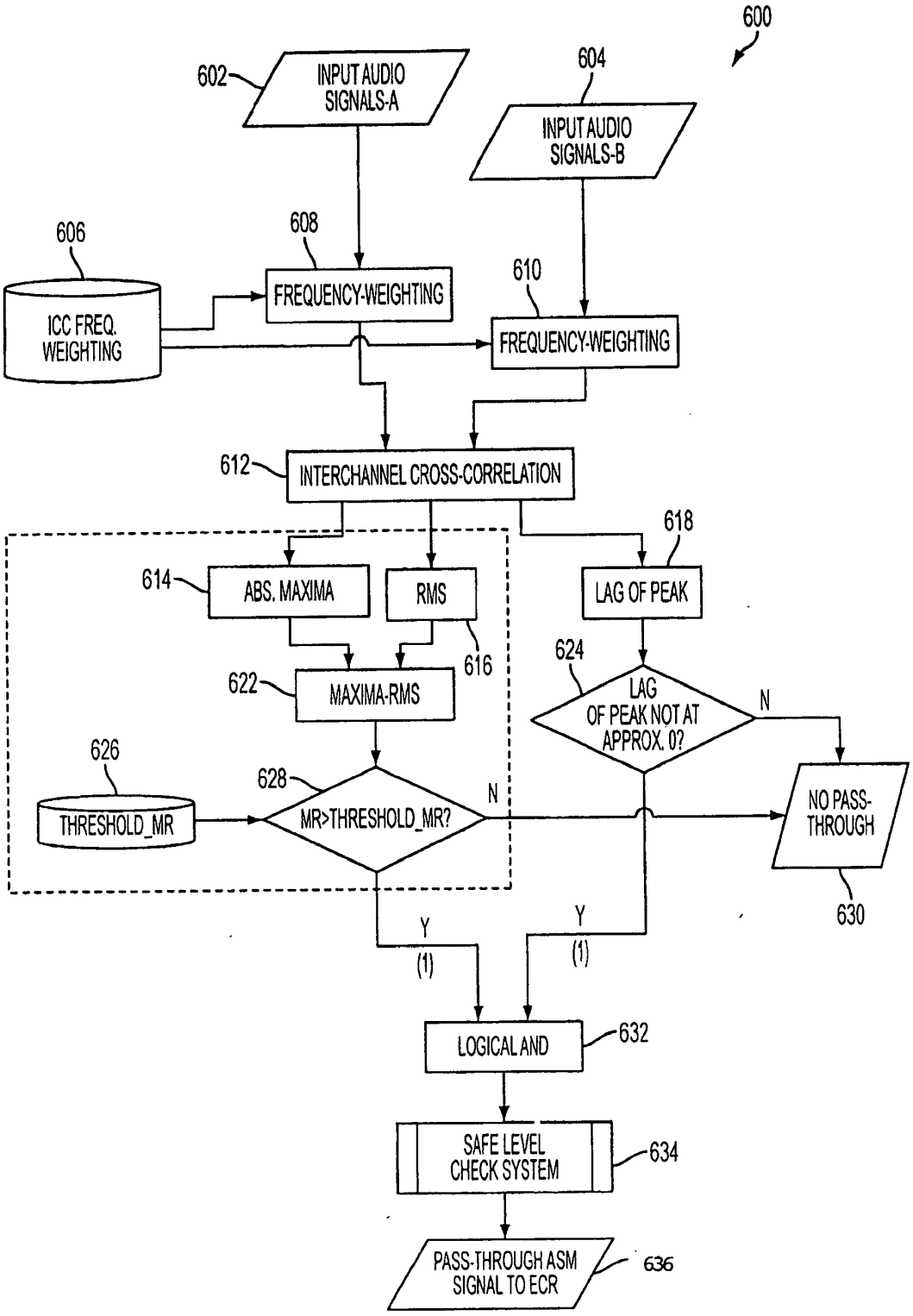
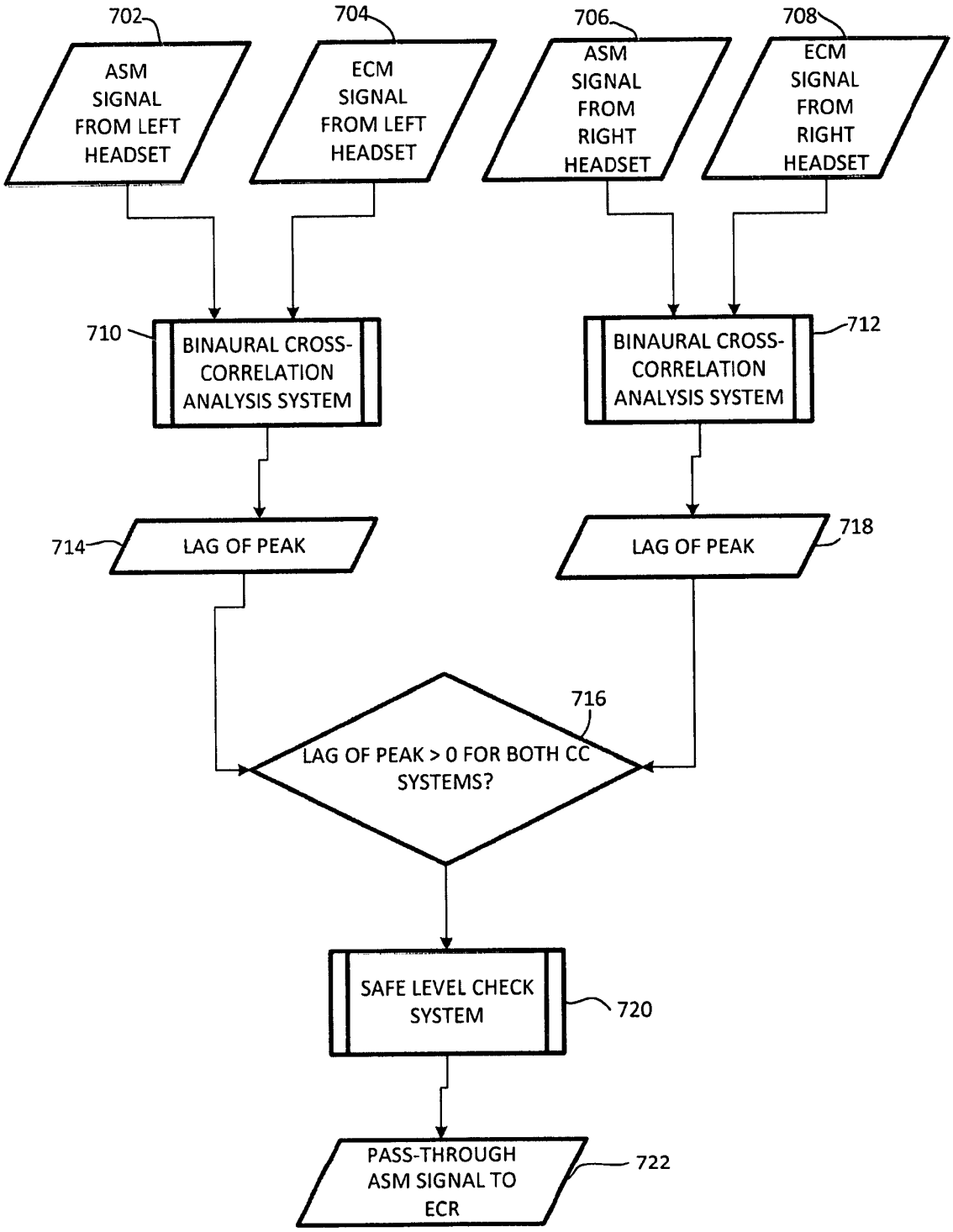

600
602
INPUT AUDIO SIGNALS-A
604
INPUT AUDIO SIGNALS-B
606
ICC FREQ. WEIGHTING
608
FREQUENCY-WEIGHTING
610
FREQUENCY-WEIGHTING
612
INTERCHANNEL CROSS-CORRELATION
614
ABS. MAXIMA
RMS
616
618
LAG OF PEAK
622
MAXIMA-RMS
624
LAG OF PEAK NOT AT APPROX. 0?
N
626
THRESHOLD_MR
628
MR>THRESHOLD_MR?
N
NO PASS-THROUGH
630
Y
(1)
Y
(1)
LOGICAL AND
632
SAFE LEVEL CHECK SYSTEM
634
PASS-THROUGH ASM SIGNAL TO ECR
636

FIG. 6

FIG. 7


702
ASM SIGNAL FROM LEFT HEADSET
704
ECM SIGNAL FROM LEFT HEADSET
706
ASM SIGNAL FROM RIGHT HEADSET
708
ECM SIGNAL FROM RIGHT HEADSET
710
BINAURAL CROSS-CORRELATION ANALYSIS SYSTEM
712
BINAURAL CROSS-CORRELATION ANALYSIS SYSTEM
714
LAG OF PEAK
718
LAG OF PEAK
716
LAG OF PEAK > 0 FOR BOTH CC SYSTEMS?
SAFE LEVEL CHECK SYSTEM
720
PASS-THROUGH ASM SIGNAL TO ECR
722

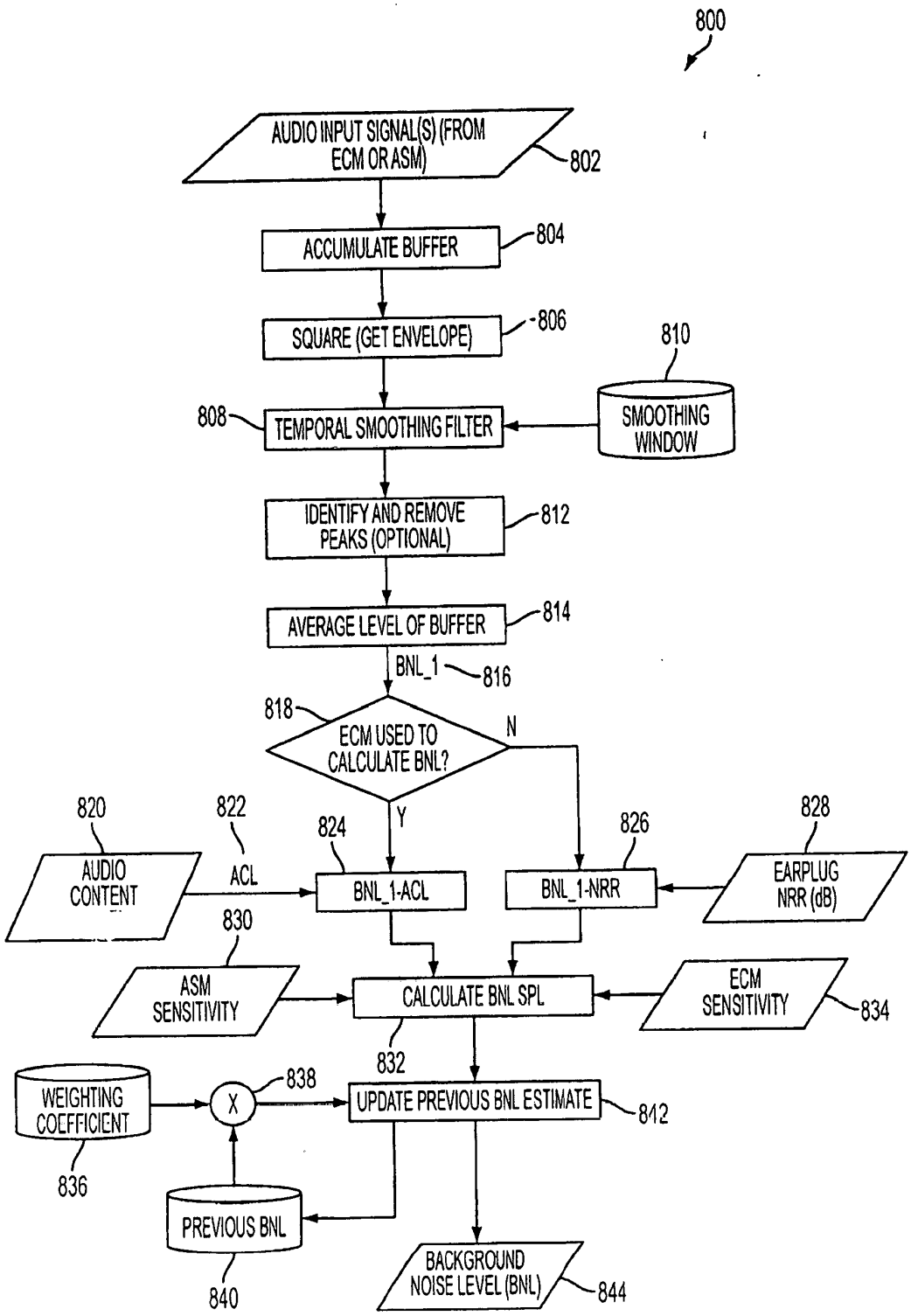

800
AUDIO INPUT SIGNAL(S) (FROM ECM OR ASM)
802
ACCUMULATE BUFFER
804
SQUARE (GET ENVELOPE)
806
810
SMOOTHING WINDOW
808
TEMPORAL SMOOTHING FILTER
IDENTIFY AND REMOVE PEAKS (OPTIONAL)
812
AVERAGE LEVEL OF BUFFER
814
BNL_1
816
818
ECM USED TO CALCULATE BNL?
N
Y
820
822
824
826
828
AUDIO CONTENT
ACL
BNL_1-ACL
BNL_1-NRR
EARPLUG NRR (dB)
830
ASM SENSITIVITY
CALCULATE BNL SPL
ECM SENSITIVITY
834
832
WEIGHTING COEFFICIENT
X
838
UPDATE PREVIOUS BNL ESTIMATE
842
836
PREVIOUS BNL
840
BACKGROUND NOISE LEVEL (BNL)
844

FIG. 8

FIG. 9

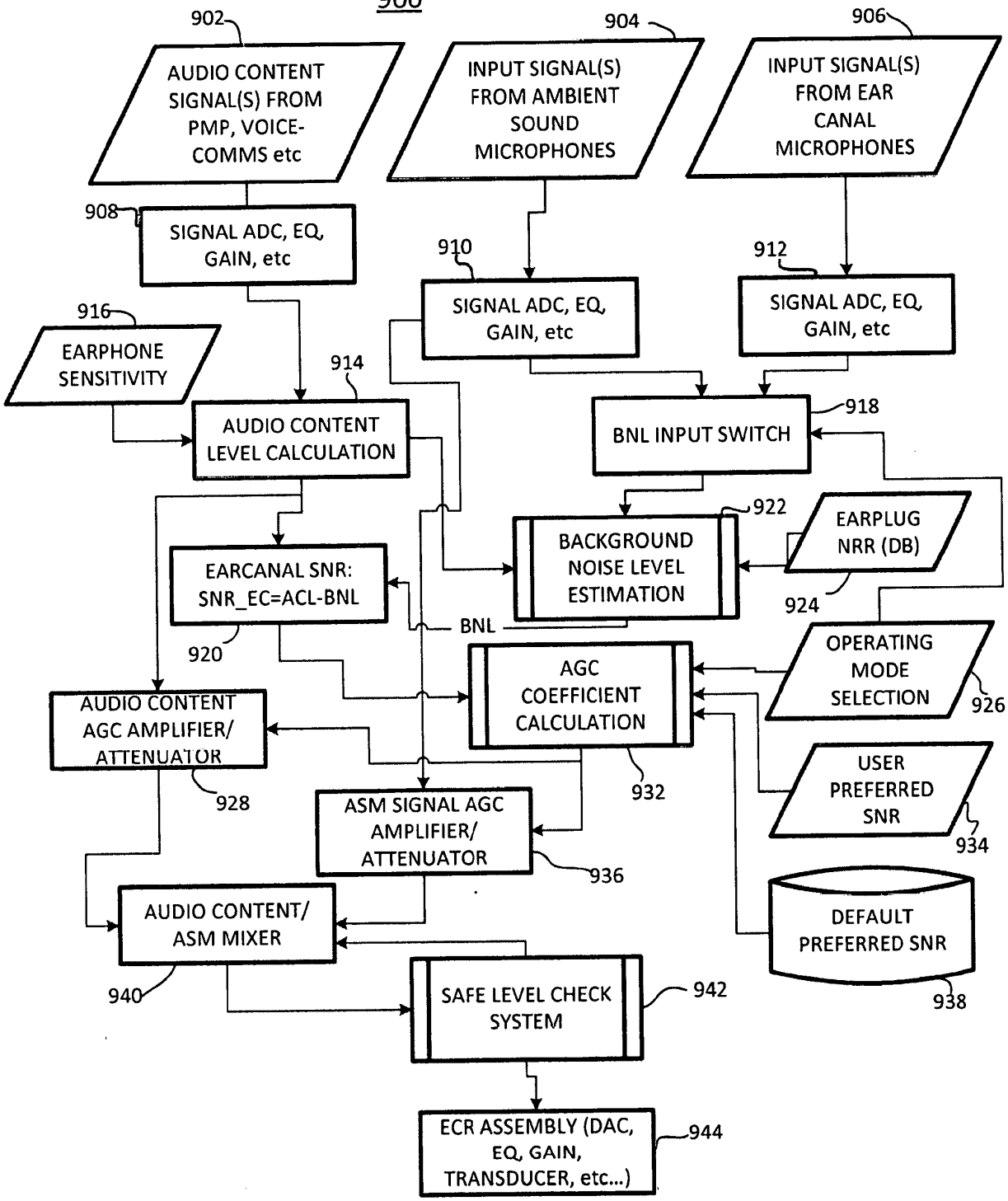
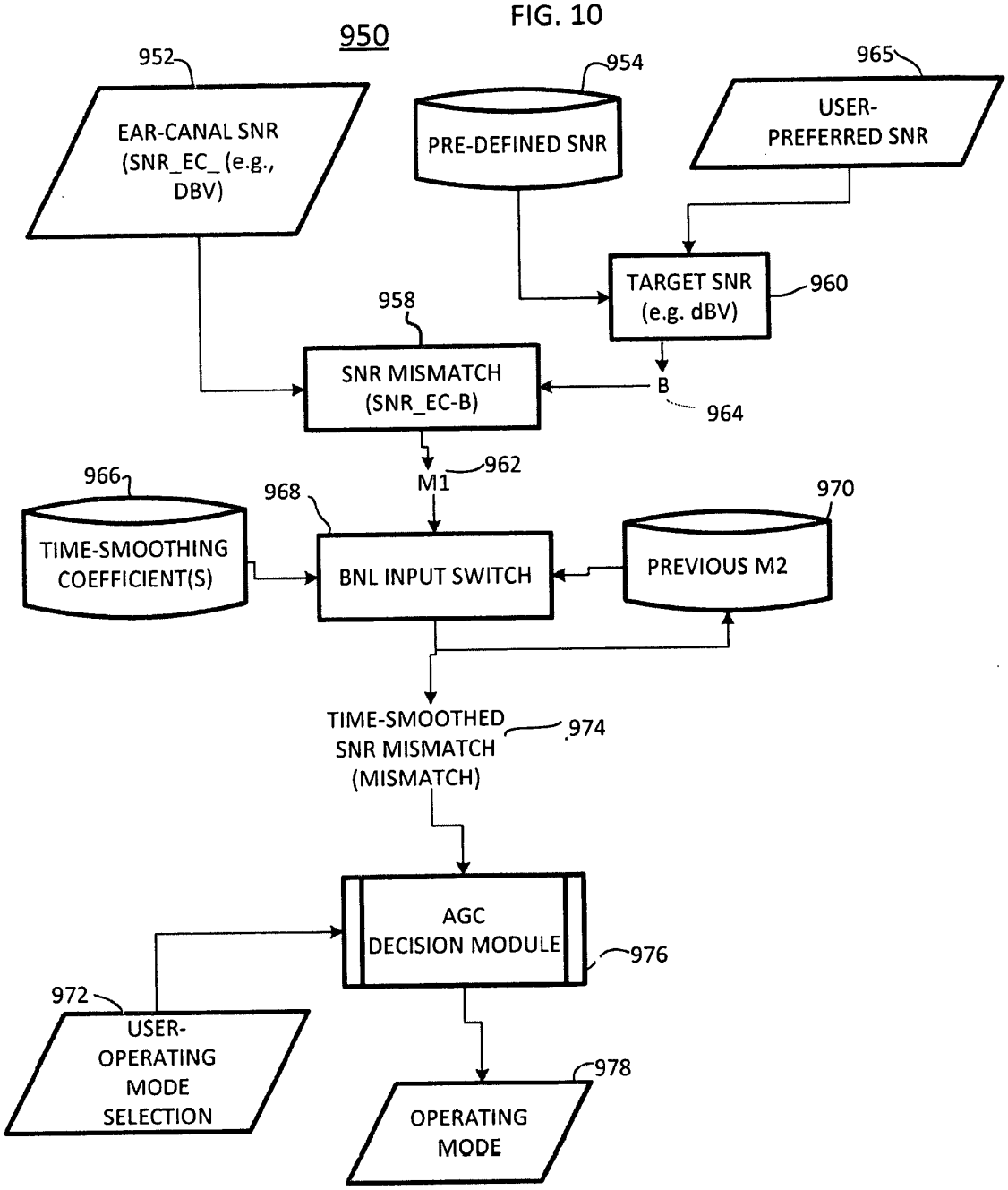

900
902
AUDIO CONTENT SIGNAL(S) FROM PMP, VOICE-COMMS etc
904
INPUT SIGNAL(S) FROM AMBIENT SOUND MICROPHONES
906
INPUT SIGNAL(S) FROM EAR CANAL MICROPHONES
908
SIGNAL ADC, EQ, GAIN, etc
910
SIGNAL ADC, EQ, GAIN, etc
912
SIGNAL ADC, EQ, GAIN, etc
916
EARPHONE SENSITIVITY
914
AUDIO CONTENT LEVEL CALCULATION
918
BNL INPUT SWITCH
922
BACKGROUND NOISE LEVEL ESTIMATION
EARPLUG NRR (DB)
924
EARCANAL SNR: SNR_EC=ACL-BNL
BNL
920
OPERATING MODE SELECTION
926
AGC COEFFICIENT CALCULATION
AUDIO CONTENT AGC AMPLIFIER/ ATTENUATOR
928
932
USER PREFERRED SNR
934
ASM SIGNAL AGC AMPLIFIER/ ATTENUATOR
936
AUDIO CONTENT/ ASM MIXER
DEFAULT PREFERRED SNR
940
SAFE LEVEL CHECK SYSTEM
942
938
ECR ASSEMBLY (DAC, EQ, GAIN, TRANSDUCER, etc...)
944

FIG. 10


950
952
EAR-CANAL SNR (SNR_EC_ (e.g., DBV)
954
PRE-DEFINED SNR
965
USER-PREFERRED SNR
TARGET SNR (e.g. dBV)
960
958
SNR MISMATCH (SNR_EC-B)
B
964
M1
962
966
TIME-SMOOTHING COEFFICIENT(S)
968
BNL INPUT SWITCH
970
PREVIOUS M2
TIME-SMOOTHED SNR MISMATCH (MISMATCH)
974
AGC DECISION MODULE
976
972
USER-OPERATING MODE SELECTION
978
OPERATING MODE

CLAIMS

What is claimed is:

1. An earphone comprising:

a first microphone configured to measure an ambient sound;

a second microphone configured to measure an acoustic environment closer the ear canal of a wearer than that measured by the first microphone;

a speaker configured to play an audio signal;

a memory that stores instructions; and

a processor that is configured to execute the instructions to perform operations, wherein the processor is coupled to the first microphone, wherein the processor is coupled to the second microphone, wherein the processor is coupled to the speaker, and the operations comprising:

receiving a first microphone signal from the first microphone;

receiving a second microphone signal from the second microphone;

generating an ambient sound signal from at least one of the first microphone signal or the second microphone signal or a combination of both signals;

receiving a level of noise reduction from memory, wherein the level of noise reduction is related to an amount of the ambient sound to pass through the earphone;

generating a noise reduction signal from at least one of the first microphone signal, the second microphone signal or a combination of both signals, wherein the generating of the noise reduction signal additionally uses the level of noise reduction;

mixing the noise reduction signal with an audio content signal to generate a mixed signal; and

sending the mixed signal to the speaker.

2. The earphone according to claim 1, wherein the operations further comprise:

generating a modified mixed signal by mixing the mixed signal with a modified ambient sound signal;

sending the modified mixed signal instead of the mixed signal to the speaker.

3. The earphone according to claim 1, wherein the level of noise reduction is set by a user using a software application.

4. The earphone according to claim 3, wherein the level of noise reduction has a higher value when the user wants less ambient sound to pass through the earphone and a lower value when the user wants more ambient sound to pass through the earphone.

5. The earphone according to claim 1, wherein the audio content signal contains voice content.

6. The earphone according to claim 5, wherein the voice content is composed of the user's voice.

7. The earphone according to claim 5, wherein the voice content is composed of a caller's voice.

8. The earphone according to claim 1, wherein the audio content signal includes a portion of the ambient sound signal.

9. The earphone according to claim 1, where operations further comprise:

analyzing at least one of the first microphone signal, the second microphone signal or a combination of both signals to detect a user's voice.

10. The earphone according to claim 9, where operations further comprise:

including a portion of the ambient sound signal in the audio content signal.

11. The earphone according to claim 9, where operations further comprise:

adjusting the level of noise reduction when a user's voice is detected.

12. The earphone according to claim 1, where the operations further comprise:

decreasing a volume of the audio content signal when at least one of an alarm, a warning, a siren or a combination of, is detected.

13. The earphone according to claim 12, where the operations further comprise:

sending a notification signal to the speaker.

14. The earphone according to claim 12, wherein the warning is at least one of a bell or the sound of an emergency vehicle or the sound of a security system or a combination.

15. The earphone according to claim 12, wherein the alarm is at least one of a police siren or an ambulance siren or a car honking or a combination.

16. The earphone according to claim 1, wherein the earphone includes a sealing section.

17. The earphone according to claim 2, where the operations further comprise:

adjusting the modified mixed signal when a user's voice is detected.

18. The earphone according to claim 17, wherein the operation of adjusting the modified mixed signal is to reduce the audio content signal and increase the ambient sound signal.

19. The earphone according to claim 2, where the modified mixed audio signal only includes the noise reduction signal and the modified ambient sound signal.

CONT-16987396

ABSTRACT

Earpieces and methods for acute sound detection and reproduction are provided. A method can include measuring an external ambient sound level (xASL), monitoring a change in the xASL for detecting an acute sound, estimating a proximity of the acute sound, and upon detecting the acute sound and its proximity, reproducing the acute sound within an ear canal, where the ear canal is at least partially occluded by an earpiece. Other embodiments are disclosed.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION
First Named Inventor/Applicant Name:	Steven Wayne Goldstein
Filer:	John Patrick Keady
Attorney Docket Number:	CONT-16987396

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	80	80
UTILITY SEARCH FEE	2111	1	350	350
UTILITY EXAMINATION FEE	2311	1	400	400
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**830**

Electronic Acknowledgement Receipt	
EFS ID:	42738433
Application Number:	17321892
International Application Number:	
Confirmation Number:	8980
Title of Invention:	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION
First Named Inventor/Applicant Name:	Steven Wayne Goldstein
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	CONT-16987396
Receipt Date:	17-MAY-2021
Filing Date:	
Time Stamp:	14:13:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$830
RAM confirmation Number	E20215GE15063987
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	WebADS.pdf	156037 f37456b18c93423c6d99b6211bfbafc2c23d9c64	no	9
Warnings:					
Information:					
2	Power of Attorney	CONT-16987396-POA-Executed.PDF	70455 9d3afa5a708e2fb10c4b14a54f13a57914976f12	no	1
Warnings:					
Information:					
3	Specification	CONT-16987396_spec.pdf	314549 309c1ec167312ed110e75aabcc86018c90a89c86	no	17
Warnings:					
Information:					
4	Oath or Declaration filed	CONT-16987396_oath.pdf	235475 23b096732c2817df3ca3c3daa96c31cd9f7bb54d	no	3
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	CONT-16987396_IDS.pdf	1041425 7f14aee3efd6e55bbcc2d77b533801df29b55b90	no	5
Warnings:					
Information:					

A U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form. You may remove the form to add the required data in order to correct the Informational Message or if you chose not to, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.

6	Drawings-only black and white line drawings	CONT-16987396_drawings.pdf	565488 21d99341dc7eb35d96375fb7f15cc0edec592fa8	no	9
Warnings:					
Information:					
7	Claims	CONT-16987396_claims.pdf	132734 914bbb51c5581fffc8f489f625336e3a1ab962c2	no	5
Warnings:					
Information:					
8	Abstract	CONT-16987396_abstract.pdf	87240 6b4378dba20c29f4497d6179a3f086791ec66927	no	1
Warnings:					
Information:					
9	Fee Worksheet (SB06)	fee-info.pdf	35256 95e570d015fd3f0e3c82666814e892be5cf6a02c	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	2638659	

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<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Steven	Wayne	Goldstein	

Residence Information (Select One) ◉ US Residency ◯ Non US Residency ◯ Active US Military Service

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Postal Code	33445	Country i	US

Inventor 2

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
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Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

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Postal Code	EX123LB	Country i	GB

Inventor 3

Legal Name

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

Prefix	**Given Name**	**Middle Name**	**Family Name**	**Suffix**
	Marc	Andre	Boillot	

Residence Information (Select One) ◉ US Residency ◯ Non US Residency ◯ Active US Military Service

City	Plantation	**State/Province**	FL	**Country of Residence** i	US

Mailing Address of Inventor:

Address 1	16193 bridlewood circle		
Address 2			
City	Delray Beach	**State/Province**	FL
Postal Code	33445	**Country** i	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	150139		
Email Address	ip@akerman.com	Add Email	Remove Email

Application Information:

Title of the Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION		
Attorney Docket Number	CONT-16987396	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	9	**Suggested Figure for Publication (if any)**	9

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country i

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	◯ US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	150139		

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove

Registration Number	

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	Remove

Registration Number	

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16987396	2020-08-07

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

Prior Application Status	Patented			Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16987396	Continuation of	16669490	2019-10-30	10810989	2020-10-20

Prior Application Status	Patented			Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16669490	Continuation of	16193568	2018-11-16	10535334	2020-01-14

Prior Application Status	Patented			Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16193568	Continuation of	14574589	2014-12-18	10134377	2018-11-20

Prior Application Status	Patented			Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14574589	Continuation of	12017878	2008-01-22	8917894	2014-12-23

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12017878	Claims benefit of provisional	60885917	2007-01-22

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
	US		

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

○ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
◉ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Staton Techiya LLC		
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Address 2			
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Country[i]	US	Postal Code	33064
Phone Number		Fax Number	
Email Address	Daniel@techiya.co		

Additional Applicant Data may be generated within this form by selecting the Add button.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	Staton Techiya LLC		
Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1	2500 NE 35th Street		
Address 2			
City	Lighthouse Point	**State/Province**	FL
Country i	US	Postal Code	33064
Phone Number		Fax Number	
Email Address	Daniel@techiya.co		

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16987396
	Application Number	
Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION	

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/John P. Keady/			Date (YYYY-MM-DD)	
First Name	John	Last Name	Keady	Registration Number	56389

Additional Signature may be generated within this form by selecting the Add button.

PTO/SB/80 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 150139

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 150139

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

Staton Techiya LLC. 16193 Bridlewood Circle, Delray Beach, FL 33445

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	8-14-17
Name	DANIEL C. STATON	Telephone	513-404-0099
Title	MANAGING MEMBER		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This is a continuation of and claims priority to U.S. Patent Application No. 16/987,396, filed 7 Aug. 2020, which is a continuation of and claims priority to U.S. Patent Application No. 16/669,490, filed 30 Oct. 2019, which is a continuation of and claims priority to U.S. Patent Application No. 16/193,568, filed 16 Nov. 2018, now U.S. Patent No. 10,535,334, which is a continuation of and claims priority to U.S. Patent Application Serial No. 14/574,589, filed on December 18, 2014, now U.S. Patent No. 10,134,377, which claims priority to and is a continuation of U.S. Patent Application Serial No. 12/017,878, filed on January 22, 2008, now U.S. Patent No. 8,917,894, which claims the benefit of U.S. Provisional Patent Application Serial No. 60/885,917, filed on January 22, 2007, all of which are herein incorporated by reference in their entireties.

FIELD OF THE INVENTION

[0002] The present invention relates to a device that monitors sound directed to an occluded ear, and more particularly, though not exclusively, to an earpiece and method of operating an earpiece that detects acute sounds and allows the acute sounds to be reproduced in an ear canal of the occluded ear.

BACKGROUND

[0003] Since the advent of industrialization over two centuries ago, the human auditory system has been increasingly stressed to tolerate high noise levels to which it had hitherto been unexposed. Recently, human knowledge of the causes of hearing damage have been researched intensively and models for predicting hearing loss have been developed and verified with empirical data from decades of scientific research. Yet it can be strongly argued that the danger of permanent hearing damage is more present in our daily lives than ever, and that sound levels from personal audio systems in particular (i.e. from portable audio devices), live sound events, and the urban environment are a ubiquitous threat to healthy auditory functioning across the global population.

[0004] Environmental noise is constantly presented in industrialized societies given the ubiquity of external sound intrusions. Examples include people talking on their cell phones, blaring music in health clubs, or the constant hum of air conditioning systems in schools and office buildings.

Excess noise exposure can also induce auditory fatigue, possibly comprising a person's listening abilities. On a daily basis, people are exposed to various environmental sounds and noises within their environment, such as the sounds from traffic, construction, and industry.

[0005] To combat the undesired cacophony of annoying sounds, people are arming themselves with portable audio playback devices to drown out intrusive noise. The majority of devices providing the person with audio content do so using insert (or in-ear) earbuds. These earbuds deliver sound directly to the ear canal at high sound levels over the background noise even though the earbuds generally provide little to no ambient sound isolation. Moreover, when people wear earbuds (or headphones) to listen to music, or engage in a call using a telephone, they can effectively impair their auditory judgment and their ability to discriminate between sounds. With such devices, the person is immersed in the audio experience and generally less likely to hear warning sounds within their environment. In some cases, the user may even tum up the volume to hear their personal audio over environmental noises. It also puts them at high sound exposure risk which can potentially cause long term hearing damage.

[0006] With earbuds, personal audio reproduction levels can reach in excess of 100 dB. This is enough to exceed recommended daily sound exposure levels in less than a minute and to cause permanent acoustic trauma. Furthermore, rising population densities have continually increased sound levels in society. According to researchers, 40% of the European community is continuously exposed to transportation noise of 55 dBA and 20% are exposed to greater than 65 dBA. This level of 65 dBA is considered by the World Health Organization to be intrusive or annoying, and as mentioned, can lead to users of personal audio devices increasing reproduction levels to compensate for ambient noise.

[0007] A need therefore exists for enhancing the user's ability to listen in the environment without harming his or her hearing faculties.

SUMMARY

[0008] Embodiments in accordance with the present invention provide a method and device for acute sound detection and reproduction.

[0009] In a first embodiment, an earpiece can include an Ambient Sound Microphone (ASM) to capture ambient sound, at least one Ear Canal Receiver (ECR) to deliver audio to an ear canal; and a processor

operatively coupled to the ASM and the at least one ECR. The processor can monitor a change in the ambient sound level to detect an acute sound from the change. The acute sound can be reproduced within the ear canal via the ECR responsive to detecting the acute sound.

[0010] The processor can pass (transmit) sound from the ASM directly to the ECR to produce sound within the ear canal at a same sound pressure level (SPL) as the acute sound measured at an entrance to the ear canal. In one arrangement, the processor can maintain an approximately constant ratio between an audio content level (ACL) and an internal ambient sound level (iASL) measured within the ear canal. In one arrangement, the processor can measure an external ambient sound level (xASL) of the ambient sound with the ASM and subtract an attenuation level of the earpiece from the xASL to estimate the internal ambient sound level (iASL) within the ear canal.

[0011] The earpiece can further include an Ear Canal Microphone (ECM) to measure an ear canal sound level (ECL) within the ear canal. In this configuration, the processor can estimate the internal ambient sound level (iASL) within the ear canal by subtracting an estimated audio content sound level (ACL) from the ECL. For instance, the processor can measure a voltage level of the audio content sent to the ECR, and apply a transfer function of the ECR to convert the voltage level to the ACL. The processor can be located external to the earpiece on a portable computing device.

[0012] In a second embodiment, an earpiece can comprise an Ambient Sound Microphone (ASM) to capture ambient sound, at least one Ear Canal Receiver (ECR) to deliver audio to an ear canal, an audio interface operatively coupled to the processor to receive audio content, and a processor operatively coupled to the ASM and the at least one ECR. The processor can monitor a change in the ambient sound level to detect an acute sound from the change, adjust an audio content level (ACL) of the audio content delivered to the ear canal, and reproduce the acute sound within the ear canal via the ECR responsive to detecting the acute sound and based on the ACL.

[0013] The audio interface can receive the audio content from at least one among a portable music player, a cell phone, and a portable communication device. During operation, the processor can maintain an approximately constant ratio between an audio content level (ACL) and an internal ambient sound level (iASL) measured within the ear canal. In one arrangement, the processor can mute the audio content and pass the acute sound to the ECR for reproducing the acute sound within the ear canal. In another arrangement, the processor can amplify the acute sound with respect to the audio content level (ACL).

[0014] In a third embodiment, a method for acute sound detection and reproduction can include the steps of measuring an ambient sound level (xASL) of ambient sound external to an ear canal at least partially occluded by the earpiece, monitoring a change in the xASL for detecting an acute sound, and reproducing the acute sound within the ear canal responsive to detecting the acute sound. The reproducing can include enhancing the acute sound over the ambient sound. The step of reproducing can produce sound within the ear canal at a same sound pressure level (SPL) as the acute sound measured at an entrance to the ear canal.

[0015] The method can further include receiving audio content from an audio interface that is directed to the ear canal, and maintaining an approximately constant ratio between a level of the audio content (ACL) and a level of an internal ambient sound level (iASL) measured within the ear canal. The ACL can be determined by measuring a voltage level of the audio content sent to the ECR, and applying a transfer function of the ECR to convert the voltage level to the ACL. The method can further include measuring an Ear Canal Level (ECL) within the ear canal, and subtracting the ACL from the ECL to estimate the iASL. The iASL can be estimated by subtracting an attenuation level of the earpiece from the xASL.

[0016] In a fourth embodiment, a method for acute sound detection and reproduction suitable for use with an earpiece can include the steps of measuring an external ambient sound level (xASL) in an ear canal at least partially occluded by the earpiece, monitoring a change in the xASL for detecting an acute sound, estimating a proximity of the acute sound, and reproducing the acute sound within the ear canal responsive to detecting the acute sound based on the proximity. The step of estimating a proximity can include performing a cross correlation analysis between at least two microphones, identifying a peak in the cross correlation and an associated time lag, and determining the direction from the associated time lag. The method can further include identifying whether the acute sound is a vocal signal produced by a user operating the earpiece or a sound source external from the user.

[0017] In a fifth embodiment, a method for acute sound detection and reproduction suitable for use with an earpiece can include measuring an external ambient sound level (xASL) due to ambient sound outside of an ear canal at least partially occluded by the earpiece, measuring an internal ambient sound level (iASL) due to residual ambient sound within the ear canal at least partially occluded by the earpiece, monitoring a high frequency change between the xASL and the iASL with respect to a low frequency change between the xASL and the iASL for detecting an acute sound, and reproducing the xASL within the ear canal responsive to detecting the high frequency change. The method can further

include determining a proximity of a sound source producing the acute sound.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a pictorial diagram of an earpiece in accordance with an exemplary embodiment;

[0019] FIG. 2 is a block diagram of the earpiece in accordance with an exemplary embodiment;

[0020] FIG. 3 is a flowchart of a method for acute sound detection m accordance with an exemplary embodiment;

[0021] FIG. 4 is a more detailed approach to the method of FIG. 3 in accordance with an exemplary embodiment;

[0022] FIG. 5 is a flowchart of a method for acute sound source proximity in accordance with an exemplary embodiment;

[0023] FIG. 6 is a flowchart of a method for binaural analysis in accordance with an exemplary embodiment;

[0024] FIG. 7 is a flowchart of a method for logic control in accordance with an exemplary embodiment;

[0025] FIG. 8 is a flowchart of a method for estimating background noise level in accordance with an exemplary embodiment;

[0026] FIG. 9 is a flowchart of a method for maintaining constant audio content level (ACL) to internal ambient sound level (iASL) in accordance with an exemplary embodiment; and

[0027] FIG. 10 is a flowchart of a method for adjusting audio content gain in accordance with an exemplary embodiment.

DETAILED DESCRIPTION

[0028] The following description of at least one exemplary embodiment is merely illustrative in nature and is in no way intended to limit the invention, its application, or uses.

[0029] Processes, techniques, apparatus, and materials as known by one of ordinary skill in the relevant art may not be discussed in detail but are intended to be part of the enabling description where appropriate, for example the fabrication and use of transducers. Additionally in at least one exemplary embodiment the sampling rate of the transducers can be varied to pick up pulses of sound, for example less than 50 milliseconds.

[0030] In all of the examples illustrated and discussed herein, any specific values, for example the sound pressure level change, should be interpreted to be illustrative only and non-limiting. Thus, other examples of the exemplary embodiments could have different values.

[0031] Note that similar reference numerals and letters refer to similar items in the following figures, and thus once an item is defined in one figure, it may not be discussed for following figures.

[0032] Note that herein when referring to correcting or preventing an error or damage (e.g., hearing damage), a reduction of the damage or error and/or a correction of the damage or error are intended.

[0033] At least one exemplary embodiment of the invention is directed to an earpiece for ambient sound monitoring and warning detection. Reference is made to FIG. 1 in which an earpiece device, generally indicated as earpiece 100, is constructed in accordance with at least one exemplary embodiment of the invention. As illustrated, earpiece 100 depicts an electro- acoustical assembly 113 for an in-the-ear acoustic assembly, as it would typically be placed in the ear canal 131 of a user 135. The earpiece 100 can be an in the ear earpiece, behind the ear earpiece, receiver in the ear, open-fit device, or any other suitable earpiece type. The earpiece 100 can be partially or fully occluded in the ear canal, and is suitable for use with users having healthy or abnormal auditory functioning.

[0034] Earpiece 100 includes an Ambient Sound Microphone (ASM) Ill to capture ambient sound, an Ear Canal Receiver (ECR) 125 to deliver audio to an ear canal 131, and an Ear Canal Microphone (ECM) 123 to assess a sound exposure 1evel within the ear canal. The earpiece 100 can partially or fully occlude the ear canal 131 to provide various degrees of acoustic isolation. The assembly is designed to be inserted into the user's ear canal 131, and to form an acoustic seal with the walls 129 of the ear canal at a location 127 between the entrance 117 to the ear canal and the tympanic membrane (or ear drum)
133. Such a seal is typically achieved by means of a soft and compliant housing of assembly 113. Such a seal is pertinent to the performance of the system in that it creates a closed cavity 131 of approximately

5 cc between the in-ear assembly 113 and the tympanic membrane 133. As a result of this seal, the ECR (speaker) 125 is able to generate a full range bass response when reproducing sounds for the user. This seal also serves to significantly reduce the sound pressure level at the user's eardrum 133 resulting from the sound field at the entrance to the ear canal. This seal is also the basis for the sound isolating performance of the electro-acoustic assembly 113.

[0035] Located adjacent to the ECR 125, is the ECM 123, which is acoustically coupled to the (closed) ear canal cavity 131. One of its functions is that of measuring the sound pressure level in the ear canal cavity 131 as a part of testing the hearing acuity of the user as well as confirming the integrity of the acoustic seal and the working condition of itself and the ECR. The ASM 111 is housed in an assembly 113 and monitors sound pressure at the entrance to the occluded or partially occluded ear canal. All transducers shown can receive or transmit audio signals to a processor 121 that undertakes audio signal processing and provides a transceiver for audio via the wired or wireless communication path 119.

[0036] Referring to FIG. 2, a block diagram of the earpiece 100 in accordance with an exemplary embodiment is shown. As illustrated, the earpiece 100 can include a processor 206 operatively coupled to the ASM 111, ECR 125, and ECM 123 via one or more Analog to Digital Converters (ADC) 202 and Digital to Analog Converters (DAC) 203. The processor 206 can monitor the ambient sound captured by the ASM 111 for acute sounds in the environment, such as an abrupt high energy sound corresponding to the on-set of a warning sound (e.g., bell, emergency vehicle, security system, etc.), siren (e.g., police car, ambulance, etc.), voice (e.g., "help", "stop", "police", etc.), or specific noise type (e.g., breaking glass, gunshot, etc.). The processor 206 can utilize computing technologies such as a microprocessor, Application Specific Integrated Chip (ASIC), and/or digital signal processor (DSP) with associated storage memory 208 such as Flash, ROM, RAM, SRAM, DRAM or other like technologies for controlling operations of the earpiece device 100. The memory 208 can store program instructions for execution on the processor 206 as well as captured audio processing data.

[0037] The earpiece 100 can include an audio interface 212 operatively coupled to the processor 206 to receive audio content, for example from a media player or cell phone, and deliver the audio content to the processor 206. The processor 206 responsive to detecting acute sounds can adjust the audio content and pass the acute sounds directly to the ear canal. For instance, the processor can lower a volume of the audio content responsive to detecting an acute sound for transmitting the acute sound to the ear canal. The processor 206 can also actively monitor the sound exposure level inside the

ear canal and adjust the audio to within a safe and subjectively optimized listening level range.

[0038] The earpiece 100 can further include a transceiver 204 that can support singly or in combination any number of wireless access technologies including without limitation Bluetooth.TM., Wireless Fidelity (WiFi), Worldwide Interoperability for Microwave Access (WiMAX), and/or other short or long range communication protocols. The transceiver 204 can also provide support for dynamic downloading over-the-air to the earpiece 100. It should be noted also that next generation access technologies can also be applied to the present disclosure.

[0039] The power supply 210 can utilize common power management technologies such as replaceable batteries, supply regulation technologies, and charging system technologies for supplying energy to the components of the earpiece 100 and to facilitate portable applications. A motor (not shown) can be a single supply motor driver coupled to the power supply 210 to improve sensory input via haptic vibration. As an example, the processor 206 can direct the motor to vibrate responsive to an action, such as a detection of a warning sound or an incoming voice call.

[0040] The earpiece 100 can further represent a single operational device or a family of devices configured in a master-slave arrangement, for example, a mobile device and an earpiece. In the latter embodiment, the components of the earpiece 100 can be reused in different form factors for the master and slave devices.

[0041] FIG. 3 is a flowchart of a method 300 for acute sound detection and reproduction in accordance with an exemplary embodiment. The method 300 can be practiced with more or less than the number of steps shown and is not limited to the order shown. To describe the method 300, reference will be made to components of FIG. 2, although it is understood that the method 300 can be implemented in any other manner using other suitable components. The method 300 can be implemented in a single earpiece, a pair of earpieces, headphones, or other suitable headset audio delivery devices.

[0042] The method 300 can start in a state wherein the earpiece 100 has been inserted and powered on. As shown in step 302, the earpiece 100 can monitor the environment for ambient sounds received at the ASM 111. Ambient sounds correspond to sounds within the environment such as the sound of traffic noise, street noise, conversation babble, or any other acoustic sound. Ambient sounds can also correspond to industrial sounds present in an industrial setting, such as factory noise, lifting vehicles, automobiles, and robots to name a few.

[0043] Although the earpiece 100 when inserted in the ear can partially occlude the ear canal, the earpiece 100 may not completely attenuate the ambient sound. During the monitoring of ambient sounds in the environment, the earpiece 100 also monitors ear canal levels via the ECM 123 as shown in step 304. The passive aspect of the physical earpiece 100, due to the mechanical and sealing properties, can provide upwards of a 22-26 dB noise reduction. However, portions of ambient sounds higher than 26 dB can still pass through the earpiece 100 into the ear canal. For instance, high energy low frequency sounds are not completely attenuated. Accordingly, residual sound may be resident in the ear canal and heard by the user.

[0044] Sound within the ear canal 131 can also be provided via the audio interface 212. The audio interface 212 can receive the audio content from at least one among a portable music player, a cell phone, and a portable communication device. The audio interface 212 responsive to user input can direct sound to the ECR 125. For instance, a user can elect to play music through the earpiece 100 which can be audibly presented to the ear canal 131 for listening. The user can also elect to receive voice communications (e.g., cell phone, voice mail, messaging) via the earpiece 100. For instance, the user can receive audio content for voice mail or a phone call directed to the ear canal via the ECR 125. As shown in step 304, the earpiece 100 can monitor ear canal levels due to ambient sound and user selected sound via the ECM 123.

[0045] If at step 306, audio is playing (e.g., music, cell phone, etc.), the earpiece 100 adjusts a sound level of the audio based on the ambient sound to maintain a constant signal to noise ratio with respect to the ear canal level at step 308. For instance, the processor 206 can selectively amplify or attenuate audio content received from the audio interface 212 before it is delivered to the ECR 125. The processor 206 estimates a background noise level from the ambient sound received at the ASM 111, and adjusts the audio level of delivered audio content (e.g., music, cell phone audio) to maintain a constant signal (e.g., audio content) to noise level (e.g., ambient sound). By way of example, if the background noise level increases due to traffic sounds, the earpiece 100 automatically increases the volume of the audio content. Similarly, if the background noise level decreases, the earpiece 100 automatically decreases the volume of the audio content. The processor 206 can track variations on the ambient sound level to adjust the audio content level.

[0046] If at step 310, an acute sound is detected within the ambient sound, the earpiece 100 activates "sound pass-through" to reproduce the ambient sound in the ear canal by way of the ECR 125. The processor 206 permits the ambient sound to pass through the ECR 125 to the ear canal 131 directly for

example by replicating the ambient sound external to the ear canal within the ear canal. This is important if the acute sound corresponds to an on-set for a warning sound such as a bell, a car, or an object. In such regard, the ambient sound containing the acute sound is presented directly to the ear canal in an original form. Although, the earpiece 100 inherently provides attenuation due to the physical and mechanical aspects of the earpiece and its sealing properties, the processor 206 can reproduce the ambient sound within the ear canal 131 at an original amplitude level and frequency content to provide "transparency". For instance, the processor 206 measures and applies a transfer function of the ear canal to the passed ambient sound signal to provide an accurate reproduction of the ambient sound within the ear canal.

[0047] In one embodiment, the earpiece 100 looks for temporal and spectral characteristics in the ambient sound for detecting acute sounds. For instance, as will be explained ahead, the processor 206 looks for an abrupt change in the Sound Pressure Level (SPL) of an ambient sound across a small time period. The processor 206 can also detect abrupt magnitude changes across frequency sub-bands (e.g. filter-bank, FFT, etc.). Notably, the processor 206 can search for on-sets (e.g., fast rising amplitude wave-front) of an acute sound or other abrupt feature characteristics without initially attempting to initially identify or recognize the sound source. That is, the processor 206 is actively listening for a presence of acute sounds before identifying the type of sound source.

[0048] Even though the earplug inherently provides a certain attenuation level (e.g., noise reduction rating), the processor 206 in view of the ear canal level (ECL) and ambient sound level (ASL) can reproduce the ambient sound within the ear canal to allow the user to make an informed decision with regard to the acute sound. The ECL corresponds to all sounds within the ear canal and includes the internal ambient sound level (iASL) resulting from residual ambient sounds through the earpiece and the audio content level (ACL) resulting from the audio delivered via the audio interface 212. Briefly, xASL is the external ambient sound external to the ear canal and the earpiece (e.g., ambient sound outside the ear canal). iASL is the residual ambient sound that remains internal in the ear canal. The following equations describe the relationship among terms:

iASL=xASL-NRR (EQ 1)

iASL=ECL-ACL (EQ 2)

[0049] As EQ 1 shows, the iASL is the difference between the external ambient sound (xASL) and the attenuation of the earpiece (Noise Reduction Rating) due to the physical and sealing properties of the earpiece. The processor 206 can measure an external ambient sound level (xASL) of the ambient

sound with the ASM 111 and subtracts an attenuation level of the earpiece (NRR) from the xASL to estimate the internal ambient sound level (iASL) within the ear canal.

[0050] EQ 2 is an alternate, or supplemental, method for calculating the iASL as the difference between the ECL and the Audio Content Level (ACL). By way of the ECM 123, the processor 206 can estimate an internal ambient sound level (iASL) within the ear canal by subtracting the estimated audio content sound level (ACL) from the ECL. The processor 206 measures a voltage level of the audio content sent to the ECR 125, and applies a transfer function of the ECR 125 to convert the voltage level to the ACL.

[0051] The processor 206 evaluates the equations above to pass sound from the ASM 111 directly to the ECR 125 to produce sound within the ear canal at a same sound pressure level (SPL) and frequency representation as the acute sound measured at an entrance to the ear canal. Further, the processor 206 can maintain an approximately constant ratio between an audio content level (ACL) and an internal ambient sound level (iASL) measured within the ear canal.

[0052] At step 314, the earpiece 100 can estimate a proximity of the acute sound. For instance, as will be shown ahead, the processor 206 can perform a correlation analysis on at least two microphones to determine whether the sound source is internal (e.g., the user) or external (e.g., an object other than the user). At step 316, the earpiece 100 determines whether it is the user's voice that generates the acute sound when the user speaks, or whether it is an external sound such as a vehicle approaching the user. If at step 316, the processor 206 determines that the acute sound is a result of the user speaking, the processor 206 does not activate a pass-through mode, since this is not considered an external warning sound. The pass-through mode permits ambient sound detected at the ASM 111 to be transmitted directly to the ear canal. If however, the acute sound corresponds to an external sound source, such as an on-set of a warning sound, the earpiece at step 318 activates "sound pass-through" to reproduce the ambient sound in the ear canal by way of the ECR 125. The earpiece 100 can also present an audible notification to the user indicating that an external sound source generating the acute sound has been detected. The method 300 can proceed back to step 302 to continually monitor for acute sounds in the environment.

[0053] FIG. 4 is a detailed approach to the method 400 of FIG. 3 for an Acute-Sound Pass- Through System (ACPTS) in accordance with an exemplary embodiment. The method 400 can be practiced with more or less than the number of steps shown and is not limited to the order shown. To describe the method 400, reference will be made to components of FIG. 2, although it is understood that the method 400 can be implemented in any other manner using other suitable components. The method 400 can be

implemented in a single earpiece, a pair of earpieces, headphones, or other suitable headset audio delivery devices.

[0054] At step 402, the earpiece 100 captures ambient sound signals from the ASM 111. At step 404, the processor 206 applies analog and discrete time signal processing to condition and compensate the ambient sound signal for the ASM 111 transducer. At step 406, the processor 206 estimates a background noise level (BNL) as will be discussed ahead. At step 408, the processor 206 identifies at least one peak in a data buffer storing a portion of the ambient sound signal. The processor 206 at step 410 gets a level of the peak (e.g., dBV). Block 412 presents a method for warning signal detection (e.g. car horns, klaxons). When a warning signal is detected at step 416, the processor 206 invokes at step 418 a pass-through mode whereby the ASM signal is reproduced with the ECR 125. Upon activating pass-through mode, the processor 206 can perform a safe level check at step 452. If a warning signal is not detected, the method 400 proceeds to step 420.

[0055] At step 420, the processor 206 subtracts the estimated BNL from an SPL of the ambient sound signal to produce signal "A". A high energy level transient signal is indicative of an acute sound. At step 422, a frequency dependent threshold is retrieved at step 424, and subtracted from signal "A", as shown in step 422 to produce signal "B". At step 426, the processor 206 determines if signal "B" is positive. If not, the processor 206 performs a hysterisis to determine if the acute sound has already been detected. If not, the processor at step 428 determines if an SPL of the ambient sound is greater than a signal "C" (e.g. threshold). If the SPL is greater than signal "C", the earpiece generates a user generated sound at step 434. The signal "C" is used to ensure that the SPL between the signal and background noise is positive and greater than a predetermined amount. For instance, a low SPL threshold (e.g., "C" 40 dB) can be used as shown in step 430, although it can adapt to different environmental conditions. The low SPL threshold provides an absolute measure to the SPL difference. At step 436, a proximity of a sound source generating the acute sound can be estimated as will be discussed ahead. The method 400 can continue to step 432.

[0056] Briefly, if a transient, high-level sound (or acute sound) is detected in the ambient sound signal (ASM input signal), then it is converted to a level, and its magnitude compared with the BNL is calculated. The magnitude of this resulting difference (signal "A") is compared with the threshold (see step 422). If the value is positive, and the level of the transient is greater than a predefined threshold (see step 428), the processor 206 invokes the optional Source Proximity Detector at step 436, which determines if the acute sound was created by the User's voice (i.e., a user generated sound). If a user-generated sound is NOT detected, then Pass-through operation at step 438 is invoked, whereby the

ambient sound signal is reproduced with the ECR 125. If the difference signal at step 428 is not positive, or the level of the identified transient is too low, then the hysteresis is invoked at step 432. The processor 206 decides if the pass-through was recently used at step 440 (e.g. in the last 10 ms). If pass-through mode was recently activated, then processor 206 invokes the pass-through system at step 438; otherwise there is no pass-through of the ASM signal to the ECR as shown at step 442. Upon activating pass-through mode, the processor 206 can perform a safe level check at step 452.

[0057] FIG. 5 is a flowchart of a method 500 for acute sound source proximity. The method 500 can be practiced with more or less than the number of steps shown and is not limited to the order shown. To describe the method 500, reference will be made to components of FIG. 2, although it is understood that the method 500 can be implemented in any other manner using other suitable components. The method 500 can be implemented in a single earpiece, a pair of earpieces, headphones, or other suitable headset audio delivery devices.

[0058] Briefly, FIG. 5 describes a method 500 for Source Proximity Detection (SPD) to determine if the Acute sound detected was created by the User's voice operating the earpiece 100. The SPD method 500 uses as its inputs the external ambient sound signals from left and right electro-acoustic earpiece 100 assemblies (e.g., a headphone). In some embodiments the SPD method 500 employs Ear Canal Microphone (ECM) signals from left and right earpiece 100 assemblies placed on left and right ears respectively. The processor 206 performs an electronic cross-correlation between the external ambient sound signals to determine a Pass-through or Non Pass-through operating mode. In the described embodiment whereby the cross-correlation of both the ASM and ECM signals is involved, a pass-through mode is invoked when the cross- correlation analysis for both the left and right earpiece 100 assemblies return a "Pass-through" operating mode, as determined by a logical AND unit.

[0059] For instance, at step 502 a left ASM signal from a left headset incorporating the earpiece 100 assembles is received. Simultaneously, at step 504 a right ASM signal from a right headset is received. At step 510, the processor 206 performs a binaural cross correlation on the left ASM signal and the right ASM signal to evaluate a pass through mode 516. At step 506 a left ECM signal from the left headset is received. At step 508, a right ECM signal from the right headset is received. At step 514, the processor 206 performs a binaural cross correlation on the left ECM signal and the right ECM signal to evaluate a pass through mode 518. A pass through mode 524 is invoked if both the ASM and ECM cross correlation analysis are the same as determined in step 520. A safe level check can be performed by processor 206 at step 522.

[0060] FIG. 6 is a flowchart of a method 600 for binaural analysis. The method 600 can be practiced

with more or less than the number of steps shown and is not limited to the order shown. To describe the method 600, reference will be made to components of FIG. 2, although it is understood that the method 600 can be implemented in any other manner using other suitable components. The method 600 can be implemented in a single earpiece, a pair of earpieces, headphones, or other suitable headset audio delivery devices.

[0061] Briefly, FIG. 6 describes a component of the SPD method 500 wherein a cross-correlation of two input audio signals 602 and 604 (e.g., left and right ASM signals) is calculated. The input signals may first be weighted using a frequency-dependent filter (e.g. an FIR-type filter) using filter coefficients 606 and filtering networks 608 and 610. Alternatively, an interchannel cross- correlation calculated with function 612 can return a frequency-dependent correlation such as a coherence function. The absolute maximum peak of a calculated cross-correlation 614 can be subtracted from a mean (or RMS) 616 correlation, with subtractor 622, and compared 628 with a predefined threshold 626, to determine if the peak is significantly greater than the average correlation (i.e. a test for peakedness). Alternatively, the maxima of the peak may simply be compared with the threshold 628 without the subtraction process 622. If the lag-time of the peak 618 is at approximately lag-sample 0, then the sound source is determined, at step 624, as being on the interaural axis-indicative of User-generated speech, and a no-pass through mode is returned 630 (a further function described in FIG. 7 may be used to confirm that the sound source originates in the User-head, rather than external to the user- and further confirming that the acute sound is a User-generated voice sound). The logical AND unit
632 activates the pass- through mode 636 if both criteria in the decision units 628 and 624 confirm that the absolute maxima of the peak is above a predefined threshold 626, AND the lag of the peak is NOT at approximately lag sample zero. A safe level check may be performed by processor 206 at step
634.

[0062] FIG. 7 is a flowchart of a method 700 for logic control. The method 700 can be practiced with more or less than the number of steps shown and is not limited to the order shown. To describe the method 700, reference will be made to components of FIG. 2, although it is understood that the method 700 can be implemented in any other manner using other suitable components. The method 700 can be implemented in a single earpiece, a pair of earpieces, headphones, or other suitable headset audio delivery devices.

[0063] Briefly, FIG. 7 describes a further component of the SPD method 500, which is optional to confirm that the acute sound source is from a location indicative of user-generated speech; i.e. inside the head. Method steps 702-712 are similar to Method steps 502-514 of FIG. 5. The cross- correlations

of step 710 and 712 provide a time-lag of the maximum absolute peak for a pair of input signals; the ASM and ECM signals for the same headset (e.g. the ASM and ECM for the left headset). At step 714 a left lag of a peak of the left cross correlation is determined, and simultaneously, a right lag of a peak of the right cross correlation is determined at step 718. If a lag of a respective peak is greater than zero--this indicates that the sound arrived at the ECM signal before the ASM signal. Decision step 716 determines if the lag is greater than zero for both the left and right headsets- and activates the pass-through mode 722 if so. A safe level check may be performed by processor 206 at step 720.

[0064] FIG. 8 is a flowchart of a method 800 for estimating background sound level. The method 800 can be practiced with more or less than the number of steps shown and is not limited to the order shown. To describe the method 800, reference will be made to components of FIG. 2, although it is understood that the method 800 can be implemented in any other manner using other suitable components. The method 800 can be implemented in a single earpiece, a pair of earpieces, headphones, or other suitable headset audio delivery devices.

[0065] Briefly, method 800 receives as its input 802 either or both the ASM signal from ASM 111 and a signal from the ECM 123. An audio buffer 804 of the input audio signal is accumulated (e.g. 10 ms of data), which is then processed by squaring step 806 to obtain the temporal envelope. The envelope is smoothed (e.g. an FIR-type low-pass digital filter) at step 808 using a smoothing window 810 stored in data memory (e.g. a Hanning or Hamming shaped window). At step 812, transient peaks in the input buffer can be identified and removed to determine a "steady-state" Background Noise Level (BNL). At step 814 an average BNL 816 can be obtained (similar to, or the same as, the RMS) that is frequency dependent or a single value averaged over all frequencies. If the ECM 123 is used to determine the BNL, then decision step 818 adjusts the ambient BNL estimation to provide an equivalent ear-canal BNL SPL, by deducting an Earpiece Noise Reduction Rating 828 from the BNL estimate 826. Alternatively, if the ECM 123 is used, then the Audio Content SPL level (ACL) 822 of any reproduced Audio Content 820 is deducted from the ECM level at step 824. The updated BNL estimate is then converted to a Sound Pressure Level (SPL) equivalent 832 (i.e. substantially equal to the SPL at the ear-drum in which the earphone device is inserted) by taking into account the sensitivity (e.g. measured in V per dB) of either the ASM 111 or ECM 123 at steps 830 and 834 respectively. The resulting BNL SPL is then combined at step 842 with the previous BNL estimate 840, by averaging 838 a weighted previous BNL (weighted with coefficient 836), to give a new ear-canal BNL 844.

[0066] FIG. 9 is a flowchart of a method 900 for maintaining constant audio content level (ACL) to

internal ambient sound level (iASL). The method 900 can be practiced with more or less than the number of steps shown and is not limited to the order shown. To describe the method 900, reference will be made to components of FIG. 2, although it is understood that the method 900 can be implemented in any other manner using other suitable components. The method 900 can be implemented in a single earpiece, a pair of earpieces, headphones, or other suitable headset audio delivery devices.

[0067] Briefly, FIG. 9 describes a method 900 for Constant Signal-to-Noise Ratio (CSNRS). At step 904 an input signal is captured from the ASM 111 and processed at step 910 (e.g. ADC, EQ, gain). Similarly, at step 906 an input signal from the ECM 123 is captured and processed at step 912. The method 900 also receives as input an Audio Content signal 902, e.g. a music audio signal from a portable Media Player or mobile-phone, which is processed with an analog and digital signal processing system as shown in step 908. An Audio Content Level (ACL) is determined at step 914 based on an earpiece sensitivity from step 916, and returns a dBV value.

[0068] In one exemplary embodiment, method 900 calculates a RMS value over a window (e.g. the last 100 ms). The RMS value can then be first weighted with a first weighting coefficient and then averaged with a weighted previous level estimate. The ACL is converted to an equivalent SPL value (ACL), which may use either a look-up-table or algorithm to calculate the ear-canal SPL of the signal if it was reproduced with the ECR 125. To calculate the equivalent ear canal SPL, the sensitivity of the ear canal receiver can be factored in during processing.

[0069] At step 922 the BNL is estimated using inputs from either or both the ASM signal at step 902, and/or the ECM signal at step 906. The BNL may be adjusted by the earpiece noise reduction rating 924. These signals are selected using the BNL input switch at step 918, which may be controlled automatically or with a specific user-generated manual operation at step 926. The Ear-Canal SNR is calculated at step 920 by differencing the ACL from step 914 and the BNL from step 922 and the resulting SNR 930 is passed to the method step 932 for AGC coefficient calculation. The AGC coefficient calculation 932 calculates gains for the Audio Content signal and ASM signal from the Automatic Gain Control steps 928 and 936 (for the Audio Content and ASM signals, respectively). AGC coefficient calculation 932 may use a default preferred SNR 938 or a user- preferred SNR 934 in its calculation. After the ASM signal and Audio content signal have been processed by the AGCs 928 and 936, the two signals are mixed at step 940.

[0070] At step 942, a safe-level check determines if the resulting mixed signal is too high, if it were reproduced with the ECR 125 as shown in block 944. The safe-level check can use information regarding the user's listening history to determine if the user's sound exposure is such that it may cause a

temporary or a permanent hearing threshold shift. If such high levels are measured, then the safe-level check reduces the signal level of the mixed signals via a feedback path to step 940. The resulting audio signal generated after step 942 is then reproduced with the ECR 125.

[0071] FIG. 10 is a flowchart of a method 950 for maintaining a constant signal to noise ratio based on automatic gain control (AGC). The method 950 can be practiced with more or less than the number of steps shown and is not limited to the order shown. To describe the method 950, reference will be made to components of FIG. 2, although it is understood that the method 950 can be implemented in any other manner using other suitable components. The method 950 can be implemented in a single earpiece, a pair of earpieces, headphones, or other suitable headset audio delivery devices.

[0072] Method 950 describes calculation of AGC coefficients. The method 950 receives as its inputs an Ear Canal SNR 952 and a target SNR 960 to provide a SNR mismatch 958. The target SNR 964 is chosen from a pre-defined SNR 954, sorted in computer memory or a manually defined SNR 956. At step 958, a difference is calculated between the actual ear-canal SNR and the target SNR to produce the mismatch 962. The mismatch level 962 is smoothed over time at step 968, which uses a previous mismatch 970 that is weighted using single or multiple weighting coefficients 966, to give a new time-smoothed SNR mismatch 974. Depending on the magnitude of this mismatch, various operating modes 972, 978 can be invoked, for example, as described by the AGC decision module 976 (step 932 in FIG. 9).

[0073] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all modifications, equivalent structures and functions of the relevant exemplary embodiments. Thus, the description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the exemplary embodiments of the present invention. Such variations are not to be regarded as a departure from the spirit and scope of the present invention.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND DEVICE FOR ACUTE SOUND DETECTION AND REPRODUCTION

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____

  filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: _____ Date (Optional): 12/10/14

Signature: Marc Andre Boillot

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: J. Usher Date (Optional): 11 Dec 2014

Signature: John Usher

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LEGAL NAME OF INVENTOR

Inventor: Steven Wayne Goldstein Date (Optional) :_____

Signature: /Steven Wayne Goldstein/

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