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Samsung et al. v. Techiya
IPR2024-01034
Exhibit 1004

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	John Usher
Art Unit	
Examiner Name	Unknown
Attorney Docket Number	CONT-16838277

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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	7801318		2010-09-21	Barthel	
	2	8774433		2014-07-08	Goldstein	
	3	7801318		2010-09-21	Barthel, Roland	
	4	8401200		2009-11-19	Tiscareno	
	5	5138722		2010-09-21	Urella	
	6	5764781		1998-06-09	Ding	
	7	6321070		2001-11-20	Clark	
	8	9293128		2016-03-22	Goldstein	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	John Usher
	Art Unit	
	Examiner Name	Unknown
	Attorney Docket Number	CONT-16838277

	9	4020297		1977-04-26	Brodie S Dan	
	10	5142587		1992-08-25	Kobayashi	
	11	5319163		1994-06-07	Scott	
	12	5712453		1998-01-27	Bungardt	
	13	9084060		2015-07-14	Liu	
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	15	7688983		2010-03-30	Voix	
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	18	8971561		2015-03-03	Howes et al.	
	19	9313572		2016-04-12	Dusan et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	John Usher
	Art Unit	
	Examiner Name	Unknown
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	2	20140247952		2014-09-04	Goldstein	
	3	20130177179		2013-07-11	Ambrose	
	4	20180176681		2018-06-21	Asada	

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	1	107071123	CN		2017-08-18			

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
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	Attorney Docket Number	CONT-16838277

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	John Usher
	Art Unit	
	Examiner Name	Unknown
	Attorney Docket Number	CONT-16838277

CERTIFICATION STATEMENT

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)	2021-02-23
Name/Print	John P. Keady	Registration Number	56389

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

Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [■] 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.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: John Usher Date (Optional): 13-Aug-2015

Signature: J. Usher

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.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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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Doc Code: Oath
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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted With Initial Filing OR ☒ Declaration Submitted After Initial Filing (surcharge (37 CFR 1.16(f)) required)

Attorney Docket Number	PRS-160US2
First Named Inventor	John Usher
COMPLETE IF KNOWN	
Application Number	14/827,332
Filing Date	08-17-2015
Art Unit	2654
Examiner Name	KIM, PAUL

ACOUSTIC SEALING ANALYSIS SYSTEM

(Title of the Invention)

As a below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application,

OR

☒ United States Application Number or PCT International application number 14/827,332

filed on 08-17-2015.

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

I believe 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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DECLARATION — Utility or Design Patent Application

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LEGAL NAME OF SOLE OR FIRST INVENTOR:

(*E.g.,* Given Name (first and middle if any) and Family Name or Surname)

John P Keady

Inventor's Signature	Date (Optional)
/John P. Keady/	

Residence: City	State	Country
Fairfax Station	VA	USA

Mailing Address

8138 Crestridge Rd.

City	State	Zip	Country
Fairfax Station	VA	22039	USA

☐ Additional inventors are being named on the _____ Supplemental sheet(s) PTO/AIA/10 attached hereto

ACOUSTIC SEALING ANALYSIS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Patent Application Ser. No. 16/838,277, filed April 2, 2020, which is a continuation of U.S. Patent Application Ser. No. 16/414,136, filed May 16, 2019, which is a continuation of U.S. Patent Application Ser. No. 15/700,511, filed September 11, 2017, which is a continuation of U.S. Patent Application Ser. No. 14/827,332, filed August 17, 2015, now U.S. Patent No. 9,781,530, which is a continuation of U.S. Patent Application Ser. No. 14/054,015, filed October 15, 2013, now U.S. Patent No. 9,113,267, which is a Divisional Application of U.S. Application Ser. No. 12/555,864, filed September 9, 2009, now U.S. Patent No. 8,600,067 and claims the benefit of U.S. Provisional Patent Application No. 61/098,250 filed September 19, 2008. The disclosure of all the aforementioned references are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to testing the seal of an orifice-inserted device, and more particularly, though not exclusively, to a device and method for determining if an earpiece is sealed correctly in an ear canal.

BACKGROUND OF THE INVENTION

[0003] It can be difficult to communicate using an earpiece or earphone device in the presence of high-level background sounds. In many earpiece designs a transducer is placed near the ear canal opening. Ambient sound from the surrounding environment enters the ear canal with the audio content from the transducer. Environmental sounds such as traffic, construction, and nearby conversations can degrade the quality of the audio content.

[0004] Although audio processing technologies can adequately suppress noise, the earpiece is generally sound agnostic and cannot differentiate sounds. Thus, one method to prevent ambient sound from entering the ear is to seal or provide an acoustic barrier at the opening of the ear canal. Sealing minimizes ambient sound leakage into the ear canal, and under the correct conditions can provide a level of noise suppression under high background noise conditions. Certain types of acoustic software (e.g., communication in a noisy environment via an ear canal microphone) may require some minimum noise isolation from the ambient sound to provide adequate performance to the user. Additionally, user conditions may change substantially

during the operation of the earpiece, and in some circumstances, the earpiece may become misaligned or may be fit incorrectly such that it is not sealed correctly. A method of seal detection is needed to optimize performance.

SUMMARY OF THE INVENTION

[0005] Broadly stated, embodiments are directed to a device and method to determine if an earpiece is sealing within the design specification of the device.

[0006] In one embodiment, the device can include a sealing section forming an acoustic barrier between a first volume and a second volume. An ear canal receiver (ECR) can be configured to generate an acoustic signal in the first volume. An Ear Canal Microphone (ECM) in the first volume can be configured to measure the acoustic signal in the first volume. The first acoustic signal emitted by the ECR can be cross-correlated with the first acoustic signal detected with the ECM to determine if the sealing section is sealed properly.

[0007] At least one exemplary embodiment is directed to a method of detecting sealing integrity of an earpiece comprising the steps of: providing a test signal; generating an acoustic signal corresponding to the test signal incident on an ear canal side of a sealing section; converting the acoustic signal incident on a first side of the sealing section to an electrical signal; and cross- correlating the test signal to the electrical signal where the earpiece is sealed correctly when a cross-correlation between the test signal and the electrical signal is above a threshold.

[0008] At least one exemplary embodiment is directed to a method of adjusting attenuation of an earpiece comprising the steps of: relating cross-correlation of a test signal and a measured acoustic signal in an ear canal of a user to an attenuation level of a sealing section of the earpiece; comparing the attenuation level of the sealing section of the earpiece to a minimum attenuation value; and adjusting a pressure of the sealing section to meet the minimum attenuation value.

[0009] At least one exemplary embodiment is directed to a device comprising: a sealing section configured to seal a user's orifice, where the sealing section is configured to produce an acoustic seal between a first side of the sealing section and a second side of the sealing section; a transducer configured to generate a first acoustic signal incident on the first side of the sealing section; and a first microphone configured to measure a second acoustic signal incident on the second side of the sealing section, where the second acoustic signal includes at least a portion of the first acoustic signal that has passed from the first side to the second side of the sealing section where the first acoustic signal is compared to the second acoustic signal to determine if

the sealing section is sealed.

[0010] Further areas of applicability of exemplary embodiments of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Exemplary embodiments of the present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0012] FIG. 1 is a diagram of an earpiece inserted in an ear canal in accordance with an exemplary embodiment;

[0013] FIG. 2 is a block diagram of optional components of an earpiece in accordance with an exemplary embodiment;

[0014] FIG. 3 is a flowchart of a method for checking an ear seal in accordance with an exemplary embodiment;

[0015] FIG. 4 is a flowchart to determine acoustic seal integrity of an earpiece in accordance with the exemplary embodiment.

[0016] FIG. 5 is a flowchart of a method to estimate the instantaneous cross-correlation between a first and second audio signal.

[0017] FIG. 6 is a flowchart to determine when to emit a test signal in accordance with an exemplary embodiment;

[0018] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention;

[0019] FIG. 8 is a block diagram for a method of adjusting the IMS system in accordance with at least one exemplary embodiment;

[0020] FIG. 9 is a block diagram for a method of adjusting IMS pressure in accordance with at least one exemplary embodiment;

[0021] FIG. 10 illustrates a sample relationship between EarSeal attenuation and XCorr in accordance with

at least one exemplary embodiment;

[0022] FIG. 11 illustrates a flowchart of an exemplary method to determine a test signal fundamental;

[0023] FIG. 12 illustrates a flowchart of an exemplary embodiment to determine tonal presence in audio content;

[0024] FIG. 13 illustrates a flowchart of a method to determine when to emit the test signal;

[0025] FIG. 14 illustrates a flowchart of an exemplary method to determine acoustic seal integrity;

[0026] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment; and

[0027] FIG. 16 illustrates the sending of a signal to an inflation controller upon detection of a seal fail to modify the seal pressure in accordance with at least one exemplary embodiment.

DETAILED DESCRIPTION

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

[0029] Exemplary embodiments are directed to or can be operatively used on various wired or wireless orifice inserted devices for example earpiece devices (e.g., earbuds, headphones, ear terminals, behind the ear devices or other acoustic devices as known by one of ordinary skill, and equivalents).

[0030] Processes, techniques, apparatus, and materials as known by one of ordinary skill in the art may not be discussed in detail but are intended to be part of the enabling description where appropriate. For example specific computer code may not be listed for achieving each of the steps discussed, however one of ordinary skill would be able, without undo experimentation, to write such code given the enabling disclosure herein. Such code is intended to fall within the scope of at least one exemplary embodiment.

[0031] Additionally exemplary embodiments are not limited to earpieces, for example some functionality can be implemented on other systems with speakers and/or microphones for example computer systems, PDAs, BlackBerry® smart phones, cell and mobile phones, and any other device that emits or measures acoustic energy. Additionally, exemplary embodiments can be used with digital and non-digital acoustic systems. Additionally various receivers and microphones can be used, for example MEMs transducers, diaphragm transducers, for example Knowles' FG and EG series transducers.

[0032] Notice 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 or further defined in the following figures.

[0033] 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.

[0034] 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.

[0035] At least one exemplary embodiment of the invention is directed to an earpiece for sealing or partially sealing an ear. FIG. 1 is a diagram of an earpiece inserted in an ear canal 124 in accordance with at least one exemplary embodiment of the invention. FIG. 1 also illustrates portions of the ear including pinna 128, ear canal 124 and eardrum 126. As illustrated, the earpiece comprises an electronic housing unit 100 and a sealing unit 108. The earpiece depicts an electro-acoustical assembly for an in-the-ear acoustic assembly, as it would typically be placed in an ear canal 124 of a user 130. The earpiece is an in-ear earpiece, behind the ear earpiece, receiver in the ear, partial-fit device, or any other suitable earpiece type. The earpiece can partially or fully occlude the ear canal 124.

[0036] The earpiece includes an Ambient Sound Microphone (ASM) 120 to capture ambient sound, an Ear Canal Receiver (ECR) 114 to deliver audio to an ear canal124, and an Ear Canal Microphone (ECM) 106 to capture and assess a sound exposure level within the ear canal 124. The earpiece can partially or fully occlude the ear canal 124 to provide various degrees of acoustic isolation. The assembly is designed to be inserted into the user's ear canal 124, and to form an acoustic seal with the walls of the ear canal 124 at a location between the entrance to the ear canal 124 and the tympanic membrane (or ear drum) 126. In general, such a seal is typically achieved by means of a soft and compliant housing of the sealing unit 108. Additionally, the sealing unit 108 can be a pressurized expandable element that fills a portion of the available local space.

[0037] Sealing unit 108 is an acoustic barrier having a first side corresponding to ear canal124 and a second side corresponding to the ambient environment. In at least one exemplary embodiment, sealing unit 108 includes an ear canal microphone tube 110 and an ear canal receiver tube 112. Sealing unit 108 creates a closed cavity of approximately 5 cc or less between the first side of sealing unit 108 and the tympanic membrane 126 in ear canal124. In at least one exemplary embodiment the sealing facilitates using the ECR

(speaker) 114 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 126 resulting from the sound field at the entrance to the ear canal 124. This seal is also a basis for a sound isolating performance of the electro-acoustic assembly.

[0038] In at least one exemplary embodiment and in broader context, the second side of sealing unit 108 corresponds to the side adjacent to electronic housing unit 100. Ambient sound microphone 120 is housed in electronic housing unit 100 and is exposed to the ambient environment for receiving sound from the ambient environment around the user.

[0039] The electronic housing unit 100 can include various system components such as a microprocessor 116, memory 104, battery 102, ECM 106, ASM 120, ECR, 114, and user interface 122, or these components can reside in a separate system or interface operatively connected. Microprocessor 116 (or processor 116) can be a logic circuit, a digital signal processor, controller, or the like for performing calculations and operations for the earpiece. Microprocessor 116 is operatively coupled to memory 104, ECM 106, ASM 120, ECR 114, and user interface 122. An optional wire 118 can provide an external connection to the earpiece. Battery 102 powers the circuits and transducers of the earpiece. Battery 102 can be a rechargeable or replaceable battery.

[0040] In at least one exemplary embodiment, electronic housing unit 100 is adjacent to sealing unit 108. Openings in electronic housing unit 100 receive ECM tube 110 and ECR tube 112 to respectively couple to ECM 106 and ECR 114. ECR tube 112 and ECM tube 110 acoustically couple signals to and from ear canal 124. For example, ECR 114 outputs an acoustic signal through ECR tube 112 and into ear canal 124 where it is received by the tympanic membrane 126 of the user of the earpiece. Conversely, ECM 106 receives an acoustic signal present in ear canal124 though ECM tube 110.

[0041] One function of ECM 106 is that of measuring the sound pressure level in the ear canal cavity 124 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 the earpiece. In one arrangement, ASM 120 is used to monitor sound pressure at the entrance to the occluded or partially occluded ear canal 124. All transducers shown can receive or transmit audio signals to a processor 116 that undertakes audio signal processing and provides a transceiver for audio via the wired (wire 118) or a wireless communication path. Note also that the acoustic signals can be stored for later retrieval.

[0042] In at least one exemplary embodiment the earpiece can be constructed to actively monitor a sound

pressure level both inside and outside an ear canal 124. In at least one exemplary embodiment monitored data can be used to enhance spatial and timbral sound quality while maintaining supervision to ensure safe sound reproduction levels. In at least one exemplary embodiment an earpiece can facilitate at least one of conducting listening tests, filtering sounds in the environment, monitoring warning sounds in the environment, presenting notification based on identified warning sounds, maintaining constant audio content to ambient sound levels, and filtering sound in accordance with a Personalized Hearing Level (PHL).

[0043] The earpiece can generate an Ear Canal Transfer Function (ECTF) to model the ear canal 124 using ECR 114 and ECM 106, as well as an Outer Ear Canal Transfer function (OETF) using ASM 120. For instance, the ECR 114 can deliver an impulse within the ear canal124 and generate the ECTF via cross correlation of the impulse with the impulse response of the ear canal 124. The earpiece can also determine a sealing profile with the user's ear to compensate for any leakage. In at least one exemplary embodiment the earpiece can use either the ASM 120 or the ECM 106 to monitor the sound pressure level, which can then be used in a Sound Pressure Level Dosimeter calculation, to estimate sound exposure and recovery times. This permits the earpiece to safely administer and monitor sound exposure to the ear.

[0044] Referring to FIG. 2, a block diagram of an earpiece 201 in accordance with an exemplary embodiment is shown. A power supply 205 (e.g., USB power connection, hearing aid battery (batteries)) powers components of the earpiece 201 including microprocessor 206 (or processor 206, e.g., Texas Instruments TMS320C6713) and a data communication system 216 (e.g., RF or Bluetooth communication chip). As illustrated, the earpiece 201 includes the processor 206 operatively coupled to data communication system 216, ASM 210, ECR 212, and ECM 208. Data communication system 216 may include one or more Analog to Digital Converters and Digital to Analog Converters (DAC). The processor 206 can utilize computing technologies such as a microprocessor, Application Specific Integrated Chip (ASIC), and/or digital signal processor (DSP) with associated Random Access Memory (RAM) 202 and Read Only Memory (ROM) 204. Other memory types such as Flash, non-volatile memory, SRAM, DRAM or other like technologies can be used for storage with processor 206. The processor 206 can also include a clock to record a time stamp.

[0045] In general, data communication system 216 is a communication pathway to components of the earpiece 201 and components external to the earpiece 201. The communication link can be wired or wireless. In at least one exemplary embodiment, data communication system 216 is configured to communicate with ECM 208, ASM 210, visual display 218, and user control interface 214 of the earpiece 201. As shown, user control interface 214 can be wired or wirelessly connected. In at least one exemplary embodiment, data communication system 216 is capable of communication to devices exterior to the

earpiece 201 such as the user's mobile phone 234, a second earpiece 222, and a portable media player 228. Portable media player 228 can be controlled by a manual user control 230.

[0046] The user's mobile phone 234 includes a mobile phone communication system 224. A microprocessor 226 is operatively coupled to mobile phone communication system 224. As illustrated multiple devices can be wirelessly connected to one another such as an earpiece 220 worn by another person to the user's mobile phone. Similarly, the user's mobile phone 234 can be connected to the data communication system 216 of the earpiece 201 as well as the second earpiece 222. This connection would allow one or more people to listen and respond to a call on the user's mobile phone 234 through their respective earpieces.

[0047] As illustrated, a data communication system 216 can include a voice operated control (VOX) module to provide voice control to one or more subsystems, such as a voice recognition system, a voice dictation system, a voice recorder, or any other voice related processor. The VOX module can also serve as a switch to indicate to the subsystem a presence of spoken voice and a voice activity level of the spoken voice. The VOX can be a hardware component implemented by discrete or analog electronic components or a software component. In one arrangement, the processor 206 can provide functionality of the VOX by way of software, such as program code, assembly language, or machine language.

[0048] The RAM 202 stores program instructions for execution on the processor 206 as well as captured audio processing data. For instance, memory RAM 202 and ROM 204 can be off-chip and external to the processor 206 and include a data buffer to temporarily capture the ambient sound and the internal sound, and a storage memory to save from the data buffer the recent portion of the history in a compressed format responsive to a directive by the processor. In at least one exemplary embodiment, the data buffer can be a circular buffer that temporarily stores audio sound at a current time point to a previous time point. It should also be noted that the data buffer is operatively connected with processor 206 to provide high speed data access. The storage memory can be non-volatile memory such as SRAM to store captured or compressed audio data.

[0049] Data communication system 216 includes an audio interface operatively coupled to the processor 206 and the VOX to receive audio content, for example from portable media player 228, a cell phone, or any other communication device, and deliver the audio content to the processor 206. The processor 206 responsive to detecting voice-operated events from the VOX can adjust the audio content delivered to the ear canal of the user of the earpiece. For instance, the processor 206 (or the VOX of data communication system 216) can lower a volume of the audio content responsive to detecting an event for transmitting the acute sound to the ear canal of the user. The processor 206 by way of the ECM 208 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 based on voice operating decisions made by the VOX of data communication system 216.

[0050] The earpiece 201 and data communication system 216 can further include a transceiver that can support singly or in combination any number of wireless access technologies including without limitation Bluetooth™, Wireless Fidelity (WiFi), Worldwide Interoperability for Microwave Access (WiMAX), and/or other short or long range communication protocols. The transceiver can also provide support for dynamic downloading over-the-air to the earpiece 201. It should be noted also that next generation access technologies can also be used in exemplary embodiments.

[0051] Data communication system 216 can also include a location receiver that utilizes common technology such as a common GPS (Global Positioning System) receiver that can intercept satellite signals and therefrom determine a location fix of the earpiece 201.

[0052] The power supply 205 utilizes common power management technologies such as replaceable batteries, supply regulation technologies, and charging system technologies for supplying energy to the components of the earpiece 201 and to facilitate portable applications. A motor (not shown) can be a single supply motor driver coupled to the power supply 205 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.

[0053] Microprocessor 206 is operatively connected with an EarSeal Inflation Management System 232 to control the degree to which the sealing unit 108 is inflated or deflated. In one exemplary embodiment, sealing unit 108 comprises an expandable element (e.g., inflatable balloon mechanism), whereby a cavity can be filled with air or a liquid to change the degree of acoustic isolation between the internal ear canal space 124 and the ambient environment. Alternately, a passive system for sealing ear canal 124 is used such as a flexible rubber or a silicon sealing unit or a foam plug. In one exemplary embodiment, the passive system is a balloon mechanism that is filled with air or liquid. The balloon mechanism conforms to the shape and size of an ear canal and includes a restorative force module that applies a pressure to the balloon mechanism for sealing the ear canal cavity.

[0054] The earpiece is 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 are reused in different form factors for the master and slave devices.

[0055] Referring to FIG. 3, a flowchart illustrates a method for an acoustic sealing analysis system in accordance with an exemplary embodiment. In general, a first volume is acoustically isolated from a second volume. The test determines if the two volumes have sufficient acoustic isolation from one another. For example, cars are designed to have a quiet interior. Users of an automobile do not want to be subjected to the noise of the external environment. Thus, a car interior (first volume) is acoustically isolated from the external environment outside of the automobile. Similarly, an earpiece having a sealing unit such as described in FIG. 1 will create a first volume (the ear canal) that is acoustically isolated from the ambient environment of the user (second volume). In either example, the acoustic sealing analysis system determines if there is sufficient acoustic isolation for the application. In the earpiece example, random or periodic testing of the seal may be beneficial because a new seal is formed in the ear canal when the device is put in the ear or it may shift over time depending on user activity.

[0056] The method begins at step 302. A test signal is acquired in a step 304. For example, the test signal can be stored in memory or generated by a microprocessor. The test signal is provided to the acoustic transducer. The acoustic transducer or loudspeaker (such as an ECR) emits an acoustic signal corresponding to the test signal within the first volume in a step 306. The acoustic field in the first volume is detected by an Ear Canal Microphone (ECM) in a step 308. The acoustic loading on both the ECR and ECM will change depending on the degree of acoustic sealing, thereby affecting the degree magnitude of the radiated ECR signal detected by the ECM. In general, as the degree of ear seal decreases, the effect of lumped air mass coupled to the ECR and ECM will decrease thereby increasing in Thevenin capacitance, which effectively reduces the transfer of low frequency emitted sound from the ECR to the ECM.

[0057] In one exemplary embodiment, the test signal and the acoustic signal emitted by the loudspeaker into the first volume is a single frequency sine wave signal for testing leakage from one volume to another.

[0058] The degree of sealing between the first and second acoustic volumes is determined in a step 310 and the process ends at step 312. The cross-correlation between the emitted test signal and detected ECM signal is taken. In at least one exemplary embodiment, the test signal and the measured acoustic signal emitted by the loudspeaker are conditioned using a time delay and frequency dependent filter. The ear-seal is determined to be low (or "leaky") if the cross- correlated signals are below a predetermined value. In at least one exemplary embodiment, automatic adjustments to the sealing section are made (such as deflating and re-inflating the sealing balloon to reseal the sealing section including retesting). Alternately, an audible sound, vocal response, or visual response can be provided to let the user know that the earpiece is sealed correctly

or incorrectly.

[0059] Referring to FIG. 1, the earpiece is used as an example to illustrate a test sequence as disclosed in FIG. 3. Sealing unit 108 occludes an opening of ear canal 124 creating a first volume (ear canal124) and a second volume (the ambient environment). Sealing unit 108 has a first side exposed to ear canal 124 and a second side is exposed to or corresponds to the ambient environment external to the ear.

[0060] In at least one exemplary embodiment, processor 116 is configured to receive a test signal in memory 104. Processor 116 generates the test signal and provides the test signal to Ear Canal Receiver 114 (ECR 114). ECR 114 emits the test signal into Ear Canal Receiver Tube (ECR Tube 112). The test signal propagates through ECR tube 112 and into ear canal 124. Ear Canal Microphone tube 110 (ECM tube 110) is configured to receive an acoustic signal incident on the first side of sealing unit 108. The test signal in ear canal 124 propagates through ECM tube 110 and is received by Ear Canal Microphone 106 (ECM 106). ECM 106 is configured to measure the test signal in ear canal124 and provide the measured test signal to processor 116.

[0061] As shown, electronic housing unit 100 of the earpiece is adjacent to the second side of sealing unit 108. Electronic housing unit 100 is exposed to the ambient environment and for purposes of acoustic sealing analysis is considered the second side of sealing unit 108. Electronic housing unit 100 includes Ambient Sound Microphone 120 (ASM 120), which is configured to measure sounds in the ambient environment. Thus, ASM 120 receives and measures an ambient signal corresponding to a signal incident on the second side of sealing unit 108. ASM 120 provides the measured ambient signal to processor 116.

[0062] Ideally, sealing unit 108 is an acoustic barrier preventing the test signal or very little of the test signal from getting past sealing unit 108 and into the ambient environment. Conversely, sealing unit 108 if improperly sealed will pass some of the test signal. Processor 116 compares the test signal to the signal provided by ECM 106 corresponding to the acoustic signal in ear canal124. In particular, processor 116 undertakes the cross-correlation between emitted test signal and the ECM signal.

[0063] Referring to FIG. 4, a flowchart of an exemplary method to determine the acoustic seal integrity of an earpiece in accordance with an exemplary embodiment is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user. This allows unobtrusive (periodic or non-periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0064] In at least one exemplary embodiment, an audio content is provided in a step 402. A step 404 stores the test signal in a test signal data buffer. For example, a single frequency sine wave is stored in the test signal data buffer. The output (or alternatively--input) of the test signal data buffer is optionally delayed by digital delay unit 406. The function of delay unit 406 is to time- align the emitted test signal with the ECM signal so the cross-correlation is sensitive to changes in ear seal.

[0065] A step 408 stores the test ECM signal in a test signal data buffer. The output (or alternatively--input) of the ECM signal buffer can be filtered with a low-pass filter 410. The low pass filter can be configured so that the pass-band covers the frequency of the test signal. In one exemplary configuration, the low-pass filter can be a cascaded bi-quad IIR type filter with the cut-off frequency equal to 10Hz greater than the test signal frequency.

[0066] A step 412 cross-correlates the optionally delayed test signal buffer with the low-pass filtered ECM signal buffer. An exemplary method for the cross-correlation algorithm is described in FIG. 5. The instantaneous cross-correlation (i.e. the cross-correlation at zero-lag) value from step 412 is compared with the cross-correlation threshold value 414 using comparator unit 416. If the instantaneous cross-correlation of the two signal buffers is less than the threshold value 414, then the seal test status is set to FAIL 418 (i.e. an ear-seal leak is detected); otherwise, if the cross-correlation is suitably high, the seal test status is set to PASS 420.

[0067] Referring to FIG. 5, a flowchart of an exemplary embodiment to determine the instantaneous cross-correlation between a first audio signal and a second audio signal is illustrated. The process begins at step 500. In at least one exemplary embodiment, the first audio signal is the test signal (i.e. a sine wave) and the second signal is the low-pass-filtered ECM signal.

[0068] The correlation between two signals x and y at time k using an exponential window is defined as:

[0069] $$p(k) = \frac{S_{xy}(k)}{\sqrt{S_{xx}(k)_{yy}(k)}} \qquad (1)$$

[0070] Where

[0071] $$S_{xx}(k) = \sum_{l=0}^{\infty} ce^{-\eta^l} x_{k-l} y_{k-l}$$

$$c = 1 - e^{-\eta}$$

[0072] And S_{xx} and S_{yy} are defined similarly as in (2) (replacing y with x for S_{xx} etc.).

[0073] It can be shown (see Aarts et al, 2001) that (1) can be approximated with the recursion:

[0074] $$\hat{\rho}(k) = \hat{\rho}(k-1) + \gamma[\partial_k - \beta_k \hat{\rho}(k-1)] \quad (3)$$

$$\partial_k = 2x_k y_k$$

$$\beta_k = \alpha x_k^2 \alpha^{-1} y_k^2$$

[0075] Where

$$\alpha = \frac{y_{RMS}}{x_{RMS}}$$

$$\gamma = \frac{ce^{\eta}}{2x_{RMS}y_{RMS}} \quad (4)$$

[0077] The cross-correlation estimate using the above recursion is modified for block-wise processing rather than the sample-by-sample basis. This modification replaces the sample values (i.e. x(k) and y(k)) with values for the N-length block mean, i.e.

[0078]

$$x(k) = \frac{1}{N}\sum_{l=0}^{N-1} x(k-l)$$

[0079] Furthermore, the numerator for *y* is replaced with a small constant and so is *a* (replacing *a* with a constant effectively un-normalizes the correlation estimate). It is found that the modified un-normalized block-wise cross-correlation accurately estimates the cross-correlation compared with using the standard cross-correlation for two signals.

[0080] The modified block-wise fast cross-correlation algorithm, as summarized in FIG. 5, comprises the following steps:

1. A first signal buffer 502 is accumulated. This signal buffer corresponds to the emitted test signal (i.e. the sine wave).
2. The RMS level of the first buffer is calculated 504 (x_{RMS})
3. The mean level of the first buffer is calculated 506.

4. A second signal buffer 508 is accumulated. This signal buffer corresponds to the filtered ECM signal.

5. The RMS level of the second buffer is calculated 510 (y_{RMS}).

6. The mean level of the second buffer is calculated 512.

7. In step 514, γ (gamma) is approximated as:

$$\gamma = \frac{\Gamma}{2x_{RMS}y_{RMS}}$$

Where Γ is a small constant, e.g. 10E-3.

8. In step 516,∂_k (delta) calculated as twice the product of the first signal buffer mean and the second signal buffer mean.

9. In step 518, beta is calculated as the sum of the square of the mean value of the first buffer with the sum of the square of the mean value of the second buffer.

10. In step 520, the new temporary estimate of the correlation newRho_temp is calculated as: newRho_temp=(delta-beta*rho_old))

11. In step 522, the new estimate of the correlation newRho is updated by summing the previous estimate of the correlation with the product of gamma and the temporary estimate of the correlation newRho_temp.

12. In step 524, the "old" value of the correlation is set to the newest correlation estimate, ready for the next iteration of the update algorithm.

13. In step 526, the current correlation estimate between the emitted test signal and the received and filtered ECM signal is set as equal to the value of newRho.

[0081] Referring to FIG. 6, a flowchart of a method to determine when to emit the test signal is shown. The test signal is emitted when the test can be performed unobtrusively to the user and also provides an accurate test. In at least one exemplary embodiment, a test event to determine if an earpiece is sealed correctly is initiated via a timing methodology. In a first timing scenario, the test event occurs after a delay of a first predetermined time period when the RMS of the Audio Content (AC) is less than a RMS threshold. In a second timing scenario, the delay of the first predetermined time period is allowed to lapse without the test event occurring when the RMS of the audio content is greater than the RMS threshold. A second predetermined time period is started where the test event occurs when the RMS of the audio content is less than the RMS threshold. The test event is then initiated when the second predetermined time period is exceeded independent of the RMS of the audio content.

[0082] A test sequence is initiated in a step 602. The previous seal test event resets the first digital timer in a step 604. A time delay is generated by the loop comprising steps 606 and 608. The first digital timer is time incremented in the step 606. After each added time increment, the first digital timer is compared against a

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digital_timer_threshold1. The first digital timer is time incremented (after the time has advanced another increment) after the comparison in the step 608 if the first digital timer is less than the digital_timer_threshold1.

[0083] A second digital timer is reset in a step 610 when the first digital timer is greater than the digital_timer_threshold1. The second digital timer is time incremented in a step 612. Audio content (AC) from a signal buffer is retrieved in a step 614. The audio content can be filtered through a low pass filter in an optional step 616. The RMS of the audio content is calculated in a step 618. The calculated RMS of the audio content is compared against an RMS_threshold 622 in a step 620. The second digital timer is compared against a digital_timer_threshold2 in a step 624 if the RMS of the audio content is greater than the RMS_threshold. The second digital timer is time incremented (after the time has advanced another increment) when the second digital timer is less than digital_timer_threshold2 in the step of 624.

[0084] The audio content signal is mixed with the test signal when the RMS of the audio content is less than the RMS_threshold in a step 626. Also, the audio content signal is mixed with the test signal when the second digital timer is greater than digital_timer_threshold2 in the step 624. The modified audio signal (having the test signal mixed in) is emitted by the ECR in a step 628 for testing the sealing section of the earpiece. The first digital timer is then reset in the step 604 to begin a timing sequence for another sealing section test.

[0085] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention. The estimated un-normalized cross-correlation between the ECM signal and the test signal (i.e. sine wave) is shown for different sine wave frequencies from 30-80Hz. Three different curves are provided corresponding to a good fit (i.e. a tight optimal seal providing approximately 20-30 dB of acoustic attenuation), mid or partial seal (i.e. an ear-seal that could be characterized as "half in" providing approximately 10-15 dB of acoustic attenuation), and a poor seal (i.e. an ear-seal providing less than 10 dB of acoustic attenuation). At lower test frequencies, the change in correlation is more pronounced as the degree of ear seal fitting is changed from "good" to "mid" and "poor". From the data, the threshold used to determine whether the ear seal can be characterized as "good" is approximately -20 dB, (i.e. 0.85 of FIG. 10 which corresponds to the value for XCorr_threshold 414 in FIG. 4).

[0086] In at least one exemplary embodiment, the test signal for testing a seal of a sealing section is less than 200 hertz. The frequency of the emitted test signal is chosen to satisfy the requirements of being able to reveal small degradations in ear seal quality. It is also beneficial if the selected test signal frequency can be acoustically masked by reproduced audio to minimize detection of the test by an earpiece user. Both of these

criteria are met using a test signal frequency below 200 Hz. The sensitivity is highest from the measured data at frequencies below 50 Hz. Conversely, as the test signal frequency increases the cross-correlation difference between a "good" and "bad" acoustic seal decreases. For example, with a 40Hz test tone, the cross-correlation for a "good" ear seal is -8 dB, and for a bad ear seal it is -68 dB (i.e. a 60 dB difference). At a test signal frequency of 80Hz, the cross-correlation for a "good" ear seal is -8 dB and for a bad ear seal it is -38 dB (i.e. a 30 dB difference). Thus, above 200Hz the cross- correlation difference between a "good" and "bad" acoustic seal is further reduced thereby reducing the sensitivity of the test.

[0087] Using the cross-correlation rather than a level differencing approach improves the accuracy and minimizes errors which occur due to user non-speech body noise, such as teeth chatter; sneezes, coughs, etcetera. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0088] FIG. 8 is a flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) in accordance with an exemplary embodiment. The IMS is adjusted depending on the degree of acoustic sealing provided by an earpiece. The method begins at step 802. The acoustic sealing is measured as disclosed in FIG. 7 and the result provided in a step 804 to determine the cross-correlation (XCorr) between a test signal and corresponding ECM signal. In general, the higher the cross-correlation, the higher the degree of acoustic sealing. An exemplary graph showing the relationship between XCorr and acoustic sealing is given in FIG. 10. The degree of acoustic sealing is determined from known XCorr using a look-up (or "hash") table or using a formula (e.g. of a polynomial form) that maps the acoustic sealing to the known XCorr value. The ambient sound level is measured in a step 806. The ambient sound level corresponds to the noise level in proximity to the user. In general, a higher degree of attenuation is desired when the ambient sound levels are high. Conversely, at low ambient sound levels the attenuation level of the IMS may be less of an issue and comfort more of a factor. The IMS is adjusted in a step 808 to meet the attenuation needs. In general, inflating the IMS increases attenuation while deflating the IMS decreases attenuation. The method terminates at step 810.

[0089] Referring to FIG. 9, a more detailed flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) is shown. In general, the attenuation increases when the pressure in the IMS is raised thereby allowing a degree of control to make adjustments. For example, an adjustment is made to increase attenuation when the background noise level rises or a seal check produces a failed result. Adjustments are made until the seal check passes. The pressure level adjustments of the IMS will fall within a comfort range of a user (e.g., between 0.1 bar and 0.3 bar gauge pressure). Typically, the pressure level is set at a minimum level to achieve a predetermined attenuation level.

[0090] The method begins at step 902. The degree of acoustic sealing is determined from cross-correlation between the ECM signal and the generated test signal. The XCorr value is provided in a step 904. In step 906, the attenuation provided by the IMS is calculated (equation) or looked up (table) from data such as that shown in FIG. 10. In one exemplary embodiment, the desired attenuation value is dependant on the ambient sound level of the user. In another exemplary embodiment, the desired attenuation value is dependant on the ear-canal sound level of the user. In yet another exemplary embodiment, the desired attenuation value is dependant on the level of audio content (e.g. speech or music audio) reproduced with the earphone device. In all of the above examples, the desired attenuation value is determined by one or more of the embodiments in a step 907.

[0091] The difference between the degree of acoustic sealing determined in step 906 and the desired attenuation value determined in step 907 is calculated in step 908. The difference value in step 908 is used to determine the change in pressure of the IMS necessary to minimize the difference value in a step 910. In at least one exemplary embodiment, the difference value of the attenuation is converted into a corresponding pressure value change (e.g. in milli-Bars) using a similar look-up table or equation method as described previously. The pressure change in the IMS is then affected with step 912 to meet the desired attenuation level. For example if the desired attenuation is a decrease of 10 dB in sound across the earpiece in the ear canal, then a pressure of a variable volume inflatable system can have a gauge pressure of about 0.15 bar. If the desired attenuation is a decrease of 20 dB across the earpiece in the ear canal then the gauge pressure can be increased to about 0.25 bar, where an increased pressure is associated with an increase in attenuation. An experimental table for each earpiece can be generated in a standard devised experimental setup (e.g. impedance tunnel) and referred to when changes are needed. The method ends at step 914.

[0092] Referring to FIG. 11, a flowchart of an exemplary method to determine a test signal fundamental is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user or made pleasant such that the user is unaware that the test signal is being played. This allows unobtrusive (periodic or non- periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0093] In at least one exemplary embodiment, an audio content 1102 is provided. A step 1104 stores audio content 1102 in a data buffer. In this example, audio content 1102 is music played from a media player and received via a wired or wireless connection to at least one earpiece in the user's ear. An alternate example would be that audio content 1102 is a speech audio signal from a portable telephone device or the like.

[0094] A step 1106 determines if the buffer of audio content 1102 comprises a strong tonal signal

component. Mixing the test signal having a similar fundamental frequency as audio content 1102 will mask the test signal when played to the user. Thus, the test signal is musically in harmony with the reproduced music and results in very little perceptual degradation in sound quality.

[0095] A step 1108 determines whether to update or generate the first fundamental tone for the test signal. The test signal is not updated or generated if buffered audio content 402 does not contain a strong tonal signal component. A return to step 1104 fills the buffer with the next audio content 402 for analysis.

[0096] A step 1110 analyzes the buffer of data of audio content 1102 when it has been determined that it contains a strong tonal signal component. Step 1110 determines the fundamental frequency of the tonal signal. The fundamental tone, often referred to as the fundamental and abbreviate f_0 is the lowest frequency in a harmonic series. The fundamental frequency (also called a natural frequency) of a periodic signal is the inverse of the pitch period length. The pitch period is the smallest repeating unit of a signal. The fundamental frequency of the tonal signal can be calculated using an autocorrelation analysis.

[0097] In one exemplary embodiment, a mathematical operation 1114 is performed where the frequency component of the test signal is limited to a frequency range below a lower minimum and upper maximum frequency range. Fund_ratio is calculated, which is defined as a ratio of the determined fundamental frequency (F_fund) of the tonal signal from step 1110 to an upper threshold value F_fund_threshold 1112, which in one exemplary embodiment, is a fixed constant equal to approximately 100Hz. In general, F_fund_threshold 1112 is chosen to be a low frequency value which is above the lowest (or -3 dB) frequency that a transducer can reproduce, but below a predetermined frequency. In a comparison step 1116, if the estimated F-fund is higher than the F_fund_threshold 1112 (ratio > 1), then F_fund is reduced by an integer multiple to be below F_fund_threshold 1112 corresponding to the mathematical operation of step 1118. Otherwise, the test signal fundamental is equal to F_fund as shown in step 1120. Although not shown, the calculated test signal fundamental is compared and determined to be greater than a predetermined threshold.

[0098] Referring to FIG. 1, in at least one exemplary embodiment, processor 116 is configured to receive or generate audio content. As mentioned previously, the audio content can from external devices such as a portable phone or a media player. Memory 104 can be used as a buffer for the audio content. Processor 116 is configured to receive the buffer of audio content from memory 104. The steps and calculations of the block diagram of FIG. 4 are then performed by processor 116. The result being one of the identification of a strong tonal signal component in the buffer of audio content and the test signal fundamental or loading the buffer with new audio content and starting the process again.

[0099] Referring to FIG. 12, a flowchart of an exemplary embodiment to determine tonal presence in audio content is shown. In particular, the exemplary embodiment relates to step 1106 of FIG. 11 that analyzes audio content stored in a buffer. The method begins at step 1202. A step 1204 gets the audio content stored in an audio signal buffer hereinafter called the audio signal. A filter step 1206 filters the audio signal to a frequency range of interest that relates to a sealing test frequency. For example, a band pass filter in the range of 20Hz to 500Hz could be used to filter the audio signal where the test signal is in the lower audio frequency range. An auto-correlation step 1208 analyzes the audio signal where a strong tonal signal component is represented by peaks in the analysis results. A step 1210 generates Absolute(Acorr) which is a number representing the absolute magnitude of the peaks from the analysis. For example, Absolute(Acorr) can be the square of the results from the auto-correlation.

[0100] A crest_factor_Acorr 1218 is generated from the results by calculating an RMS value 1214 (or time-averaged peak value) and peak value 1216 (or time averaged peak value). In at least one exemplary embodiment, the crest_factor_Acorr 1218 is the ratio of the peak value to the RMS value of an absolute auto-correlation sequence of the audio signal.

[0101] A comparison step 1222 is then performed. A strong tonal presence is identified when crest_factor_Acorr 1218 is greater than a threshold Crest_factor_Acorr_threshold 1220. Identification of the strong tonal presence indicates the audio signal would facilitate masking of the test signal to determine sealing of the device (step 1226). The audio signal is not used in conjunction with the test signal if crest_factor_Acorr 1218 is less than Crest_factor_Acorr_threshold 1220 (step 1224). The process would begin again loading a next sequence of the audio signal into the buffer for review.

[0102] Referring to FIG. 1, as mentioned previously, audio content is stored in a buffer, for example memory 104. The audio content in the buffer is provided to processor 116. In at least one exemplary embodiment, processor 116, runs the analysis as described in the block diagram of FIG. 12 thereby determining if a strong tonal presence is found in the audio content in the buffer. New audio content is loaded into the buffer (memory 104) if a strong tonal presence is not found beginning the procedure again.

[0103] Referring to FIG. 13, a flowchart of a method to determine when to emit the test signal is shown. The method begins at step 1302. The test signal is emitted when the test can be performed unobtrusively to the user and also provide an accurate test. In a step 1304, an audio signal is retrieved from a buffer. In at least one exemplary embodiment, the audio signal is received from an ECM or an ASM. The audio signal is measured to determine when the sound level is low in the ear canal, the ambient environment, or both. In

general, the test signal is emitted when the sound level is low.

[0104] A filter step 1306 band pass filters the audio signal. In one exemplary embodiment, filter step 1306 filters the audio signal from 50 Hz to 150Hz which corresponds to a frequency range of the test signal. In a step 1308, the RMS of the audio signal is calculated. The audio signal is analyzed to detect when the energy within an audio frequency range is below a threshold RMS_threshold 1310. The RMS of the audio signal is the signal level in the volume being measured. A comparison step 1312 compares the measured RMS level of the filtered audio signal against RMS_threshold 1310. In a step 1314, a test signal is emitted when the measured RMS value is less than RMS_threshold 1310. No test signal is emitted when the RMS of the audio signal is greater than RMS_threshold 1310. The method ends at step 1316.

[0105] Referring to FIG. 14, a flowchart of an exemplary method to determine acoustic seal integrity is illustrated. For example, an earpiece seal integrity corresponds to a full or partial acoustic barrier between a first volume (ear canal) and a second volume (ambient environment). In one exemplary embodiment, the degree of acoustic seal integrity is expressed as either a PASS or FAIL status, where FAIL indicates that the acoustic seal is compromised relative to a normal operating acoustic seal. For example, an earpiece that has performed the seal test and determined that the sealing unit is not sealed correctly in the ear canal of the user can provide a signal or message indicating the problem. The user can then remove, reinsert, and retest the earpiece to ensure that the seal is within normal operating specifications.

[0106] The method begins at step 1402. An acoustic test signal is provided in a first volume. In a step 1404 a transducer measures the acoustic test signal and stores it in a signal buffer. In a step 1406, a second transducer in a second volume isolated from the first volume by an acoustic barrier measures a second acoustic signal in the second volume. A portion of the acoustic test signal passes the acoustic barrier into the second volume. The amount of the acoustic test signal passing the acoustic barrier is a measure of the seal provided by the acoustic barrier.

[0107] In a filter step 1408, the measured acoustic test signal in the first volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals that are not part of the test. The measured signal from the first volume is heretofore called the first volume signal. Similarly, in a step 1410, the measured signal in the second volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals not related to the test (outside the frequency range) in the second volume. The measured signal from the second volume is heretofore called the second volume signal.

[0108] A correlation, cross-correlation, or coherence analysis is performed on the first volume signal and

the second volume signal. The correlation, cross-correlation, or coherence analysis is a measure of the similarity of the signals in the first and second volumes. In particular, the non- difference analysis measures the acoustic test signal leaking past the acoustic barrier by identifying the portion of the second volume signal that is similar to the acoustic test signal in the first volume.

[0109] In at least one exemplary embodiment, a correlation step 1412 is performed comprising a cross-correlation of the first volume signal and the second volume signal. In a step 1414, the peak of the cross-correlation is identified. The peak of the cross-correlation is Absolute(XCorr). In a mathematical step 1418, the Lag-time of Peak 1420 and the Magnitude of Peak 1422 is calculated. The Lag-time of Peak 1420 is a measure of the time delay between receiving the signals in the first and second volumes. In particular, the first volume signal should be received before the second volume signal. The Magnitude of Peak 1422 corresponds to the similarity between the signals in the first and second volumes. Thus, a larger number for Magnitude of Peak relates to more leakage of the acoustic test signal getting past the acoustic barrier.

[0110] Two comparisons are performed that determine if the acoustic barrier is sealed correctly based on the measured and calculated data from the first and second volumes. In a comparison step 1426, the measured Lag-time of Peak is compared against Target Lag Limits 1424. The measured lag-time should fall within the predetermined range (Target Lag Limits 1424) for the seal test to be valid. If the Lag-time of Peak is within the appropriate range then a logic 1 is provided to AND function 1432, otherwise a logic 0 is provided. In a second comparison step 1428, the Magnitude of Peak is compared against a Peak_threshold 1430. If the Magnitude of Peak is greater than the Peak_threshold 1430 a logic 1 is provided to AND function 1432. This indicates that a significant portion of the acoustic test signal is present in the second volume measurement, otherwise a logic 0 is provided. A FAIL output 1434 corresponds to a logic 1 at the output of AND function 1432. The FAIL occurs when the Lag-time of Peak is within the predetermined range and the Magnitude of Peak is greater than the Peak_threshold indicating that the acoustic barrier is sealed improperly. All other conditions indicate a PASS output 1434 and the acoustic barrier is sealed correctly.

[0111] In at least one exemplary embodiment and referring briefly to FIG. 1, an earpiece is tested to determine if sealing unit 108 is sealed correctly to the ear canal of the user. Sealing unit 108 creates a first volume in ear canal 124 and a second volume outside the ear canal 124 in the ambient environment. A masking approach is used to perform seal testing unobtrusively to the user. The user is listening to music or speech (audio content) provided to ear canal124 from ECR 114.

[0112] The music or speech is buffered in memory 104 or memory in processor 116. Processor 116 analyzes the audio content in the buffer to identify a strong tonal content. A test signal can

be created once audio content with strong tonal content is found. The test signal will have at least one fundamental pitch corresponding to the strong tonal content and optionally further harmonics. Processor 116 also analyzes the measured signals from ECM 106 and ASM 120 to determine when to emit the test signal. Processor 116 monitors and compares the sound level in the ambient environment and ear canal124. Processor 116 will provide the generated test signal to ECR 114 during an optimum time for test accuracy such as when the ambient sound level is low, the ear canal sound level is low, or both. Also, processor 116 will not output the test signal if there is audio content similar to the test signal in the ear canal or ambient environment.

[0113] Processor 116 monitors the test conditions and then provides the test signal to ECR 114 when an accurate sealing test can be performed. ECR 114 outputs an acoustic test signal which may or may not have other audio content. ECM 106 and ASM 120 respectively measure acoustic signals in ear canal 124 and the ambient environment. Processor 116 is operatively coupled to ECM 106 and ASM 120. The measured signals are buffered in memory 104.

[0114] In an exemplary embodiment, a cross-correlation is used to measure the similarity between the signals in ear canal124 and the ambient environment. Processor 116 performs the cross-correlation calculations using the measured acoustic signals from ECM 106 and ASM 120. In particular, the cross-correlation is used to identify and compare the acoustic test signal present in the two volumes separated by the acoustic barrier. A cross-correlation between ASM and ECM signals is defined according to the following equation (5):

$$XCorr(n,l) = \sum_{n=0}^{N} ASM(n)ECM(n-l), \qquad (5)$$

Where: l=0, 1, 2, … N

[0115] Where ASM(n) is the nth sample of the ASM signal, and ECM(n-1) is the $(n-1)^{th}$ sample of the ECM signal. A peak of the absolute cross-correlation is estimated using a peak- picking function and also the lag time at which this peak occurs (i.e. the index I at which this occurs). Thus, the Lag-time of Peak and the Magnitude of Peak are known and respectively compared against a Target Lag Limit range and a Peak Threshold. The user of the earpiece is notified or warned that sealing unit 108 is improperly sealed by processor 116 if the measured Lag-time of Peak is within the Target Lag Limit range and the Magnitude of Peak is greater than the Peak Threshold.

[0116] Like Correlation and Cross-Correlation, a coherence function is also a measure of similarity between two signals. Coherence is another non-difference comparison approach that can be used for detecting acoustic seal integrity. Coherence is defined as:

$$\gamma^2{}_{xy} = \frac{|G_{xy}(f)|^2}{G_{xx}(f)G_{yy}(f)} \quad (6)$$

[0117] Where Gxy is the cross-spectrum of two signals (e.g. the ASM and ECM signals), and can be calculated by first computing the cross-correlation in equation (5), applying a window function, for example a Hanning window, and transforming to the frequency domain, for example via an FFT. Gxx or Gyy is the auto-power spectrum of either the ASM or ECM signals, and can be calculated by first computing the auto-correlation (using equation 5, but where the two input signals are both from either the ASM or ECM and transforming to the frequency domain. The coherence function gives a frequency-dependent vector between 0 and 1, where a high coherence at a particular frequency indicates a high degree of coherence at this frequency, and can therefore be used to analyze test signal frequencies in the ASM and ECM signals whereby a high coherence indicates the presence of the test signal in the ambient environment (indicating leakage past the acoustic barrier).

[0118] Other approaches such as frequency spectrum analysis and RMS levels can also be used to determine if the earpiece is sealed correctly. Using a non-difference comparison approach such as coherence or cross-correlation between the ASM and ECM signals to determine sealing is more reliable than taking the level difference of the ASM and ECM signals. Using the cross correlation rather than a level differencing approach improves the accuracy and minimizes errors which may occur due to user non-speech body noise, such as teeth chatter, sneezes, coughs, etcetera. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0119] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment. In the non-limiting example, when a seal is essentially detected as being low, for example the calculated sound isolation of the system is 3 dB or less, a signal is sent to a seal varying device (e.g., 1500) to vary the seal, in this case increase (i.e. increase the sound isolation of the system) the seal value. The signal can be instructions to send a current over a period of time to an actuator, which can decrease the overall volume of the system (hence increasing the pressure and effectively the sealing). For example a slider actuator such as the P-653 PILine® can be used. Which has the dimensions of 15 mm by 11 mm by 8 mm, which includes an attached electronics control board, and

has a mass of 1 gram. General operation uses 5V and about 100 mamps with a typical speed of 50 to 90 mm/sec. Note that the max force of about 0.15 N but such systems can be tailored to enable pumping beyond atmospheric pressure (e.g., can increase the max force). The non limiting example illustrated in FIGS. 15A and 15B shows a slider actuator 1500, with a moving slide 1510, having attached a pumping arm 1560, with a hole 1550 covering bump 1520. Upon receipt of a signal1505 the actuator can move 1570 such that the bump 1520 covers the hole 1550 in a bellows 1530 pump. The actuation compresses the miniature bellows 1530 pushing 1590 gas through the one-way valve 1540, upon the back stroke the bump 1520 uncovers the hole 1550 and air rushes back into the bellows 1530 for the next pump. For example if the stroke length is 2 mm and the pump arm 1560 contact area is about 9 mm 2 then each stroke moves 18 mm 3 of volume. If an inflation system 1570 needs to be inflated more (e.g., more gas to increase sealing) then each stroke can provide an additional volume of gas of 18 mm 3 into the system increasing the inflation system 1580. If the inflation system is initially empty (e.g., needs 1000 mm 3 of gas volume to inflate) then about 56 strokes would be needed for inflation, which is about 110 mm one direction stroke length or about 2 seconds at P-653 PILine speeds. The number of oscillations and stroke length can be determined according to the signal 1505 sent, which can be specifically tailored depending upon the electronics controlling the actuators. Note that PI-653 is an example only. Other actuation systems can be used and controlled by signal 1505.

[0120] FIG. 16 illustrates a block diagram of controlled sealing in response to a seal fail signal and/or a request for increased seal attenuation. For example, a command signal 1600 is received (e.g., a seal fail signal in which a default attenuation value is attached for example 15 dB, or a signal requesting an additional amount of attenuation) by a processor. The command signal specifies an additional amount of attenuation or that the seal has failed. An attenuation needed N is identified 1610. For example if the current attenuation is 5 dB loss at f=500 Hz, at a pressure of 0.1 bar, and a command signal is received requesting a 10 dB loss at 500 Hz, then an experimental table is queried to find the pressure needed P which is then subtracted from the current pressure to obtain an increase in pressure DP needed. The increase in pressure is converted into a volume of gas increase needed (e.g., again referring to experimental tables based upon the inflation system volume). The volume of gas increase needed can then be directly linked with the number of cycles of an actuator pump M, 1620. The number of requested cycles **M** can then be sent 1630 to the actuator control circuit to pump the designated number of cycles. The system can then retest the attenuation 1640 and if refinements are needed the process can start again.

[0121] 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. For example, if words such as "orthogonal", "perpendicular" are used the intended meaning is "substantially orthogonal" and "substantially perpendicular" respectively. Additionally although specific numbers may be quoted in the claims, it is intended that a number close to the one stated is also within the intended scope, i.e. any stated number (e.g., 90 degrees) should be interpreted to be "about" the value of the stated number (e.g., about 90 degrees).

[0122] 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.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Filer:	John Patrick Keady
Attorney Docket Number:	CONT-16838277

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:	41996490
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	CONT-16838277
Receipt Date:	23-FEB-2021
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Payment was successfully received in RAM	$830
RAM confirmation Number	E20212MD59562657
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	WebADS.pdf	146161 a7e8e35eaea7a4b4967f4e3b0afb1136a2c6a451	no	8
Warnings:					
Information:					
2	Abstract	CONT-16838277-ABSTRACT.pdf	89807 43541fcfe5d0a4f8bd3782787896311c8f0eaa59	no	1
Warnings:					
Information:					
3	Claims	CONT-16838277-CLAIMS.pdf	101173 06536d969e6576942108bfc788572058e284ab9f	no	3
Warnings:					
Information:					
4	Drawings-other than black and white line drawings	CONT-16838277-FIGS.pdf	3310893 aa1d2110f2221990c48b590bbbf49ba5ff857dc9	no	15
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	CONT-16838277-IDS.pdf	1035190 d461402f03e932e35f04553a2a837bff56ab2f00	no	6
Warnings:					
Information:					
6	Oath or Declaration filed	CONT-16838277-OATH.pdf	146637 0e9029c44af35f4d94410ba917c849704535c256	no	3
Warnings:					
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7	Specification	CONT-16838277-SPEC-FINAL.pdf	380845 58ec988a87fa4676f383002400b82745ac0cc7ff	no	25
Warnings:					
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8	Fee Worksheet (SB06)	fee-info.pdf	34798 58bbba9fb7538cf821aa2ef9e8474b277bb9df48	no	2
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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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16838277
	Application Number	
Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM	

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.

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☐ 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.)

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16838277
	Application Number	
Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM	

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Customer Number	150139		
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Application Information:

Title of the Invention	ACOUSTIC SEALING ANALYSIS SYSTEM		
Attorney Docket Number	CONT-16838277	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	15	**Suggested Figure for Publication (if any)**	14

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

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.

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16838277
	Application Number	
Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM	

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

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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	16838277	2020-04-02

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16838277	Continuation of	16414136	2019-05-16	10701499	2020-06-30

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16414136	Continuation of	15700511	2017-09-11	10299053	2019-05-21

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15700511	Continuation of	14827332	2015-08-17	9781530	2017-10-03

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14827332	Continuation of	14054015	2013-10-15	9113267	2015-08-18

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16838277
	Application Number	
Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM	

Prior Application Status	Patented		Remove		
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14054015	Division of	12555864	2009-09-09	8600067	2013-12-03

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
12555864	Claims benefit of provisional	61098250	2008-09-19

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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.

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.

PTO/AIA/14 (08-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16838277
	Application Number	
Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM	

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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16838277
	Application Number	
Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM	

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

Mailing Address Information For Applicant:

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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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16838277
	Application Number	
Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM	

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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CONT-16838277
	Application Number	
Title of Invention	ACOUSTIC SEALING ANALYSIS SYSTEM	

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.

ABSTRACT

A device or a method using the device includes a balloon configured to seal a user's orifice, where the balloon is configured to produce an acoustic seal between a first side and a second side of the balloon in an ear canal. At least a second side of the balloon is fitted into the ear canal. Audio processing circuitry produces an audio signal for driving a speaker in the device and to measure sound level using output from the microphone in the device while the speaker is being driven by the audio signal. The device or method further includes control circuitry to evaluate a seal quality of the device. Other embodiments are disclosed.

CLAIMS

We claim:

1. An audio device configured to monitor the seal between a first side and a second side of the audio device comprising:

a microphone configured to measure sound from a first side of the audio device;

a speaker, wherein the speaker is configured to emit an audio signal from the first side of the audio device;

a sealing section, configured to seal the audio device between the first side and a second side of the audio device;

a memory that stores instructions; and

a processor, operatively connected to the microphone, where the processor is operatively connected to the speaker, where the processor is operatively connected to the memory, where the processor is configured to execute the instructions to perform operations, the operations comprising:

sending a playback signal to the speaker;

receiving a microphone signal from the microphone;

comparing the microphone signal to the playback signal to generate a seal quality between the first and second sides; and

generating a filter to the playback signal based upon the seal quality.

2. The audio device according to claim 1, where the operations further comprise:

applying the filter to the playback signal to generate a corrected playback signal.

3. The audio device according to claim 2, where the operations further comprise:

sending the corrected playback signal to the speaker.

4. The audio device according to claim 3, wherein the seal quality is determined at least in part by comparing frequency components below 300Hz of the microphone signal and the playback signal.

5. The audio device according to claim 4, wherein the seal quality is determined at least in part by comparing frequency components below 200Hz of the microphone signal and playback signal.

6. The audio device according to claim 2, wherein the sealing section is a foam eartip.

7. The audio device according to claim 2, wherein the microphone signal is buffered in the memory.

8. The audio device of claim 2, where the audio device is a headphone.

9. The audio device of claim 2, where the audio device is an earphone.

10. An audio device comprising:

an ambient sound microphone configured to measure sound from an ambient side of the audio device;

an ear canal microphone configured to measure sound from an ear canal side of the audio device;

a speaker, wherein the speaker is configured to emit an audio signal;

a sealing section, configured to seal the audio device between the ambient side and the ear canal side of the audio device;

a memory that stores instructions; and

a processor connected to the microphone, where the processor is connected to the speaker, where the processor is connected to the memory, where the processor is configured to execute the instructions to perform operations, the operations comprising:

monitoring the seal quality of the audio device between the ear canal side and the ambient side for a period of time.

11. The audio device according to claim 10, where the operations further comprise:

generating a playback correction to a playback signal.

12. The audio device according to claim 11, where the operations further comprise:

generating an adjusted playback signal using the playback correction.

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

sending the adjusted playback signal to the speaker.

14. The audio device according to claim 10, wherein the seal quality is determined at least in part by comparing frequency components below 1000Hz of the microphone signal and the playback signal.

15. The audio device according to claim 14, wherein the microphone signal is buffered in the memory.

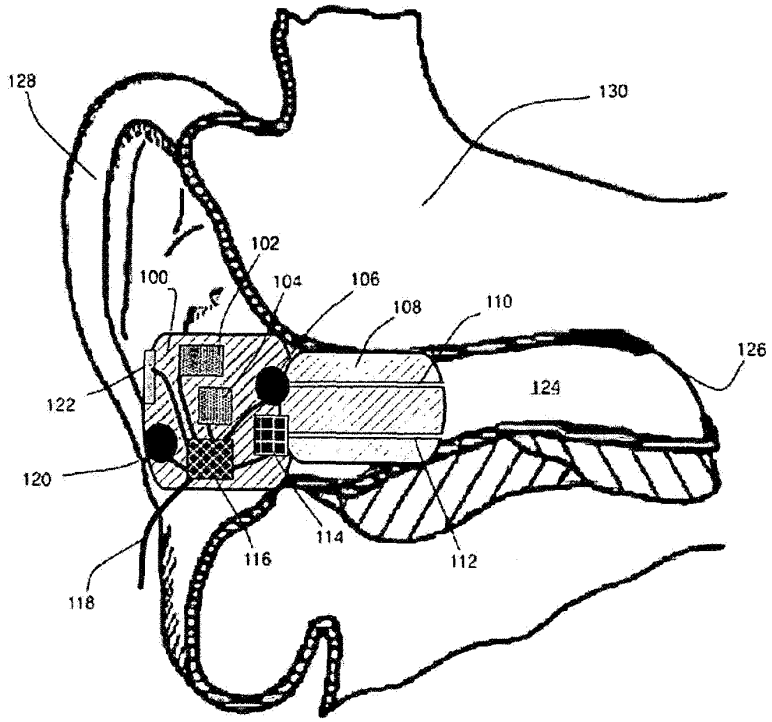
16. The audio device of claim 10, where the audio device is a headphone.

17. The audio device of claim 10, where the audio device is an earphone.

18. The earphone according to claim 17, where the sealing section is an eartip.

19. The earphone according to claim 16, where the sealing section is a foam cup.

FIG. 1



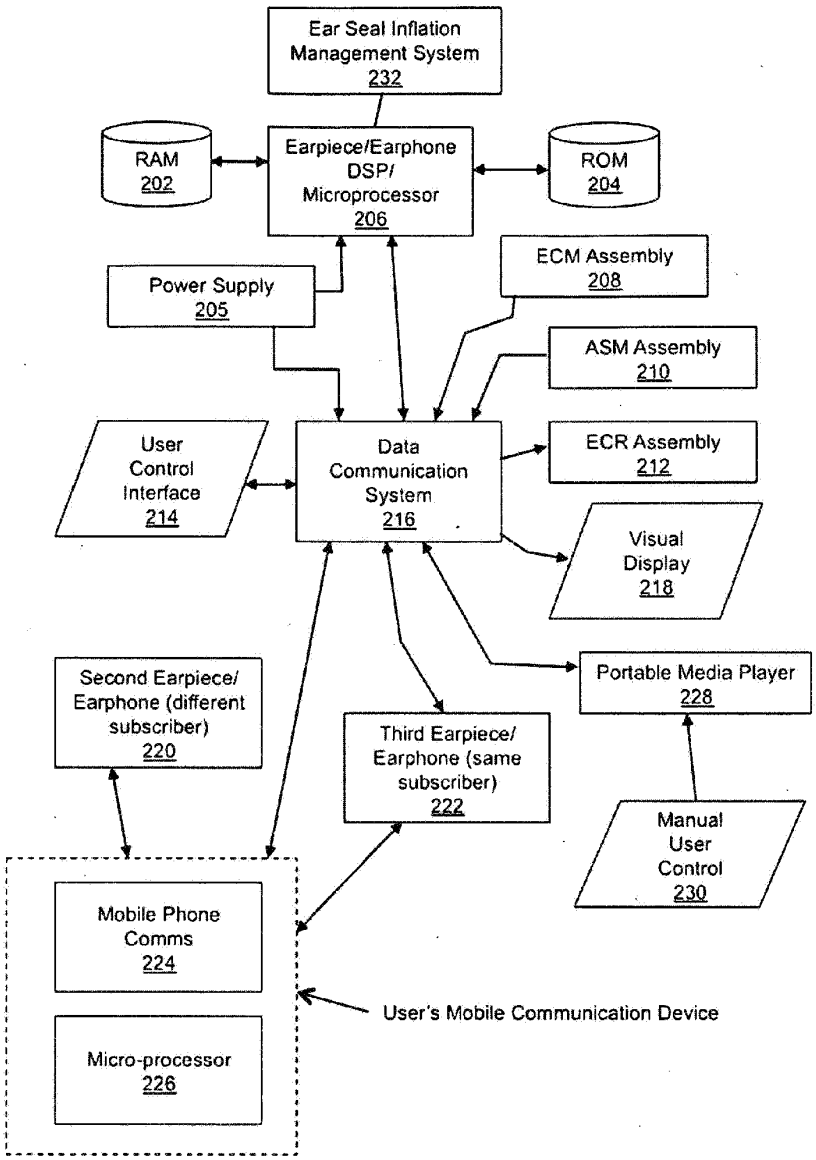

Ear Seal Inflation Management System 232
RAM 202
Earpiece/Earphone DSP/ Microprocessor 206
ROM 204
Power Supply 205
ECM Assembly 208
ASM Assembly 210
User Control Interface 214
Data Communication System 216
ECR Assembly 212
Visual Display 218
Second Earpiece/ Earphone (different subscriber) 220
Third Earpiece/ Earphone (same subscriber) 222
Portable Media Player 228
Manual User Control 230
Mobile Phone Comms 224
Micro-processor 226
User's Mobile Communication Device

FIG. 2

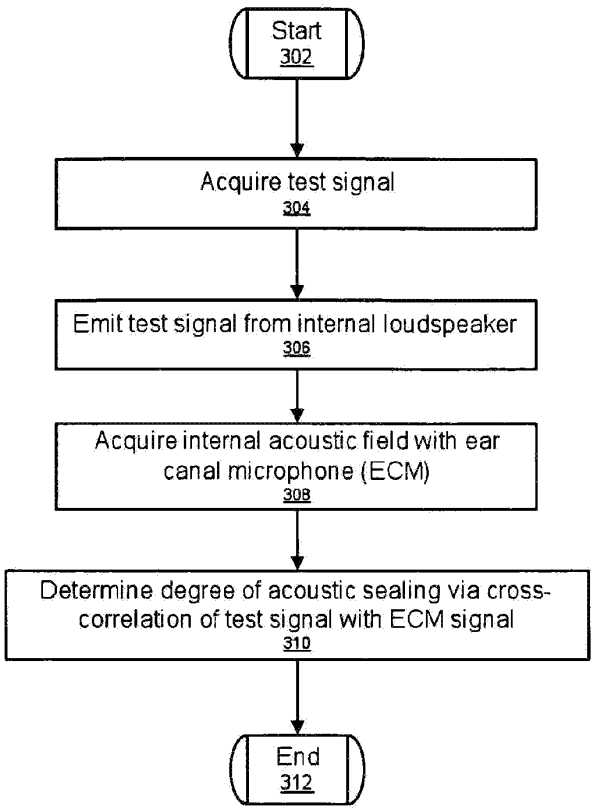

Start
302
Acquire test signal
304
Emit test signal from internal loudspeaker
306
Acquire internal acoustic field with ear canal microphone (ECM)
308
Determine degree of acoustic sealing via cross-correlation of test signal with ECM signal
310
End
312

FIG. 3

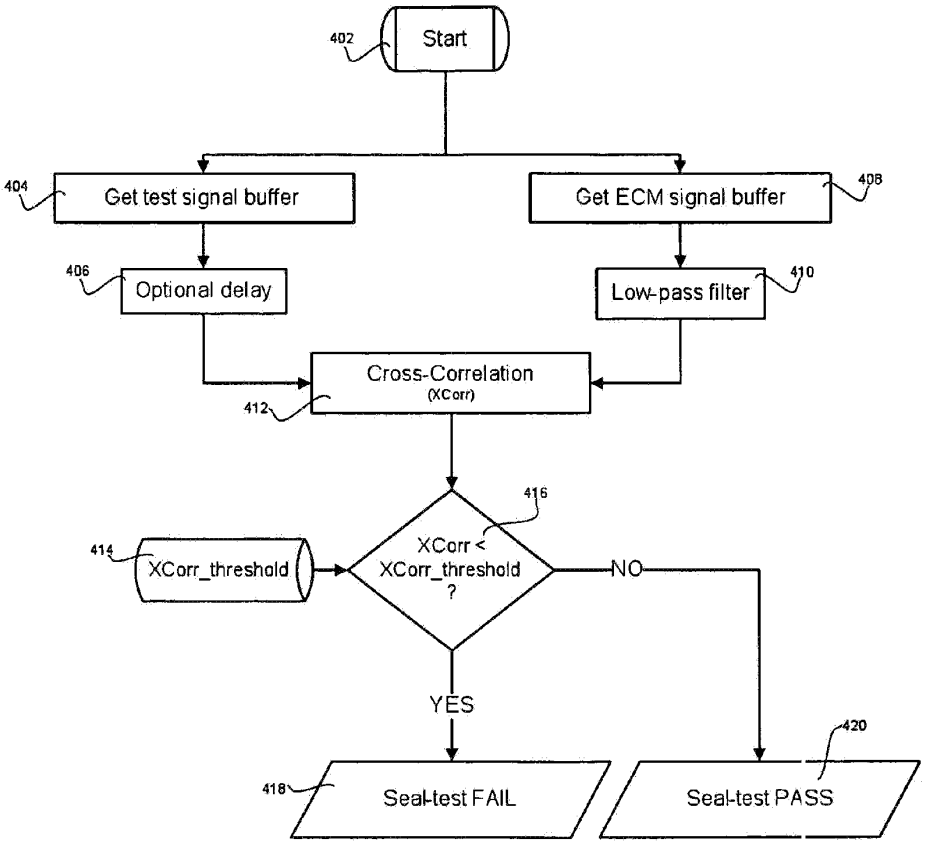

Start
402
Get test signal buffer
404
Get ECM signal buffer
408
Optional delay
406
Low-pass filter
410
Cross-Correlation
(XCorr)
412
XCorr_threshold
414
XCorr <
XCorr_threshold
?
416
NO
YES
Seal-test FAIL
418
Seal-test PASS
420

FIG. 4

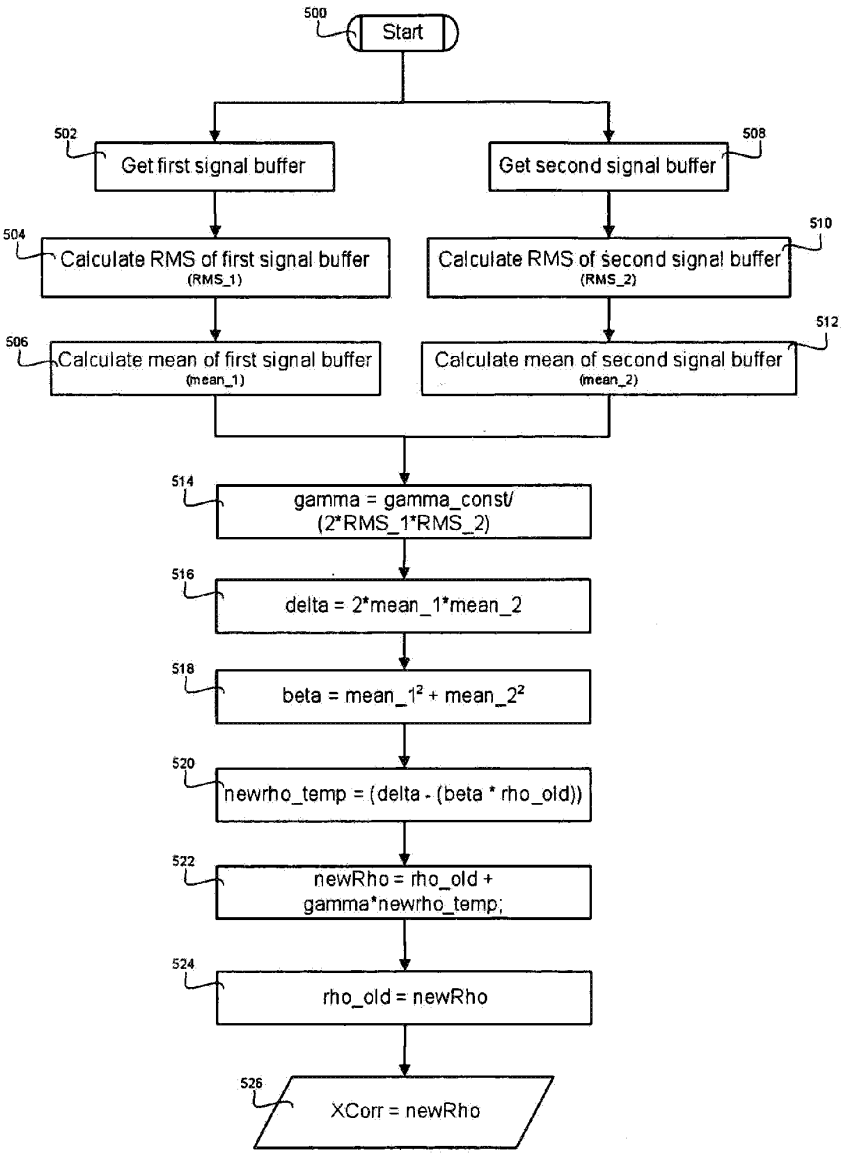

500
Start
502
Get first signal buffer
508
Get second signal buffer
504
Calculate RMS of first signal buffer
(RMS_1)
510
Calculate RMS of second signal buffer
(RMS_2)
506
Calculate mean of first signal buffer
(mean_1)
512
Calculate mean of second signal buffer
(mean_2)
514
gamma = gamma_const/
(2*RMS_1*RMS_2)
516
delta = 2*mean_1*mean_2
518
beta = mean_1² + mean_2²
520
newrho_temp = (delta - (beta * rho_old))
522
newRho = rho_old +
gamma*newrho_temp;
524
rho_old = newRho
526
XCorr = newRho

FIG.5

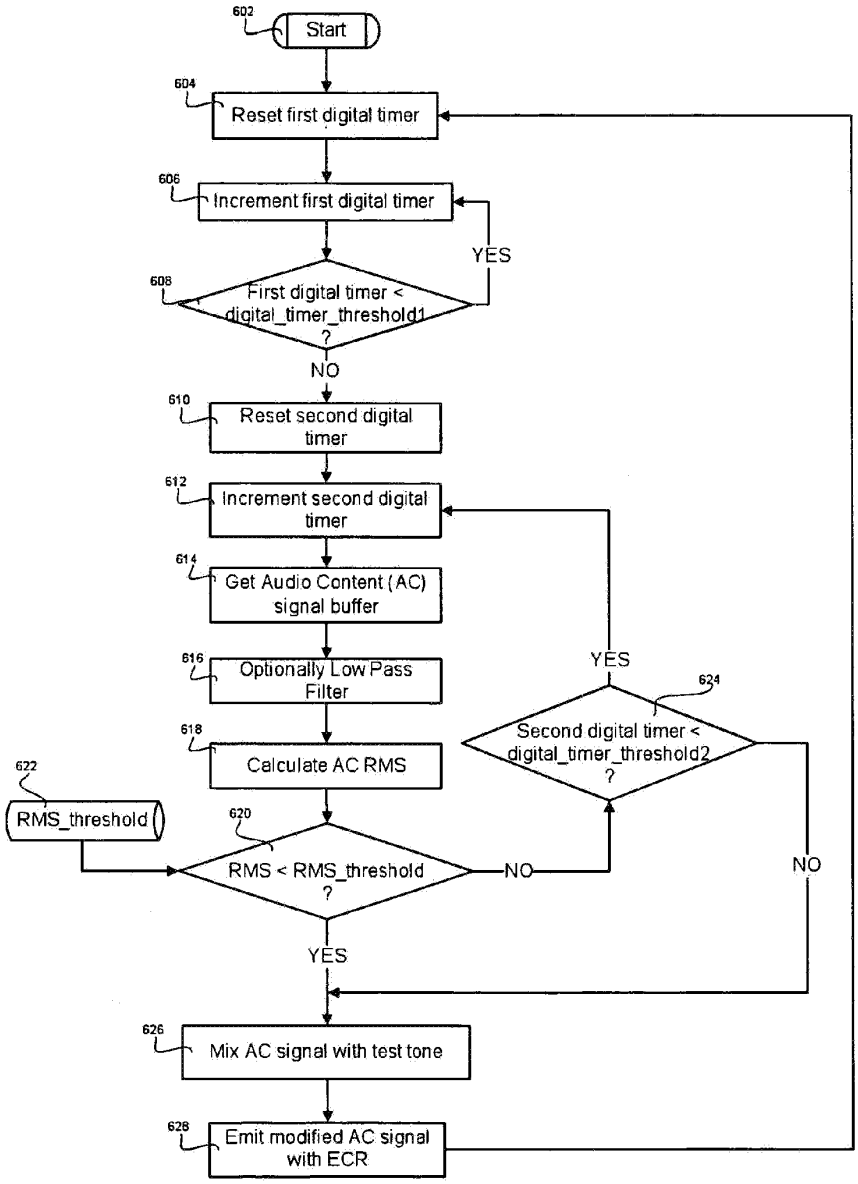

602
Start
604
Reset first digital timer
606
Increment first digital timer
YES
608
First digital timer < digital_timer_threshold1 ?
NO
610
Reset second digital timer
612
Increment second digital timer
614
Get Audio Content (AC) signal buffer
616
Optionally Low Pass Filter
618
Calculate AC RMS
622
RMS_threshold
620
RMS < RMS_threshold ?
NO
YES
624
Second digital timer < digital_timer_threshold2 ?
YES
NO
626
Mix AC signal with test tone
628
Emit modified AC signal with ECR

FIG. 6

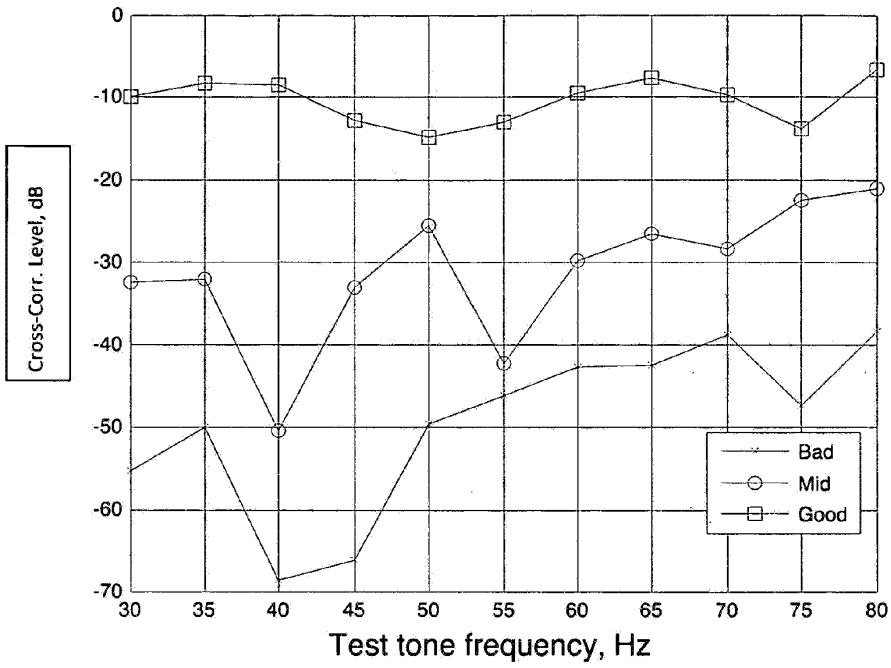

0
-10
-20
-30
-40
-50
-60
-70
Cross-Corr. Level, dB
30
35
40
45
50
55
60
65
70
75
80
Test tone frequency, Hz
Bad
Mid
Good

FIG. 7

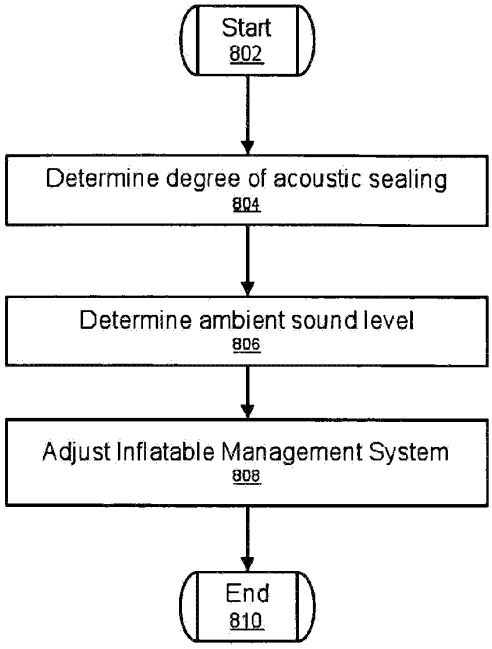

Start
802
Determine degree of acoustic sealing
804
Determine ambient sound level
806
Adjust Inflatable Management System
808
End
810

FIG. 8

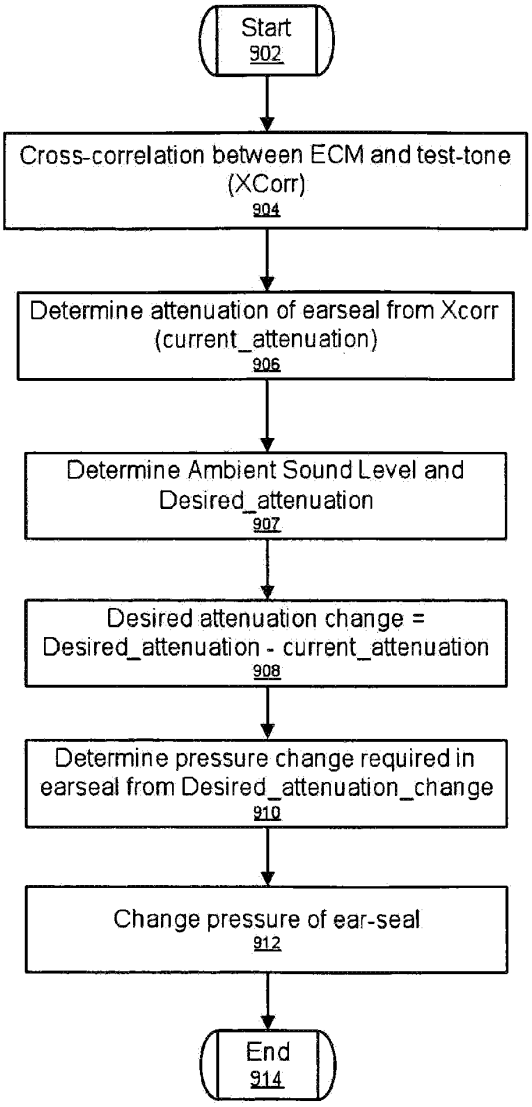

Start
902
Cross-correlation between ECM and test-tone (XCorr)
904
Determine attenuation of earseal from Xcorr (current_attenuation)
906
Determine Ambient Sound Level and Desired_attenuation
907
Desired attenuation change = Desired_attenuation - current_attenuation
908
Determine pressure change required in earseal from Desired_attenuation_change
910
Change pressure of ear-seal
912
End
914

FIG. 9

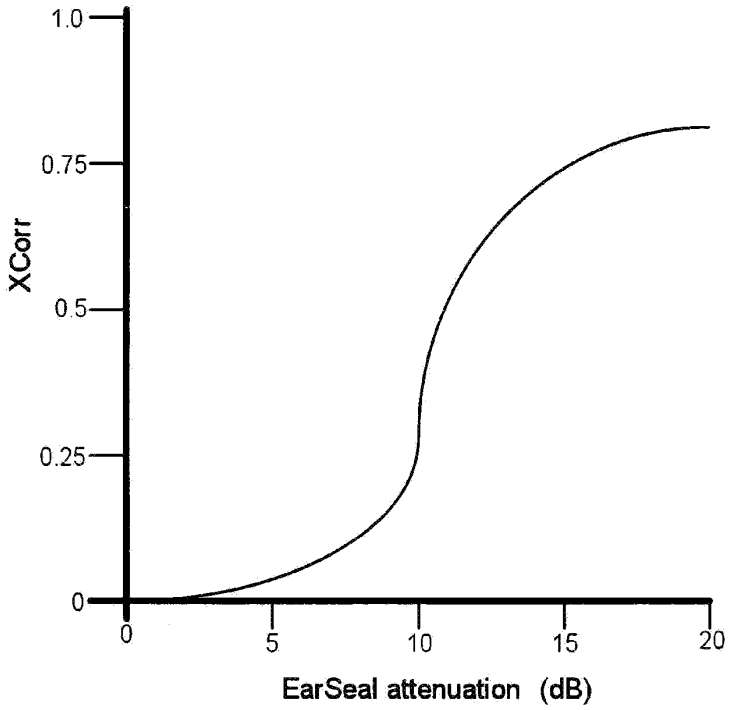


FIG. 10

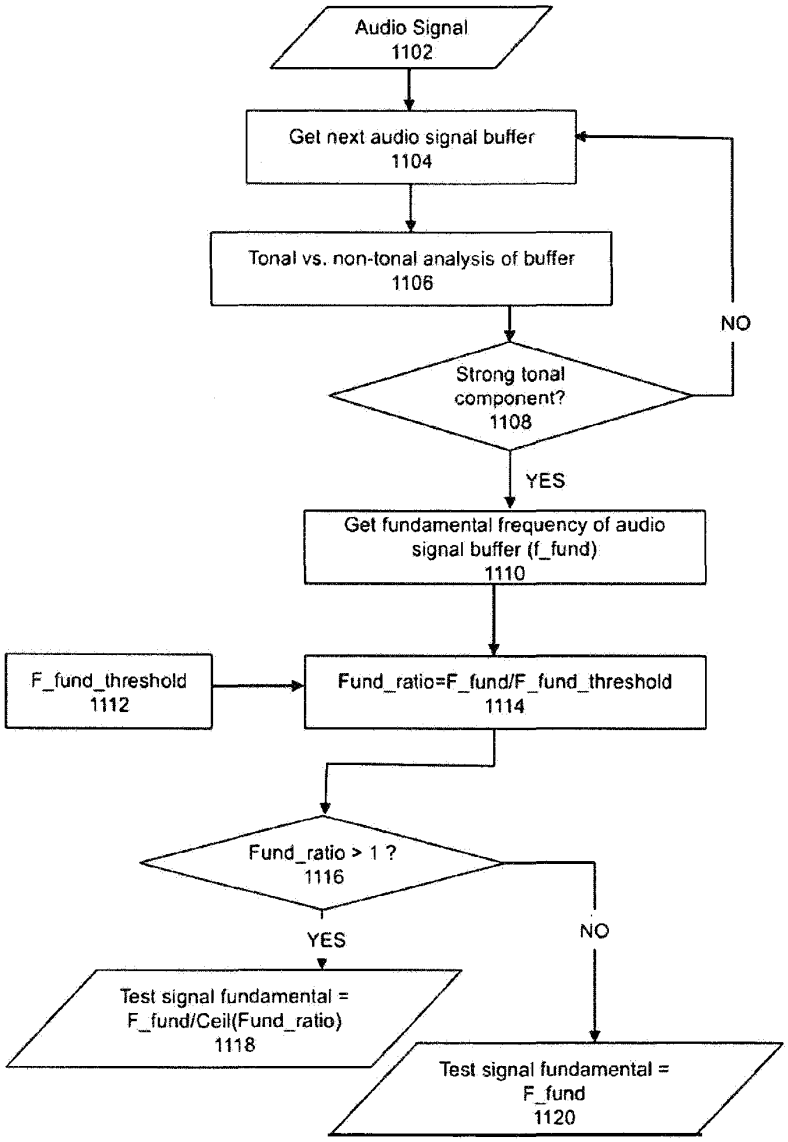

Audio Signal
1102
Get next audio signal buffer
1104
Tonal vs. non-tonal analysis of buffer
1106
Strong tonal component?
1108
NO
YES
Get fundamental frequency of audio signal buffer (f_fund)
1110
F_fund_threshold
1112
Fund_ratio=F_fund/F_fund_threshold
1114
Fund_ratio > 1 ?
1116
YES
NO
Test signal fundamental = F_fund/Ceil(Fund_ratio)
1118
Test signal fundamental = F_fund
1120

FIG. 11

Fig. 12

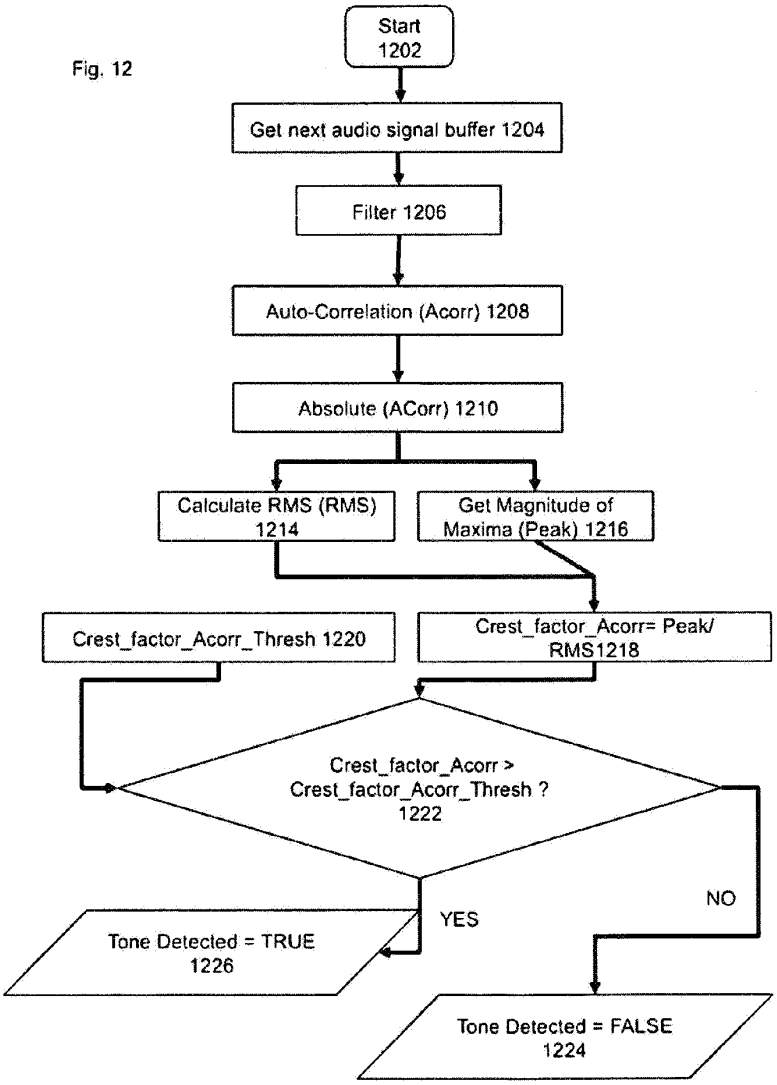

Start
1202
Get next audio signal buffer 1204
Filter 1206
Auto-Correlation (Acorr) 1208
Absolute (ACorr) 1210
Calculate RMS (RMS)
1214
Get Magnitude of
Maxima (Peak) 1216
Crest_factor_Acorr_Thresh 1220
Crest_factor_Acorr= Peak/
RMS1218
Crest_factor_Acorr >
Crest_factor_Acorr_Thresh ?
1222
YES
NO
Tone Detected = TRUE
1226
Tone Detected = FALSE
1224

Fig. 13

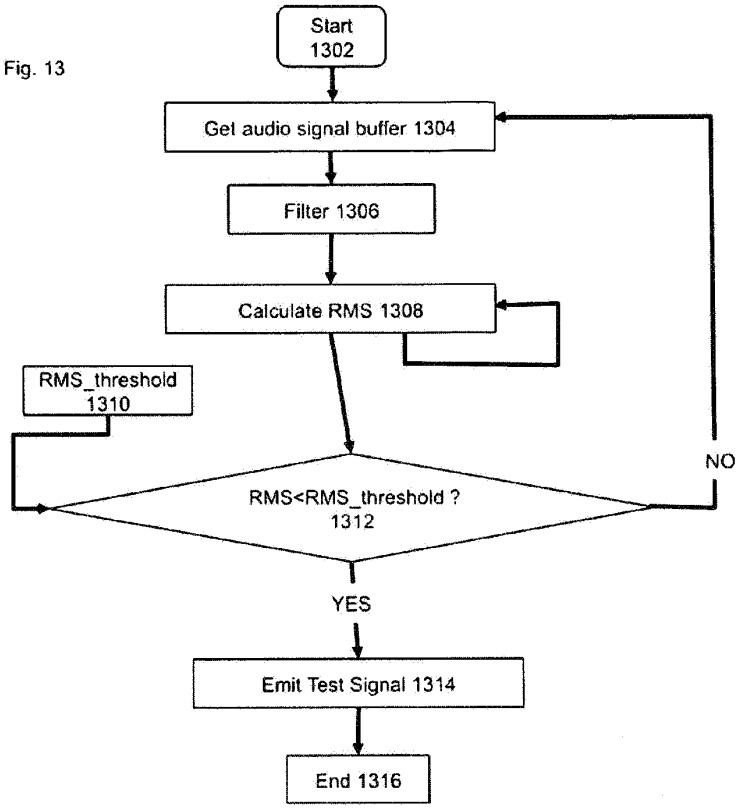

Start
1302
Get audio signal buffer 1304
Filter 1306
Calculate RMS 1308
RMS_threshold
1310
RMS<RMS_threshold ?
1312
NO
YES
Emit Test Signal 1314
End 1316

Fig. 14

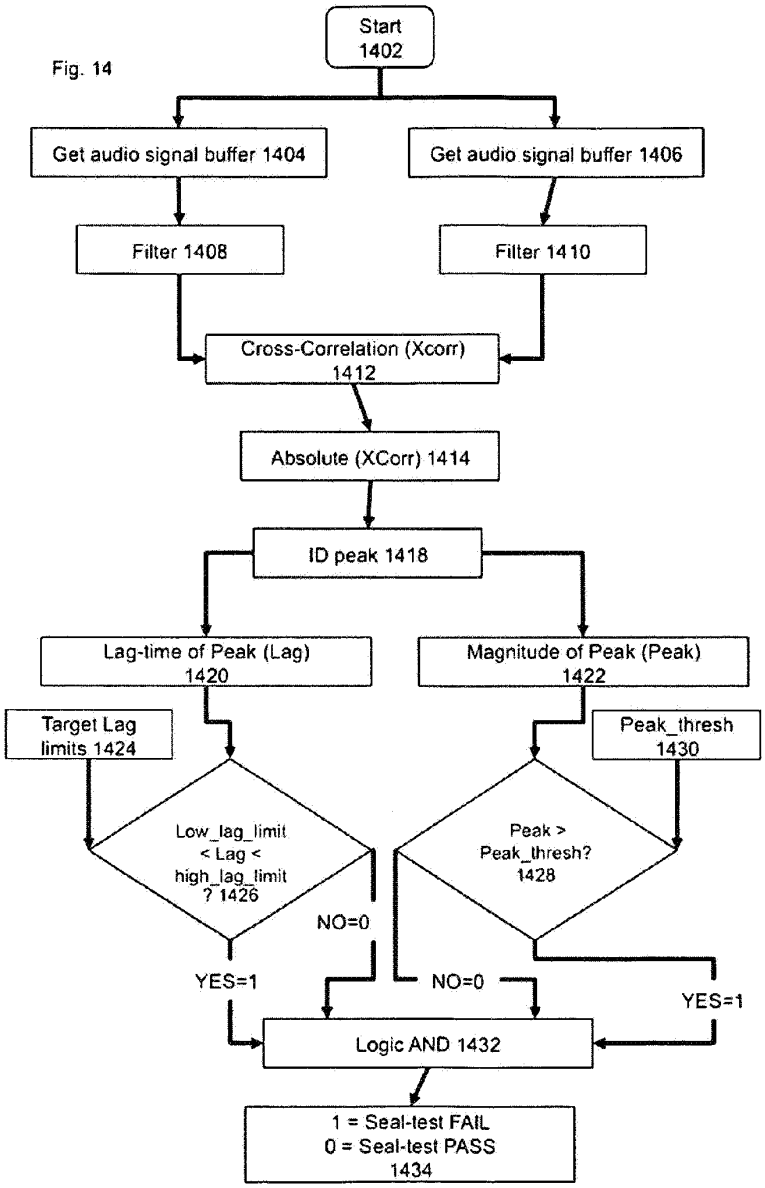

Start
1402
Get audio signal buffer 1404
Get audio signal buffer 1406
Filter 1408
Filter 1410
Cross-Correlation (Xcorr)
1412
Absolute (XCorr) 1414
ID peak 1418
Lag-time of Peak (Lag)
1420
Magnitude of Peak (Peak)
1422
Target Lag
limits 1424
Peak_thresh
1430
Low_lag_limit
< Lag <
high_lag_limit
? 1426
Peak >
Peak_thresh?
1428
NO=0
YES=1
NO=0
YES=1
Logic AND 1432
1 = Seal-test FAIL
0 = Seal-test PASS
1434

FIG. 15A

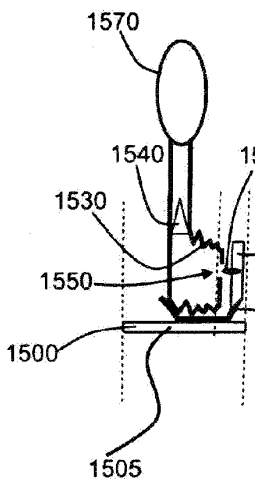


FIG. 15B

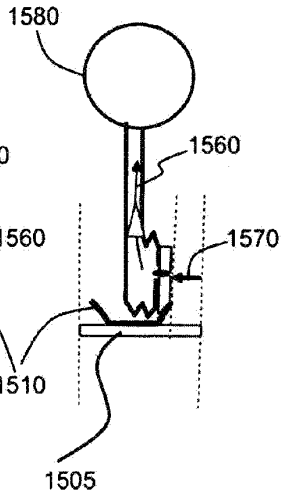
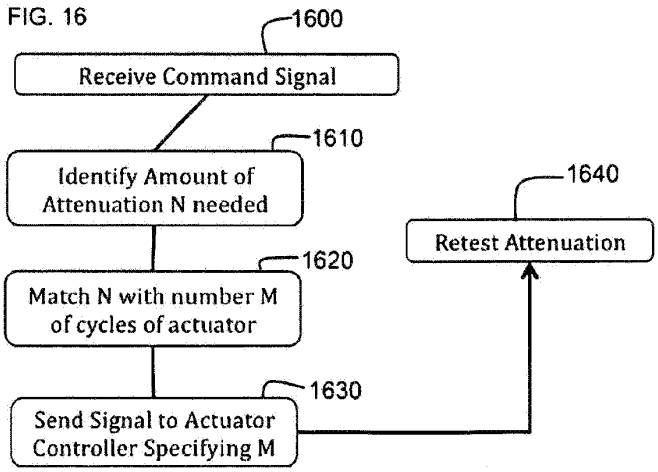


FIG. 16



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/182,570	02/23/2021	2654	830	CONT-16838277	19	2

CONFIRMATION NO. 5671

FILING RECEIPT

150139
Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

OC000000123820378

Date Mailed: 03/05/2021

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

John Usher, Devon, UNITED KINGDOM;
John P. Keady, Fairfax Station, VA;

Applicant(s)

Staton Techiya LLC, Lighthouse Point, FL

Assignment For Published Patent Application

Staton Techiya LLC, Lighthouse Point, FL

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 16/838,277 04/02/2020
which is a CON of 16/414,136 05/16/2019 PAT 10701499
which is a CON of 15/700,511 09/11/2017 PAT 10299053
which is a CON of 14/827,332 08/17/2015 PAT 9781530
which is a CON of 14/054,015 10/15/2013 PAT 9113267
which is a DIV of 12/555,864 09/09/2009 PAT 8600067
which claims benefit of 61/098,250 09/19/2008

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 03/04/2021

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/182,570**

Projected Publication Date: 06/10/2021

Non-Publication Request: No

Early Publication Request: No

** **SMALL ENTITY** **

Title

ACOUSTIC SEALING ANALYSIS SYSTEM

Preliminary Class

381

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 17/182,570

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	80		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	350		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	400		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =	*	x 50 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*	x 240 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	830		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/182,570	02/23/2021	John Usher	CONT-16838277

CONFIRMATION NO. 5671

150139
Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

PUBLICATION NOTICE



Title:ACOUSTIC SEALING ANALYSIS SYSTEM

Publication No.US-2021-0176576-A1
Publication Date:06/10/2021

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	17182570
Filing Date	2021-02-23
First Named Inventor	John Usher
Art Unit	OPAP
Examiner Name	UNKNOWN
Attorney Docket Number	CONT-16838277

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	6359993		2002-03-19	Brimhall	
	2	7072482		2006-07-04	Van Doorn et al.	
	3	7778434		2010-08-17	Juneau et al.	
	4	5524056		1996-06-04	Killion et al.	
	5	6415034		2002-07-02	Hietanen	
	6	8014553		2011-09-06	Radivojevic et al.	
	7	4088849		1978-05-09	Usami et al.	
	8	7209569		2007-04-24	Boesen	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	9	6754359		2004-06-22	Svean et al.	
	10	6021207		2000-02-01	Puthuff et al.	
	11	5267321		1993-11-30	Langberg	
	12	RE38351		2003-12-16	Iseberg et al.	
	13	7477756		2009-01-13	Wickstrom et al.	
	14	7450730		2008-11-11	Bertg et al.	
	15	6567524		2003-05-20	Svean et al.	
	16	6728385		2004-04-27	Kvaloy et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030165246		2003-09-04	Kvaloy et al.	

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	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	2	20080037801		2008-02-14	Alves et al.		
	3	20060204014		2006-09-14	Isenberg et al.		
	4	20050078838		2005-04-14	Simon		

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Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	First Named Inventor	John Usher
	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

CERTIFICATION STATEMENT

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

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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)	2022-01-10
Name/Print	John P. Keady	Registration Number	56389

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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)).

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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.

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First Named Inventor	John Usher
Art Unit	OPAP
Examiner Name	UNKNOWN
Attorney Docket Number	CONT-16838277

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	6804638		2004-10-12	Fiedler; Mark	
	2	6163508		2000-12-19	Kim et al.	
	3	6400652		2002-06-04	Goldberg et al.	
	4	7433714		2008-10-07	Howard et al.	
	5	7562020		2009-06-14	Le et al.	
	6	9135797		2015-09-15	Couper et al.	
	7	9123343		2015-09-01	Kurki-Suonio	
	8	7756285		2010-07-13	Sjursen et al.	

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	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	9	5903868		1999-05-11	Yuen et al.	
	10	3876843		1975-04-08	Moen	
	11	5208867		1993-05-04	Stites, III	
	12	6226389		2001-05-01	Lemelson et al.	
	13	8493204		2013-07-23	Wong et al.	
	14	6661901		2003-12-09	Svean et al.	
	15	7430299		2008-09-30	Armstrong et al.	
	16	6567524		2003-05-20	Svean et al.	
	17	7107109		2006-09-12	Nathan et al.	
	18	4947440		1990-08-07	Bateman et al.	
	19	9037458		2015-05-19	Park et al.	

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	Attorney Docket Number	CONT-16838277

	20	4054749		1977-10-18	Suzuki et al.	
	21	6298323		2001-10-02	Kaemmerer	
	22	6804643		2004-10-12	Kiss	
	23	6163338		2000-12-19	Johnson et al.	
	24	6748238		2004-06-08	Lau	
	25	6021325		2000-02-01	Hall	
	26	8750295		2014-06-10	Liron	
	27	7920557		2011-04-05	Moote	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030165246		2003-09-04	Kvaloy et al.	

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	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	2	20050288057		2005-12-29	Lai et al.	
	3	20060195322		2006-08-31	Broussard et al.	
	4	20070043563		2007-02-22	Comerford et al.	
	5	20010046304		2001-11-29	Rast	
	6	20070189544		2007-08-16	Rosenberg	
	7	20060092043		2006-05-04	Lagassey	
	8	20020106091		2002-08-08	Furst et al.	
	9	20040109668		2004-06-10	Stuckman	
	10	20020118798		2002-08-29	Langhart et al.	
	11	20040042103		2004-03-04	Mayer	
	12	20030161097		2003-08-28	Le et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	John Usher
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	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	13	20160104452		2016-04-14	Guan et al.	
	14	20040203351		2004-10-14	Shearer et al.	
	15	20080165988		2008-07-10	Terlizzi et al.	
	16	20070291953		2007-12-20	Ngia et al.	
	17	20110096939		2011-04-28	Ichimura	
	18	20060067551		2006-03-30	Cartwright et al.	
	19	20090024234		2009-01-22	Archibald	
	20	20090010456		2009-01-08	Goldstein et al.	
	21	20070086600		2007-04-19	Boesen	
	22	20040190737		2004-09-30	Kuhnel et al.	
	23	20040196992		2004-10-07	Ryan	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	24	20050123146		2005-06-09	Voix et al.	
	25	20040125965		2004-07-01	Alberth Jr., et al.	
	26	20060083395		2006-04-20	Allen et al.	
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	28	20100296668		2010-11-25	Lee et al.	
	29	20110293103		2011-12-01	Park et al.	
	30	20100061564		2010-03-11	Clemow et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	EP1519625	EP	A2		Victorian		
	2	2006037156	WO	A1		Mejia et al.		

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

NON-PATENT LITERATURE DOCUMENTS			Remove
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Olwal, A. and Feiner S. Interaction Techniques Using Prosodic Features of Speech and Audio Localization. Proceedings of IUI 2005 (International Conference on Intelligent User Interfaces), San Diego, CA, Jan 9-12, 2005, p. 284-286.	
	2	Bernard Widrow, John R. Glover Jr., John M. McCool, John Kaunitz, Charles S. Williams, Robert H. Hearn, James R. Zeidler, Eugene Dong Jr, and Robert C. Goodlin, Adaptive Noise Cancelling: Principles and Applications, PROCEEDINGS OF THE IEEE, VOL. 63, NO. 12, DECEMBER 1975	
	3	Mauro Dentino, John M. McCool, and Bernard Widrow, Adaptive Filtering in the Frequency Domain, PROCEEDINGS OF THE IEEE, VOL. 66, NO. 12, DECEMBER 1978	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

CERTIFICATION STATEMENT

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)	2022-01-10
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.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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.

Electronic Acknowledgement Receipt

EFS ID:	44707337
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	CONT-16838277
Receipt Date:	10-JAN-2022
Filing Date:	23-FEB-2021
Time Stamp:	15:07:09
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	17182570_transmittal_ltr.pdf	124895 75134c0da3f48d0fdbd74d6d8c89b51fc7b81e05	no	1

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	MASTER_HARWARE-IDS.pdf	1035152 9f1f7ba6626189771b374035f409adc6e1117470	no	6
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	MASTER_SOFTWARE-IDS.pdf	1036606 6155612effb85f771f9176b080ae9d42b1a8c11b	no	9
Warnings:					
Information:					
4	Non Patent Literature	ref2-pdf2.pdf	3762561 39646ce913fa97e4a1efb547fcce8a48fc8e6d08	no	10
Warnings:					
Information:					
5	Non Patent Literature	ref1.pdf	1115022 01c5b583e9d89f0e10dda2f41631f1a7c8c19dda	no	2
Warnings:					
Information:					
6	Non Patent Literature	ref3.pdf	2858776 2418fbe7a8c340eaa35ef3922c589767859789c3	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	9933012	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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.

National Stage of an International Application under 35 U.S.C. 371

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.

New International Application Filed with the USPTO as a Receiving Office

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	:	17/182,570	CONFIRMATION NO.	5671
APPLICATION OF	:	John Usher		

TRANSMITTAL LETTER

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Date: January 10, 2022

Sir:

Please find attached:

- **IDS:** The attached IDS, consisting of two parts, list references that were cited in several IPRs for related Patents with some of the same inventors in the Staton Techiya LLC Patent Portfolio. Applicant appreciates the Examiner for taking the time to consider the extensive list for the present application. Attached are also three non-patent references cited. Should the Examiner have any questions, the Examiner is respectfully requested to contact the undersigned representative at the telephone number listed below.

Respectfully submitted,

TECHIYA LLC

/John P. Keady/

John P. Keady
Ph.D. (Physics), Ph.D.(Comp. Sci.)
Assistant General Counsel: Intellectual Property
and Chief Technical Officer
Staton Techiya LLC
Reg. No. 56,389
Tel: 571-606-1291

Electronic Acknowledgement Receipt

EFS ID:	44861100
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	CONT-16838277
Receipt Date:	28-JAN-2022
Filing Date:	23-FEB-2021
Time Stamp:	11:44:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	17182570-PRELIMINARY-AMDT.pdf	175994 dd85e1e557280aef04c8188fa0516bd1dfc72b2c	no	5

Warnings:

Information:	
Total Files Size (in bytes):	175994

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New Applications Under 35 U.S.C. 111
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.
National Stage of an International Application under 35 U.S.C. 371
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.
New International Application Filed with the USPTO as a Receiving Office
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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	:	17/182,570	CONFIRMATION NO. 5671
APPLICATION OF	:	John Usher	
DATE FILED	:	23 Feb. 2021	
EXAMINER	:	UNKNOWN	
TC/A.U.	:	OPAP	
DOCKET	:	CONT-16838277	
TITLE	:	ACOUSTIC SEALING ANALYSIS SYSTEM	

PRELIMINARY AMENDMENT

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Date: January 28, 2022

Sir:

Please find herein a preliminary amendment, replacing the previously filed claims with new claims, for the above identified application. Please amend the above-identified patent application as follows:

- **Amendments to the Claims** begin on page 2 of this paper.

Should the Examiner believe that anything further is necessary, the Examiner is respectfully requested to contact the undersigned representative at the telephone number listed below.

Respectfully submitted,

TECHIYA LLC

Date: January 28, 2022

/John P. Keady/

John P. Keady
CTO and Assistant General Counsel IP
Ph.D (Physics), Ph.D(Comp. Sci), JD, MBA
Reg. No. 56,389
Va Bar No. 47027
571-606-1291

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

Claims 1-19 (cancelled)

20.(new) A wearable device that can test the seal quality of an earphone comprising:

a memory that stores instructions; and

a processor that executes the instructions to perform operations, the operations comprising:

generating a test signal, wherein the test signal includes frequency components between the range of 30Hz and 200Hz;

sending the test signal to a speaker of an earphone, wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user;

receiving a first microphone signal from the first microphone;

calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination;

comparing the value to a threshold to determine a seal quality between the first side and the second side;

generating a message to convey the seal quality; and

sending the message to the user.

21.(new) The wearable according to claim 1, wherein the message is an acoustic message.

22.(new) The wearable according to claim 1, wherein the message is a visual message sent to a display of the wearable device.

23.(new) The wearable according to claim 1, wherein the speaker plays the test signal from the first side.

24.(new) The wearable according to claim 23, wherein the first microphone measures sound from the first side.

25.(new) The wearable according to claim 23, wherein the first microphone measures sound from the second side.

26.(new) The wearable according to claim 1, wherein the first signal is the test signal and the second signal is the first microphone signal.

27.(new) The wearable according to claim 1, wherein the first signal is the test signal and the second signal is a modified microphone signal.

28.(new) The wearable according to claim 1, wherein the first signal is a modified test signal and the second signal is the first microphone signal.

29.(new) The wearable according to claim 1, wherein the first signal is a modified test signal and the second signal is a modified first microphone signal.

30.(new) The wearable according to claim 27, where the modified first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than 200Hz.

31.(new) The wearable according to claim 29, where the modified first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than 200Hz.

32.(new) The wearable according to claim 1, wherein the earphone includes a second microphone.

33.(new) The wearable according to claim 32, wherein the operations further include:

receiving a second microphone signal from the second microphone.

34.(new) The wearable device according to claim 33, wherein the first signal is the first microphone signal and the second signal is the second microphone signal.

35.(new) The wearable device according to claim 33, wherein the first signal is a modified first microphone signal and the second signal is the second microphone signal.

36.(new) The wearable device according to claim 33, wherein the first signal is a modified first microphone signal and the second signal is a modified second microphone signal.

37.(new) The wearable device according to claim 1, wherein the seal quality is good if the value is at or above the threshold.

38.(new) The wearable according to claim 36, wherein the first microphone measures sound from the first side and the second microphone measures sound from the second side.

39.(new) The audio device of claim 1, wherein the sealing section is composed of at least one of rubber, silicone, a flexible polymer, or a combination.

26.(new) The audio device of claim 25, wherein the eartip is a flexible polymer.

27.(new) The audio device according to claim 1, wherein the message is sent to a communication device connected to the audio device.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/182,570	Filing Date 02/23/2021	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $50 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $240 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	01/28/2022	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 22	Minus	** 20	= 2		x $50 =	100
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $240 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	100

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/TINA M. BELL/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. 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 12 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.

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UNITED STATES DEPARTMENT OF COMMERCE
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	CONT-16838277	5671

150139 7590 02/09/2022

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

EXAMINER	
KIM, PAUL	

ART UNIT	PAPER NUMBER
2654	

NOTIFICATION DATE	DELIVERY MODE
02/09/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ip@akerman.com
jp.keady@techiya.co
personics_docketing@cardinal-ip.com

Notice of Non-Compliant Amendment (37 CFR 1.121)	Application No. 17/182,570	Applicant(s) Usher et al.
	Art Unit OED2	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

The amendment document filed on 01/28/2022 is considered non-compliant because it has failed to meet the requirements of 37 CFR 1.121 or 1.4. In order for the amendment document to be compliant, correction of the following item(s) is required.

THE FOLLOWING MARKED (X) ITEM(S) CAUSE THE AMENDMENT DOCUMENT TO BE NON-COMPLIANT:

- ☐ 1. Amendments to the specification:
  - ☐ A. Amended paragraph(s) do not include markings.
  - ☐ B. New paragraph(s) should not be underlined.
  - ☐ C. Other _____ .
- ☐ 2. Abstract:
  - ☐ A.Not presented on a separate sheet. 37 CFR 1.72.
  - ☐ B.Other _____ .
- ☐ 3. Amendments to the drawings:
  - ☐ A. The drawings are not properly identified in the top margin as "Replacement Sheet", "New Sheet", or "Annotated Sheet" as required by 37 CFR 1.121(d).
  - ☐ B. The practice of submitting proposed drawing correction has been eliminated. Replacement drawings showing amended figures, without markings, in compliance with 37 CFR 1.84 are required .
  - ☐ C. Other _____ .
- ☑ 4. Amendments to the claims:
  - ☐ A. A complete listing of all of the claims is not present.
  - ☐ B. The listing of claims does not include the text of all pending claims (including withdrawn claims)
  - ☐ C. Each claim has not been provided with the proper status identifier, and as such, the individual status of each claim cannot be identified. Note: the status of every claim must be indicated after its claim number by using one of the following status identifiers: (Original), (Currently amended), (Canceled), (Previously presented), (New), (Not entered), (Withdrawn) and (Withdrawn-currently amended).
  - ☑ D. The claims of this amendment paper have not been presented in ascending numerical order.
  - ☐ E. Other: _____ .
- ☐ 5. Other (e.g., the amendment is unsigned or not signed in accordance with 37 CFR 1.4): For further explanation of the amendment format required by 37 CFR 1.121, see MPEP § 714.

TIME PERIODS FOR FILING A REPLY TO THIS NOTICE:

1. Applicant is given **no new time period** if the non-compliant amendment is an after-final amendment or an amendment filed after allowance, or a drawing submission (only) If applicant wishes to resubmit the non-compliant after-final amendment with corrections, the **entire corrected amendment** must be resubmitted.
2. Applicant is given **two months** from the mail date of this notice to supply the correction, if the non-compliant amendment is one of the following: a preliminary amendment, a non-final amendment (including a submission for a request for continued examination (RCE) under 37 CFR 1.114), a supplemental amendment filed within a suspension period under 37 CFR 1.103(a) or (c), and an amendment filed in response to a Quayle action. If any of above boxes 1 to 4 are checked, the correction required is only the corrected section of the non-compliant amendment in compliance with 37 CFR 1.121.

Extensions of time are available under 37 CFR 1.136(a) only if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action.

Failure to timely respond to this notice will result in:

Abandonment of the application if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action; or

Non-entry of the amendment if the non-compliant amendment is a preliminary amendment or supplemental amendment.

Legal Instruments Examiner (LIE), if applicable /TINA M. BELL/ Telephone No: (571)272-1553

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	CONT-16838277	5671

150139 7590 02/11/2022

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

EXAMINER	
KIM, PAUL	

ART UNIT	PAPER NUMBER
2654	

NOTIFICATION DATE	DELIVERY MODE
02/11/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ip@akerman.com
jp.keady@techiya.co
personics_docketing@cardinal-ip.com

NOTICE REQUIRING EXCESS CLAIMS FEES	Application No.	Applicant(s)
	17/182,570	Usher et al.
	Art Unit	AIA (FITF) Status
	OED2	Yes

The excess claim(s) filed on 28 January 2022 is/are not accompanied by the appropriate payment of excess claims fees set forth in 37 CFR 1.16(h)-(j) or 1.492(d)-(f). Excess claims fees are required for each claim in independent form in excess of three (§ 1.16(h)), each claim (whether dependent or independent) in excess of twenty (note that § 1.75(c) indicates how multiple dependent claims are considered for fee calculation purposes) (§ 1.16(i)), and each application that contains a multiple dependent claim (§ 1.16(j)).

Since the application is not under a final rejection, applicant is given a time period of **TWO (2) MONTHS** from the mailing date of this notice to submit either: (1) the fee payment of $ 100 , or (2) an amendment in compliance with 37 CFR 1.121 that cancels the excess claim(s), in order to avoid ABANDONMENT. Extensions of this time period may be granted under 37 CFR 1.136, unless the excess claim(s) was/were presented in a preliminary amendment.

☐ 1. The funds in Deposit Account No. _____ are insufficient to cover the entire fee due. The balance is due within the time period set forth in this notice. See note below regarding the appropriate service charge.

☐ 2. The Credit Card payment to cover the entire fee due to Account _____ (**Card type + last 4 digits ONLY**) was refused. The balance is due within the time period set forth in this notice. See note below regarding the appropriate service charge.

☑ 3. The amendment that includes the excess claim(s) has not been entered, since applicant has failed to remit (or authorize charge to a Deposit Account or Credit Card) the fee as indicated on the attached Patent Application Fee Determination Record (PTO/SB/06). Remittance or authorization is due within the time period set forth in this notice .

☐ 4. The fee submitted in this application is insufficient. A balance of $ _____ is due for presentation of excess claims (37 CFR 1.16(h)-(j) or 1.492(d)-(f)).

☑ 5. Other.

Explanation (*Provide specific details of the required correction in order to assist the applicant. Indicate whether a service charge has been added to the fee due*): Please submit $100 for two dependent claims over 20

THE AMOUNT OF THE FEE(S) DUE IS SUBJECT TO CHANGE, GENERALLY ON OCTOBER 1 OF EACH YEAR (37 CFR 1.16, 1.21 & 1.492). THE **AMOUNT OF THE FEE(S) DUE IS DETERMINED AS OF THE DATE A COMPLETE REPLY WITH THE APPROPRIATE FEE(S) IS RECEIVED BY THE OFFICE** (37 CFR 1.8 & 1.10). BECAUSE THE AMOUNT DUE IS SUBJECT TO CHANGE, IT IS RECOMMENDED THAT APPLICANT CHECK THE CURRENT FEE SCHEDULE WHICH IS AVAILABLE ON THE USPTOS WEBSITE AT: ***http://www.uspto.gov/web/offices/ac/qs/ope/fees.htm***

Service Charges: There is a $50 service charge for processing each payment refused (including a check returned unpaid) or charged back by a financial institution (37 CFR 1.21(m)). There is a $25.00 service charge for each month when the balance of a deposit account is below $1000 at the end of the month (37 CFR 1.21(b)(2)).

Technical Support Staff (TSS): /TINA M. BELL/ Phone Number: (571)272-1553

Note to TSS: Please do NOT use this notice if the application is under a final rejection.

Electronic Acknowledgement Receipt

EFS ID:	44986364
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	CONT-16838277
Receipt Date:	14-FEB-2022
Filing Date:	23-FEB-2021
Time Stamp:	12:08:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	17182570-PRELIMINARY-AMDT-2nd.pdf	184668 85c79b4e3a9ea663867a09033cefeb4650ab0069	no	6

Warnings:

Information:	
Total Files Size (in bytes):	184668

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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.

National Stage of an International Application under 35 U.S.C. 371

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.

New International Application Filed with the USPTO as a Receiving Office

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	:	17/182,570	CONFIRMATION NO. 5671
APPLICATION OF	:	John Usher	
DATE FILED	:	23 Feb. 2021	
EXAMINER	:	UNKNOWN	
TC/A.U.	:	OPAP	
DOCKET	:	CONT-16838277	
TITLE	:	ACOUSTIC SEALING ANALYSIS SYSTEM	

PRELIMINARY AMENDMENT

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Date: February 14, 2022

Sir: This preliminary amendment and response is filed in response to the notice of Additional Fees Due and Notice to the Applicant of 11 Feb. 2022, regarding an alleged non-compliant amendment filed 28 Jan. 2022. First note this preliminary amendment replaces the not entered preliminary amendment of 28 Jan. 2022. No fees are due since no additional independent claims nor claims over 20 have been added.

Please amend the above-identified patent application as follows:

- **Amendments to the Claims** begin on page 2 of this paper.

Should the Examiner believe that anything further is necessary, the Examiner is respectfully requested to contact the undersigned representative at the telephone number listed below.

Respectfully submitted,

TECHIYA LLC

Date: February 14, 2022

/John P. Keady/

John P. Keady
CTO and Assistant General Counsel IP
Ph.D (Physics), Ph.D(Comp. Sci), JD, MBA
Reg. No. 56,389
Va Bar No. 47027
571-606-1291

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1.(currently amended) An audio device configured to ~~monitor~~ test the seal ~~between a first side and a second side~~ of ~~the audio device~~ an earphone comprising:

~~a microphone configured to measure sound from a first side of the audio device;~~

~~a speaker, wherein the speaker is configured to emit an audio signal from the first side of the audio device;~~

~~a sealing section, configured to seal the audio device between the first side and a second side of the audio device;~~

a memory that stores instructions; and

a processor, ~~operatively connected to the microphone, where the processor is operatively connected to the speaker, where the processor is operatively connected to the memory,~~ wherein the processor is configured to execute the instructions to perform operations, the operations comprising:

~~sending a playback signal to the speaker;~~

~~receiving a microphone signal from the microphone;~~

~~comparing the microphone signal to the playback signal to generate a seal quality between the first and second sides; and~~

~~generating a filter to the playback signal based upon the seal quality~~

generating a test signal, wherein the test signal includes multiple frequency components, wherein at least one component lies between the range of 30Hz and 200Hz;

sending the test signal to a speaker of an earphone, wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user;

receiving a first microphone signal from the first microphone;

calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination;

comparing the value to a threshold to determine a seal quality between the first side and the second side;

generating a message to convey the seal quality; and

sending the message to the user.

.

2.(currently amended) The audio device according to claim 1, wherein the message is an acoustic message. ~~the operations further comprise:~~

~~applying the filter to the playback signal to generate a corrected playback signal.~~

3(currently amended). The audio device according to claim [[2]]1, wherein ~~the operations further comprise:~~

~~sending the corrected playback signal to the speaker~~ the message is a visual message sent to a display of the audio device.

4.(currently amended) The audio device according to claim [[3]]1, wherein the speaker plays the test signal from the first side. ~~seal quality is determined at least in part by comparing frequency components below 300Hz of the microphone signal and the playback signal.~~

5.(currently amended) The audio device according to claim 4, wherein the first microphone measures sound from the first side. ~~seal quality is determined at least in part by comparing frequency components below 200Hz of the microphone signal and playback~~ signal.

6.(currently amended) The audio device according to claim [[2]]4, wherein the first microphone measures sound from the second side. ~~the sealing section is a foam eartip.~~

7.(currently amended) The audio device according to claim [[2]]1, wherein the ~~microphone signal is buffered in the memory~~ first signal is the test signal and the second signal is the first microphone signal .

8.(currently amended) The audio device of claim [[2]]1, wherein the first signal is the test signal and the second signal is a modified first microphone signal. ~~audio device is a headphone.~~

9.(currently amended) The audio device of claim [[2]]1, wherein the first signal is a modified test signal and the second signal is the first microphone signal. ~~audio device is an earphone.~~

10.(currently amended) ~~An~~ The audio device according to claim 1, wherein the first signal is a modified test signal and the second signal is a modified first microphone signal. ~~comprising:~~

~~an ambient sound microphone configured to measure sound from an ambient side of the audio device;~~

~~an ear canal microphone configured to measure sound from an ear canal side of the audio device;~~

~~a speaker, wherein the speaker is configured to emit an audio signal;~~

~~a sealing section, configured to seal the audio device between the ambient side and the ear canal side of the audio device;~~

~~a memory that stores instructions; and~~

~~a processor connected to the microphone, where the processor is connected to the speaker, where the processor is connected to the memory, where the processor is configured to execute the instructions to perform operations, the operations comprising:~~

~~monitoring the seal quality of the audio device between the ear canal side and the ambient side for a period of time.~~

11.(currently amended) The audio device according to claim [[10]]8, ~~where the operations further comprise:~~

~~generating a playback correction to a playback signal.~~ wherein the modified first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200Hz.

12.(currently amended) The audio device according to claim [[11]]10, ~~where the operations further comprise:~~

~~generating an adjusted playback signal using the playback correction.~~ wherein the first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200Hz.

13.(currently amended) The audio device according to claim [[12]]1, wherein the earphone includes a second microphone. ~~where the operations further comprise:~~

~~sending the adjusted playback signal to the speaker.~~

14.(currently amended) The audio device according to claim [[10]]13, wherein the operations further comprise:

receiving a second microphone signal from the second microphone. ~~seal quality is determined at least in part by comparing frequency components below 1000Hz of the microphone signal and the playback signal.~~

15.(currently amended) The audio device according to claim 14, wherein the first signal is the fist microphone signal and the second signal is the second microphone signal. ~~microphone signal is buffered in the memory~~.

16.(currently amended) The audio device of claim [[10]]14, wherein the first signal is a modified first microphone signal and the second signal is the second microphone signal ~~the audio device is a headphone.~~

17.(currently amended) The audio device of claim [[10]]14, wherein the first signal is a modified first microphone signal and the second signal is a modified second microphone signal. ~~the audio device is an earphone.~~

18.(currently amended) The audio device of claim 1, wherein the seal quality is good if the value is at or above the threshold value. ~~earphone according to claim 17, where the sealing section is an eartip.~~

19.(currently amended) The audio device of claim 1, wherein the sealing section is composed of at least one of rubber, silicone, a flexible polymer, or a combination thereof. ~~The earphone according to claim 16, where the sealing section is a foam cup.~~

20.(new) The audio device of claim 1, wherein the sealing section is an eartip.

Electronic Patent Application Fee Transmittal

Application Number:	17182570
Filing Date:	23-Feb-2021
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Filer:	John Patrick Keady
Attorney Docket Number:	CONT-16838277

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2202	2	50	100
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Extension - 1 month with $0 paid	2251	1	110	110
Miscellaneous:				
		Total in USD ($)		**210**

Electronic Acknowledgement Receipt	
EFS ID:	45491649
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	CONT-16838277
Receipt Date:	18-APR-2022
Filing Date:	23-FEB-2021
Time Stamp:	09:14:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$210
RAM confirmation Number	E20224H016392405
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	Fee Worksheet (SB06)	fee-info.pdf	40145 b4eb4b5b9e2423c98b8b759c4d3ed0cc19ff8464	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	40145		

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New Applications Under 35 U.S.C. 111
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.
National Stage of an International Application under 35 U.S.C. 371
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.
New International Application Filed with the USPTO as a Receiving Office
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.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	2654
	Examiner Name	KIM, PAUL
	Attorney Docket Number	CONT-16838277

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	2654
	Examiner Name	KIM, PAUL
	Attorney Docket Number	CONT-16838277

	1	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00282, December 21, 2021	
	2	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00242, December 23, 2021	
	3	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00243, December 23, 2021	
	4	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00234, December 21, 2021	
	5	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00253, January 18, 2022	
	6	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00324, January 13, 2022	
	7	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00281, January 18, 2022	
	8	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00302, January 13, 2022	
	9	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00369, February 18, 2022	
	10	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00388, February 18, 2022	
	11	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00410, February 18, 2022	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	2654
	Examiner Name	KIM, PAUL
	Attorney Docket Number	CONT-16838277

If you wish to add additional non-patent literature document citation information please click the Add button	Add		
EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	2654
	Examiner Name	KIM, PAUL
	Attorney Docket Number	CONT-16838277

CERTIFICATION STATEMENT

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)	2022-04-18
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.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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.

Electronic Patent Application Fee Transmittal

Application Number:	17182570
Filing Date:	23-Feb-2021
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Filer:	John Patrick Keady
Attorney Docket Number:	CONT-16838277

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	130	130
		Total in USD ($)		**130**

Electronic Acknowledgement Receipt	
EFS ID:	45491763
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	CONT-16838277
Receipt Date:	18-APR-2022
Filing Date:	23-FEB-2021
Time Stamp:	09:34:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$130
RAM confirmation Number	E20224H036312556
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	Transmittal Letter	17182570-trns-ltr.pdf	120757 0717b14177481ca64618de0eef695d45328b12b9	no	1
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IPR-IDS.pdf	1034835 4df4ab5d46c07e582b2d4f74fcadc3a1651965d6	no	5
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, 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.					
3	Non Patent Literature	IPR1A.pdf	1065114 b32633d9277d1d5cbb0af2066ff5867d862385c1	no	80
Warnings:					
Information:					
4	Non Patent Literature	IPR2A.pdf	1943835 da801697fc2947375e698af3715a85d228c3169b	no	79
Warnings:					
Information:					
5	Non Patent Literature	IPR3A.pdf	1479136 586f5587012890efc764c06c62325f6658d3e6b0	no	80
Warnings:					
Information:					

6	Non Patent Literature	IPR4A.pdf	5856275 bbb6e06c8da39022bf9185c6f1f5e759e4c972a1	no	88
Warnings:					
Information:					
7	Non Patent Literature	IPR5A.pdf	8407299 889345276652cbf08e8b18236b62f4a383c4f305	no	93
Warnings:					
Information:					
8	Non Patent Literature	IPR6A.pdf	2934158 e3cdedca197bf8edfaca52fd01beac9ae8e9dc1f	no	96
Warnings:					
Information:					
9	Non Patent Literature	IPR7A.pdf	8015419 daf57ea06e8b5a9fac276fdf4986680d2d48e57a	no	91
Warnings:					
Information:					
10	Non Patent Literature	IPR8A.pdf	1207844 e3045ff9a612a959a7d0b32668a27ada07cb7f9f	no	79
Warnings:					
Information:					
11	Non Patent Literature	IPR9A.pdf	2841009 9ef3d0e90e5f4822674c42f5aafb0d7a2ac41139	no	84
Warnings:					
Information:					
12	Non Patent Literature	IPR10A.pdf	1712217 0fc9ba7b23d69dc17b42f5eceb527eae3739084f	no	58
Warnings:					
Information:					

13	Non Patent Literature	IPR11A.pdf	2025912 bc48559c25842c20f54e91f5b4ffb3950ac0ced29	no	84
Warnings:					
Information:					
14	Fee Worksheet (SB06)	fee-info.pdf	37649 8ebb3d755e40a8794ec9cdbf165a7576f626931c	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	38681459	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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.

National Stage of an International Application under 35 U.S.C. 371

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.

New International Application Filed with the USPTO as a Receiving Office

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	:	17/182,570	CONFIRMATION NO. 5671
APPLICATION OF	:	John Usher	
DATE FILED	:	23 Feb. 2021	
EXAMINER	:	KIM, PAUL	
TC/A.U.	:	2654	
DOCKET	:	CONT-16838277	
TITLE	:	ACOUSTIC SEALING ANALYSIS SYSTEM	

Transmittal Letter

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Date: April 18, 2022

Sir:

The attached IDS contains the IPRs whose references have already been previously submitted to the Examiner, however in the abundance of due diligence, Applicant has included the IPRs in the attached IDS for the Examiner's consideration. Note the Patent Owner POPR responses have not been included. Should the Examiner believe that anything further is necessary, the Examiner is respectfully requested to contact the undersigned representative at the telephone number listed below.

Respectfully submitted,

TECHIYA LLC

Date: April 18, 2022

/John P. Keady/
John P. Keady
Reg. No. 56,389
571-606-1291

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

150139 7590 11/16/2022

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

EXAMINER
KIM, PAUL

ART UNIT	PAPER NUMBER
2654	

DATE MAILED: 11/16/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	CONT-16838277	5671

TITLE OF INVENTION: ACOUSTIC SEALING ANALYSIS SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/16/2023

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PTOL-85 (Rev. 02/11)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

150139 7590 11/16/2022

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	CONT-16838277	5671

TITLE OF INVENTION: ACOUSTIC SEALING ANALYSIS SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/16/2023

EXAMINER	ART UNIT	CLASS-SUBCLASS
KIM, PAUL	2654	381-059000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1_____
2_____
3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	CONT-16838277	5671

150139 7590 11/16/2022

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

EXAMINER	
KIM, PAUL	
ART UNIT	**PAPER NUMBER**
2654	

DATE MAILED: 11/16/2022

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 30 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. 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.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
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.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
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.

Notice of Allowability	Application No. 17/182,570	Applicant(s) Usher et al.	
	Examiner PAUL KIM	Art Unit 2654	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 2/23/2021.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-20 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/PAUL KIM/
Primary Examiner, Art Unit 2654

DETAILED ACTION

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

EXAMINER'S AMENDMENT

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

The application has been amended as follows:

Claim 1 (amended): An audio device configured to test [[the]] a seal of an earphone comprising:

a memory that stores instructions; and

a processor, wherein the processor is configured to execute the instructions to perform operations, the operations comprising:

generating a test signal, wherein the test signal includes multiple frequency components, wherein at least one component lies between [[the]] a range of 30Hz and 200Hz;

sending the test signal to a speaker of an earphone, wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing

section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user,

receiving a first microphone signal from the first microphone;

calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination;

comparing the value to a threshold to determine a seal quality between the first side and the second side;

generating a message to convey the seal quality; and

sending the message to the user.

Claim 16 (amended): The audio device of claim 14, wherein the first signal is a modified first microphone signal and the second signal is the second microphone signal.

Allowable Subject Matter

The following is an examiner's statement of reasons for allowance:

Regarding independent claim 1, the closest prior art of record, Svean et al. (US Pat. 6567524) discloses an audio device configured to test a seal of an earphone comprising: a memory that stores instructions; and a processor, wherein the processor is configured to execute the instructions to perform operations, the operations comprising: wherein the earphone includes a first microphone, the speaker, and a

sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user, receiving a first microphone signal from the first microphone; determine a seal quality between the first side and the second side; generating a message to convey the seal quality; and sending the message to the user.

However, Svean fails to teach the combination of an audio device configured to test a seal of an earphone comprising: a memory that stores instructions; and a processor, wherein the processor is configured to execute the instructions to perform operations, the operations comprising: generating a test signal, wherein the test signal includes multiple frequency components, wherein at least one component lies between a range of 30Hz and 200Hz; sending the test signal to a speaker of an earphone, wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user, receiving a first microphone signal from the first microphone; calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination; comparing the value to a threshold to determine a seal quality between the first side and the second side; generating a message to convey the seal quality; and sending the message to the user. The distinct features, as disclosed in independent claim 1, render the claims allowable.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to PAUL KIM whose telephone number is (571)270-7697. The examiner can normally be reached on 9 AM - 5 PM, PST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, VIVIAN CHIN can be reached on (571) 272-7848. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/PAUL KIM/
Primary Examiner, Art Unit 2654

Notice of References Cited	Application/Control No. 17/182,570	Applicant(s)/Patent Under Reexamination Usher et al.	
	Examiner PAUL KIM	Art Unit 2654	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-6567524-B1	05-2003	Svean; Jarle	A61F11/08	381/317
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	**Art Unit**
	PAUL KIM	2654

CPC						
Symbol					**Type**	**Version**
H04R	/	29	/	001	F	2013-01-01
H04R	/	25	/	70	I	2013-01-01
H04R	/	1	/	1016	I	2013-01-01
H04R	/	1	/	1091	I	2013-01-01
H04R	/	29	/	00	I	2013-01-01
H04R	/	2460	/	15	A	2013-01-01
H04R	/	2460	/	07	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/PAUL KIM/ Primary Examiner, Art Unit 2654	05 November 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1,3

U.S. Patent and Trademark Office — Part of Paper No.: 20221105

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	**Art Unit**
	PAUL KIM	2654

INTERNATIONAL CLASSIFICATION					
CLAIMED					
H04R29/00	/	29	/	00	
H04R1/10	/	1	/	10	

NON-CLAIMED					
H04R25/00	/	25	/	00	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
381	59

CROSS REFERENCES(S)							
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**						
381	60	58					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 20	
/PAUL KIM/ Primary Examiner, Art Unit 2654 (Primary Examiner)	05 November 2022 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1,3

U.S. Patent and Trademark Office — Part of Paper No.: 20221105

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	Art Unit
	PAUL KIM	2654

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	11	10	19	19										
2	2	9	11	20	20										
3	3	12	12												
4	4	13	13												
5	5	14	14												
6	6	15	15												
7	7	16	16												
8	8	17	17												
10	9	18	18												

NONE (Assistant Examiner)	(Date)	Total Claims Allowed: 20	
/PAUL KIM/ Primary Examiner, Art Unit 2654 (Primary Examiner)	05 November 2022 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1,3

U.S. Patent and Trademark Office Part of Paper No.: 20221105

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	Art Unit
	PAUL KIM	2654

CPC - Searched*		
Symbol	Date	Examiner
H04R25/70 OR H04R29/001 OR H04R29/00 OR H04R2460/15 OR H04R1/1016 OR H04R1/1091 OR H04R2460/07	11/05/2022	PK

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
381	58, 59, 60	11/05/2022	PK

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

/PAUL KIM/ Primary Examiner, Art Unit 2654	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	Art Unit
	PAUL KIM	2654

Search Notes		
Search Notes	**Date**	**Examiner**
Inventor search - John Usher, John Keady	11/05/2022	PK
PE2E search - see PE2E search note	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 01/14/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 05/18/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 06/14/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 06/23/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 07/1/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 08/12/2022	11/05/2022	PK

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
	See attached search history	11/05/2022	PK

/PAUL KIM/ Primary Examiner, Art Unit 2654	

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	1	"17182570"	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 02:30 AM
L2	12	"12555864"	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 02:30 AM
L3	117	((("Staton") near3 ("Techiya") near3 ("LLC"))).AS,AANM.	(USPAT)	OR	ON	ON	2022/11/05 02:31 AM
L4	289	((("Usher") near3 ("John"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:32 AM
L5	149	((("Keady") near3 ("John") near3 ("P"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:32 AM
L6	245	((("Staton") near3 ("Techiya") near3 ("LLC"))).AS,AANM.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:33 AM
L7	917	(381/59).ccls.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:34 AM
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L9	5965	H04R1/1016	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:35 AM
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L12	2674	H04R25/70	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:35 AM
L13	8905	H04R29/00	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:36 AM
L14	892	H04R2460/07	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:36 AM
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L16	19612	L8 OR L9 OR L10 OR L12 OR L13 OR L14 OR l15	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:37 AM
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L19	1	"20060188105"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 04:47 AM
L20	128	"6567524"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 04:48 AM
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L22	42	("5142587"|"5764781"|"8774435"|"20050078838"|"5267321"|"6021207"|"7072482"|"10860287"|"7801318"|"8971561"|"9293128"|"7477756"|"20140247948"|"4020297"|"5319163"|"7688983"|"8550206"|"20080037801"|"6567524"|"6728385"|"6754359"|"20130177179"|"5138722"|"5712453"|"8774433"|"6321070"|"8401200"|"6415034"|"7450730"|"8014553"|"20140247952"|"20060204014"|"4088849"|"777834"|"RE38351"|"20180176681"|"9313572"|"6359993"|"9084060"|"20030165246"|"5524056"|"7209569").PN.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:01 PM
L23	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) SAME (generat$4 WITH test WITH signal$2 WITH multiple$2 WITH frequenc$5) SAME (microphone$2 WITH acoustic WITH barrier$2) SAME (calculat$4 WITH value$2 WITH (coherence OR correlation OR difference$2 OR cross-correlation)) SAME (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:08 PM
L24	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:09 PM

		earbud$2))) AND (generat$4 WITH test WITH signal$2 WITH multiple$2 WITH frequenc$5) AND (microphone$2 WITH acoustic WITH barrier$2) AND (calculat$4 WITH value$2 WITH (coherence OR correlation OR difference$2 OR cross-correlation)) AND (compar$4 WITH threshold WITH qualit$4)					
L25	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2) AND (microphone$2 WITH acoustic WITH barrier$2) AND (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:10 PM
L26	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2) AND (microphone$2 WITH acoustic WITH barrier$2)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:10 PM
L27	358040	((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5) OR (headset$2 OR earphone$2 OR headphone$2 OR	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:11 PM

		earpiece$2 OR earbud$2))					
L28	1606	L27 AND (test$4 WITH seal$3)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:12 PM
L29	422	L28 AND L16	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:13 PM
L30	65	L29 AND L21	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:13 PM
L31	119	L29 AND (test$3 near3 signal$2)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:15 PM
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L33	2215	L27 AND ((test$4 OR analy$3) WITH seal$3)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:16 PM
L34	706	I33 AND (test$3 near3 signal$2)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:17 PM
L35	123	L34 AND L16	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:17 PM
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L37	44	(Artificial Intelligence) Similar to: 16/838,277 with 0 CPC Selections and 0 Text Selections Text: (US-10986432-B2 OR EP-3646614-A1 OR WO-2019005492-A1 OR US-20190007762-A1 OR EP-2737720-A2 OR US-20220256270-A1 OR EP-2737720-B1 OR US-20200068283-A1 OR US-10972823-B2 OR WO-2013016336-A2 OR US-20210022996-A1 OR US-10462549-B2 OR US-8737669-B2 OR FR-3062014-A1 OR KR-102213388-B1 OR US-7837005-B2 OR CN-113491504-A OR JP-6037483-B2 OR KR-	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2022/11/05 05:19 PM

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L41	41	(Artificial Intelligence) More like doc: US-20060188105-A1 Text: (CA-2497710-A1 OR CA-2477010-C OR US-10645505-B2 OR AU-2002220394-B2 OR CN-100505921-C OR CN-1483298-A OR EP-4075830-A1 OR CN-112534221-A OR US-20090220099-A1 OR AU-2004310732-B2 OR US-20050123146-A1 OR CA-2952220-C OR AU-2004310732-A1 OR WO-2005055656-A1 OR EP-1702497-A1 OR CA-2549279-A1 OR CA-2549279-C OR US-8254586-B2 OR AU-2004310732-A2 OR US-20200196078-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/11/05 05:21 PM
L42	5	("2006/0188105").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:22 PM
L43	37	(Artificial Intelligence) More like doc: US-7801318-B2 Text: (US-20060285709-A1 OR EP-1737270-B2 OR EP-1737270-B1 OR EP-1737270-A1 OR DE-102005028742-B3 OR JP-H06189397-A OR AU-2008306923-B2 OR EP-2046073-B1 OR US-20100254555-A1 OR EP-0581261-B1 OR US-10009695-B2 OR AU-660818-B2 OR US-9432783-B2 OR EP-2661103-A1 OR JP-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/11/05 05:23 PM

		WO2010061539-A1 OR JP-4652488-B2 OR EP-0581261-A1 OR DK-1690252-T3 OR US-20130294610-A1 OR CA-2100015-A1).did.					
L44	21	("4689820" | "5259033" | "5402496" | "5524150" | "6219427" | "6398858" | "20020176584" | "20030161492" | "20040013280" | "20050047620" | "20050190929").pn. OR ("7801318").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:23 PM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) SAME (generat$4 WITH test WITH signal$2 WITH multiple$2 WITH frequenc$5) SAME (microphone$2 WITH acoustic WITH barrier$2) SAME (calculat$4 WITH value$2 WITH (coherence OR correlation OR difference$2 OR cross-correlation)) SAME (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/05 05:08 PM
N2	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/05 05:09 PM

		earbud$2))) AND (generat$4 WITH test WITH signal$2 WITH multiple$2 WITH frequenc$5) AND (microphone$2 WITH acoustic WITH barrier$2) AND (calculat$4 WITH value$2 WITH (coherence OR correlation OR difference$2 OR cross-correlation)) AND (compar$4 WITH threshold WITH qualit$4)					
N3	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2) AND (microphone$2 WITH acoustic WITH barrier$2) AND (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/05 05:10 PM
N4	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2) AND (microphone$2 WITH acoustic WITH barrier$2)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/05 05:10 PM

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	17182570
Filing Date	2021-02-23
First Named Inventor	John Usher
Art Unit	OPAP
Examiner Name	UNKNOWN
Attorney Docket Number	CONT-16838277

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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	6359993		2002-03-19	Brimhall	
	2	7072482		2006-07-04	Van Doorn et al.	
	3	7778434		2010-08-17	Juneau et al.	
	4	5524056		1996-06-04	Killion et al.	
	5	6415034		2002-07-02	Hietanen	
	6	8014553		2011-09-06	Radivojevic et al.	
	7	4088849		1978-05-09	Usami et al.	
	8	7209569		2007-04-24	Boesen	

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	First Named Inventor	John Usher
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	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	9	6754359		2004-06-22	Svean et al.	
	10	6021207		2000-02-01	Puthuff et al.	
	11	5267321		1993-11-30	Langberg	
	12	RE38351		2003-12-16	Iseberg et al.	
	13	7477756		2009-01-13	Wickstrom et al.	
	14	7450730		2008-11-11	Bertg et al.	
	15	6567524		2003-05-20	Svean et al.	
	16	6728385		2004-04-27	Kvaloy et al.	

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	1	20030165246		2003-09-04	Kvaloy et al.	

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	First Named Inventor	John Usher
	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	2	20080037801		2008-02-14	Alves et al.	
	3	20060204014		2006-09-14	Isenberg et al.	
	4	20050078838		2005-04-14	Simon	

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	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

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	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

CERTIFICATION STATEMENT

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)	2022-01-10
Name/Print	John P. Keady	Registration Number	56389

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Doc code: IDS
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
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Application Number	17182570
Filing Date	2021-02-23
First Named Inventor	John Usher
Art Unit	OPAP
Examiner Name	UNKNOWN
Attorney Docket Number	CONT-16838277

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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	6804638		2004-10-12	Fiedler; Mark	
	2	6163508		2000-12-19	Kim et al.	
	3	6400652		2002-06-04	Goldberg et al.	
	4	7433714		2008-10-07	Howard et al.	
	5	7562020		2009-06-14	Le et al.	
	6	9135797		2015-09-15	Couper et al.	
	7	9123343		2015-09-01	Kurki-Suonio	
	8	7756285		2010-07-13	Sjursen et al.	

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	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	9	5903868		1999-05-11	Yuen et al.	
	10	3876843		1975-04-08	Moen	
	11	5208867		1993-05-04	Stites, III	
	12	6226389		2001-05-01	Lemelson et al.	
	13	8493204		2013-07-23	Wong et al.	
	14	6661901		2003-12-09	Svean et al.	
	15	7430299		2008-09-30	Armstrong et al.	
	16	6567524		2003-05-20	Svean et al.	
	17	7107109		2006-09-12	Nathan et al.	
	18	4947440		1990-08-07	Bateman et al.	
	19	9037458		2015-05-19	Park et al.	

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	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	20	4054749		1977-10-18	Suzuki et al.	
	21	6298323		2001-10-02	Kaemmerer	
	22	6804643		2004-10-12	Kiss	
	23	6163338		2000-12-19	Johnson et al.	
	24	6748238		2004-06-08	Lau	
	25	6021325		2000-02-01	Hall	
	26	8750295		2014-06-10	Liron	
	27	7920557		2011-04-05	Moote	

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	1	20030165246		2003-09-04	Kvaloy et al.	

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	First Named Inventor	John Usher
	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	2	20050288057		2005-12-29	Lai et al.	
	3	20060195322		2006-08-31	Broussard et al.	
	4	20070043563		2007-02-22	Comerford et al.	
	5	20010046304		2001-11-29	Rast	
	6	20070189544		2007-08-16	Rosenberg	
	7	20060092043		2006-05-04	Lagassey	
	8	20020106091		2002-08-08	Furst et al.	
	9	20040109668		2004-06-10	Stuckman	
	10	20020118798		2002-08-29	Langhart et al.	
	11	20040042103		2004-03-04	Mayer	
	12	20030161097		2003-08-28	Le et al.	

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	Attorney Docket Number	CONT-16838277

	13	20160104452		2016-04-14	Guan et al.	
	14	20040203351		2004-10-14	Shearer et al.	
	15	20080165988		2008-07-10	Terlizzi et al.	
	16	20070291953		2007-12-20	Ngia et al.	
	17	20110096939		2011-04-28	Ichimura	
	18	20060067551		2006-03-30	Cartwright et al.	
	19	20090024234		2009-01-22	Archibald	
	20	20090010456		2009-01-08	Goldstein et al.	
	21	20070086600		2007-04-19	Boesen	
	22	20040190737		2004-09-30	Kuhnel et al.	
	23	20040196992		2004-10-07	Ryan	

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	Attorney Docket Number	CONT-16838277

	24	20050123146		2005-06-09	Voix et al.	
	25	20040125965		2004-07-01	Alberth Jr., et al.	
	26	20060083395		2006-04-20	Allen et al.	
	27	20110264447		2011-10-27	Visser et al.	
	28	20100296668		2010-11-25	Lee et al.	
	29	20110293103		2011-12-01	Park et al.	
	30	20100061564		2010-03-11	Clemow et al.	

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	1	EP1519625	EP	A2		Victorian		
	2	2006037156	WO	A1		Mejia et al.		

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	1	Olwal, A. and Feiner S. Interaction Techniques Using Prosodic Features of Speech and Audio Localization. Proceedings of IUI 2005 (International Conference on Intelligent User Interfaces), San Diego, CA, Jan 9-12, 2005, p. 284-286.	
	2	Bernard Widrow, John R. Glover Jr., John M. McCool, John Kaunitz, Charles S. Williams, Robert H. Hearn, James R. Zeidler, Eugene Dong Jr, and Robert C. Goodlin, Adaptive Noise Cancelling: Principles and Applications, PROCEEDINGS OF THE IEEE, VOL. 63, NO. 12, DECEMBER 1975	
	3	Mauro Dentino, John M. McCool, and Bernard Widrow, Adaptive Filtering in the Frequency Domain, PROCEEDINGS OF THE IEEE, VOL. 66, NO. 12, DECEMBER 1978	

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OR

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See attached certification statement.

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Signature	/John P. Keady/	Date (YYYY-MM-DD)	2022-01-10
Name/Print	John P. Keady	Registration Number	56389

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
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Application Number	
Filing Date	
First Named Inventor	John Usher
Art Unit	
Examiner Name	Unknown
Attorney Docket Number	CONT-16838277

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	7801318		2010-09-21	Barthel	
	2	8774433		2014-07-08	Goldstein	
	3	7801318		2010-09-21	Barthel, Roland	
	4	8401200		2009-11-19	Tiscareno	
	5	5138722		2010-09-21	Urella	
	6	5764781		1998-06-09	Ding	
	7	6321070		2001-11-20	Clark	
	8	9293128		2016-03-22	Goldstein	

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	Examiner Name	Unknown
	Attorney Docket Number	CONT-16838277

	9	4020297		1977-04-26	Brodie S Dan	
	10	5142587		1992-08-25	Kobayashi	
	11	5319163		1994-06-07	Scott	
	12	5712453		1998-01-27	Bungardt	
	13	9084060		2015-07-14	Liu	
	14	8774435		2014-07-08	Ambrose	
	15	7688983		2010-03-30	Voix	
	16	8550206		2013-10-08	Keady	
	17	10860287		2020-12-08	Konagai	
	18	8971561		2015-03-03	Howes et al.	
	19	9313572		2016-04-12	Dusan et al.	

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	1	20140247948		2014-09-04	Goldstein	
	2	20140247952		2014-09-04	Goldstein	
	3	20130177179		2013-07-11	Ambrose	
	4	20180176681		2018-06-21	Asada	

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	1	107071123	CN		2017-08-18			

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	Examiner Name	Unknown
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Bibliographic Data

Application No: 17/182,570

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /PAUL KIM/ (Examiner's Signature) (Initials)

Title: ACOUSTIC SEALING ANALYSIS SYSTEM

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
02/23/2021	381	2654	CONT-16838277
RULE			

APPLICANTS

Staton Techiya LLC, Lighthouse Point, FL, UNITED STATES

INVENTORS

John Usher, Devon, UNITED KINGDOM

John P. Keady, Fairfax Station, VA, UNITED STATES

CONTINUING DATA

This application is a CON of 16838277 04/02/2020 PAT 10979836

16838277 is a CON of 16414136 05/16/2019 PAT 10701499

16414136 is a CON of 15700511 09/11/2017 PAT 10299053

15700511 is a CON of 14827332 08/17/2015 PAT 9781530

14827332 is a CON of 14054015 10/15/2013 PAT 9113267

14054015 is a DIV of 12555864 09/09/2009 PAT 8600067

12555864 has PRO of 61098250 09/19/2008

FOREIGN APPLICATIONS

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Akerman LLP

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UNITED STATES

FILING FEE RECEIVED

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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Filing Date	2021-02-23
First Named Inventor	John Usher
Art Unit	2654
Examiner Name	KIM, PAUL
Attorney Docket Number	CONT-16838277

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	1	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00282, December 21, 2021	
	2	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00242, December 23, 2021	
	3	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00243, December 23, 2021	
	4	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00234, December 21, 2021	
	5	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00253, January 18, 2022	
	6	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00324, January 13, 2022	
	7	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00281, January 18, 2022	
	8	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00302, January 13, 2022	
	9	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00369, February 18, 2022	
	10	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00388, February 18, 2022	
	11	SAMSUNG ELECTRONICS CO., LTD., and SAMSUNG ELECTRONICS, AMERICA, INC., v. STATON TECHIYA, LLC, IPR2022-00410, February 18, 2022	

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.K/

DocCode - SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 17182570 Document Date: 11/18/2022

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

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Form Revision Date: March 1, 2019

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	17/182,570	Filing Date	2021-02-23	Docket Number (if applicable)	CONT-16838277	Art Unit	2654
First Named Inventor	John Usher			Examiner Name	Kim, Paul		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☐ Other _____

☒ Enclosed

☐ Amendment/Reply

☐ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☒ Other IDS, Replacement Sheets 1-15

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☐ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No _____

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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.

Signature of Registered U.S. Patent Practitioner			
Signature	/John P. Keady/	Date (YYYY-MM-DD)	2022-11-18
Name	John P. Keady	Registration Number	56389

This collection of information is required by 37 CFR 1.114. 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 12 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.

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

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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)).

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17182570
Filing Date	2021-02-23
First Named Inventor	John Usher
Art Unit	2654
Examiner Name	KIM, PAUL
Attorney Docket Number	CONT-16838277

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	2654
	Examiner Name	KIM, PAUL
	Attorney Docket Number	CONT-16838277

	1	90/015,146, Samsung Electronics Co., Ltd. and Samsung Electronics, America, Inc., REQUEST FOR EX PARTE REEXAMINATION OF U.S. PATENT NO. 10,979,836

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	John Usher
	Art Unit	2654
	Examiner Name	KIM, PAUL
	Attorney Docket Number	CONT-16838277

CERTIFICATION STATEMENT

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)	2022-11-18
Name/Print	John P. Keady	Registration Number	56389

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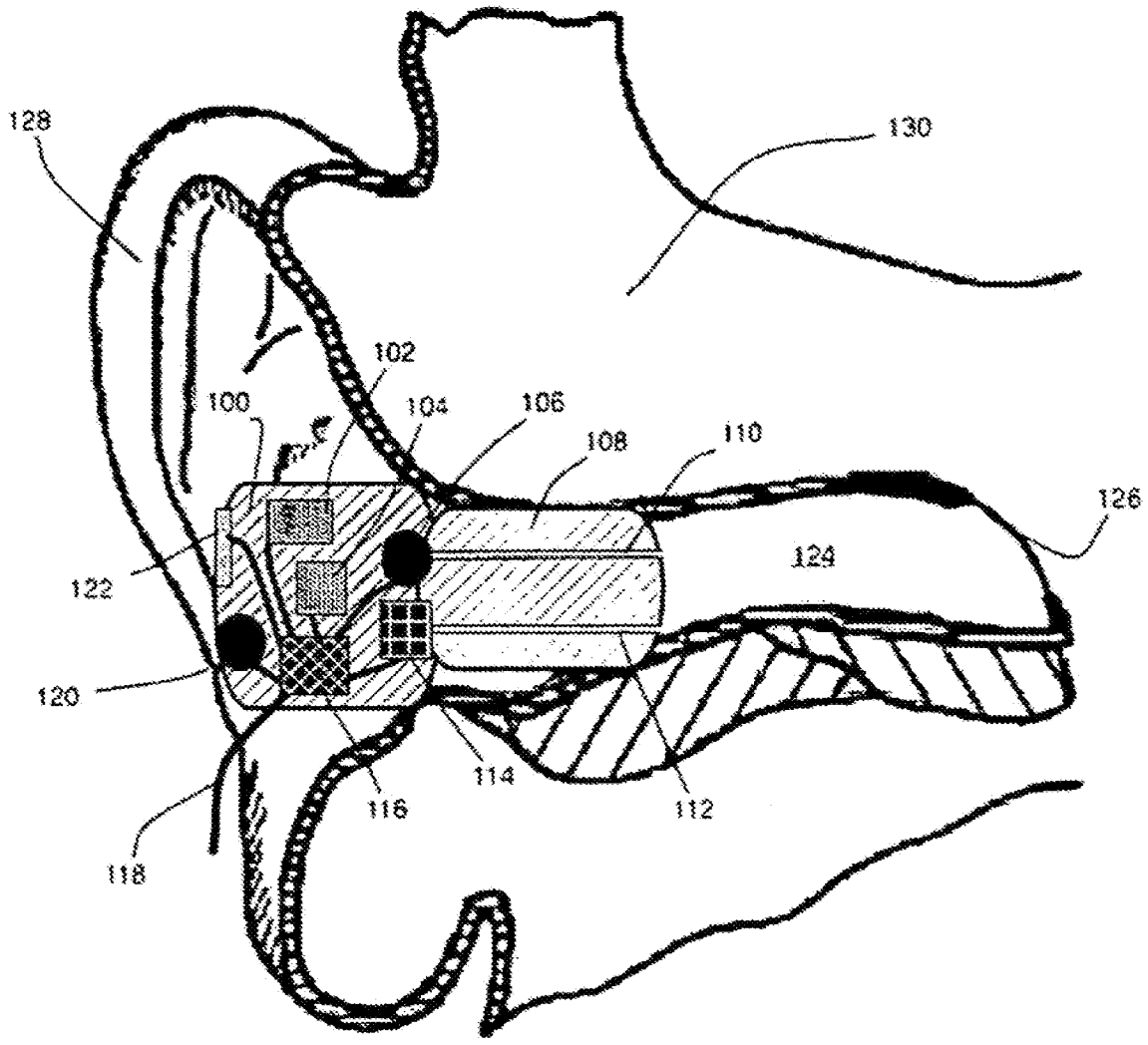
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FIG 1



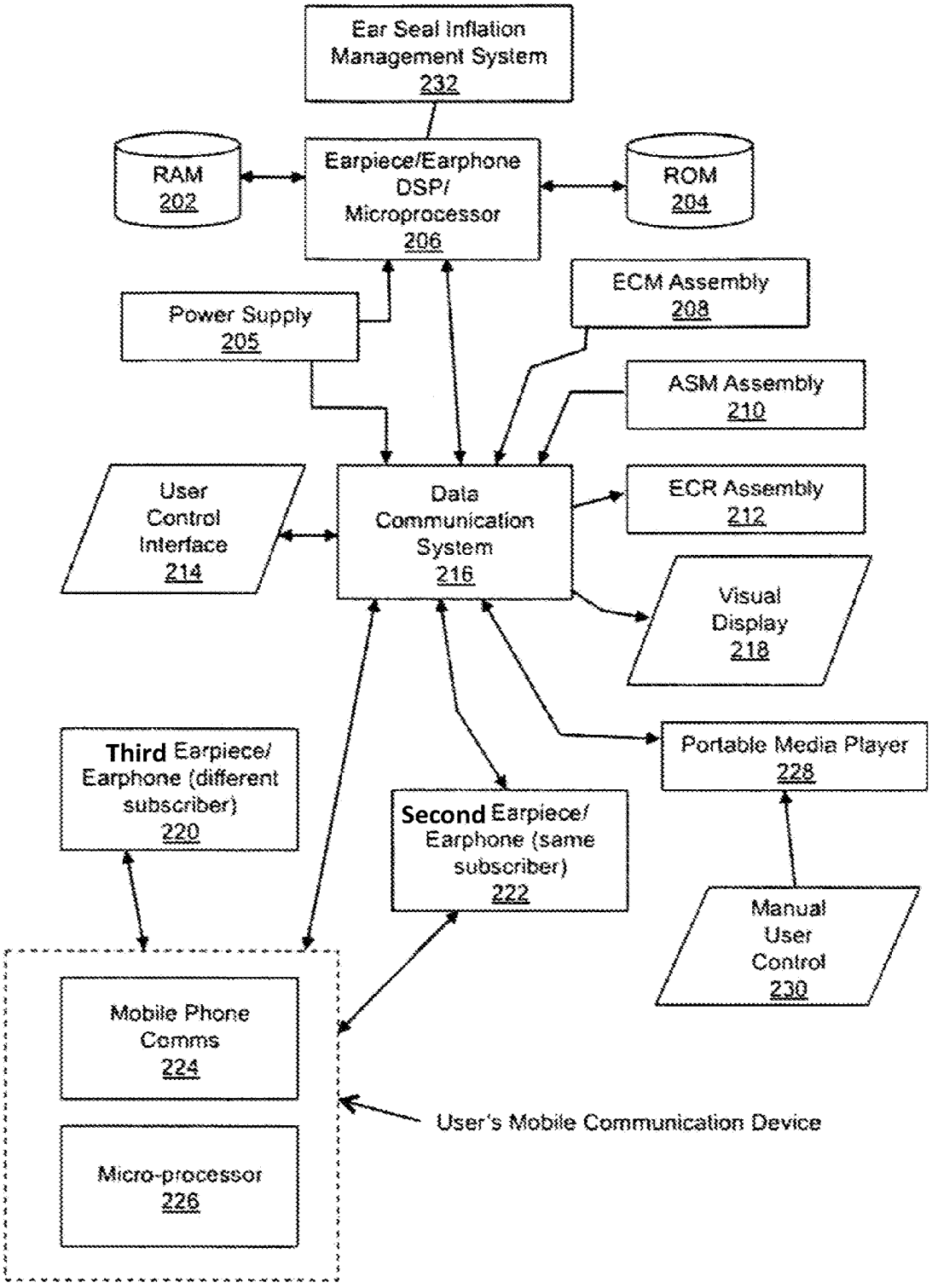

Ear Seal Inflation Management System 232
RAM 202
Earpiece/Earphone DSP/ Microprocessor 206
ROM 204
Power Supply 205
ECM Assembly 208
ASM Assembly 210
User Control Interface 214
Data Communication System 216
ECR Assembly 212
Visual Display 218
Third Earpiece/ Earphone (different subscriber) 220
Second Earpiece/ Earphone (same subscriber) 222
Portable Media Player 228
Manual User Control 230
Mobile Phone Comms 224
Micro-processor 226
User's Mobile Communication Device

FIG. 2

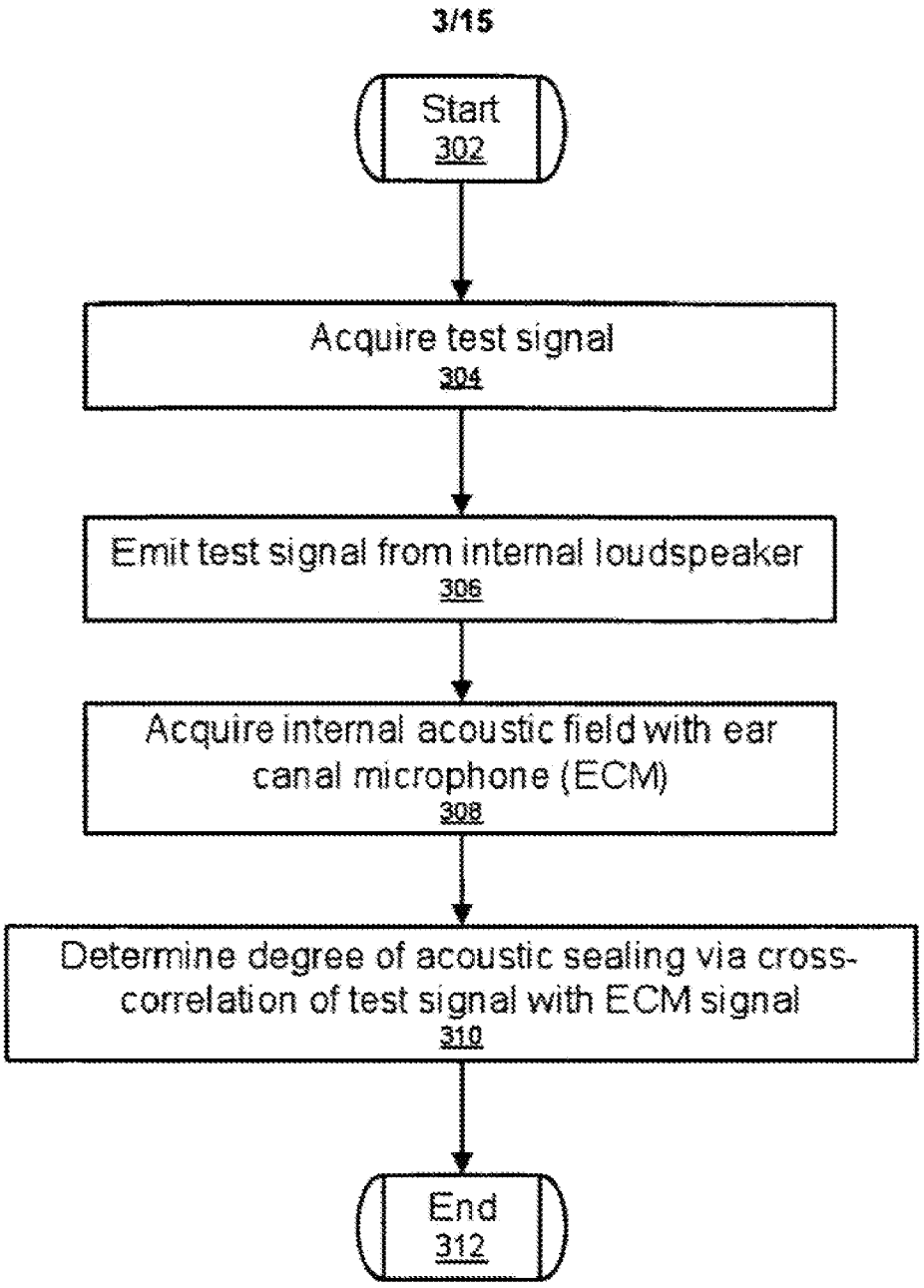

3/15
Start
302
Acquire test signal
304
Emit test signal from internal loudspeaker
306
Acquire internal acoustic field with ear canal microphone (ECM)
308
Determine degree of acoustic sealing via cross-correlation of test signal with ECM signal
310
End
312

FIG. 3

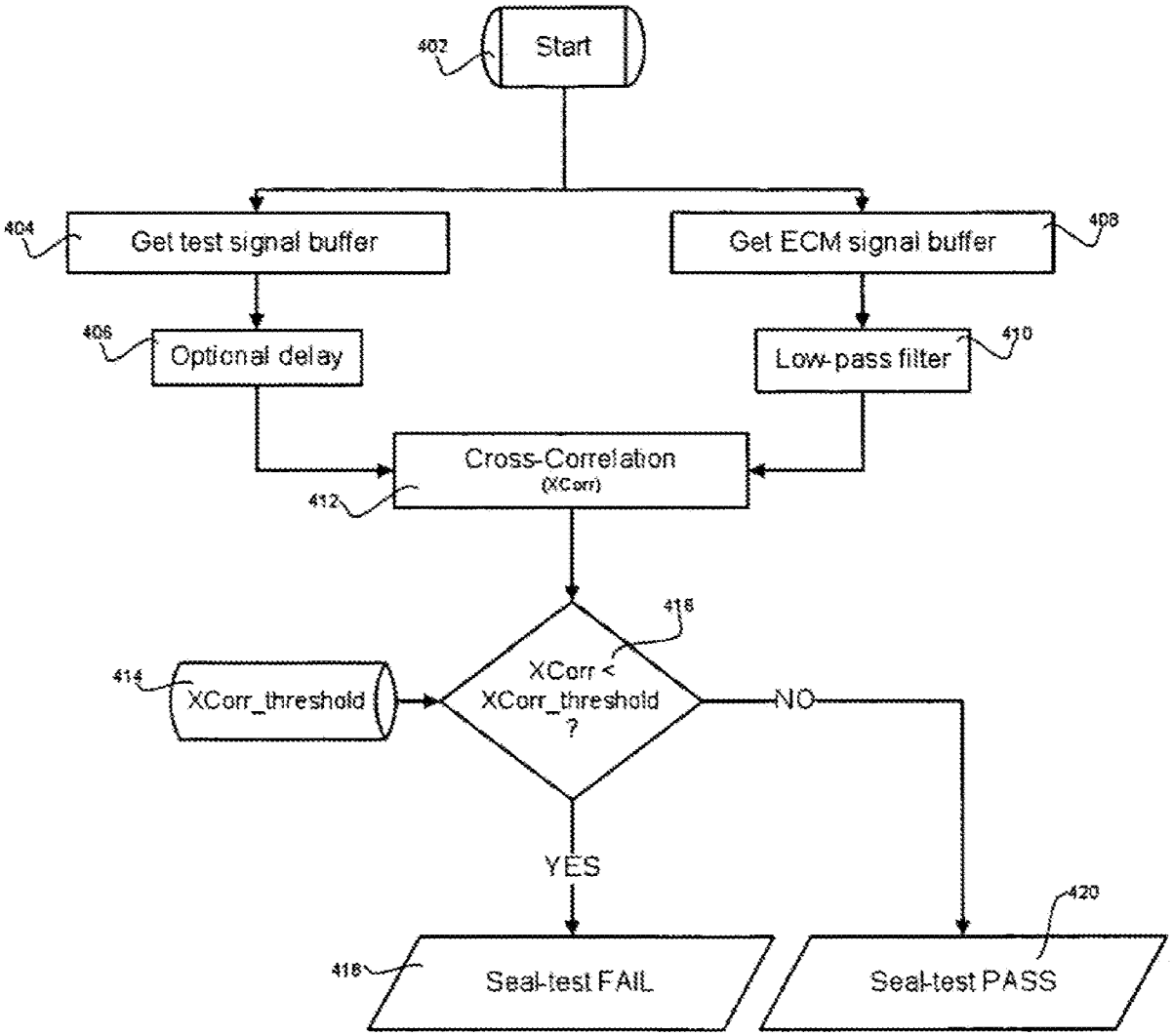

402
Start
404
Get test signal buffer
408
Get ECM signal buffer
406
Optional delay
410
Low-pass filter
Cross-Correlation
(XCorr)
412
418
XCorr <
XCorr_threshold
?
414
XCorr_threshold
NO
YES
420
416
Seal-test FAIL
Seal-test PASS

FIG. 4

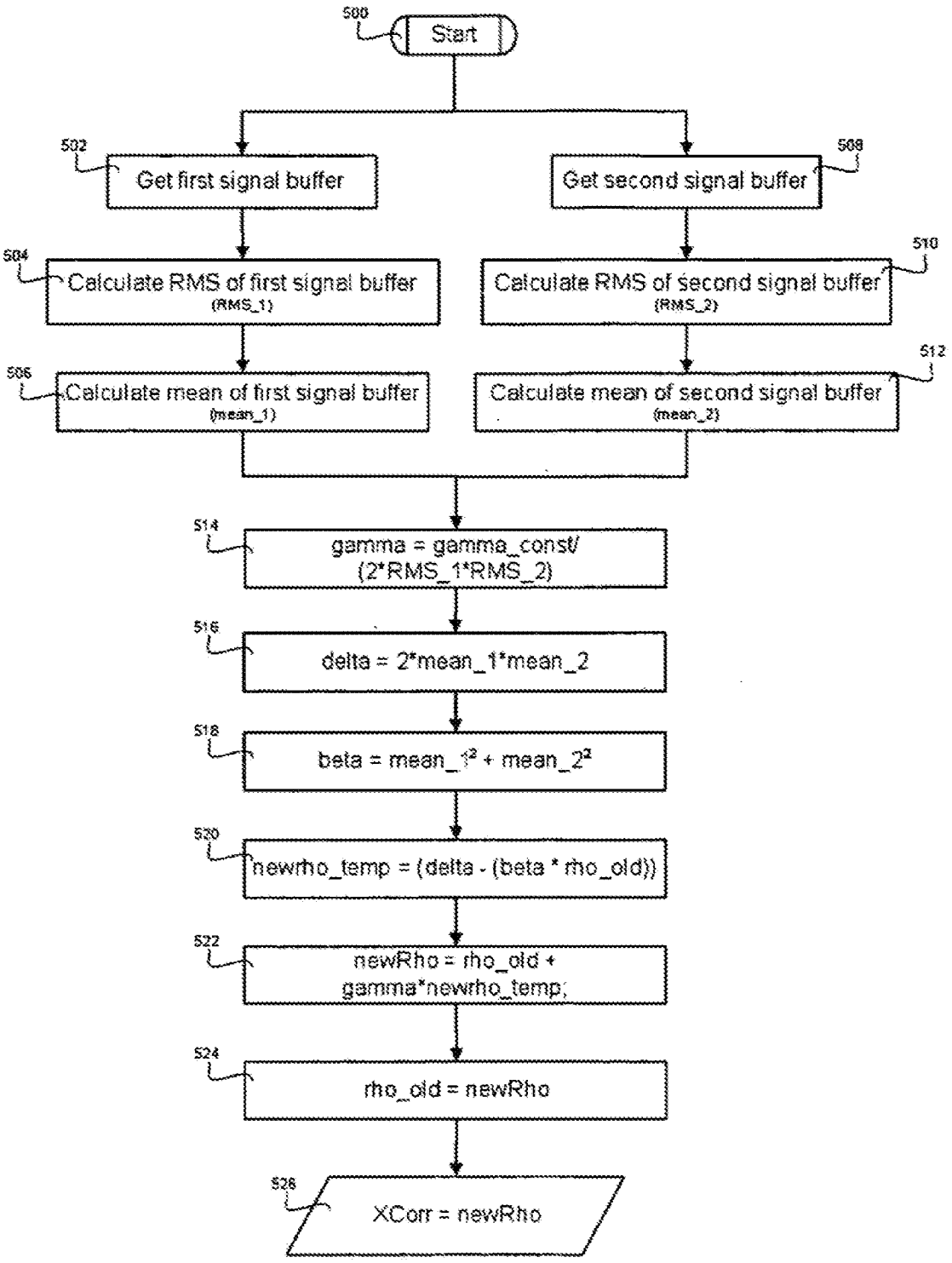

500
Start
502
Get first signal buffer
508
Get second signal buffer
504
Calculate RMS of first signal buffer
(RMS_1)
510
Calculate RMS of second signal buffer
(RMS_2)
506
Calculate mean of first signal buffer
(mean_1)
512
Calculate mean of second signal buffer
(mean_2)
514
gamma = gamma_const/
(2*RMS_1*RMS_2)
516
delta = 2*mean_1*mean_2
518
beta = mean_1^2 + mean_2^2
520
newrho_temp = (delta - (beta * rho_old))
522
newRho = rho_old +
gamma*newrho_temp;
524
rho_old = newRho
526
XCorr = newRho

FIG.5

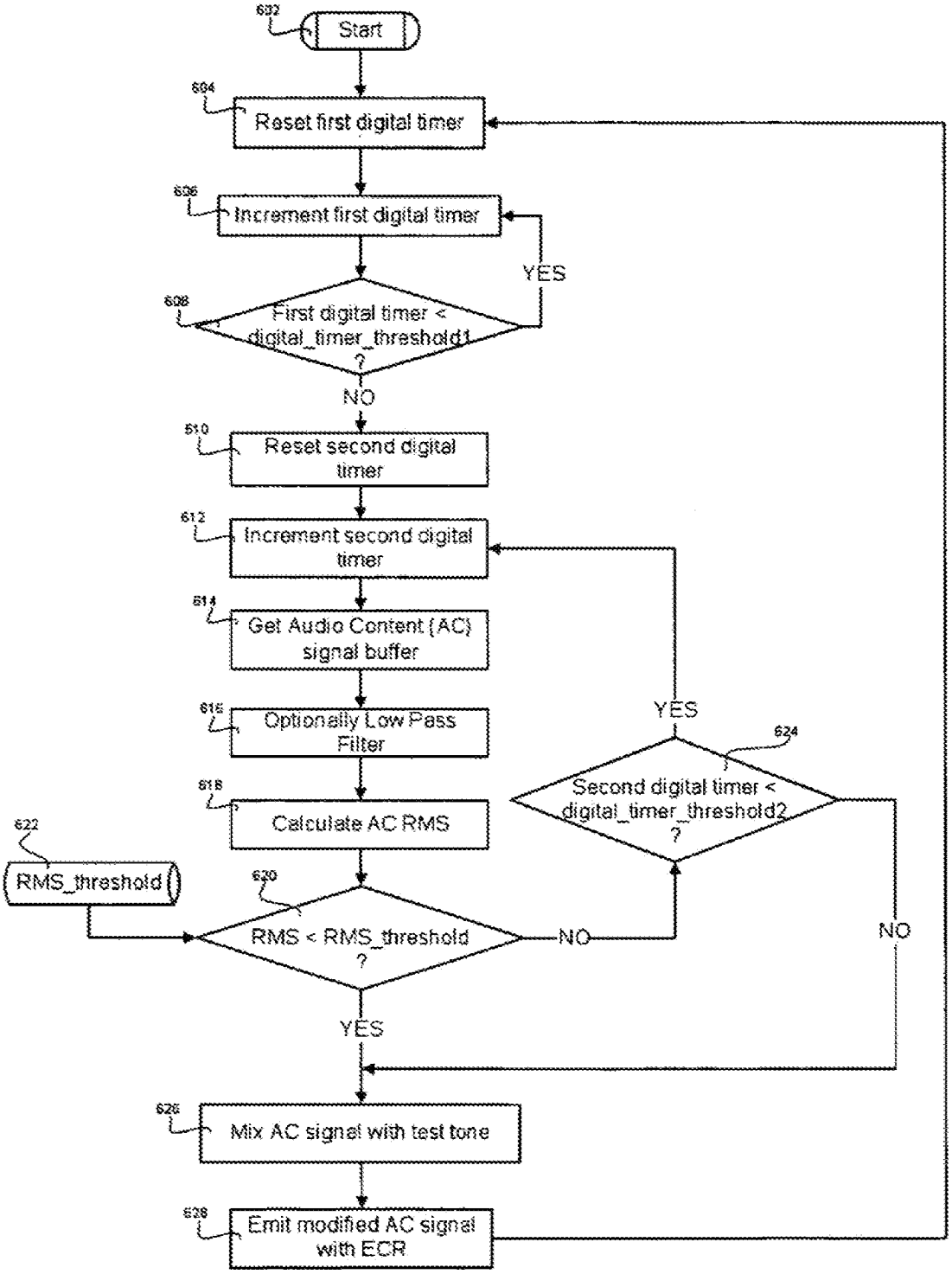

602
Start
604
Reset first digital timer
606
Increment first digital timer
YES
608
First digital timer < digital_timer_threshold1 ?
NO
610
Reset second digital timer
612
Increment second digital timer
614
Get Audio Content (AC) signal buffer
616
Optionally Low Pass Filter
618
Calculate AC RMS
622
RMS_threshold
620
RMS < RMS_threshold ?
NO
YES
624
Second digital timer < digital_timer_threshold2 ?
YES
NO
626
Mix AC signal with test tone
628
Emit modified AC signal with ECR

FIG. 6

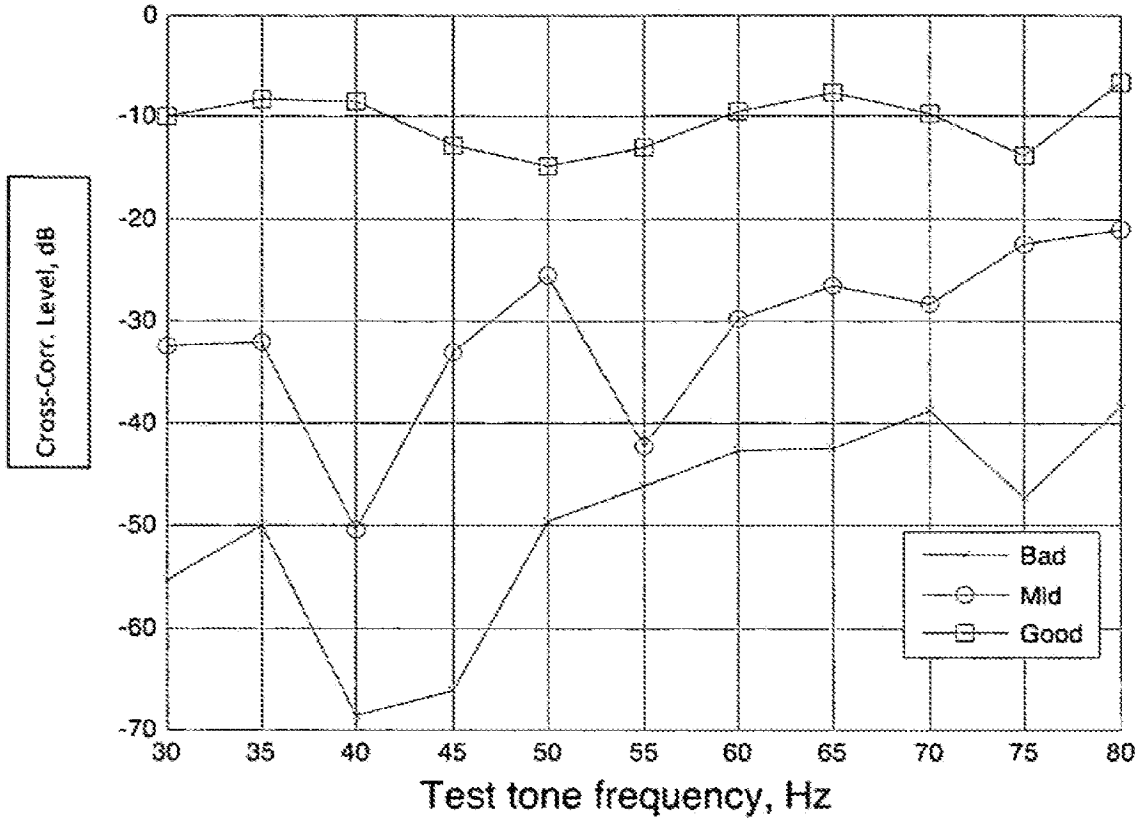

Cross-Corr. Level, dB
0
-10
-20
-30
-40
-50
-60
-70
30
35
40
45
50
55
60
65
70
75
80
Test tone frequency, Hz
Bad
Mid
Good

FIG. 7

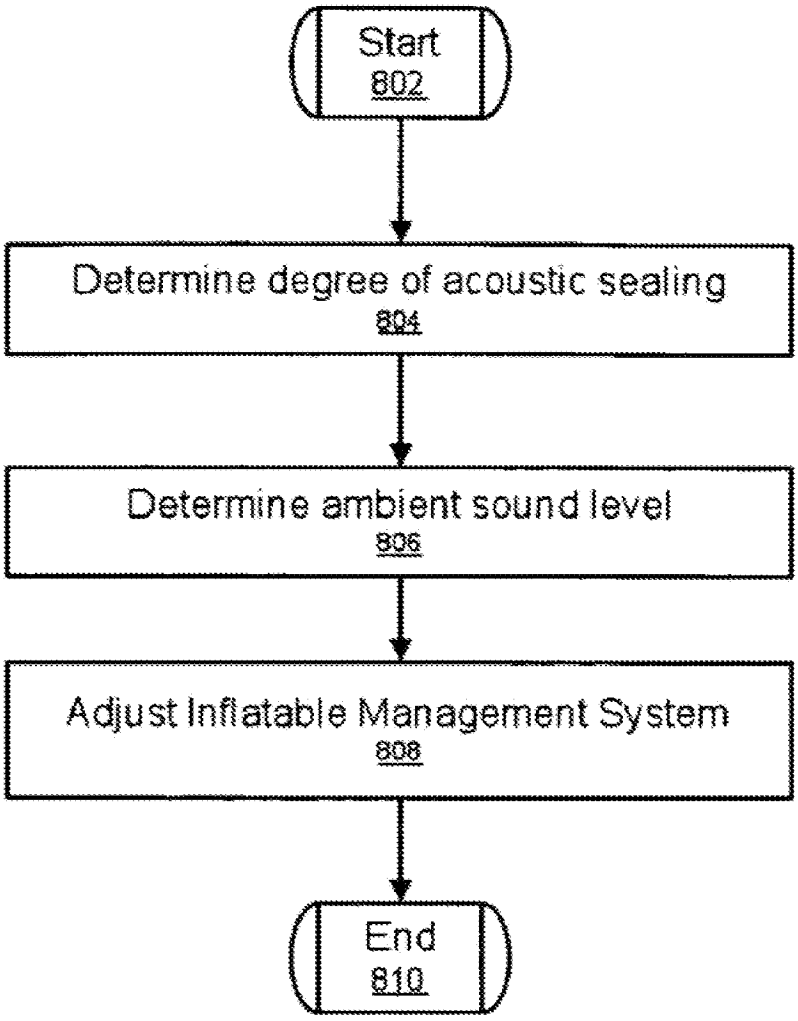

Start
802
Determine degree of acoustic sealing
804
Determine ambient sound level
806
Adjust Inflatable Management System
808
End
810

FIG. 8

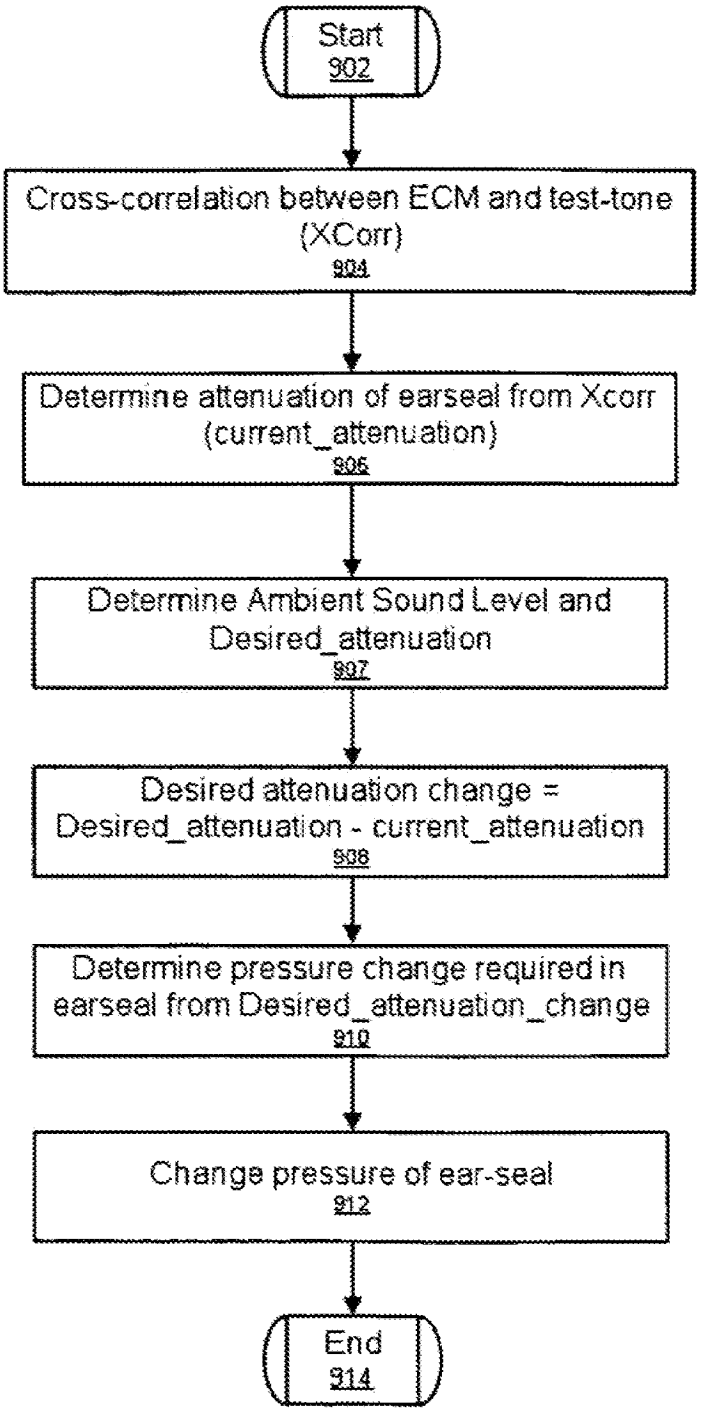

Start
902
Cross-correlation between ECM and test-tone (XCorr)
904
Determine attenuation of earseal from Xcorr (current_attenuation)
906
Determine Ambient Sound Level and Desired_attenuation
907
Desired attenuation change = Desired_attenuation - current_attenuation
908
Determine pressure change required in earseal from Desired_attenuation_change
910
Change pressure of ear-seal
912
End
914

FIG. 9

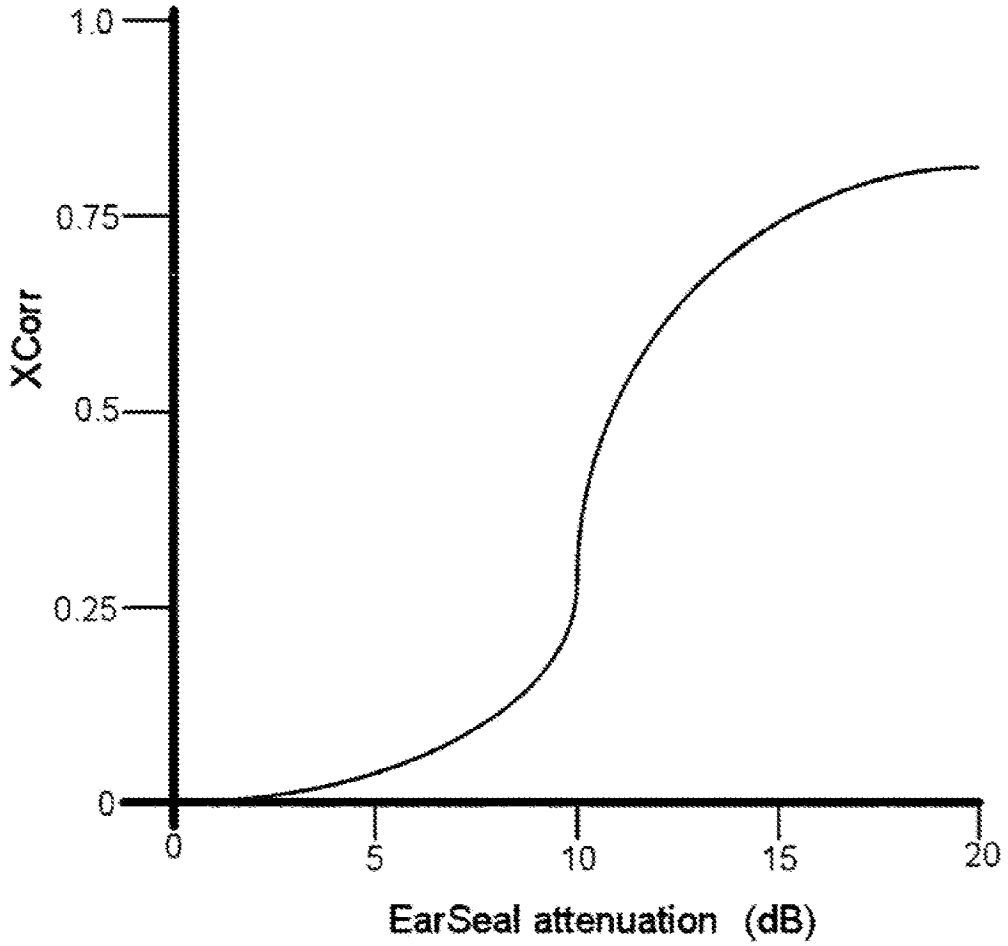


FIG. 10

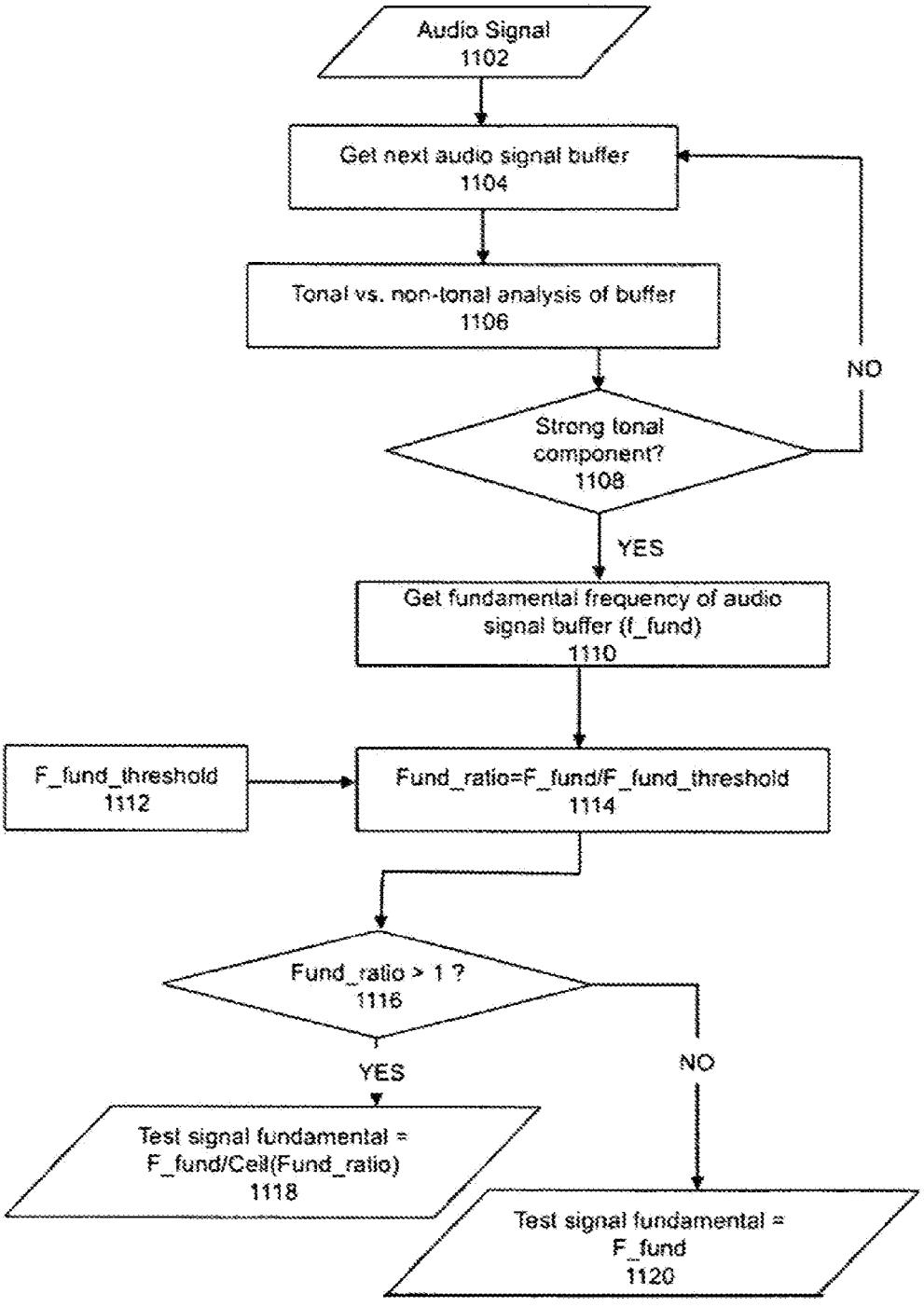

Audio Signal
1102
Get next audio signal buffer
1104
Tonal vs. non-tonal analysis of buffer
1106
Strong tonal component?
1108
NO
YES
Get fundamental frequency of audio signal buffer (f_fund)
1110
F_fund_threshold
1112
Fund_ratio=F_fund/F_fund_threshold
1114
Fund_ratio > 1 ?
1116
YES
NO
Test signal fundamental = F_fund/Ceil(Fund_ratio)
1118
Test signal fundamental = F_fund
1120

FIG. 11

Fig. 12

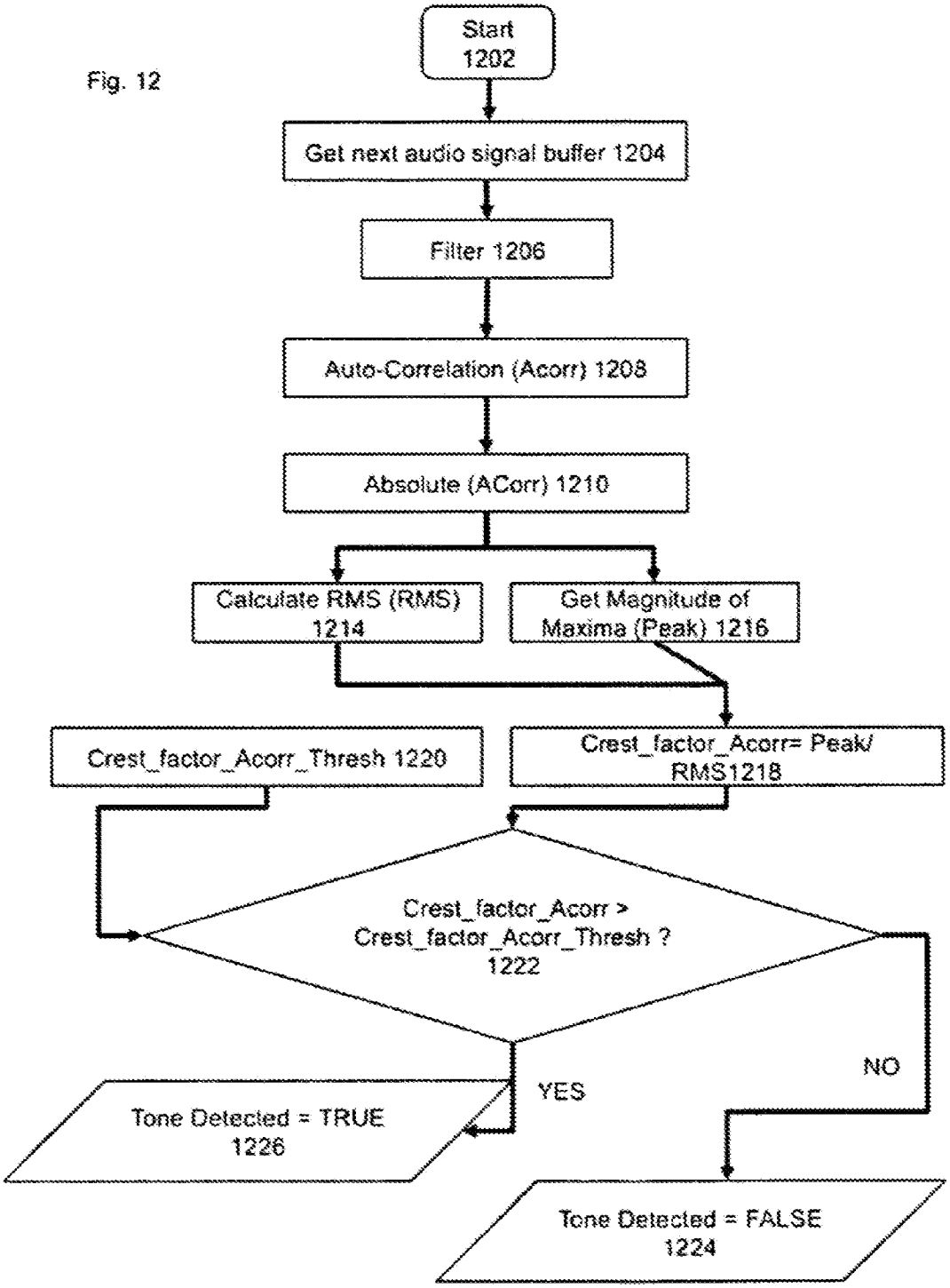

Start
1202
Get next audio signal buffer 1204
Filter 1206
Auto-Correlation (Acorr) 1208
Absolute (ACorr) 1210
Calculate RMS (RMS)
1214
Get Magnitude of
Maxima (Peak) 1216
Crest_factor_Acorr_Thresh 1220
Crest_factor_Acorr= Peak/
RMS1218
Crest_factor_Acorr >
Crest_factor_Acorr_Thresh ?
1222
YES
NO
Tone Detected = TRUE
1226
Tone Detected = FALSE
1224

Fig. 13

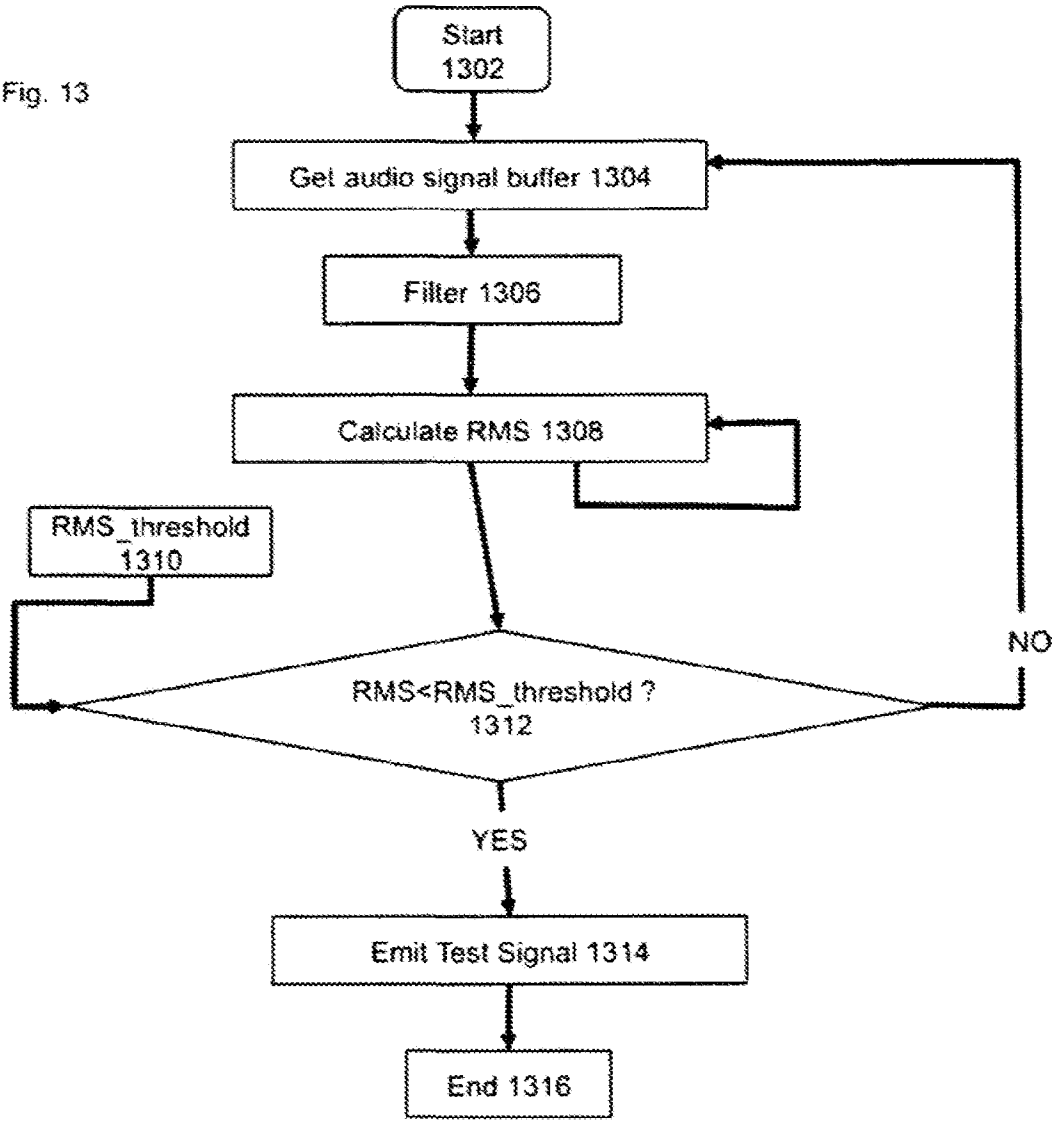

Start
1302
Get audio signal buffer 1304
Filter 1306
Calculate RMS 1308
RMS_threshold
1310
RMS<RMS_threshold ?
1312
NO
YES
Emit Test Signal 1314
End 1316

Fig. 14

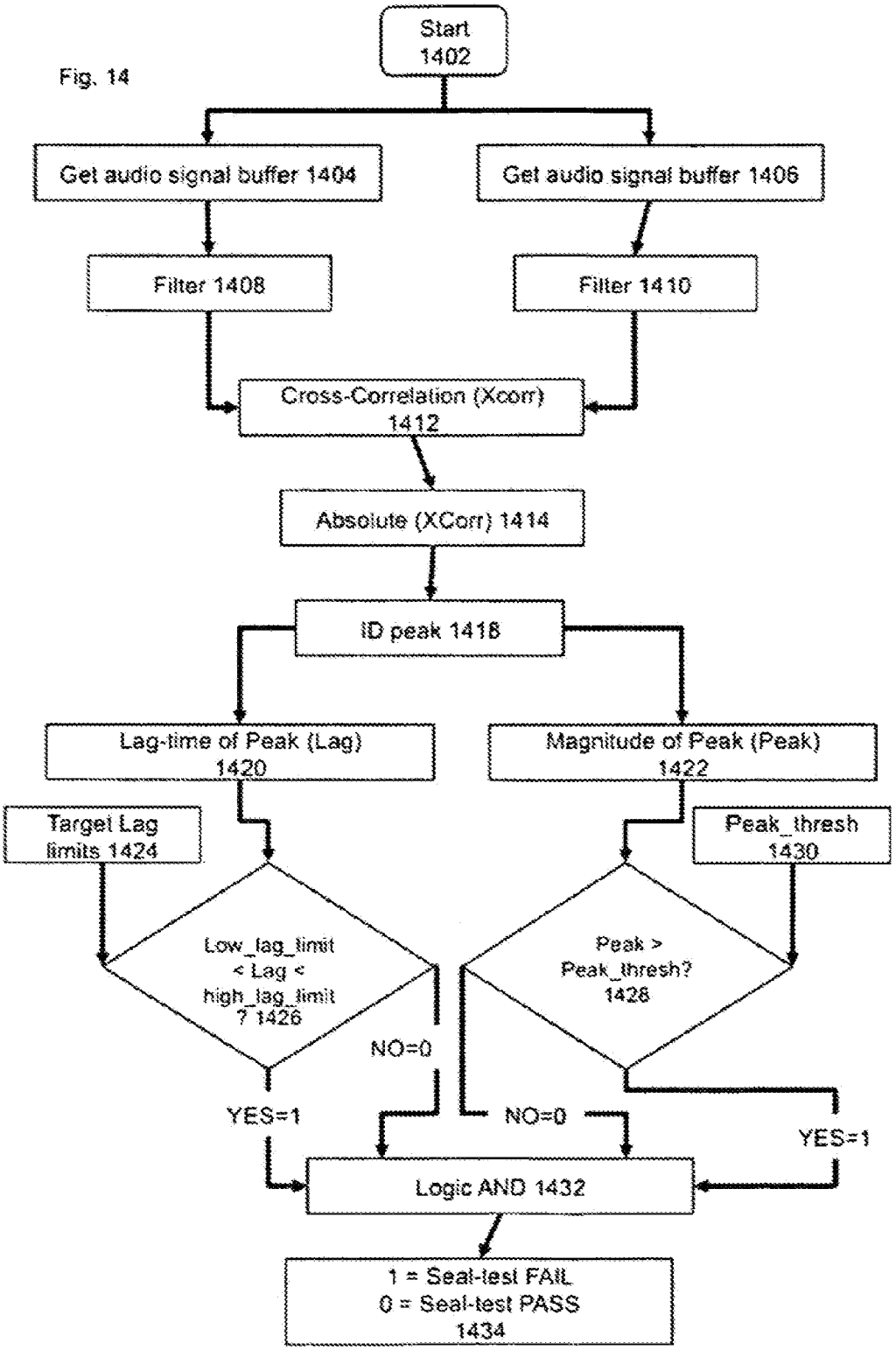

Start
1402
Get audio signal buffer 1404
Get audio signal buffer 1406
Filter 1408
Filter 1410
Cross-Correlation (Xcorr)
1412
Absolute (XCorr) 1414
ID peak 1418
Lag-time of Peak (Lag)
1420
Magnitude of Peak (Peak)
1422
Target Lag
limits 1424
Peak_thresh
1430
Low_lag_limit
< Lag <
high_lag_limit
? 1426
Peak >
Peak_thresh?
1428
NO=0
YES=1
NO=0
YES=1
Logic AND 1432
1 = Seal-test FAIL
0 = Seal-test PASS
1434

FIG. 15A

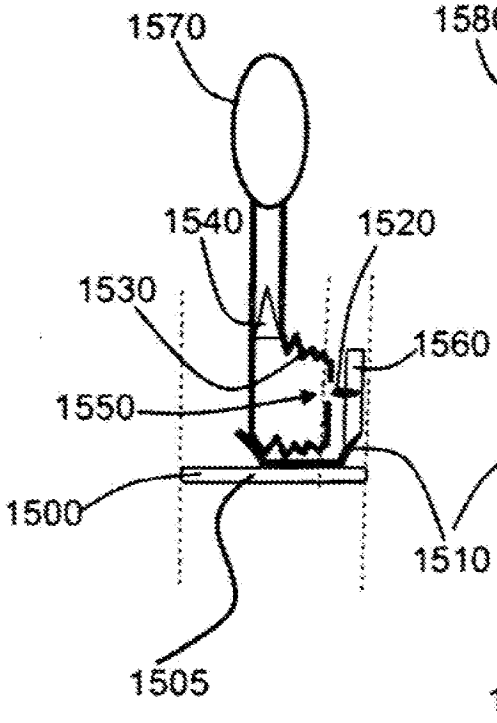


FIG. 15B

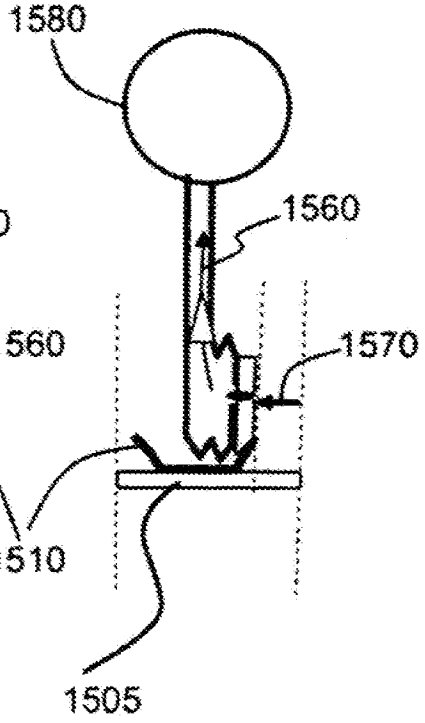
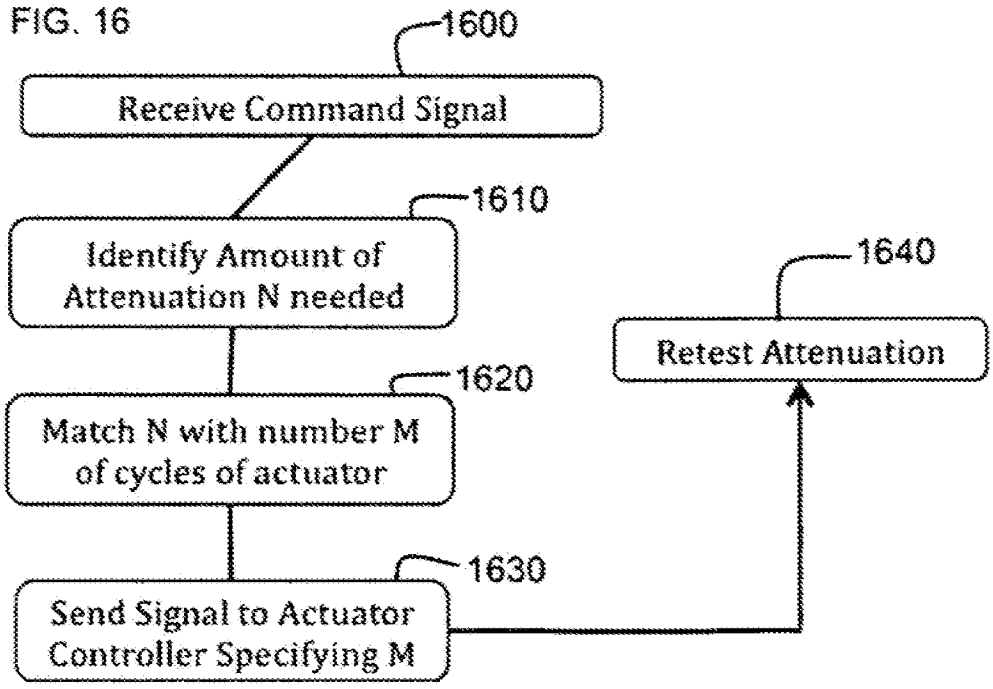


FIG. 16



Electronic Patent Application Fee Transmittal

Application Number:	17182570
Filing Date:	23-Feb-2021
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Filer:	John Patrick Keady
Attorney Docket Number:	CONT-16838277

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 1ST REQUEST	2801	1	680	680
		Total in USD ($)		**680**

Electronic Acknowledgement Receipt	
EFS ID:	47058673
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	CONT-16838277
Receipt Date:	18-NOV-2022
Filing Date:	23-FEB-2021
Time Stamp:	23:16:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$680
RAM confirmation Number	E2022AHN18040556
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	Request for Continued Examination (RCE)	17182570_RCE.pdf	1349948 6bad239e2368bd53477334656d102b878cde3371	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	17182570_RCE-IDS.pdf	1034424 e07475121ad3fc35d42573040651d41b97168d95	no	4
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, 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.					
3	Amendment Submitted/Entered with Filing of Continued Prosecution Application (CPA)/Request for Continued Examination(RCE)	17182570_RCE-LTR.pdf	168412 203367740e538cb15fa98f64c4074e7b6748c615	no	6
Warnings:					
Information:					
4	Drawings-other than black and white line drawings	17182570-FIGS-REPLACEMENT.pdf	2822352 5e575ed34dd26dac2ba02c8c89dab8bbfce6fdab	no	15
Warnings:					
Information:					
5	Non Patent Literature	ExParte_Request_10979836.PDF	2466545 7dff27b8c9b00c21db3f8d2c1d0cce7482382b31	no	133
Warnings:					
Information:					

6	Fee Worksheet (SB06)	fee-info.pdf	37777 50d1226088c7ddd27cd547ab76b9d232d3e2f64a	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	7879458	

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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.

IN THE U.S. PATENT AND TRADEMARK OFFICE

First Named Inventor: John Usher		Conf.: 5671
Appl. No.:	17/182,570	Art Unit: 2654
Filed:	02/23/2021	Examiner: Kim, Paul
For:	ACOUSTIC SEALING ANALYSIS SYSTEM	

RESPONSE TO OFFICE ACTION

Commissioner of Patents
Alexandria, VA 22313-1450

DUE DATE: 26 Nov. 2021

Sir:

Applicant appreciates the Examiner's Notice of Allowance dated 16 Nov. 2022, and after a review of the IDS (e.g., 1449) and Figures, the following additional IDS is submitted for the Examiner's consideration, which includes an Exparte Re-Examination filing for the Parent Patent No. 10,979,836, grammatical correction to claims 5 and 15, and Figure replacement sheets 1-15, where in particular Figure 2 reference number 222 should read "Second Earpiece" in keeping with specification ([0045]-[0046]) and as also reflected in Parent Patent 10,979,836. Remarks are respectfully submitted in connection with the above-identified application as is a Request for Continued Examination.

Amendment(s) to the Claims begin on page 2 of this paper.

Amendment(s) to the Drawings begin on page 6 of this paper.

If the Examiner has any questions concerning this application, the Examiner is requested to contact the undersigned at 571-606-1291 in the Washington D.C. Metro area.

Respectfully submitted,
TECHIYA LLC

Date: November 18, 2022

/John P. Keady/

John P. Keady, Ph.D (Physics), Ph.D (Comp. Sci), J.D.
Assistant General Counsel: Intellectual Property
and Chief Technical Officer
Staton Techiya LLC
Reg. No. 56,389

Amendment(s) to the Claim(s):

The listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1.(previously presented) An audio device configured to test a seal of an earphone comprising:

a memory that stores instructions; and

a processor, wherein the processor is configured to execute the instructions to perform operations, the operations comprising:

generating a test signal, wherein the test signal includes multiple frequency components, wherein at least one component lies between a range of 30Hz and 200Hz;

sending the test signal to a speaker of an earphone, wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user;

receiving a first microphone signal from the first microphone;

calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination;

comparing the value to a threshold to determine a seal quality between the first side and the second side;

generating a message to convey the seal quality; and

sending the message to the user.

2.(previously presented) The audio device according to claim 1, wherein the message is an acoustic message.

3(previously presented). The audio device according to claim 1, wherein the message is a visual message sent to a display of the audio device.

4.(previously presented) The audio device according to claim 1, wherein the speaker plays the test signal from the first side.

5.(currently amended) The audio device according to claim 4, wherein the first microphone measures sound from the first side. ~~signal.~~

6.(previously presented) The audio device according to claim 4, wherein the first microphone measures sound from the second side.

7.(previously presented) The audio device according to claim 1, wherein the first signal is the test signal and the second signal is the first microphone signal.

8.(previously presented) The audio device of claim 1, wherein the first signal is the test signal and the second signal is a modified first microphone signal.

9.(previously presented) The audio device of claim 1, wherein the first signal is a modified test signal and the second signal is the first microphone signal.

10.(previously presented) The audio device according to claim 1, wherein the first signal is a modified test signal and the second signal is a modified first microphone signal.

11.(previously presented) The audio device according to claim 8, wherein the modified first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200Hz.

12.(previously presented) The audio device according to claim 10, wherein the first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200Hz.

13.(previously presented) The audio device according to claim 1, wherein the earphone includes a second microphone.

14.(previously presented) The audio device according to claim 13, wherein the operations further comprise:

receiving a second microphone signal from the second microphone.

15.(currently amended) The audio device according to claim 14, wherein the first signal is the first microphone signal and the second signal is the second microphone signal.

16.(previously presented) The audio device of claim 14, wherein the first signal is a modified first microphone signal and the second signal is the second microphone signal.

17.(previously presented) The audio device of claim 14, wherein the first signal is a modified first microphone signal and the second signal is a modified second microphone signal.

18.(previously presented) The audio device of claim 1, wherein the seal quality is good if the value is at or above the threshold value.

19.(previously presented) The audio device of claim 1, wherein the sealing section is composed of at least one of rubber, silicone, a flexible polymer, or a combination thereof.

20.(previously presented) The audio device of claim 1, wherein the sealing section is an eartip.

Amendments to the Drawings:

The attached sheet of drawings, sheets 1-15, includes changes to Figure 2, where reference 222 should refer to “Second Earpiece” in accordance with referral to specification [0045] and [0046].

Attachment: Replacement Sheets

PTO/SB/80 (11-08)
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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	[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.**

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PTO/AIA/96 (08-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Staton Techiya, LLC

Application No./Patent No.: 17/182,570 Filed/Issue Date: February 23, 2021

Titled: ACOUSTIC SEALING ANALYSIS SYSTEM

Staton Techiya, LLC, a limited liability company

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: John Usher To: PERSONICS HOLDINGS, LLC

The document was recorded in the United States Patent and Trademark Office at Reel 057620, Frame 0870, or for which a copy thereof is attached.

2. From: John P. Keady To: PERSONICS HOLDINGS, LLC

The document was recorded in the United States Patent and Trademark Office at Reel 057620, Frame 0943, or for which a copy thereof is attached.

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STATEMENT UNDER 37 CFR 3.73(c)

3. From: PERSONICS HOLDINGS, INC. and PERSONICS HOLDINGS, LLC To: DM STATON FAMILY LIMITED PARTNERSHIP

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4. From: DM STATON FAMILY LIMITED PARTNERSHIP To: STATON TECHIYA, LLC

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5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
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6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
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☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Peter A. Chiabotti/	December 15, 2022
Signature	Date
Peter A. Chiabotti	54603
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

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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)).
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/182,570	**12/15/2022 04:23:13 PM ET**	**11472-36-3_CONT-16838277**

Title of Invention

ACOUSTIC SEALING ANALYSIS SYSTEM

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5671	FILED BY	Yoshi Hassan
PATENT CENTER #	61307289	FILING DATE	02/23/2021
CUSTOMER #	150139	FIRST NAMED INVENTOR	John Usher
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Peter Chiabotti

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
11472-36-3 POA-Executed.PDF	1	Power of Attorney	69 KB
11472-36-3 Statement Under 37 CFR 3_73.pdf	3	Assignee showing of ownership per 37 CFR 3.73	239 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
11472-36-3 POA-Executed.PDF	C2CCCA2BE90B29224908557544D64DAEB158FDDBE3B9370 702642BE7F5C5A750A87870A48FFA0DA0A5FD2B8B2798EE50

	AF46F9956498999852D56E3EFBDA46F
11472-36-3 Statement Under 37 CFR 3_73.pdf	02A74B12F6198850A4BE5C34BB3916E93BE8B0B7D625EA76E584D058F8EE1503B6788FF6315F55B65E5367E7E7B954EC5AA6FB4B807F93FE7B83D26C5ABF0130

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150139 7590 12/23/2022

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

EXAMINER
KIM, PAUL

ART UNIT	PAPER NUMBER
2654	

DATE MAILED: 12/23/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	11472-36-3_CONT-16838277	5671

TITLE OF INVENTION: ACOUSTIC SEALING ANALYSIS SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	03/23/2023

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PTOL-85 (Rev. 02/11)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

150139 7590 12/23/2022

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	11472-36-3_CONT-16838277	5671

TITLE OF INVENTION: ACOUSTIC SEALING ANALYSIS SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	03/23/2023

EXAMINER	ART UNIT	CLASS-SUBCLASS
KIM, PAUL	2654	381-059000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1_____
2_____
3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	11472-36-3_CONT-16838277	5671

150139 7590 12/23/2022

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

EXAMINER	
KIM, PAUL	

ART UNIT	PAPER NUMBER
2654	

DATE MAILED: 12/23/2022

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 30 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. 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.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
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.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
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.

Notice of Allowability	Application No. 17/182,570	Applicant(s) Usher et al.	
	Examiner PAUL KIM	Art Unit 2654	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 11/18/2022.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-20 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/PAUL KIM/
Primary Examiner, Art Unit 2654

DETAILED ACTION

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Allowable Subject Matter

The following is an examiner's statement of reasons for allowance:

Regarding independent claim 1, the closest prior art of record, Svean et al. (US Pat. 6567524) discloses an audio device configured to test a seal of an earphone comprising: a memory that stores instructions; and a processor, wherein the processor is configured to execute the instructions to perform operations, the operations comprising: wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user, receiving a first microphone signal from the first microphone; determine a seal quality between the first side and the second side; generating a message to convey the seal quality; and sending the message to the user.

However, Svean fails to teach the combination of an audio device configured to test a seal of an earphone comprising: a memory that stores instructions; and a processor, wherein the processor is configured to execute the instructions to perform operations, the operations comprising: generating a test signal, wherein the test signal includes multiple frequency components, wherein at least one

component lies between a range of 30Hz and 200Hz; sending the test signal to a speaker of an earphone, wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user, receiving a first microphone signal from the first microphone; calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination; comparing the value to a threshold to determine a seal quality between the first side and the second side; generating a message to convey the seal quality; and sending the message to the user. The distinct features, as disclosed in independent claim 1, render the claims allowable.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

2. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Ryan (US Pub. 20040196992) discloses a system and method for detecting the insertion or removal of a hearing instrument from the ear canal.

Siltmann (US Pub. 20070019817) discloses a hearing device with automatic determination of its fit in the ear and corresponding method.

Padhi (US Pub. 20050096899) discloses an apparatus, method, and computer program for comparing audio signals.

Oliveira (US Pat. 5002151) discloses an ear piece having disposable compressible polymeric foam sleeve.

Rast (US Pub. 20010046304) discloses a system and method for selective control of acoustic isolation in headset.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to PAUL KIM whose telephone number is (571)270-7697. The examiner can normally be reached on 9 AM - 5 PM, PST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, VIVIAN CHIN can be reached on (571) 272-7848. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/PAUL KIM/
Primary Examiner, Art Unit 2654

Notice of References Cited	Application/Control No. 17/182,570	Applicant(s)/Patent Under Reexamination Usher et al.	
	Examiner PAUL KIM	Art Unit 2654	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-6567524-B1	05-2003	Svean; Jarle	A61F11/08	381/317
*	B	US-20040196992-A1	10-2004	Ryan, Jim G.	H04R1/10	381/317
*	C	US-20070019817-A1	01-2007	Siltmann; Simone	H04R25/305	381/60
*	D	US-20050096899-A1	05-2005	Padhi, Kabi P.	G10L15/10	704/216
*	E	US-5002151-A	03-1991	Oliveira; Robert J.	H04R25/656	381/328
*	F	US-20010046304-A1	11-2001	Rast, Rodger H.	H04R1/1083	381/26
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	**Art Unit**
	PAUL KIM	2654

CPC						
Symbol					**Type**	**Version**
H04R	/	29	/	001	F	2013-01-01
H04R	/	25	/	70	I	2013-01-01
H04R	/	1	/	1016	I	2013-01-01
H04R	/	1	/	1091	I	2013-01-01
H04R	/	29	/	00	I	2013-01-01
H04R	/	2460	/	15	A	2013-01-01
H04R	/	2460	/	07	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/PAUL KIM/ Primary Examiner, Art Unit 2654	13 December 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1,3

U.S. Patent and Trademark Office — Part of Paper No.: 20221213

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	**Art Unit**
	PAUL KIM	2654

INTERNATIONAL CLASSIFICATION					
CLAIMED					
H04R29/00	/	29	/	00	
H04R1/10	/	1	/	10	

NON-CLAIMED					
H04R25/00	/	25	/	00	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
381	59

CROSS REFERENCES(S)							
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**						
381	60	58					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 20	
/PAUL KIM/ Primary Examiner, Art Unit 2654 (Primary Examiner)	13 December 2022 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1,3

U.S. Patent and Trademark Office — Part of Paper No.: 20221213

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	Art Unit
	PAUL KIM	2654

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	11	10	19	19										
2	2	9	11	20	20										
3	3	12	12												
4	4	13	13												
5	5	14	14												
6	6	15	15												
7	7	16	16												
8	8	17	17												
10	9	18	18												

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/PAUL KIM/ Primary Examiner, Art Unit 2654	13 December 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1,3

U.S. Patent and Trademark Office — Part of Paper No.: 20221213

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	Art Unit
	PAUL KIM	2654

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04R25/70 OR H04R29/001 OR H04R29/00 OR H04R2460/15 OR H04R1/1016 OR H04R1/1091 OR H04R2460/07	11/05/2022	PK

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
381	58, 59, 60	11/05/2022	PK

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

/PAUL KIM/ Primary Examiner, Art Unit 2654	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/182,570	Usher et al.
	Examiner	Art Unit
	PAUL KIM	2654

Search Notes		
Search Notes	**Date**	**Examiner**
Inventor search - John Usher, John Keady	11/05/2022	PK
PE2E search - see PE2E search note	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 01/14/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 05/18/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 06/14/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 06/23/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 07/1/2022	11/05/2022	PK
IPR2022-00410 Reviewed Petition for Inter Partes Review of U.S. Patent No. 10979836 on 08/12/2022	11/05/2022	PK
Updated search - see PE2E search note	12/13/2022	PK

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
	See attached search history	11/05/2022	PK

/PAUL KIM/ Primary Examiner, Art Unit 2654	

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17182570
Filing Date	2021-02-23
First Named Inventor	John Usher
Art Unit	2654
Examiner Name	KIM, PAUL
Attorney Docket Number	CONT-16838277

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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
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.K/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	2654
	Examiner Name	KIM, PAUL
	Attorney Docket Number	CONT-16838277

	1	90/015,146, Samsung Electronics Co., Ltd. and Samsung Electronics, America, Inc., REQUEST FOR EX PARTE REEXAMINATION OF U.S. PATENT NO. 10,979,836	

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EXAMINER SIGNATURE

Examiner Signature	/PAUL KIM/	Date Considered	12/13/2022

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.K/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	2654
	Examiner Name	KIM, PAUL
	Attorney Docket Number	CONT-16838277

CERTIFICATION STATEMENT

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)	2022-11-18
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.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.K/

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.K/

Bibliographic Data

Application No: 17/182,570

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /PAUL KIM/ Examiner's Signature | Initials

Title: ACOUSTIC SEALING ANALYSIS SYSTEM

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
02/23/2021	381	2654	CONT-16838277
RULE			

APPLICANTS

Staton Techiya LLC, Lighthouse Point, FL, UNITED STATES

INVENTORS

John Usher, Devon, UNITED KINGDOM

John P. Keady, Fairfax Station, VA, UNITED STATES

CONTINUING DATA

This application is a CON of 16838277 04/02/2020 PAT 10979836

16838277 is a CON of 16414136 05/16/2019 PAT 10701499

16414136 is a CON of 15700511 09/11/2017 PAT 10299053

15700511 is a CON of 14827332 08/17/2015 PAT 9781530

14827332 is a CON of 14054015 10/15/2013 PAT 9113267

14054015 is a DIV of 12555864 09/09/2009 PAT 8600067

12555864 has PRO of 61098250 09/19/2008

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

03/04/2021

**** SMALL ENTITY ****

STATE OR COUNTRY

UNITED KINGDOM

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Akerman LLP

777 South Flagler Drive

Suite 1100 West Tower

West Palm Beach, FL 33401

UNITED STATES

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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	1	"17182570"	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 02:30 AM
L2	12	"12555864"	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 02:30 AM
L3	117	((("Staton") near3 ("Techiya") near3 ("LLC"))).AS,AANM.	(USPAT)	OR	ON	ON	2022/11/05 02:31 AM
L4	289	((("Usher") near3 ("John"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:32 AM
L5	149	((("Keady") near3 ("John") near3 ("P"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:32 AM
L6	245	((("Staton") near3 ("Techiya") near3 ("LLC"))).AS,AANM.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:33 AM
L7	917	(381/59).ccls.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:34 AM
L8	3298	H04R29/001	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:35 AM
L9	5965	H04R1/1016	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:35 AM
L10	2719	H04R1/1091	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:35 AM
L12	2674	H04R25/70	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:35 AM
L13	8905	H04R29/00	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:36 AM
L14	892	H04R2460/07	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:36 AM
L15	496	H04R2460/15	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:36 AM
L16	19612	L8 OR L9 OR L10 OR L12 OR L13 OR L14 OR l15	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:37 AM
L17	13	L8 AND L9 AND L10 AND L12 AND L13 AND L14 AND L15	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:49 AM
L18	652	L7 AND L16	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 02:51 AM
L19	1	"20060188105"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 04:47 AM
L20	128	"6567524"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 04:48 AM
L21	2764	(381/58,59,60).ccls.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:00 PM

L22	42	("5142587"|"5764781"|"8774435"|"20050078838"|"5267321"|"6021207"|"7072482"|"10860287"|"7801318"|"8971561"|"9293128"|"7477756"|"20140247948"|"4020297"|"5319163"|"7688983"|"8550206"|"20080037801"|"6567524"|"6728385"|"6754359"|"20130177179"|"5138722"|"5712453"|"8774433"|"6321070"|"8401200"|"6415034"|"7450730"|"8014553"|"20140247952"|"20060204014"|"4088849"|"777834"|"RE38351"|"20180176681"|"9313572"|"6359993"|"9084060"|"20030165246"|"5524056"|"7209569").PN.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:01 PM
L23	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) SAME (generat$4 WITH test WITH signal$2 WITH multiple$2 WITH frequenc$5) SAME (microphone$2 WITH acoustic WITH barrier$2) SAME (calculat$4 WITH value$2 WITH (coherence OR correlation OR difference$2 OR cross-correlation)) SAME (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:08 PM
L24	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:09 PM

		earbud$2))) AND (generat$4 WITH test WITH signal$2 WITH multiple$2 WITH frequenc$5) AND (microphone$2 WITH acoustic WITH barrier$2) AND (calculat$4 WITH value$2 WITH (coherence OR correlation OR difference$2 OR cross-correlation)) AND (compar$4 WITH threshold WITH qualit$4)					
L25	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2) AND (microphone$2 WITH acoustic WITH barrier$2) AND (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:10 PM
L26	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2) AND (microphone$2 WITH acoustic WITH barrier$2)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:10 PM
L27	358040	((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5) OR (headset$2 OR earphone$2 OR headphone$2 OR	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:11 PM

		earpiece$2 OR earbud$2))					
L28	1606	L27 AND (test$4 WITH seal$3)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:12 PM
L29	422	L28 AND L16	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:13 PM
L30	65	L29 AND L21	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:13 PM
L31	119	L29 AND (test$3 near3 signal$2)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:15 PM
L32	25	L31 AND I21	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:15 PM
L33	2215	L27 AND ((test$4 OR analy$3) WITH seal$3)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:16 PM
L34	706	I33 AND (test$3 near3 signal$2)	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:17 PM
L35	123	L34 AND L16	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:17 PM
L36	27	L34 AND L21	(US-PGPUB; USPAT; USOCR; EPO; DERWENT)	OR	ON	ON	2022/11/05 05:17 PM
L37	44	(Artificial Intelligence) Similar to: 16/838,277 with 0 CPC Selections and 0 Text Selections Text: (US-10986432-B2 OR EP-3646614-A1 OR WO-2019005492-A1 OR US-20190007762-A1 OR EP-2737720-A2 OR US-20220256270-A1 OR EP-2737720-B1 OR US-20200068283-A1 OR US-10972823-B2 OR WO-2013016336-A2 OR US-20210022996-A1 OR US-10462549-B2 OR US-8737669-B2 OR FR-3062014-A1 OR KR-102213388-B1 OR US-7837005-B2 OR CN-113491504-A OR JP-6037483-B2 OR KR-	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2022/11/05 05:19 PM

		102336438-B1 OR JP-2016048931-A OR US-11159876-B2 OR CN-209184754-U OR CN-209184762-U OR JP-2021150949-A OR JP-5934358-B2 OR JP-2014524219-A OR JP-2014087054-A OR US-20210297765-A1 OR US-20130230204-A1 OR EP-3852386-A1 OR JP-6306273-B2 OR JP-2018502525-A OR CN-112703747-B OR US-20200025732-A1 OR CN-107925810-B OR US-9351064-B2 OR US-20210007669-A1 OR US-20200016006-A1 OR EP-3522842-A1 OR WO-2018065255-A1 OR EP-3522842-B1 OR US-20190387305-A1 OR US-20070240931-A1 OR US-11381897-B2 OR US-20220070572-A1 OR US-20090041285-A1 OR US-20140177899-A1 OR AU-2016209621-A1 OR CN-209402688-U OR US-20170360614-A1).did.					
L38	33	(Artificial Intelligence) Similar to: 17/182,570 with 0 CPC Selections and 0 Text Selections Text: (US-20210211797-A1 OR US-5699435-A OR EP-2894879-A3 OR EP-2858383-A3 OR EP-2884769-A3 OR EP-2884768-A3 OR EP-2879406-A3 OR EP-3120578-B2 OR EP-3120578-B1 OR US-20160112814-A1 OR US-20150271607-A1 OR WO-2015143151-A1 OR EP-3120578-A1 OR CN-106465025-A OR CN-106465025-B OR	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2022/11/05 05:19 PM

		CN-106331972-A OR CN-106331972-B OR US-10448177-B2 OR EP-3113519-A1 OR US-11438716-B1 OR US-11218817-B1 OR EP-3503573-A1 OR US-20150271608-A1 OR EP-1416764-A3 OR US-20210185466-A1 OR US-9648430-B2 OR US-10945086-B2 OR CA-2215764-C OR US-20190191254-A1 OR US-20200045484-A1 OR CN-110035344-A OR US-11019434-B2 OR JP-2019146152-A OR CH-708901-A2 OR WO-2015069416-A1 OR CN-1627865-A OR US-20170195807-A1 OR WO-2012093343-A3 OR DE-4418203-A1 OR US-20030021434-A1 OR EP-3849212-A1 OR EP-2547120-A1 OR US-10645505-B2 OR EP-1416764-A2 OR US-20150124977-A1 OR EP-1416764-B1 OR CN-113099334-B OR CH-690220-A5 OR CN-113099334-A OR US-11197081-B2).did.					
L39	39	(Artificial Intelligence) More like doc: US-6567524-B1 Text: (WO-0217838-A1 OR EP-1313419-A1 OR EP-1313419-B1 OR CA-2418027-C OR CA-2418027-A1 OR WO-0217839-A1 OR EP-1322268-A1 OR EP-1322268-B1 OR CA-2418031-C OR WO-0217836-A1 OR EP-1313417-A1 OR EP-1313417-B1 OR ES-2279829-T3 OR CA-2418010-C OR WO-0217837-A1 OR EP-1313418-A1 OR WO-0217835-A1 OR US-6661901-B1 OR US-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/11/05 05:20 PM

		7039195-B1 OR EP-1313418-B1).did.					
L40	118	("4049930" | "4489440" | "4548082" | "4985925" | "5201006" | "5276739" | "5426719" | "5680466").pn. OR ("6567524").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:21 PM
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L42	5	("2006/0188105").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/11/05 05:22 PM
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L58	38	(Artificial Intelligence) More like doc:	(US-PGPUB; USPAT; USOCR; FIT (AU, AP,	OR	ON	ON	2022/12/13 08:07 PM

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L61	167	("2001/0046304").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/12/13 08:08 PM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) SAME (generat$4 WITH test WITH signal$2 WITH multiple$2 WITH frequenc$5) SAME (microphone$2 WITH acoustic WITH barrier$2) SAME (calculat$4 WITH value$2 WITH (coherence OR correlation OR difference$2 OR cross-correlation)) SAME (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/05 05:08 PM
N2	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2 WITH multiple$2 WITH frequenc$5) AND (microphone$2 WITH acoustic WITH barrier$2) AND (calculat$4 WITH value$2 WITH (coherence OR correlation OR difference$2 OR cross-correlation)) AND (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/05 05:09 PM

N3	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2) AND (microphone$2 WITH acoustic WITH barrier$2) AND (compar$4 WITH threshold WITH qualit$4)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/05 05:10 PM
N4	0	(test$4 WITH seal$3 WITH (((hearing near1 aid$2) OR (hearing-aid) OR (hearing near2 assist$5)) OR (headset$2 OR earphone$2 OR headphone$2 OR earpiece$2 OR earbud$2))) AND (generat$4 WITH test WITH signal$2) AND (microphone$2 WITH acoustic WITH barrier$2)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/05 05:10 PM

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/182,570	02/23/2021	John Usher	11472-36-3_CONT-16838277

CONFIRMATION NO. 5671

150139
Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

POA ACCEPTANCE LETTER

OC000000137069763

Date Mailed: 12/28/2022

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/15/2022.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/qnguyen/

IN THE U.S. PATENT AND TRADEMARK OFFICE

First Named Inventor:	John Usher	Conf.: 5671
Appl. No.:	17/182,570	Art Unit: 2654
Filed:	02/23/2021	Examiner: Kim, Paul
For:	ACOUSTIC SEALING ANALYSIS SYSTEM	

Amendment After Allowance Under 37 CFR 1.312

Commissioner of Patents
Alexandria, VA 22313-1450

DATE: 30 Dec. 2022

The Office issued a notice of allowance 23 Dec. 2022. Applicants submit the attached marked-up and clean version of the specification to address typographical errors, in particular in paragraphs [0079] and [0115].

The minor amendment does not require an additional search, does not require more than a cursory review of the record, and do not involve materially added work on the part of the Office. However, should the Examiner believe that anything further is necessary in order to place the application in better condition for allowance, the Examiner is respectfully requested to contact the undersigned representative at the telephone number listed below.

Respectfully submitted,
TECHIYA LLC

Date: December 30, 2022

/John P. Keady/
John P. Keady, Ph.D (Physics), Ph.D (Comp. Sci), J.D.
Assistant General Counsel: Intellectual Property
and Chief Technical Officer
Staton Techiya LLC
Reg. No. 56,389
571-606-1291

Electronic Acknowledgement Receipt

EFS ID:	47298370
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	11472-36-3_CONT-16838277
Receipt Date:	30-DEC-2022
Filing Date:	23-FEB-2021
Time Stamp:	12:04:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Arguments/Remarks Made in an Amendment	CONT-17182570-SPEC-MARKED.pdf	395404 9626b89e3b6ac48bca9d58169c780cce6d5f21be	no	25

Warnings:

Information:					
2	Specification	CONT-17182570-SPEC-CLEAN.pdf	385532 4622978cd82c041d61e9cd18d0254f81aee0f944	no	25
Warnings:					
Information:					
3	Amendment after Notice of Allowance (Rule 312)	17182570_312-amndt.pdf	115954 43b458623a1d68213553706a53451af17d21d73c	no	1
Warnings:					
Information:					
		Total Files Size (in bytes):	896890		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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.

National Stage of an International Application under 35 U.S.C. 371

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.

New International Application Filed with the USPTO as a Receiving Office

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.

ACOUSTIC SEALING ANALYSIS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Patent Application Ser. No. 17/182,570, filed 23 Feb. 2021, which is a continuation of U.S. Patent Application Ser. No. 16/838,277, filed April 2, 2020, which is a continuation of U.S. Patent Application Ser. No. 16/414,136, filed May 16, 2019, which is a continuation of U.S. Patent Application Ser. No. 15/700,511, filed September 11, 2017, which is a continuation of U.S. Patent Application Ser. No. 14/827,332, filed August 17, 2015, now U.S. Patent No. 9,781,530, which is a continuation of U.S. Patent Application Ser. No. 14/054,015, filed October 15, 2013, now U.S. Patent No. 9,113,267, which is a Divisional Application of U.S. Application Ser. No. 12/555,864, filed September 9, 2009, now U.S. Patent No. 8,600,067 and claims the benefit of U.S. Provisional Patent Application No. 61/098,250 filed September 19, 2008. The disclosure of all the aforementioned references are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to testing the seal of an orifice-inserted device, and more particularly, though not exclusively, to a device and method for determining if an earpiece is sealed correctly in an ear canal.

BACKGROUND OF THE INVENTION

[0003] It can be difficult to communicate using an earpiece or earphone device in the presence of high-level background sounds. In many earpiece designs a transducer is placed near the ear canal opening. Ambient sound from the surrounding environment enters the ear canal with the audio content from the transducer. Environmental sounds such as traffic, construction, and nearby conversations can degrade the quality of the audio content.

[0004] Although audio processing technologies can adequately suppress noise, the earpiece is generally sound agnostic and cannot differentiate sounds. Thus, one method to prevent ambient sound from entering the ear is to seal or provide an acoustic barrier at the opening of the ear canal. Sealing minimizes ambient sound leakage into the ear canal, and under the correct conditions can provide a level of noise suppression under high background noise conditions. Certain types of acoustic software (e.g., communication in a noisy environment via an ear canal microphone) may require some minimum noise isolation from the ambient

sound to provide adequate performance to the user. Additionally, user conditions may change substantially during the operation of the earpiece, and in some circumstances, the earpiece may become misaligned or may be fit incorrectly such that it is not sealed correctly. A method of seal detection is needed to optimize performance.

SUMMARY OF THE INVENTION

[0005] Broadly stated, embodiments are directed to a device and method to determine if an earpiece is sealing within the design specification of the device.

[0006] In one embodiment, the device can include a sealing section forming an acoustic barrier between a first volume and a second volume. An ear canal receiver (ECR) can be configured to generate an acoustic signal in the first volume. An Ear Canal Microphone (ECM) in the first volume can be configured to measure the acoustic signal in the first volume. The first acoustic signal emitted by the ECR can be cross-correlated with the first acoustic signal detected with the ECM to determine if the sealing section is sealed properly.

[0007] At least one exemplary embodiment is directed to a method of detecting sealing integrity of an earpiece comprising the steps of: providing a test signal; generating an acoustic signal corresponding to the test signal incident on an ear canal side of a sealing section; converting the acoustic signal incident on a first side of the sealing section to an electrical signal; and cross- correlating the test signal to the electrical signal where the earpiece is sealed correctly when a cross-correlation between the test signal and the electrical signal is above a threshold.

[0008] At least one exemplary embodiment is directed to a method of adjusting attenuation of an earpiece comprising the steps of: relating cross-correlation of a test signal and a measured acoustic signal in an ear canal of a user to an attenuation level of a sealing section of the earpiece; comparing the attenuation level of the sealing section of the earpiece to a minimum attenuation value; and adjusting a pressure of the sealing section to meet the minimum attenuation value.

[0009] At least one exemplary embodiment is directed to a device comprising: a sealing section configured to seal a user's orifice, where the sealing section is configured to produce an acoustic seal between a first side of the sealing section and a second side of the sealing section; a transducer configured to generate a first acoustic signal incident on the first side of the sealing section; and a first microphone configured to measure a second acoustic signal incident on the second side of the sealing section, where the second acoustic signal

includes at least a portion of the first acoustic signal that has passed from the first side to the second side of the sealing section where the first acoustic signal is compared to the second acoustic signal to determine if the sealing section is sealed.

[0010] Further areas of applicability of exemplary embodiments of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Exemplary embodiments of the present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0012] FIG. 1 is a diagram of an earpiece inserted in an ear canal in accordance with an exemplary embodiment;

[0013] FIG. 2 is a block diagram of optional components of an earpiece in accordance with an exemplary embodiment;

[0014] FIG. 3 is a flowchart of a method for checking an ear seal in accordance with an exemplary embodiment;

[0015] FIG. 4 is a flowchart to determine acoustic seal integrity of an earpiece in accordance with the exemplary embodiment.

[0016] FIG. 5 is a flowchart of a method to estimate the instantaneous cross-correlation between a first and second audio signal.

[0017] FIG. 6 is a flowchart to determine when to emit a test signal in accordance with an exemplary embodiment;

[0018] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention;

[0019] FIG. 8 is a block diagram for a method of adjusting the IMS system in accordance with at least one exemplary embodiment;

[0020] FIG. 9 is a block diagram for a method of adjusting IMS pressure in accordance with at least one exemplary embodiment;

[0021] FIG. 10 illustrates a sample relationship between EarSeal attenuation and XCorr in accordance with at least one exemplary embodiment;

[0022] FIG. 11 illustrates a flowchart of an exemplary method to determine a test signal fundamental;

[0023] FIG. 12 illustrates a flowchart of an exemplary embodiment to determine tonal presence in audio content;

[0024] FIG. 13 illustrates a flowchart of a method to determine when to emit the test signal;

[0025] FIG. 14 illustrates a flowchart of an exemplary method to determine acoustic seal integrity;

[0026] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment; and

[0027] FIG. 16 illustrates the sending of a signal to an inflation controller upon detection of a seal fail to modify the seal pressure in accordance with at least one exemplary embodiment.

DETAILED DESCRIPTION

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

[0029] Exemplary embodiments are directed to or can be operatively used on various wired or wireless orifice inserted devices for example earpiece devices (e.g., earbuds, headphones, ear terminals, behind the ear devices or other acoustic devices as known by one of ordinary skill, and equivalents).

[0030] Processes, techniques, apparatus, and materials as known by one of ordinary skill in the art may not be discussed in detail but are intended to be part of the enabling description where appropriate. For example specific computer code may not be listed for achieving each of the steps discussed, however one of ordinary skill would be able, without undo experimentation, to write such code given the enabling disclosure herein. Such code is intended to fall within the scope of at least one exemplary embodiment.

[0031] Additionally exemplary embodiments are not limited to earpieces, for example some functionality can be implemented on other systems with speakers and/or microphones for example computer systems, PDAs, BlackBerry® smart phones, cell and mobile phones, and any other device that emits or measures acoustic energy. Additionally, exemplary embodiments can be used with digital and non-digital acoustic

systems. Additionally various receivers and microphones can be used, for example MEMs transducers, diaphragm transducers, for example Knowles' FG and EG series transducers.

[0032] Notice 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 or further defined in the following figures.

[0033] 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.

[0034] 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.

[0035] At least one exemplary embodiment of the invention is directed to an earpiece for sealing or partially sealing an ear. FIG. 1 is a diagram of an earpiece inserted in an ear canal 124 in accordance with at least one exemplary embodiment of the invention. FIG. 1 also illustrates portions of the ear including pinna 128, ear canal 124 and eardrum 126. As illustrated, the earpiece comprises an electronic housing unit 100 and a sealing unit 108. The earpiece depicts an electro-acoustical assembly for an in-the-ear acoustic assembly, as it would typically be placed in an ear canal 124 of a user 130. The earpiece is an in-ear earpiece, behind the ear earpiece, receiver in the ear, partial-fit device, or any other suitable earpiece type. The earpiece can partially or fully occlude the ear canal 124.

[0036] The earpiece includes an Ambient Sound Microphone (ASM) 120 to capture ambient sound, an Ear Canal Receiver (ECR) 114 to deliver audio to an ear canal124, and an Ear Canal Microphone (ECM) 106 to capture and assess a sound exposure level within the ear canal 124. The earpiece can partially or fully occlude the ear canal 124 to provide various degrees of acoustic isolation. The assembly is designed to be inserted into the user's ear canal 124, and to form an acoustic seal with the walls of the ear canal 124 at a location between the entrance to the ear canal 124 and the tympanic membrane (or ear drum) 126. In general, such a seal is typically achieved by means of a soft and compliant housing of the sealing unit 108. Additionally, the sealing unit 108 can be a pressurized expandable element that fills a portion of the available local space.

[0037] Sealing unit 108 is an acoustic barrier having a first side corresponding to ear canal124 and a second

side corresponding to the ambient environment. In at least one exemplary embodiment, sealing unit 108 includes an ear canal microphone tube 110 and an ear canal receiver tube 112. Sealing unit 108 creates a closed cavity of approximately 5 cc or less between the first side of sealing unit 108 and the tympanic membrane 126 in ear canal124. In at least one exemplary embodiment the sealing facilitates using the ECR (speaker) 114 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 126 resulting from the sound field at the entrance to the ear canal 124. This seal is also a basis for a sound isolating performance of the electro-acoustic assembly.

[0038] In at least one exemplary embodiment and in broader context, the second side of sealing unit 108 corresponds to the side adjacent to electronic housing unit 100. Ambient sound microphone 120 is housed in electronic housing unit 100 and is exposed to the ambient environment for receiving sound from the ambient environment around the user.

[0039] The electronic housing unit 100 can include various system components such as a microprocessor 116, memory 104, battery 102, ECM 106, ASM 120, ECR, 114, and user interface 122, or these components can reside in a separate system or interface operatively connected. Microprocessor 116 (or processor 116) can be a logic circuit, a digital signal processor, controller, or the like for performing calculations and operations for the earpiece. Microprocessor 116 is operatively coupled to memory 104, ECM 106, ASM 120, ECR 114, and user interface 122. An optional wire 118 can provide an external connection to the earpiece. Battery 102 powers the circuits and transducers of the earpiece. Battery 102 can be a rechargeable or replaceable battery.

[0040] In at least one exemplary embodiment, electronic housing unit 100 is adjacent to sealing unit 108. Openings in electronic housing unit 100 receive ECM tube 110 and ECR tube 112 to respectively couple to ECM 106 and ECR 114. ECR tube 112 and ECM tube 110 acoustically couple signals to and from ear canal 124. For example, ECR 114 outputs an acoustic signal through ECR tube 112 and into ear canal 124 where it is received by the tympanic membrane 126 of the user of the earpiece. Conversely, ECM 106 receives an acoustic signal present in ear canal124 though ECM tube 110.

[0041] One function of ECM 106 is that of measuring the sound pressure level in the ear canal cavity 124 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 the earpiece. In one arrangement, ASM 120 is used to monitor sound pressure at the entrance to the occluded or partially occluded ear canal 124. All transducers shown can receive or transmit

audio signals to a processor 116 that undertakes audio signal processing and provides a transceiver for audio via the wired (wire 118) or a wireless communication path. Note also that the acoustic signals can be stored for later retrieval.

[0042] In at least one exemplary embodiment the earpiece can be constructed to actively monitor a sound pressure level both inside and outside an ear canal 124. In at least one exemplary embodiment monitored data can be used to enhance spatial and timbral sound quality while maintaining supervision to ensure safe sound reproduction levels. In at least one exemplary embodiment an earpiece can facilitate at least one of conducting listening tests, filtering sounds in the environment, monitoring warning sounds in the environment, presenting notification based on identified warning sounds, maintaining constant audio content to ambient sound levels, and filtering sound in accordance with a Personalized Hearing Level (PHL).

[0043] The earpiece can generate an Ear Canal Transfer Function (ECTF) to model the ear canal 124 using ECR 114 and ECM 106, as well as an Outer Ear Canal Transfer function (OETF) using ASM 120. For instance, the ECR 114 can deliver an impulse within the ear canal124 and generate the ECTF via cross correlation of the impulse with the impulse response of the ear canal 124. The earpiece can also determine a sealing profile with the user's ear to compensate for any leakage. In at least one exemplary embodiment the earpiece can use either the ASM 120 or the ECM 106 to monitor the sound pressure level, which can then be used in a Sound Pressure Level Dosimeter calculation, to estimate sound exposure and recovery times. This permits the earpiece to safely administer and monitor sound exposure to the ear.

[0044] Referring to FIG. 2, a block diagram of an earpiece 201 in accordance with an exemplary embodiment is shown. A power supply 205 (e.g., USB power connection, hearing aid battery (batteries)) powers components of the earpiece 201 including microprocessor 206 (or processor 206, e.g., Texas Instruments TMS320C6713) and a data communication system 216 (e.g., RF or Bluetooth communication chip). As illustrated, the earpiece 201 includes the processor 206 operatively coupled to data communication system 216, ASM 210, ECR 212, and ECM 208. Data communication system 216 may include one or more Analog to Digital Converters and Digital to Analog Converters (DAC). The processor 206 can utilize computing technologies such as a microprocessor, Application Specific Integrated Chip (ASIC), and/or digital signal processor (DSP) with associated Random Access Memory (RAM) 202 and Read Only Memory (ROM) 204. Other memory types such as Flash, non-volatile memory, SRAM, DRAM or other like technologies can be used for storage with processor 206. The processor 206 can also include a clock to record a time stamp.

[0045] In general, data communication system 216 is a communication pathway to components of the earpiece 201 and components external to the earpiece 201. The communication link can be wired or wireless. In at least one exemplary embodiment, data communication system 216 is configured to communicate with ECM 208, ASM 210, visual display 218, and user control interface 214 of the earpiece 201. As shown, user control interface 214 can be wired or wirelessly connected. In at least one exemplary embodiment, data communication system 216 is capable of communication to devices exterior to the earpiece 201 such as the user's mobile phone 234, a second earpiece 222, and a portable media player 228. Portable media player 228 can be controlled by a manual user control 230.

[0046] The user's mobile phone 234 includes a mobile phone communication system 224. A microprocessor 226 is operatively coupled to mobile phone communication system 224. As illustrated multiple devices can be wirelessly connected to one another such as an earpiece 220 worn by another person to the user's mobile phone. Similarly, the user's mobile phone 234 can be connected to the data communication system 216 of the earpiece 201 as well as the second earpiece 222. This connection would allow one or more people to listen and respond to a call on the user's mobile phone 234 through their respective earpieces.

[0047] As illustrated, a data communication system 216 can include a voice operated control (VOX) module to provide voice control to one or more subsystems, such as a voice recognition system, a voice dictation system, a voice recorder, or any other voice related processor. The VOX module can also serve as a switch to indicate to the subsystem a presence of spoken voice and a voice activity level of the spoken voice. The VOX can be a hardware component implemented by discrete or analog electronic components or a software component. In one arrangement, the processor 206 can provide functionality of the VOX by way of software, such as program code, assembly language, or machine language.

[0048] The RAM 202 stores program instructions for execution on the processor 206 as well as captured audio processing data. For instance, memory RAM 202 and ROM 204 can be off-chip and external to the processor 206 and include a data buffer to temporarily capture the ambient sound and the internal sound, and a storage memory to save from the data buffer the recent portion of the history in a compressed format responsive to a directive by the processor. In at least one exemplary embodiment, the data buffer can be a circular buffer that temporarily stores audio sound at a current time point to a previous time point. It should also be noted that the data buffer is operatively connected with processor 206 to provide high speed data access. The storage memory can be non-volatile memory such as SRAM to store captured or compressed audio data.

[0049] Data communication system 216 includes an audio interface operatively coupled to the processor

206 and the VOX to receive audio content, for example from portable media player 228, a cell phone, or any other communication device, and deliver the audio content to the processor 206. The processor 206 responsive to detecting voice-operated events from the VOX can adjust the audio content delivered to the ear canal of the user of the earpiece. For instance, the processor 206 (or the VOX of data communication system 216) can lower a volume of the audio content responsive to detecting an event for transmitting the acute sound to the ear canal of the user. The processor 206 by way of the ECM 208 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 based on voice operating decisions made by the VOX of data communication system 216.

[0050] The earpiece 201 and data communication system 216 can further include a transceiver that can support singly or in combination any number of wireless access technologies including without limitation Bluetooth™, Wireless Fidelity (WiFi), Worldwide Interoperability for Microwave Access (WiMAX), and/or other short or long range communication protocols. The transceiver can also provide support for dynamic downloading over-the-air to the earpiece 201. It should be noted also that next generation access technologies can also be used in exemplary embodiments.

[0051] Data communication system 216 can also include a location receiver that utilizes common technology such as a common GPS (Global Positioning System) receiver that can intercept satellite signals and therefrom determine a location fix of the earpiece 201.

[0052] The power supply 205 utilizes common power management technologies such as replaceable batteries, supply regulation technologies, and charging system technologies for supplying energy to the components of the earpiece 201 and to facilitate portable applications. A motor (not shown) can be a single supply motor driver coupled to the power supply 205 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.

[0053] Microprocessor 206 is operatively connected with an EarSeal Inflation Management System 232 to control the degree to which the sealing unit 108 is inflated or deflated. In one exemplary embodiment, sealing unit 108 comprises an expandable element (e.g., inflatable balloon mechanism), whereby a cavity can be filled with air or a liquid to change the degree of acoustic isolation between the internal ear canal space 124 and the ambient environment. Alternately, a passive system for sealing ear canal 124 is used such as a flexible rubber or a silicon sealing unit or a foam plug. In one exemplary embodiment, the passive

system is a balloon mechanism that is filled with air or liquid. The balloon mechanism conforms to the shape and size of an ear canal and includes a restorative force module that applies a pressure to the balloon mechanism for sealing the ear canal cavity.

[0054] The earpiece is 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 are reused in different form factors for the master and slave devices.

[0055] Referring to FIG. 3, a flowchart illustrates a method for an acoustic sealing analysis system in accordance with an exemplary embodiment. In general, a first volume is acoustically isolated from a second volume. The test determines if the two volumes have sufficient acoustic isolation from one another. For example, cars are designed to have a quiet interior. Users of an automobile do not want to be subjected to the noise of the external environment. Thus, a car interior (first volume) is acoustically isolated from the external environment outside of the automobile. Similarly, an earpiece having a sealing unit such as described in FIG. 1 will create a first volume (the ear canal) that is acoustically isolated from the ambient environment of the user (second volume). In either example, the acoustic sealing analysis system determines if there is sufficient acoustic isolation for the application. In the earpiece example, random or periodic testing of the seal may be beneficial because a new seal is formed in the ear canal when the device is put in the ear or it may shift over time depending on user activity.

[0056] The method begins at step 302. A test signal is acquired in a step 304. For example, the test signal can be stored in memory or generated by a microprocessor. The test signal is provided to the acoustic transducer. The acoustic transducer or loudspeaker (such as an ECR) emits an acoustic signal corresponding to the test signal within the first volume in a step 306. The acoustic field in the first volume is detected by an Ear Canal Microphone (ECM) in a step 308. The acoustic loading on both the ECR and ECM will change depending on the degree of acoustic sealing, thereby affecting the degree magnitude of the radiated ECR signal detected by the ECM. In general, as the degree of ear seal decreases, the effect of lumped air mass coupled to the ECR and ECM will decrease thereby increasing in Thevenin capacitance, which effectively reduces the transfer of low frequency emitted sound from the ECR to the ECM.

[0057] In one exemplary embodiment, the test signal and the acoustic signal emitted by the loudspeaker into the first volume is a single frequency sine wave signal for testing leakage from one volume to another.

[0058] The degree of sealing between the first and second acoustic volumes is determined in a step 310 and the process ends at step 312. The cross-correlation between the emitted test signal and detected ECM signal is taken. In at least one exemplary embodiment, the test signal and the measured acoustic signal emitted by the loudspeaker are conditioned using a time delay and frequency dependent filter. The ear-seal is determined to be low (or "leaky") if the cross- correlated signals are below a predetermined value. In at least one exemplary embodiment, automatic adjustments to the sealing section are made (such as deflating and re-inflating the sealing balloon to reseal the sealing section including retesting). Alternately, an audible sound, vocal response, or visual response can be provided to let the user know that the earpiece is sealed correctly or incorrectly.

[0059] Referring to FIG. 1, the earpiece is used as an example to illustrate a test sequence as disclosed in FIG. 3. Sealing unit 108 occludes an opening of ear canal 124 creating a first volume (ear canal124) and a second volume (the ambient environment). Sealing unit 108 has a first side exposed to ear canal 124 and a second side is exposed to or corresponds to the ambient environment external to the ear.

[0060] In at least one exemplary embodiment, processor 116 is configured to receive a test signal in memory 104. Processor 116 generates the test signal and provides the test signal to Ear Canal Receiver 114 (ECR 114). ECR 114 emits the test signal into Ear Canal Receiver Tube (ECR Tube 112). The test signal propagates through ECR tube 112 and into ear canal 124. Ear Canal Microphone tube 110 (ECM tube 110) is configured to receive an acoustic signal incident on the first side of sealing unit 108. The test signal in ear canal 124 propagates through ECM tube 110 and is received by Ear Canal Microphone 106 (ECM 106). ECM 106 is configured to measure the test signal in ear canal124 and provide the measured test signal to processor 116.

[0061] As shown, electronic housing unit 100 of the earpiece is adjacent to the second side of sealing unit 108. Electronic housing unit 100 is exposed to the ambient environment and for purposes of acoustic sealing analysis is considered the second side of sealing unit 108. Electronic housing unit 100 includes Ambient Sound Microphone 120 (ASM 120), which is configured to measure sounds in the ambient environment. Thus, ASM 120 receives and measures an ambient signal corresponding to a signal incident on the second side of sealing unit 108. ASM 120 provides the measured ambient signal to processor 116.

[0062] Ideally, sealing unit 108 is an acoustic barrier preventing the test signal or very little of the test signal from getting past sealing unit 108 and into the ambient environment. Conversely, sealing unit 108 if improperly sealed will pass some of the test signal. Processor 116 compares the test signal to the signal

provided by ECM 106 corresponding to the acoustic signal in ear canal124. In particular, processor 116 undertakes the cross-correlation between emitted test signal and the ECM signal.

[0063] Referring to FIG. 4, a flowchart of an exemplary method to determine the acoustic seal integrity of an earpiece in accordance with an exemplary embodiment is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user. This allows unobtrusive (periodic or non-periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0064] In at least one exemplary embodiment, an audio content is provided in a step 402. A step 404 stores the test signal in a test signal data buffer. For example, a single frequency sine wave is stored in the test signal data buffer. The output (or alternatively--input) of the test signal data buffer is optionally delayed by digital delay unit 406. The function of delay unit 406 is to time- align the emitted test signal with the ECM signal so the cross-correlation is sensitive to changes in ear seal.

[0065] A step 408 stores the test ECM signal in a test signal data buffer. The output (or alternatively--input) of the ECM signal buffer can be filtered with a low-pass filter 410. The low pass filter can be configured so that the pass-band covers the frequency of the test signal. In one exemplary configuration, the low-pass filter can be a cascaded bi-quad IIR type filter with the cut-off frequency equal to 10Hz greater than the test signal frequency.

[0066] A step 412 cross-correlates the optionally delayed test signal buffer with the low-pass filtered ECM signal buffer. An exemplary method for the cross-correlation algorithm is described in FIG. 5. The instantaneous cross-correlation (i.e. the cross-correlation at zero-lag) value from step 412 is compared with the cross-correlation threshold value 414 using comparator unit 416. If the instantaneous cross-correlation of the two signal buffers is less than the threshold value 414, then the seal test status is set to FAIL 418 (i.e. an ear-seal leak is detected); otherwise, if the cross-correlation is suitably high, the seal test status is set to PASS 420.

[0067] Referring to FIG. 5, a flowchart of an exemplary embodiment to determine the instantaneous cross-correlation between a first audio signal and a second audio signal is illustrated. The process begins at step 500. In at least one exemplary embodiment, the first audio signal is the test signal (i.e. a sine wave) and the second signal is the low-pass-filtered ECM signal.

[0068] The correlation between two signals x and y at time k using an exponential window is defined as:

[0069] $$p(k) = \frac{S_{xy}(k)}{\sqrt{S_{xx}(k)_{yy}(k)}} \quad (1)$$

[0070] Where

[0071] $$S_{xx}(k) = \sum_{l=0}^{\infty} ce^{-\eta^l} x_{k-l} y_{k-l} \quad (2)$$

$$c = 1 - e^{-\eta}$$

[0072] And S_{xx} and S_{yy} are defined similarly as in (2) (replacing y with x for S_{xx} etc.).

[0073] It can be shown (see Aarts et al, 2001) that (1) can be approximated with the recursion:

[0074] $$\hat{\rho}(k) = \hat{\rho}(k-1) + \gamma[\partial_k - \beta_k \hat{\rho}(k-1)] \quad (3)$$

$$\partial_k = 2x_k y_k$$

$$\beta_k = \alpha x_k^2 \alpha^{-1} y_k^2$$

[0075] Where

$$\alpha = \frac{y_{RMS}}{x_{RMS}} \quad (4)$$

$$\gamma = \frac{ce^{\eta}}{2x_{RMS} y_{RMS}}$$

[0077] The cross-correlation estimate using the above recursion is modified for block-wise processing rather than the sample-by-sample basis. This modification replaces the sample values (i.e. x(k) and y(k)) with values for the N-length block mean, i.e.

[0078]

$$x(k) = \frac{1}{N} \sum_{l=0}^{N-1} x(k-l)$$

[0079] Furthermore, the numerator for y is replaced with a small constant and so is [[a]] α (replacing [[a]] α with a constant effectively un-normalizes the correlation estimate). It is found that the modified un-normalized block-wise cross-correlation accurately estimates the cross-correlation compared with using the standard cross-correlation for two signals.

[0080] The modified block-wise fast cross-correlation algorithm, as summarized in FIG. 5, comprises the following steps:

1. A first signal buffer 502 is accumulated. This signal buffer corresponds to the emitted test signal (i.e. the sine wave).
2. The RMS level of the first buffer is calculated 504 (x_{RMS})
3. The mean level of the first buffer is calculated 506.
4. A second signal buffer 508 is accumulated. This signal buffer corresponds to the filtered ECM signal.
5. The RMS level of the second buffer is calculated 510 (y_{RMS}).
6. The mean level of the second buffer is calculated 512.
7. In step 514, γ (gamma) is approximated as:

$$\gamma = \frac{\Gamma}{2x_{RMS}y_{RMS}}$$

Where Γ is a small constant, e.g. 10E-3.

8. In step 516,∂_k (delta) calculated as twice the product of the first signal buffer mean and the second signal buffer mean.
9. In step 518, beta is calculated as the sum of the square of the mean value of the first buffer with the sum of the square of the mean value of the second buffer.
10. In step 520, the new temporary estimate of the correlation newRho_temp is calculated as: newRho_temp=(delta-beta*rho_old))
11. In step 522, the new estimate of the correlation newRho is updated by summing the previous estimate of the correlation with the product of gamma and the temporary estimate of the correlation newRho_temp.
12. In step 524, the "old" value of the correlation is set to the newest correlation estimate, ready for the next iteration of the update algorithm.
13. In step 526, the current correlation estimate between the emitted test signal and the received and filtered ECM signal is set as equal to the value of newRho.

[0081] Referring to FIG. 6, a flowchart of a method to determine when to emit the test signal is shown. The test signal is emitted when the test can be performed unobtrusively to the user and also provides an accurate test. In at least one exemplary embodiment, a test event to determine if an earpiece is sealed correctly is

initiated via a timing methodology. In a first timing scenario, the test event occurs after a delay of a first predetermined time period when the RMS of the Audio Content (AC) is less than a RMS threshold. In a second timing scenario, the delay of the first predetermined time period is allowed to lapse without the test event occurring when the RMS of the audio content is greater than the RMS threshold. A second predetermined time period is started where the test event occurs when the RMS of the audio content is less than the RMS threshold. The test event is then initiated when the second predetermined time period is exceeded independent of the RMS of the audio content.

[0082] A test sequence is initiated in a step 602. The previous seal test event resets the first digital timer in a step 604. A time delay is generated by the loop comprising steps 606 and 608. The first digital timer is time incremented in the step 606. After each added time increment, the first digital timer is compared against a digital_timer_threshold1. The first digital timer is time incremented (after the time has advanced another increment) after the comparison in the step 608 if the first digital timer is less than the digital_timer_threshold1.

[0083] A second digital timer is reset in a step 610 when the first digital timer is greater than the digital_timer_threshold1. The second digital timer is time incremented in a step 612. Audio content (AC) from a signal buffer is retrieved in a step 614. The audio content can be filtered through a low pass filter in an optional step 616. The RMS of the audio content is calculated in a step 618. The calculated RMS of the audio content is compared against an RMS_threshold 622 in a step 620. The second digital timer is compared against a digital_timer_threshold2 in a step 624 if the RMS of the audio content is greater than the RMS_threshold. The second digital timer is time incremented (after the time has advanced another increment) when the second digital timer is less than digital_timer_threshold2 in the step of 624.

[0084] The audio content signal is mixed with the test signal when the RMS of the audio content is less than the RMS_threshold in a step 626. Also, the audio content signal is mixed with the test signal when the second digital timer is greater than digital_timer_threshold2 in the step 624. The modified audio signal (having the test signal mixed in) is emitted by the ECR in a step 628 for testing the sealing section of the earpiece. The first digital timer is then reset in the step 604 to begin a timing sequence for another sealing section test.

[0085] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention. The estimated un-normalized cross-correlation between the ECM signal and the test signal (i.e. sine wave) is shown for different sine wave frequencies from 30-80Hz. Three different curves are provided corresponding

to a good fit (i.e. a tight optimal seal providing approximately 20-30 dB of acoustic attenuation), mid or partial seal (i.e. an ear-seal that could be characterized as "half in" providing approximately 10-15 dB of acoustic attenuation), and a poor seal (i.e. an ear-seal providing less than 10 dB of acoustic attenuation). At lower test frequencies, the change in correlation is more pronounced as the degree of ear seal fitting is changed from "good" to "mid" and "poor". From the data, the threshold used to determine whether the ear seal can be characterized as "good" is approximately -20 dB, (i.e. 0.85 of FIG. 10 which corresponds to the value for XCorr_threshold 414 in FIG. 4).

[0086] In at least one exemplary embodiment, the test signal for testing a seal of a sealing section is less than 200 hertz. The frequency of the emitted test signal is chosen to satisfy the requirements of being able to reveal small degradations in ear seal quality. It is also beneficial if the selected test signal frequency can be acoustically masked by reproduced audio to minimize detection of the test by an earpiece user. Both of these criteria are met using a test signal frequency below 200 Hz. The sensitivity is highest from the measured data at frequencies below 50 Hz. Conversely, as the test signal frequency increases the cross-correlation difference between a "good" and "bad" acoustic seal decreases. For example, with a 40Hz test tone, the cross-correlation for a "good" ear seal is -8 dB, and for a bad ear seal it is -68 dB (i.e. a 60 dB difference). At a test signal frequency of 80Hz, the cross-correlation for a "good" ear seal is -8 dB and for a bad ear seal it is -38 dB (i.e. a 30 dB difference). Thus, above 200Hz the cross- correlation difference between a "good" and "bad" acoustic seal is further reduced thereby reducing the sensitivity of the test.

[0087] Using the cross-correlation rather than a level differencing approach improves the accuracy and minimizes errors which occur due to user non-speech body noise, such as teeth chatter; sneezes, coughs, etc. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0088] FIG. 8 is a flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) in accordance with an exemplary embodiment. The IMS is adjusted depending on the degree of acoustic sealing provided by an earpiece. The method begins at step 802. The acoustic sealing is measured as disclosed in FIG. 7 and the result provided in a step 804 to determine the cross-correlation (XCorr) between a test signal and corresponding ECM signal. In general, the higher the cross-correlation, the higher the degree of acoustic sealing. An exemplary graph showing the relationship between XCorr and acoustic sealing is given in FIG. 10. The degree of acoustic sealing is determined from known XCorr using a look-up (or "hash") table or using a formula (e.g. of a polynomial form) that maps the acoustic sealing to the known XCorr value. The ambient sound level is measured in a step 806. The ambient sound level corresponds to

the noise level in proximity to the user. In general, a higher degree of attenuation is desired when the ambient sound levels are high. Conversely, at low ambient sound levels the attenuation level of the IMS may be less of an issue and comfort more of a factor. The IMS is adjusted in a step 808 to meet the attenuation needs. In general, inflating the IMS increases attenuation while deflating the IMS decreases attenuation. The method terminates at step 810.

[0089] Referring to FIG. 9, a more detailed flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) is shown. In general, the attenuation increases when the pressure in the IMS is raised thereby allowing a degree of control to make adjustments. For example, an adjustment is made to increase attenuation when the background noise level rises or a seal check produces a failed result. Adjustments are made until the seal check passes. The pressure level adjustments of the IMS will fall within a comfort range of a user (e.g., between 0.1 bar and 0.3 bar gauge pressure). Typically, the pressure level is set at a minimum level to achieve a predetermined attenuation level.

[0090] The method begins at step 902. The degree of acoustic sealing is determined from cross-correlation between the ECM signal and the generated test signal. The XCorr value is provided in a step 904. In step 906, the attenuation provided by the IMS is calculated (equation) or looked up (table) from data such as that shown in FIG. 10. In one exemplary embodiment, the desired attenuation value is dependant on the ambient sound level of the user. In another exemplary embodiment, the desired attenuation value is dependant on the ear-canal sound level of the user. In yet another exemplary embodiment, the desired attenuation value is dependant on the level of audio content (e.g. speech or music audio) reproduced with the earphone device. In all of the above examples, the desired attenuation value is determined by one or more of the embodiments in a step 907.

[0091] The difference between the degree of acoustic sealing determined in step 906 and the desired attenuation value determined in step 907 is calculated in step 908. The difference value in step 908 is used to determine the change in pressure of the IMS necessary to minimize the difference value in a step 910. In at least one exemplary embodiment, the difference value of the attenuation is converted into a corresponding pressure value change (e.g. in milli-Bars) using a similar look-up table or equation method as described previously. The pressure change in the IMS is then affected with step 912 to meet the desired attenuation level. For example if the desired attenuation is a decrease of 10 dB in sound across the earpiece in the ear canal, then a pressure of a variable volume inflatable system can have a gauge pressure of about 0.15 bar. If the desired attenuation is a decrease of 20 dB across the earpiece in the ear canal then the gauge pressure can be increased to about 0.25 bar, where an increased pressure is associated with an increase in attenuation. An

experimental table for each earpiece can be generated in a standard devised experimental setup (e.g. impedance tunnel) and referred to when changes are needed. The method ends at step 914.

[0092] Referring to FIG. 11, a flowchart of an exemplary method to determine a test signal fundamental is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user or made pleasant such that the user is unaware that the test signal is being played. This allows unobtrusive (periodic or non- periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0093] In at least one exemplary embodiment, an audio content 1102 is provided. A step 1104 stores audio content 1102 in a data buffer. In this example, audio content 1102 is music played from a media player and received via a wired or wireless connection to at least one earpiece in the user's ear. An alternate example would be that audio content 1102 is a speech audio signal from a portable telephone device or the like.

[0094] A step 1106 determines if the buffer of audio content 1102 comprises a strong tonal signal component. Mixing the test signal having a similar fundamental frequency as audio content 1102 will mask the test signal when played to the user. Thus, the test signal is musically in harmony with the reproduced music and results in very little perceptual degradation in sound quality.

[0095] A step 1108 determines whether to update or generate the first fundamental tone for the test signal. The test signal is not updated or generated if buffered audio content 402 does not contain a strong tonal signal component. A return to step 1104 fills the buffer with the next audio content 402 for analysis.

[0096] A step 1110 analyzes the buffer of data of audio content 1102 when it has been determined that it contains a strong tonal signal component. Step 1110 determines the fundamental frequency of the tonal signal. The fundamental tone, often referred to as the fundamental and abbreviate f_0 is the lowest frequency in a harmonic series. The fundamental frequency (also called a natural frequency) of a periodic signal is the inverse of the pitch period length. The pitch period is the smallest repeating unit of a signal. The fundamental frequency of the tonal signal can be calculated using an autocorrelation analysis.

[0097] In one exemplary embodiment, a mathematical operation 1114 is performed where the frequency component of the test signal is limited to a frequency range below a lower minimum and upper maximum frequency range. Fund_ratio is calculated, which is defined as a ratio of the determined fundamental frequency (F_fund) of the tonal signal from step 1110 to an upper threshold value F_fund_threshold 1112, which in one exemplary embodiment, is a fixed constant equal to approximately 100Hz. In general,

F_fund_threshold 1112 is chosen to be a low frequency value which is above the lowest (or -3 dB) frequency that a transducer can reproduce, but below a predetermined frequency. In a comparison step 1116, if the estimated F-fund is higher than the F_fund_threshold 1112 (ratio > 1), then F_fund is reduced by an integer multiple to be below F_fund_threshold 1112 corresponding to the mathematical operation of step 1118. Otherwise, the test signal fundamental is equal to F_fund as shown in step 1120. Although not shown, the calculated test signal fundamental is compared and determined to be greater than a predetermined threshold.

[0098] Referring to FIG. 1, in at least one exemplary embodiment, processor 116 is configured to receive or generate audio content. As mentioned previously, the audio content can from external devices such as a portable phone or a media player. Memory 104 can be used as a buffer for the audio content. Processor 116 is configured to receive the buffer of audio content from memory 104. The steps and calculations of the block diagram of FIG. 4 are then performed by processor 116. The result being one of the identification of a strong tonal signal component in the buffer of audio content and the test signal fundamental or loading the buffer with new audio content and starting the process again.

[0099] Referring to FIG. 12, a flowchart of an exemplary embodiment to determine tonal presence in audio content is shown. In particular, the exemplary embodiment relates to step 1106 of FIG. 11 that analyzes audio content stored in a buffer. The method begins at step 1202. A step 1204 gets the audio content stored in an audio signal buffer hereinafter called the audio signal. A filter step 1206 filters the audio signal to a frequency range of interest that relates to a sealing test frequency. For example, a band pass filter in the range of 20Hz to 500Hz could be used to filter the audio signal where the test signal is in the lower audio frequency range. An auto-correlation step 1208 analyzes the audio signal where a strong tonal signal component is represented by peaks in the analysis results. A step 1210 generates Absolute(Acorr) which is a number representing the absolute magnitude of the peaks from the analysis. For example, Absolute(Acorr) can be the square of the results from the auto-correlation.

[0100] A crest_factor_Acorr 1218 is generated from the results by calculating an RMS value 1214 (or time-averaged peak value) and peak value 1216 (or time averaged peak value). In at least one exemplary embodiment, the crest_factor_Acorr 1218 is the ratio of the peak value to the RMS value of an absolute auto-correlation sequence of the audio signal.

[0101] A comparison step 1222 is then performed. A strong tonal presence is identified when crest_factor_Acorr 1218 is greater than a threshold Crest_factor_Acorr_threshold 1220. Identification of the

strong tonal presence indicates the audio signal would facilitate masking of the test signal to determine sealing of the device (step 1226). The audio signal is not used in conjunction with the test signal if crest_factor_Acorr 1218 is less than Crest_factor_Acorr_threshold 1220 (step 1224). The process would begin again loading a next sequence of the audio signal into the buffer for review.

[0102] Referring to FIG. 1, as mentioned previously, audio content is stored in a buffer, for example memory 104. The audio content in the buffer is provided to processor 116. In at least one exemplary embodiment, processor 116, runs the analysis as described in the block diagram of FIG. 12 thereby determining if a strong tonal presence is found in the audio content in the buffer. New audio content is loaded into the buffer (memory 104) if a strong tonal presence is not found beginning the procedure again.

[0103] Referring to FIG. 13, a flowchart of a method to determine when to emit the test signal is shown. The method begins at step 1302. The test signal is emitted when the test can be performed unobtrusively to the user and also provide an accurate test. In a step 1304, an audio signal is retrieved from a buffer. In at least one exemplary embodiment, the audio signal is received from an ECM or an ASM. The audio signal is measured to determine when the sound level is low in the ear canal, the ambient environment, or both. In general, the test signal is emitted when the sound level is low.

[0104] A filter step 1306 band pass filters the audio signal. In one exemplary embodiment, filter step 1306 filters the audio signal from 50 Hz to 150Hz which corresponds to a frequency range of the test signal. In a step 1308, the RMS of the audio signal is calculated. The audio signal is analyzed to detect when the energy within an audio frequency range is below a threshold RMS_threshold 1310. The RMS of the audio signal is the signal level in the volume being measured. A comparison step 1312 compares the measured RMS level of the filtered audio signal against RMS_threshold 1310. In a step 1314, a test signal is emitted when the measured RMS value is less than RMS_threshold 1310. No test signal is emitted when the RMS of the audio signal is greater than RMS_threshold 1310. The method ends at step 1316.

[0105] Referring to FIG. 14, a flowchart of an exemplary method to determine acoustic seal integrity is illustrated. For example, an earpiece seal integrity corresponds to a full or partial acoustic barrier between a first volume (ear canal) and a second volume (ambient environment). In one exemplary embodiment, the degree of acoustic seal integrity is expressed as either a PASS or FAIL status, where FAIL indicates that the acoustic seal is compromised relative to a normal operating acoustic seal. For example, an earpiece that has performed the seal test and determined that the sealing unit is not sealed correctly in the ear canal of the user can provide a signal or message indicating the problem. The user can then remove, reinsert, and retest the

earpiece to ensure that the seal is within normal operating specifications.

[0106] The method begins at step 1402. An acoustic test signal is provided in a first volume. In a step 1404 a transducer measures the acoustic test signal and stores it in a signal buffer. In a step 1406, a second transducer in a second volume isolated from the first volume by an acoustic barrier measures a second acoustic signal in the second volume. A portion of the acoustic test signal passes the acoustic barrier into the second volume. The amount of the acoustic test signal passing the acoustic barrier is a measure of the seal provided by the acoustic barrier.

[0107] In a filter step 1408, the measured acoustic test signal in the first volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals that are not part of the test. The measured signal from the first volume is heretofore called the first volume signal. Similarly, in a step 1410, the measured signal in the second volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals not related to the test (outside the frequency range) in the second volume. The measured signal from the second volume is heretofore called the second volume signal.

[0108] A correlation, cross-correlation, or coherence analysis is performed on the first volume signal and the second volume signal. The correlation, cross-correlation, or coherence analysis is a measure of the similarity of the signals in the first and second volumes. In particular, the non- difference analysis measures the acoustic test signal leaking past the acoustic barrier by identifying the portion of the second volume signal that is similar to the acoustic test signal in the first volume.

[0109] In at least one exemplary embodiment, a correlation step 1412 is performed comprising a cross-correlation of the first volume signal and the second volume signal. In a step 1414, the peak of the cross-correlation is identified. The peak of the cross-correlation is Absolute(XCorr). In a mathematical step 1418, the Lag-time of Peak 1420 and the Magnitude of Peak 1422 is calculated. The Lag-time of Peak 1420 is a measure of the time delay between receiving the signals in the first and second volumes. In particular, the first volume signal should be received before the second volume signal. The Magnitude of Peak 1422 corresponds to the similarity between the signals in the first and second volumes. Thus, a larger number for Magnitude of Peak relates to more leakage of the acoustic test signal getting past the acoustic barrier.

[0110] Two comparisons are performed that determine if the acoustic barrier is sealed correctly based on the measured and calculated data from the first and second volumes. In a comparison step 1426, the measured Lag-time of Peak is compared against Target Lag Limits 1424. The measured lag-time should fall within the

predetermined range (Target Lag Limits 1424) for the seal test to be valid. If the Lag-time of Peak is within the appropriate range then a logic 1 is provided to AND function 1432, otherwise a logic 0 is provided. In a second comparison step 1428, the Magnitude of Peak is compared against a Peak_threshold 1430. If the Magnitude of Peak is greater than the Peak_threshold 1430 a logic 1 is provided to AND function 1432. This indicates that a significant portion of the acoustic test signal is present in the second volume measurement, otherwise a logic 0 is provided. A FAIL output 1434 corresponds to a logic 1 at the output of AND function 1432. The FAIL occurs when the Lag-time of Peak is within the predetermined range and the Magnitude of Peak is greater than the Peak_threshold indicating that the acoustic barrier is sealed improperly. All other conditions indicate a PASS output 1434 and the acoustic barrier is sealed correctly.

[0111] In at least one exemplary embodiment and referring briefly to FIG. 1, an earpiece is tested to determine if sealing unit 108 is sealed correctly to the ear canal of the user. Sealing unit 108 creates a first volume in ear canal 124 and a second volume outside the ear canal 124 in the ambient environment. A masking approach is used to perform seal testing unobtrusively to the user. The user is listening to music or speech (audio content) provided to ear canal124 from ECR 114.

[0112] The music or speech is buffered in memory 104 or memory in processor 116. Processor 116 analyzes the audio content in the buffer to identify a strong tonal content. A test signal can be created once audio content with strong tonal content is found. The test signal will have at least one fundamental pitch corresponding to the strong tonal content and optionally further harmonics. Processor 116 also analyzes the measured signals from ECM 106 and ASM 120 to determine when to emit the test signal. Processor 116 monitors and compares the sound level in the ambient environment and ear canal124. Processor 116 will provide the generated test signal to ECR 114 during an optimum time for test accuracy such as when the ambient sound level is low, the ear canal sound level is low, or both. Also, processor 116 will not output the test signal if there is audio content similar to the test signal in the ear canal or ambient environment.

[0113] Processor 116 monitors the test conditions and then provides the test signal to ECR 114 when an accurate sealing test can be performed. ECR 114 outputs an acoustic test signal which may or may not have other audio content. ECM 106 and ASM 120 respectively measure acoustic signals in ear canal 124 and the ambient environment. Processor 116 is operatively coupled to ECM 106 and ASM 120. The measured signals are buffered in memory 104.

[0114] In an exemplary embodiment, a cross-correlation is used to measure the similarity between the

signals in ear canal124 and the ambient environment. Processor 116 performs the cross-correlation calculations using the measured acoustic signals from ECM 106 and ASM 120. In particular, the cross-correlation is used to identify and compare the acoustic test signal present in the two volumes separated by the acoustic barrier. A cross-correlation between ASM and ECM signals is defined according to the following equation (5):

$$XCorr(n,l) = \sum_{n=0}^{N} ASM(n)ECM(n-l), \quad (5)$$

Where: l=0, 1, 2, … N

[0115] Where ASM(n) is the nth sample of the ASM signal, and ECM(n-[[1]] l) is the (n-[[1]] l)th sample of the ECM signal. A peak of the absolute cross-correlation is estimated using a peak- picking function and also the lag time at which this peak occurs (i.e. the index I at which this occurs). Thus, the Lag-time of Peak and the Magnitude of Peak are known and respectively compared against a Target Lag Limit range and a Peak Threshold. The user of the earpiece is notified or warned that sealing unit 108 is improperly sealed by processor 116 if the measured Lag-time of Peak is within the Target Lag Limit range and the Magnitude of Peak is greater than the Peak Threshold.

[0116] Like Correlation and Cross-Correlation, a coherence function is also a measure of similarity between two signals. Coherence is another non-difference comparison approach that can be used for detecting acoustic seal integrity. Coherence is defined as:

$$\gamma^2{}_{xy} = \frac{|G_{xy}(f)|^2}{G_{xx}(f)G_{yy}(f)} \quad (6)$$

[0117] Where Gxy is the cross-spectrum of two signals (e.g. the ASM and ECM signals), and can be calculated by first computing the cross-correlation in equation (5), applying a window function, for example a Hanning window, and transforming to the frequency domain, for example via an FFT. Gxx or Gyy is the auto-power spectrum of either the ASM or ECM signals, and can be calculated by first computing the auto-correlation (using equation 5, but where the two input signals are both from either the ASM or ECM and transforming to the frequency domain. The coherence function gives a frequency-dependent vector between 0 and 1, where a high coherence at a particular frequency indicates a high degree of coherence at this frequency, and can therefore be used to analyze test signal frequencies in the ASM and ECM signals whereby a high coherence indicates the presence of the test signal in the ambient environment (indicating

leakage past the acoustic barrier).

[0118] Other approaches such as frequency spectrum analysis and RMS levels can also be used to determine if the earpiece is sealed correctly. Using a non-difference comparison approach such as coherence or cross-correlation between the ASM and ECM signals to determine sealing is more reliable than taking the level difference of the ASM and ECM signals. Using the cross correlation rather than a level differencing approach improves the accuracy and minimizes errors which may occur due to user non-speech body noise, such as teeth chatter, sneezes, coughs, etcetera. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0119] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment. In the non-limiting example, when a seal is essentially detected as being low, for example the calculated sound isolation of the system is 3 dB or less, a signal is sent to a seal varying device (e.g., 1500) to vary the seal, in this case increase (i.e. increase the sound isolation of the system) the seal value. The signal can be instructions to send a current over a period of time to an actuator, which can decrease the overall volume of the system (hence increasing the pressure and effectively the sealing). For example a slider actuator such as the P-653 PILine® can be used. Which has the dimensions of 15 mm by 11 mm by 8 mm, which includes an attached electronics control board, and has a mass of 1 gram. General operation uses 5V and about 100 mamps with a typical speed of 50 to 90 mm/sec. Note that the max force of about 0.15 N but such systems can be tailored to enable pumping beyond atmospheric pressure (e.g., can increase the max force). The non limiting example illustrated in FIGS. 15A and 15B shows a slider actuator 1500, with a moving slide 1510, having attached a pumping arm 1560, with a hole 1550 covering bump 1520. Upon receipt of a signal1505 the actuator can move 1570 such that the bump 1520 covers the hole 1550 in a bellows 1530 pump. The actuation compresses the miniature bellows 1530 pushing 1590 gas through the one-way valve 1540, upon the back stroke the bump 1520 uncovers the hole 1550 and air rushes back into the bellows 1530 for the next pump. For example if the stroke length is 2 mm and the pump arm 1560 contact area is about 9 mm 2 then each stroke moves 18 mm 3 of volume. If an inflation system 1570 needs to be inflated more (e.g., more gas to increase sealing) then each stroke can provide an additional volume of gas of 18 mm 3 into the system increasing the inflation system 1580. If the inflation system is initially empty (e.g., needs 1000 mm 3 of gas volume to inflate) then about 56 strokes would be needed for inflation, which is about 110 mm one direction stroke length or about 2 seconds at P-653 PILine speeds. The number of oscillations and stroke length can be determined according to the signal 1505 sent, which can be specifically tailored depending

upon the electronics controlling the actuators. Note that PI-653 is an example only. Other actuation systems can be used and controlled by signal 1505.

[0120] FIG. 16 illustrates a block diagram of controlled sealing in response to a seal fail signal and/or a request for increased seal attenuation. For example, a command signal 1600 is received (e.g., a seal fail signal in which a default attenuation value is attached for example 15 dB, or a signal requesting an additional amount of attenuation) by a processor. The command signal specifies an additional amount of attenuation or that the seal has failed. An attenuation needed N is identified 1610. For example if the current attenuation is 5 dB loss at f=500 Hz, at a pressure of 0.1 bar, and a command signal is received requesting a 10 dB loss at 500 Hz, then an experimental table is queried to find the pressure needed P which is then subtracted from the current pressure to obtain an increase in pressure DP needed. The increase in pressure is converted into a volume of gas increase needed (e.g., again referring to experimental tables based upon the inflation system volume). The volume of gas increase needed can then be directly linked with the number of cycles of an actuator pump M, 1620. The number of requested cycles M can then be sent 1630 to the actuator control circuit to pump the designated number of cycles. The system can then retest the attenuation 1640 and if refinements are needed the process can start again.

[0121] 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. For example, if words such as "orthogonal", "perpendicular" are used the intended meaning is "substantially orthogonal" and "substantially perpendicular" respectively. Additionally although specific numbers may be quoted in the claims, it is intended that a number close to the one stated is also within the intended scope, i.e. any stated number (e.g., 90 degrees) should be interpreted to be "about" the value of the stated number (e.g., about 90 degrees).

[0122] 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.

ACOUSTIC SEALING ANALYSIS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Patent Application Ser. No. 17/182,570, filed 23 Feb. 2021, which is a continuation of U.S. Patent Application Ser. No. 16/838,277, filed April 2, 2020, which is a continuation of U.S. Patent Application Ser. No. 16/414,136, filed May 16, 2019, which is a continuation of U.S. Patent Application Ser. No. 15/700,511, filed September 11, 2017, which is a continuation of U.S. Patent Application Ser. No. 14/827,332, filed August 17, 2015, now U.S. Patent No. 9,781,530, which is a continuation of U.S. Patent Application Ser. No. 14/054,015, filed October 15, 2013, now U.S. Patent No. 9,113,267, which is a Divisional Application of U.S. Application Ser. No. 12/555,864, filed September 9, 2009, now U.S. Patent No. 8,600,067 and claims the benefit of U.S. Provisional Patent Application No. 61/098,250 filed September 19, 2008. The disclosure of all the aforementioned references are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to testing the seal of an orifice-inserted device, and more particularly, though not exclusively, to a device and method for determining if an earpiece is sealed correctly in an ear canal.

BACKGROUND OF THE INVENTION

[0003] It can be difficult to communicate using an earpiece or earphone device in the presence of high-level background sounds. In many earpiece designs a transducer is placed near the ear canal opening. Ambient sound from the surrounding environment enters the ear canal with the audio content from the transducer. Environmental sounds such as traffic, construction, and nearby conversations can degrade the quality of the audio content.

[0004] Although audio processing technologies can adequately suppress noise, the earpiece is generally sound agnostic and cannot differentiate sounds. Thus, one method to prevent ambient sound from entering the ear is to seal or provide an acoustic barrier at the opening of the ear canal. Sealing minimizes ambient sound leakage into the ear canal, and under the correct conditions can provide a level of noise suppression under high background noise conditions. Certain types of acoustic software (e.g., communication in a noisy environment via an ear canal microphone) may require some minimum noise isolation from the ambient

sound to provide adequate performance to the user. Additionally, user conditions may change substantially during the operation of the earpiece, and in some circumstances, the earpiece may become misaligned or may be fit incorrectly such that it is not sealed correctly. A method of seal detection is needed to optimize performance.

SUMMARY OF THE INVENTION

[0005] Broadly stated, embodiments are directed to a device and method to determine if an earpiece is sealing within the design specification of the device.

[0006] In one embodiment, the device can include a sealing section forming an acoustic barrier between a first volume and a second volume. An ear canal receiver (ECR) can be configured to generate an acoustic signal in the first volume. An Ear Canal Microphone (ECM) in the first volume can be configured to measure the acoustic signal in the first volume. The first acoustic signal emitted by the ECR can be cross-correlated with the first acoustic signal detected with the ECM to determine if the sealing section is sealed properly.

[0007] At least one exemplary embodiment is directed to a method of detecting sealing integrity of an earpiece comprising the steps of: providing a test signal; generating an acoustic signal corresponding to the test signal incident on an ear canal side of a sealing section; converting the acoustic signal incident on a first side of the sealing section to an electrical signal; and cross- correlating the test signal to the electrical signal where the earpiece is sealed correctly when a cross-correlation between the test signal and the electrical signal is above a threshold.

[0008] At least one exemplary embodiment is directed to a method of adjusting attenuation of an earpiece comprising the steps of: relating cross-correlation of a test signal and a measured acoustic signal in an ear canal of a user to an attenuation level of a sealing section of the earpiece; comparing the attenuation level of the sealing section of the earpiece to a minimum attenuation value; and adjusting a pressure of the sealing section to meet the minimum attenuation value.

[0009] At least one exemplary embodiment is directed to a device comprising: a sealing section configured to seal a user's orifice, where the sealing section is configured to produce an acoustic seal between a first side of the sealing section and a second side of the sealing section; a transducer configured to generate a first acoustic signal incident on the first side of the sealing section; and a first microphone configured to measure a second acoustic signal incident on the second side of the sealing section, where the second acoustic signal

includes at least a portion of the first acoustic signal that has passed from the first side to the second side of the sealing section where the first acoustic signal is compared to the second acoustic signal to determine if the sealing section is sealed.

[0010] Further areas of applicability of exemplary embodiments of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Exemplary embodiments of the present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0012] FIG. 1 is a diagram of an earpiece inserted in an ear canal in accordance with an exemplary embodiment;

[0013] FIG. 2 is a block diagram of optional components of an earpiece in accordance with an exemplary embodiment;

[0014] FIG. 3 is a flowchart of a method for checking an ear seal in accordance with an exemplary embodiment;

[0015] FIG. 4 is a flowchart to determine acoustic seal integrity of an earpiece in accordance with the exemplary embodiment.

[0016] FIG. 5 is a flowchart of a method to estimate the instantaneous cross-correlation between a first and second audio signal.

[0017] FIG. 6 is a flowchart to determine when to emit a test signal in accordance with an exemplary embodiment;

[0018] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention;

[0019] FIG. 8 is a block diagram for a method of adjusting the IMS system in accordance with at least one exemplary embodiment;

[0020] FIG. 9 is a block diagram for a method of adjusting IMS pressure in accordance with at least one exemplary embodiment;

[0021] FIG. 10 illustrates a sample relationship between EarSeal attenuation and XCorr in accordance with at least one exemplary embodiment;

[0022] FIG. 11 illustrates a flowchart of an exemplary method to determine a test signal fundamental;

[0023] FIG. 12 illustrates a flowchart of an exemplary embodiment to determine tonal presence in audio content;

[0024] FIG. 13 illustrates a flowchart of a method to determine when to emit the test signal;

[0025] FIG. 14 illustrates a flowchart of an exemplary method to determine acoustic seal integrity;

[0026] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment; and

[0027] FIG. 16 illustrates the sending of a signal to an inflation controller upon detection of a seal fail to modify the seal pressure in accordance with at least one exemplary embodiment.

DETAILED DESCRIPTION

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

[0029] Exemplary embodiments are directed to or can be operatively used on various wired or wireless orifice inserted devices for example earpiece devices (e.g., earbuds, headphones, ear terminals, behind the ear devices or other acoustic devices as known by one of ordinary skill, and equivalents).

[0030] Processes, techniques, apparatus, and materials as known by one of ordinary skill in the art may not be discussed in detail but are intended to be part of the enabling description where appropriate. For example specific computer code may not be listed for achieving each of the steps discussed, however one of ordinary skill would be able, without undo experimentation, to write such code given the enabling disclosure herein. Such code is intended to fall within the scope of at least one exemplary embodiment.

[0031] Additionally exemplary embodiments are not limited to earpieces, for example some functionality can be implemented on other systems with speakers and/or microphones for example computer systems, PDAs, BlackBerry® smart phones, cell and mobile phones, and any other device that emits or measures acoustic energy. Additionally, exemplary embodiments can be used with digital and non-digital acoustic systems. Additionally various receivers and microphones can be used, for example MEMs transducers,

diaphragm transducers, for example Knowles' FG and EG series transducers.

[0032] Notice 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 or further defined in the following figures.

[0033] 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.

[0034] 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.

[0035] At least one exemplary embodiment of the invention is directed to an earpiece for sealing or partially sealing an ear. FIG. 1 is a diagram of an earpiece inserted in an ear canal 124 in accordance with at least one exemplary embodiment of the invention. FIG. 1 also illustrates portions of the ear including pinna 128, ear canal 124 and eardrum 126. As illustrated, the earpiece comprises an electronic housing unit 100 and a sealing unit 108. The earpiece depicts an electro-acoustical assembly for an in-the-ear acoustic assembly, as it would typically be placed in an ear canal 124 of a user 130. The earpiece is an in-ear earpiece, behind the ear earpiece, receiver in the ear, partial-fit device, or any other suitable earpiece type. The earpiece can partially or fully occlude the ear canal 124.

[0036] The earpiece includes an Ambient Sound Microphone (ASM) 120 to capture ambient sound, an Ear Canal Receiver (ECR) 114 to deliver audio to an ear canal124, and an Ear Canal Microphone (ECM) 106 to capture and assess a sound exposure level within the ear canal 124. The earpiece can partially or fully occlude the ear canal 124 to provide various degrees of acoustic isolation. The assembly is designed to be inserted into the user's ear canal 124, and to form an acoustic seal with the walls of the ear canal 124 at a location between the entrance to the ear canal 124 and the tympanic membrane (or ear drum) 126. In general, such a seal is typically achieved by means of a soft and compliant housing of the sealing unit 108. Additionally, the sealing unit 108 can be a pressurized expandable element that fills a portion of the available local space.

[0037] Sealing unit 108 is an acoustic barrier having a first side corresponding to ear canal124 and a second

side corresponding to the ambient environment. In at least one exemplary embodiment, sealing unit 108

includes an ear canal microphone tube 110 and an ear canal receiver tube 112. Sealing unit 108 creates a closed cavity of approximately 5 cc or less between the first side of sealing unit 108 and the tympanic membrane 126 in ear canal124. In at least one exemplary embodiment the sealing facilitates using the ECR (speaker) 114 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 126 resulting from the sound field at the entrance to the ear canal 124. This seal is also a basis for a sound isolating performance of the electro-acoustic assembly.

[0038] In at least one exemplary embodiment and in broader context, the second side of sealing unit 108 corresponds to the side adjacent to electronic housing unit 100. Ambient sound microphone 120 is housed in electronic housing unit 100 and is exposed to the ambient environment for receiving sound from the ambient environment around the user.

[0039] The electronic housing unit 100 can include various system components such as a microprocessor 116, memory 104, battery 102, ECM 106, ASM 120, ECR, 114, and user interface 122, or these components can reside in a separate system or interface operatively connected. Microprocessor 116 (or processor 116) can be a logic circuit, a digital signal processor, controller, or the like for performing calculations and operations for the earpiece. Microprocessor 116 is operatively coupled to memory 104, ECM 106, ASM 120, ECR 114, and user interface 122. An optional wire 118 can provide an external connection to the earpiece. Battery 102 powers the circuits and transducers of the earpiece. Battery 102 can be a rechargeable or replaceable battery.

[0040] In at least one exemplary embodiment, electronic housing unit 100 is adjacent to sealing unit 108. Openings in electronic housing unit 100 receive ECM tube 110 and ECR tube 112 to respectively couple to ECM 106 and ECR 114. ECR tube 112 and ECM tube 110 acoustically couple signals to and from ear canal 124. For example, ECR 114 outputs an acoustic signal through ECR tube 112 and into ear canal 124 where it is received by the tympanic membrane 126 of the user of the earpiece. Conversely, ECM 106 receives an acoustic signal present in ear canal124 though ECM tube 110.

[0041] One function of ECM 106 is that of measuring the sound pressure level in the ear canal cavity 124 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 the earpiece. In one arrangement, ASM 120 is used to monitor sound pressure at the entrance to the occluded or partially occluded ear canal 124. All transducers shown can receive or transmit

audio signals to a processor 116 that undertakes audio signal processing and provides a transceiver for audio

via the wired (wire 118) or a wireless communication path. Note also that the acoustic signals can be stored for later retrieval.

[0042] In at least one exemplary embodiment the earpiece can be constructed to actively monitor a sound pressure level both inside and outside an ear canal 124. In at least one exemplary embodiment monitored data can be used to enhance spatial and timbral sound quality while maintaining supervision to ensure safe sound reproduction levels. In at least one exemplary embodiment an earpiece can facilitate at least one of conducting listening tests, filtering sounds in the environment, monitoring warning sounds in the environment, presenting notification based on identified warning sounds, maintaining constant audio content to ambient sound levels, and filtering sound in accordance with a Personalized Hearing Level (PHL).

[0043] The earpiece can generate an Ear Canal Transfer Function (ECTF) to model the ear canal 124 using ECR 114 and ECM 106, as well as an Outer Ear Canal Transfer function (OETF) using ASM 120. For instance, the ECR 114 can deliver an impulse within the ear canal124 and generate the ECTF via cross correlation of the impulse with the impulse response of the ear canal 124. The earpiece can also determine a sealing profile with the user's ear to compensate for any leakage. In at least one exemplary embodiment the earpiece can use either the ASM 120 or the ECM 106 to monitor the sound pressure level, which can then be used in a Sound Pressure Level Dosimeter calculation, to estimate sound exposure and recovery times. This permits the earpiece to safely administer and monitor sound exposure to the ear.

[0044] Referring to FIG. 2, a block diagram of an earpiece 201 in accordance with an exemplary embodiment is shown. A power supply 205 (e.g., USB power connection, hearing aid battery (batteries)) powers components of the earpiece 201 including microprocessor 206 (or processor 206, e.g., Texas Instruments TMS320C6713) and a data communication system 216 (e.g., RF or Bluetooth communication chip). As illustrated, the earpiece 201 includes the processor 206 operatively coupled to data communication system 216, ASM 210, ECR 212, and ECM 208. Data communication system 216 may include one or more Analog to Digital Converters and Digital to Analog Converters (DAC). The processor 206 can utilize computing technologies such as a microprocessor, Application Specific Integrated Chip (ASIC), and/or digital signal processor (DSP) with associated Random Access Memory (RAM) 202 and Read Only Memory (ROM) 204. Other memory types such as Flash, non-volatile memory, SRAM, DRAM or other like technologies can be used for storage with processor 206. The processor 206 can also include a clock to record a time stamp.

[0045] In general, data communication system 216 is a communication pathway to components of the earpiece 201 and components external to the earpiece 201. The communication link can be wired or

wireless. In at least one exemplary embodiment, data communication system 216 is configured to communicate with ECM 208, ASM 210, visual display 218, and user control interface 214 of the earpiece 201. As shown, user control interface 214 can be wired or wirelessly connected. In at least one exemplary embodiment, data communication system 216 is capable of communication to devices exterior to the earpiece 201 such as the user's mobile phone 234, a second earpiece 222, and a portable media player 228. Portable media player 228 can be controlled by a manual user control 230.

[0046] The user's mobile phone 234 includes a mobile phone communication system 224. A microprocessor 226 is operatively coupled to mobile phone communication system 224. As illustrated multiple devices can be wirelessly connected to one another such as an earpiece 220 worn by another person to the user's mobile phone. Similarly, the user's mobile phone 234 can be connected to the data communication system 216 of the earpiece 201 as well as the second earpiece 222. This connection would allow one or more people to listen and respond to a call on the user's mobile phone 234 through their respective earpieces.

[0047] As illustrated, a data communication system 216 can include a voice operated control (VOX) module to provide voice control to one or more subsystems, such as a voice recognition system, a voice dictation system, a voice recorder, or any other voice related processor. The VOX module can also serve as a switch to indicate to the subsystem a presence of spoken voice and a voice activity level of the spoken voice. The VOX can be a hardware component implemented by discrete or analog electronic components or a software component. In one arrangement, the processor 206 can provide functionality of the VOX by way of software, such as program code, assembly language, or machine language.

[0048] The RAM 202 stores program instructions for execution on the processor 206 as well as captured audio processing data. For instance, memory RAM 202 and ROM 204 can be off-chip and external to the processor 206 and include a data buffer to temporarily capture the ambient sound and the internal sound, and a storage memory to save from the data buffer the recent portion of the history in a compressed format responsive to a directive by the processor. In at least one exemplary embodiment, the data buffer can be a circular buffer that temporarily stores audio sound at a current time point to a previous time point. It should also be noted that the data buffer is operatively connected with processor 206 to provide high speed data access. The storage memory can be non-volatile memory such as SRAM to store captured or compressed audio data.

[0049] Data communication system 216 includes an audio interface operatively coupled to the processor

206 and the VOX to receive audio content, for example from portable media player 228, a cell phone, or

any other communication device, and deliver the audio content to the processor 206. The processor 206 responsive to detecting voice-operated events from the VOX can adjust the audio content delivered to the ear canal of the user of the earpiece. For instance, the processor 206 (or the VOX of data communication system 216) can lower a volume of the audio content responsive to detecting an event for transmitting the acute sound to the ear canal of the user. The processor 206 by way of the ECM 208 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 based on voice operating decisions made by the VOX of data communication system 216.

[0050] The earpiece 201 and data communication system 216 can further include a transceiver that can support singly or in combination any number of wireless access technologies including without limitation Bluetooth™, Wireless Fidelity (WiFi), Worldwide Interoperability for Microwave Access (WiMAX), and/or other short or long range communication protocols. The transceiver can also provide support for dynamic downloading over-the-air to the earpiece 201. It should be noted also that next generation access technologies can also be used in exemplary embodiments.

[0051] Data communication system 216 can also include a location receiver that utilizes common technology such as a common GPS (Global Positioning System) receiver that can intercept satellite signals and therefrom determine a location fix of the earpiece 201.

[0052] The power supply 205 utilizes common power management technologies such as replaceable batteries, supply regulation technologies, and charging system technologies for supplying energy to the components of the earpiece 201 and to facilitate portable applications. A motor (not shown) can be a single supply motor driver coupled to the power supply 205 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.

[0053] Microprocessor 206 is operatively connected with an EarSeal Inflation Management System 232 to control the degree to which the sealing unit 108 is inflated or deflated. In one exemplary embodiment, sealing unit 108 comprises an expandable element (e.g., inflatable balloon mechanism), whereby a cavity can be filled with air or a liquid to change the degree of acoustic isolation between the internal ear canal space 124 and the ambient environment. Alternately, a passive system for sealing ear canal 124 is used such as a flexible rubber or a silicon sealing unit or a foam plug. In one exemplary embodiment, the passive

system is a balloon mechanism that is filled with air or liquid. The balloon mechanism conforms to the

shape and size of an ear canal and includes a restorative force module that applies a pressure to the balloon mechanism for sealing the ear canal cavity.

[0054] The earpiece is 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 are reused in different form factors for the master and slave devices.

[0055] Referring to FIG. 3, a flowchart illustrates a method for an acoustic sealing analysis system in accordance with an exemplary embodiment. In general, a first volume is acoustically isolated from a second volume. The test determines if the two volumes have sufficient acoustic isolation from one another. For example, cars are designed to have a quiet interior. Users of an automobile do not want to be subjected to the noise of the external environment. Thus, a car interior (first volume) is acoustically isolated from the external environment outside of the automobile. Similarly, an earpiece having a sealing unit such as described in FIG. 1 will create a first volume (the ear canal) that is acoustically isolated from the ambient environment of the user (second volume). In either example, the acoustic sealing analysis system determines if there is sufficient acoustic isolation for the application. In the earpiece example, random or periodic testing of the seal may be beneficial because a new seal is formed in the ear canal when the device is put in the ear or it may shift over time depending on user activity.

[0056] The method begins at step 302. A test signal is acquired in a step 304. For example, the test signal can be stored in memory or generated by a microprocessor. The test signal is provided to the acoustic transducer. The acoustic transducer or loudspeaker (such as an ECR) emits an acoustic signal corresponding to the test signal within the first volume in a step 306. The acoustic field in the first volume is detected by an Ear Canal Microphone (ECM) in a step 308. The acoustic loading on both the ECR and ECM will change depending on the degree of acoustic sealing, thereby affecting the degree magnitude of the radiated ECR signal detected by the ECM. In general, as the degree of ear seal decreases, the effect of lumped air mass coupled to the ECR and ECM will decrease thereby increasing in Thevenin capacitance, which effectively reduces the transfer of low frequency emitted sound from the ECR to the ECM.

[0057] In one exemplary embodiment, the test signal and the acoustic signal emitted by the loudspeaker into the first volume is a single frequency sine wave signal for testing leakage from one volume to another.

[0058] The degree of sealing between the first and second acoustic volumes is determined in a step 310 and

the process ends at step 312. The cross-correlation between the emitted test signal and detected ECM signal is taken. In at least one exemplary embodiment, the test signal and the measured acoustic signal emitted by the loudspeaker are conditioned using a time delay and frequency dependent filter. The ear-seal is determined to be low (or "leaky") if the cross- correlated signals are below a predetermined value. In at least one exemplary embodiment, automatic adjustments to the sealing section are made (such as deflating and re-inflating the sealing balloon to reseal the sealing section including retesting). Alternately, an audible sound, vocal response, or visual response can be provided to let the user know that the earpiece is sealed correctly or incorrectly.

[0059] Referring to FIG. 1, the earpiece is used as an example to illustrate a test sequence as disclosed in FIG. 3. Sealing unit 108 occludes an opening of ear canal 124 creating a first volume (ear canal124) and a second volume (the ambient environment). Sealing unit 108 has a first side exposed to ear canal 124 and a second side is exposed to or corresponds to the ambient environment external to the ear.

[0060] In at least one exemplary embodiment, processor 116 is configured to receive a test signal in memory 104. Processor 116 generates the test signal and provides the test signal to Ear Canal Receiver 114 (ECR 114). ECR 114 emits the test signal into Ear Canal Receiver Tube (ECR Tube 112). The test signal propagates through ECR tube 112 and into ear canal 124. Ear Canal Microphone tube 110 (ECM tube 110) is configured to receive an acoustic signal incident on the first side of sealing unit 108. The test signal in ear canal 124 propagates through ECM tube 110 and is received by Ear Canal Microphone 106 (ECM 106). ECM 106 is configured to measure the test signal in ear canal124 and provide the measured test signal to processor 116.

[0061] As shown, electronic housing unit 100 of the earpiece is adjacent to the second side of sealing unit 108. Electronic housing unit 100 is exposed to the ambient environment and for purposes of acoustic sealing analysis is considered the second side of sealing unit 108. Electronic housing unit 100 includes Ambient Sound Microphone 120 (ASM 120), which is configured to measure sounds in the ambient environment. Thus, ASM 120 receives and measures an ambient signal corresponding to a signal incident on the second side of sealing unit 108. ASM 120 provides the measured ambient signal to processor 116.

[0062] Ideally, sealing unit 108 is an acoustic barrier preventing the test signal or very little of the test signal from getting past sealing unit 108 and into the ambient environment. Conversely, sealing unit 108 if improperly sealed will pass some of the test signal. Processor 116 compares the test signal to the signal

provided by ECM 106 corresponding to the acoustic signal in ear canal124. In particular, processor 116

undertakes the cross-correlation between emitted test signal and the ECM signal.

[0063] Referring to FIG. 4, a flowchart of an exemplary method to determine the acoustic seal integrity of an earpiece in accordance with an exemplary embodiment is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user. This allows unobtrusive (periodic or non-periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0064] In at least one exemplary embodiment, an audio content is provided in a step 402. A step 404 stores the test signal in a test signal data buffer. For example, a single frequency sine wave is stored in the test signal data buffer. The output (or alternatively--input) of the test signal data buffer is optionally delayed by digital delay unit 406. The function of delay unit 406 is to time- align the emitted test signal with the ECM signal so the cross-correlation is sensitive to changes in ear seal.

[0065] A step 408 stores the test ECM signal in a test signal data buffer. The output (or alternatively--input) of the ECM signal buffer can be filtered with a low-pass filter 410. The low pass filter can be configured so that the pass-band covers the frequency of the test signal. In one exemplary configuration, the low-pass filter can be a cascaded bi-quad IIR type filter with the cut-off frequency equal to 10Hz greater than the test signal frequency.

[0066] A step 412 cross-correlates the optionally delayed test signal buffer with the low-pass filtered ECM signal buffer. An exemplary method for the cross-correlation algorithm is described in FIG. 5. The instantaneous cross-correlation (i.e. the cross-correlation at zero-lag) value from step 412 is compared with the cross-correlation threshold value 414 using comparator unit 416. If the instantaneous cross-correlation of the two signal buffers is less than the threshold value 414, then the seal test status is set to FAIL 418 (i.e. an ear-seal leak is detected); otherwise, if the cross-correlation is suitably high, the seal test status is set to PASS 420.

[0067] Referring to FIG. 5, a flowchart of an exemplary embodiment to determine the instantaneous cross-correlation between a first audio signal and a second audio signal is illustrated. The process begins at step 500. In at least one exemplary embodiment, the first audio signal is the test signal (i.e. a sine wave) and the second signal is the low-pass-filtered ECM signal.

[0068] The correlation between two signals x and y at time k using an exponential window is defined as:

[0069] $$p(k) = \frac{S_{xy}(k)}{\sqrt{S_{xx}(k)_{yy}(k)}} \quad (1)$$

[0070] Where

[0071] $$S_{xx}(k) = \sum_{l=0}^{\infty} ce^{-\eta^l} x_{k-l} y_{k-l} \quad (2)$$

$$c = 1 - e^{-\eta}$$

[0072] And S_{xx} and S_{yy} are defined similarly as in (2) (replacing y with x for S_{xx} etc.).

[0073] It can be shown (see Aarts et al, 2001) that (1) can be approximated with the recursion:

[0074] $$\hat{\rho}(k) = \hat{\rho}(k-1) + \gamma[\partial_k - \beta_k \hat{\rho}(k-1)] \quad (3)$$

$$\partial_k = 2x_k y_k$$

$$\beta_k = \alpha x_k^2 \alpha^{-1} y_k^2$$

[0075] Where

$$\alpha = \frac{y_{RMS}}{x_{RMS}} \quad (4)$$

$$\gamma = \frac{ce^{\eta}}{2x_{RMS} y_{RMS}}$$

[0077] The cross-correlation estimate using the above recursion is modified for block-wise processing rather than the sample-by-sample basis. This modification replaces the sample values (i.e. x(k) and y(k)) with values for the N-length block mean, i.e.

[0078]

$$x(k) = \frac{1}{N} \sum_{l=0}^{N-1} x(k-l)$$

[0079] Furthermore, the numerator for y is replaced with a small constant and so is α (replacing α with a

constant effectively un-normalizes the correlation estimate). It is found that the modified un-normalized block-wise cross-correlation accurately estimates the cross-correlation compared with using the standard cross-correlation for two signals.

[0080] The modified block-wise fast cross-correlation algorithm, as summarized in FIG. 5, comprises the following steps:

1. A first signal buffer 502 is accumulated. This signal buffer corresponds to the emitted test signal (i.e. the sine wave).
2. The RMS level of the first buffer is calculated 504 (x_{RMS})
3. The mean level of the first buffer is calculated 506.
4. A second signal buffer 508 is accumulated. This signal buffer corresponds to the filtered ECM signal.
5. The RMS level of the second buffer is calculated 510 (y_{RMS}).
6. The mean level of the second buffer is calculated 512.
7. In step 514, γ (gamma) is approximated as:

$$\gamma = \frac{\Gamma}{2x_{RMS}y_{RMS}}$$

Where Γ is a small constant, e.g. 10E-3.

8. In step 516,∂_k (delta) calculated as twice the product of the first signal buffer mean and the second signal buffer mean.
9. In step 518, beta is calculated as the sum of the square of the mean value of the first buffer with the sum of the square of the mean value of the second buffer.
10. In step 520, the new temporary estimate of the correlation newRho_temp is calculated as: newRho_temp=(delta-beta*rho_old))
11. In step 522, the new estimate of the correlation newRho is updated by summing the previous estimate of the correlation with the product of gamma and the temporary estimate of the correlation newRho_temp.
12. In step 524, the "old" value of the correlation is set to the newest correlation estimate, ready for the next iteration of the update algorithm.
13. In step 526, the current correlation estimate between the emitted test signal and the received and filtered ECM signal is set as equal to the value of newRho.

[0081] Referring to FIG. 6, a flowchart of a method to determine when to emit the test signal is shown. The test signal is emitted when the test can be performed unobtrusively to the user and also provides an accurate test. In at least one exemplary embodiment, a test event to determine if an earpiece is sealed correctly is

initiated via a timing methodology. In a first timing scenario, the test event occurs after a delay of a first

predetermined time period when the RMS of the Audio Content (AC) is less than a RMS threshold. In a second timing scenario, the delay of the first predetermined time period is allowed to lapse without the test event occurring when the RMS of the audio content is greater than the RMS threshold. A second predetermined time period is started where the test event occurs when the RMS of the audio content is less than the RMS threshold. The test event is then initiated when the second predetermined time period is exceeded independent of the RMS of the audio content.

[0082] A test sequence is initiated in a step 602. The previous seal test event resets the first digital timer in a step 604. A time delay is generated by the loop comprising steps 606 and 608. The first digital timer is time incremented in the step 606. After each added time increment, the first digital timer is compared against a digital_timer_threshold1. The first digital timer is time incremented (after the time has advanced another increment) after the comparison in the step 608 if the first digital timer is less than the digital_timer_threshold1.

[0083] A second digital timer is reset in a step 610 when the first digital timer is greater than the digital_timer_threshold1. The second digital timer is time incremented in a step 612. Audio content (AC) from a signal buffer is retrieved in a step 614. The audio content can be filtered through a low pass filter in an optional step 616. The RMS of the audio content is calculated in a step 618. The calculated RMS of the audio content is compared against an RMS_threshold 622 in a step 620. The second digital timer is compared against a digital_timer_threshold2 in a step 624 if the RMS of the audio content is greater than the RMS_threshold. The second digital timer is time incremented (after the time has advanced another increment) when the second digital timer is less than digital_timer_threshold2 in the step of 624.

[0084] The audio content signal is mixed with the test signal when the RMS of the audio content is less than the RMS_threshold in a step 626. Also, the audio content signal is mixed with the test signal when the second digital timer is greater than digital_timer_threshold2 in the step 624. The modified audio signal (having the test signal mixed in) is emitted by the ECR in a step 628 for testing the sealing section of the earpiece. The first digital timer is then reset in the step 604 to begin a timing sequence for another sealing section test.

[0085] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention. The estimated un-normalized cross-correlation between the ECM signal and the test signal (i.e. sine wave) is shown for different sine wave frequencies from 30-80Hz. Three different curves are provided corresponding

to a good fit (i.e. a tight optimal seal providing approximately 20-30 dB of acoustic attenuation), mid or

partial seal (i.e. an ear-seal that could be characterized as "half in" providing approximately 10-15 dB of acoustic attenuation), and a poor seal (i.e. an ear-seal providing less than 10 dB of acoustic attenuation). At lower test frequencies, the change in correlation is more pronounced as the degree of ear seal fitting is changed from "good" to "mid" and "poor". From the data, the threshold used to determine whether the ear seal can be characterized as "good" is approximately -20 dB, (i.e. 0.85 of FIG. 10 which corresponds to the value for XCorr_threshold 414 in FIG. 4).

[0086] In at least one exemplary embodiment, the test signal for testing a seal of a sealing section is less than 200 hertz. The frequency of the emitted test signal is chosen to satisfy the requirements of being able to reveal small degradations in ear seal quality. It is also beneficial if the selected test signal frequency can be acoustically masked by reproduced audio to minimize detection of the test by an earpiece user. Both of these criteria are met using a test signal frequency below 200 Hz. The sensitivity is highest from the measured data at frequencies below 50 Hz. Conversely, as the test signal frequency increases the cross-correlation difference between a "good" and "bad" acoustic seal decreases. For example, with a 40Hz test tone, the cross-correlation for a "good" ear seal is -8 dB, and for a bad ear seal it is -68 dB (i.e. a 60 dB difference). At a test signal frequency of 80Hz, the cross-correlation for a "good" ear seal is -8 dB and for a bad ear seal it is -38 dB (i.e. a 30 dB difference). Thus, above 200Hz the cross- correlation difference between a "good" and "bad" acoustic seal is further reduced thereby reducing the sensitivity of the test.

[0087] Using the cross-correlation rather than a level differencing approach improves the accuracy and minimizes errors which occur due to user non-speech body noise, such as teeth chatter; sneezes, coughs, etc. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0088] FIG. 8 is a flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) in accordance with an exemplary embodiment. The IMS is adjusted depending on the degree of acoustic sealing provided by an earpiece. The method begins at step 802. The acoustic sealing is measured as disclosed in FIG. 7 and the result provided in a step 804 to determine the cross-correlation (XCorr) between a test signal and corresponding ECM signal. In general, the higher the cross-correlation, the higher the degree of acoustic sealing. An exemplary graph showing the relationship between XCorr and acoustic sealing is given in FIG. 10. The degree of acoustic sealing is determined from known XCorr using a look-up (or "hash") table or using a formula (e.g. of a polynomial form) that maps the acoustic sealing to the known XCorr value. The ambient sound level is measured in a step 806. The ambient sound level corresponds to

the noise level in proximity to the user. In general, a higher degree of attenuation is desired when the

ambient sound levels are high. Conversely, at low ambient sound levels the attenuation level of the IMS may be less of an issue and comfort more of a factor. The IMS is adjusted in a step 808 to meet the attenuation needs. In general, inflating the IMS increases attenuation while deflating the IMS decreases attenuation. The method terminates at step 810.

[0089] Referring to FIG. 9, a more detailed flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) is shown. In general, the attenuation increases when the pressure in the IMS is raised thereby allowing a degree of control to make adjustments. For example, an adjustment is made to increase attenuation when the background noise level rises or a seal check produces a failed result. Adjustments are made until the seal check passes. The pressure level adjustments of the IMS will fall within a comfort range of a user (e.g., between 0.1 bar and 0.3 bar gauge pressure). Typically, the pressure level is set at a minimum level to achieve a predetermined attenuation level.

[0090] The method begins at step 902. The degree of acoustic sealing is determined from cross-correlation between the ECM signal and the generated test signal. The XCorr value is provided in a step 904. In step 906, the attenuation provided by the IMS is calculated (equation) or looked up (table) from data such as that shown in FIG. 10. In one exemplary embodiment, the desired attenuation value is dependant on the ambient sound level of the user. In another exemplary embodiment, the desired attenuation value is dependant on the ear-canal sound level of the user. In yet another exemplary embodiment, the desired attenuation value is dependant on the level of audio content (e.g. speech or music audio) reproduced with the earphone device. In all of the above examples, the desired attenuation value is determined by one or more of the embodiments in a step 907.

[0091] The difference between the degree of acoustic sealing determined in step 906 and the desired attenuation value determined in step 907 is calculated in step 908. The difference value in step 908 is used to determine the change in pressure of the IMS necessary to minimize the difference value in a step 910. In at least one exemplary embodiment, the difference value of the attenuation is converted into a corresponding pressure value change (e.g. in milli-Bars) using a similar look-up table or equation method as described previously. The pressure change in the IMS is then affected with step 912 to meet the desired attenuation level. For example if the desired attenuation is a decrease of 10 dB in sound across the earpiece in the ear canal, then a pressure of a variable volume inflatable system can have a gauge pressure of about 0.15 bar. If the desired attenuation is a decrease of 20 dB across the earpiece in the ear canal then the gauge pressure can be increased to about 0.25 bar, where an increased pressure is associated with an increase in attenuation. An

experimental table for each earpiece can be generated in a standard devised experimental setup (e.g.

impedance tunnel) and referred to when changes are needed. The method ends at step 914.

[0092] Referring to FIG. 11, a flowchart of an exemplary method to determine a test signal fundamental is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user or made pleasant such that the user is unaware that the test signal is being played. This allows unobtrusive (periodic or non- periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0093] In at least one exemplary embodiment, an audio content 1102 is provided. A step 1104 stores audio content 1102 in a data buffer. In this example, audio content 1102 is music played from a media player and received via a wired or wireless connection to at least one earpiece in the user's ear. An alternate example would be that audio content 1102 is a speech audio signal from a portable telephone device or the like.

[0094] A step 1106 determines if the buffer of audio content 1102 comprises a strong tonal signal component. Mixing the test signal having a similar fundamental frequency as audio content 1102 will mask the test signal when played to the user. Thus, the test signal is musically in harmony with the reproduced music and results in very little perceptual degradation in sound quality.

[0095] A step 1108 determines whether to update or generate the first fundamental tone for the test signal. The test signal is not updated or generated if buffered audio content 402 does not contain a strong tonal signal component. A return to step 1104 fills the buffer with the next audio content 402 for analysis.

[0096] A step 1110 analyzes the buffer of data of audio content 1102 when it has been determined that it contains a strong tonal signal component. Step 1110 determines the fundamental frequency of the tonal signal. The fundamental tone, often referred to as the fundamental and abbreviate f_0 is the lowest frequency in a harmonic series. The fundamental frequency (also called a natural frequency) of a periodic signal is the inverse of the pitch period length. The pitch period is the smallest repeating unit of a signal. The fundamental frequency of the tonal signal can be calculated using an autocorrelation analysis.

[0097] In one exemplary embodiment, a mathematical operation 1114 is performed where the frequency component of the test signal is limited to a frequency range below a lower minimum and upper maximum frequency range. Fund_ratio is calculated, which is defined as a ratio of the determined fundamental frequency (F_fund) of the tonal signal from step 1110 to an upper threshold value F_fund_threshold 1112, which in one exemplary embodiment, is a fixed constant equal to approximately 100Hz. In general,

F_fund_threshold 1112 is chosen to be a low frequency value which is above the lowest (or -3 dB)

frequency that a transducer can reproduce, but below a predetermined frequency. In a comparison step 1116, if the estimated F-fund is higher than the F_fund_threshold 1112 (ratio > 1), then F_fund is reduced by an integer multiple to be below F_fund_threshold 1112 corresponding to the mathematical operation of step 1118. Otherwise, the test signal fundamental is equal to F_fund as shown in step 1120. Although not shown, the calculated test signal fundamental is compared and determined to be greater than a predetermined threshold.

[0098] Referring to FIG. 1, in at least one exemplary embodiment, processor 116 is configured to receive or generate audio content. As mentioned previously, the audio content can from external devices such as a portable phone or a media player. Memory 104 can be used as a buffer for the audio content. Processor 116 is configured to receive the buffer of audio content from memory 104. The steps and calculations of the block diagram of FIG. 4 are then performed by processor 116. The result being one of the identification of a strong tonal signal component in the buffer of audio content and the test signal fundamental or loading the buffer with new audio content and starting the process again.

[0099] Referring to FIG. 12, a flowchart of an exemplary embodiment to determine tonal presence in audio content is shown. In particular, the exemplary embodiment relates to step 1106 of FIG. 11 that analyzes audio content stored in a buffer. The method begins at step 1202. A step
1204 gets the audio content stored in an audio signal buffer hereinafter called the audio signal. A filter step 1206 filters the audio signal to a frequency range of interest that relates to a sealing test frequency. For example, a band pass filter in the range of 20Hz to 500Hz could be used to filter the audio signal where the test signal is in the lower audio frequency range. An auto-correlation step 1208 analyzes the audio signal where a strong tonal signal component is represented by peaks in the analysis results. A step 1210 generates Absolute(Acorr) which is a number representing the absolute magnitude of the peaks from the analysis. For example, Absolute(Acorr) can be the square of the results from the auto-correlation.

[0100] A crest_factor_Acorr 1218 is generated from the results by calculating an RMS value 1214 (or time-averaged peak value) and peak value 1216 (or time averaged peak value). In at least one exemplary embodiment, the crest_factor_Acorr 1218 is the ratio of the peak value to the RMS value of an absolute auto-correlation sequence of the audio signal.

[0101] A comparison step 1222 is then performed. A strong tonal presence is identified when crest_factor_Acorr 1218 is greater than a threshold Crest_factor_Acorr_threshold 1220. Identification of the

strong tonal presence indicates the audio signal would facilitate masking of the test signal to determine

sealing of the device (step 1226). The audio signal is not used in conjunction with the test signal if crest_factor_Acorr 1218 is less than Crest_factor_Acorr_threshold 1220 (step 1224). The process would begin again loading a next sequence of the audio signal into the buffer for review.

[0102] Referring to FIG. 1, as mentioned previously, audio content is stored in a buffer, for example memory 104. The audio content in the buffer is provided to processor 116. In at least one exemplary embodiment, processor 116, runs the analysis as described in the block diagram of FIG. 12 thereby determining if a strong tonal presence is found in the audio content in the buffer. New audio content is loaded into the buffer (memory 104) if a strong tonal presence is not found beginning the procedure again.

[0103] Referring to FIG. 13, a flowchart of a method to determine when to emit the test signal is shown. The method begins at step 1302. The test signal is emitted when the test can be performed unobtrusively to the user and also provide an accurate test. In a step 1304, an audio signal is retrieved from a buffer. In at least one exemplary embodiment, the audio signal is received from an ECM or an ASM. The audio signal is measured to determine when the sound level is low in the ear canal, the ambient environment, or both. In general, the test signal is emitted when the sound level is low.

[0104] A filter step 1306 band pass filters the audio signal. In one exemplary embodiment, filter step 1306 filters the audio signal from 50 Hz to 150Hz which corresponds to a frequency range of the test signal. In a step 1308, the RMS of the audio signal is calculated. The audio signal is analyzed to detect when the energy within an audio frequency range is below a threshold RMS_threshold 1310. The RMS of the audio signal is the signal level in the volume being measured. A comparison step 1312 compares the measured RMS level of the filtered audio signal against RMS_threshold 1310. In a step 1314, a test signal is emitted when the measured RMS value is less than RMS_threshold 1310. No test signal is emitted when the RMS of the audio signal is greater than RMS_threshold 1310. The method ends at step 1316.

[0105] Referring to FIG. 14, a flowchart of an exemplary method to determine acoustic seal integrity is illustrated. For example, an earpiece seal integrity corresponds to a full or partial acoustic barrier between a first volume (ear canal) and a second volume (ambient environment). In one exemplary embodiment, the degree of acoustic seal integrity is expressed as either a PASS or FAIL status, where FAIL indicates that the acoustic seal is compromised relative to a normal operating acoustic seal. For example, an earpiece that has performed the seal test and determined that the sealing unit is not sealed correctly in the ear canal of the user can provide a signal or message indicating the problem. The user can then remove, reinsert, and retest the

earpiece to ensure that the seal is within normal operating specifications.

[0106] The method begins at step 1402. An acoustic test signal is provided in a first volume. In a step 1404 a transducer measures the acoustic test signal and stores it in a signal buffer. In a step 1406, a second transducer in a second volume isolated from the first volume by an acoustic barrier measures a second acoustic signal in the second volume. A portion of the acoustic test signal passes the acoustic barrier into the second volume. The amount of the acoustic test signal passing the acoustic barrier is a measure of the seal provided by the acoustic barrier.

[0107] In a filter step 1408, the measured acoustic test signal in the first volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals that are not part of the test. The measured signal from the first volume is heretofore called the first volume signal. Similarly, in a step 1410, the measured signal in the second volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals not related to the test (outside the frequency range) in the second volume. The measured signal from the second volume is heretofore called the second volume signal.

[0108] A correlation, cross-correlation, or coherence analysis is performed on the first volume signal and the second volume signal. The correlation, cross-correlation, or coherence analysis is a measure of the similarity of the signals in the first and second volumes. In particular, the non- difference analysis measures the acoustic test signal leaking past the acoustic barrier by identifying the portion of the second volume signal that is similar to the acoustic test signal in the first volume.

[0109] In at least one exemplary embodiment, a correlation step 1412 is performed comprising a cross-correlation of the first volume signal and the second volume signal. In a step 1414, the peak of the cross-correlation is identified. The peak of the cross-correlation is Absolute(XCorr). In a mathematical step 1418, the Lag-time of Peak 1420 and the Magnitude of Peak 1422 is calculated. The Lag-time of Peak 1420 is a measure of the time delay between receiving the signals in the first and second volumes. In particular, the first volume signal should be received before the second volume signal. The Magnitude of Peak 1422 corresponds to the similarity between the signals in the first and second volumes. Thus, a larger number for Magnitude of Peak relates to more leakage of the acoustic test signal getting past the acoustic barrier.

[0110] Two comparisons are performed that determine if the acoustic barrier is sealed correctly based on the measured and calculated data from the first and second volumes. In a comparison step 1426, the measured Lag-time of Peak is compared against Target Lag Limits 1424. The measured lag-time should fall within the

predetermined range (Target Lag Limits 1424) for the seal test to be valid. If the Lag-time of Peak is within

the appropriate range then a logic 1 is provided to AND function 1432, otherwise a logic 0 is provided. In a second comparison step 1428, the Magnitude of Peak is compared against a Peak_threshold 1430. If the Magnitude of Peak is greater than the Peak_threshold 1430 a logic 1 is provided to AND function 1432. This indicates that a significant portion of the acoustic test signal is present in the second volume measurement, otherwise a logic 0 is provided. A FAIL output 1434 corresponds to a logic 1 at the output of AND function 1432. The FAIL occurs when the Lag-time of Peak is within the predetermined range and the Magnitude of Peak is greater than the Peak_threshold indicating that the acoustic barrier is sealed improperly. All other conditions indicate a PASS output 1434 and the acoustic barrier is sealed correctly.

[0111] In at least one exemplary embodiment and referring briefly to FIG. 1, an earpiece is tested to determine if sealing unit 108 is sealed correctly to the ear canal of the user. Sealing unit 108 creates a first volume in ear canal 124 and a second volume outside the ear canal 124 in the ambient environment. A masking approach is used to perform seal testing unobtrusively to the user. The user is listening to music or speech (audio content) provided to ear canal124 from ECR 114.

[0112] The music or speech is buffered in memory 104 or memory in processor 116. Processor 116 analyzes the audio content in the buffer to identify a strong tonal content. A test signal can be created once audio content with strong tonal content is found. The test signal will have at least one fundamental pitch corresponding to the strong tonal content and optionally further harmonics. Processor 116 also analyzes the measured signals from ECM 106 and ASM 120 to determine when to emit the test signal. Processor 116 monitors and compares the sound level in the ambient environment and ear canal124. Processor 116 will provide the generated test signal to ECR 114 during an optimum time for test accuracy such as when the ambient sound level is low, the ear canal sound level is low, or both. Also, processor 116 will not output the test signal if there is audio content similar to the test signal in the ear canal or ambient environment.

[0113] Processor 116 monitors the test conditions and then provides the test signal to ECR 114 when an accurate sealing test can be performed. ECR 114 outputs an acoustic test signal which may or may not have other audio content. ECM 106 and ASM 120 respectively measure acoustic signals in ear canal 124 and the ambient environment. Processor 116 is operatively coupled to ECM 106 and ASM 120. The measured signals are buffered in memory 104.

[0114] In an exemplary embodiment, a cross-correlation is used to measure the similarity between the

signals in ear canal124 and the ambient environment. Processor 116 performs the cross-correlation

calculations using the measured acoustic signals from ECM 106 and ASM 120. In particular, the cross-correlation is used to identify and compare the acoustic test signal present in the two volumes separated by the acoustic barrier. A cross-correlation between ASM and ECM signals is defined according to the following equation (5):

$$XCorr(n, l) = \sum_{n=0}^{N} ASM(n)ECM(n - l), \quad (5)$$

Where: l=0, 1, 2, … N

[0115] Where ASM(n) is the nth sample of the ASM signal, and ECM(n-l) is the (n-l)th sample of the ECM signal. A peak of the absolute cross-correlation is estimated using a peak- picking function and also the lag time at which this peak occurs (i.e. the index I at which this occurs). Thus, the Lag-time of Peak and the Magnitude of Peak are known and respectively compared against a Target Lag Limit range and a Peak Threshold. The user of the earpiece is notified or warned that sealing unit 108 is improperly sealed by processor 116 if the measured Lag-time of Peak is within the Target Lag Limit range and the Magnitude of Peak is greater than the Peak Threshold.

[0116] Like Correlation and Cross-Correlation, a coherence function is also a measure of similarity between two signals. Coherence is another non-difference comparison approach that can be used for detecting acoustic seal integrity. Coherence is defined as:

$$\gamma^2{}_{xy} = \frac{|G_{xy}(f)|^2}{G_{xx}(f)G_{yy}(f)} \quad (6)$$

[0117] Where Gxy is the cross-spectrum of two signals (e.g. the ASM and ECM signals), and can be calculated by first computing the cross-correlation in equation (5), applying a window function, for example a Hanning window, and transforming to the frequency domain, for example via an FFT. Gxx or Gyy is the auto-power spectrum of either the ASM or ECM signals, and can be calculated by first computing the auto-correlation (using equation 5, but where the two input signals are both from either the ASM or ECM and transforming to the frequency domain. The coherence function gives a frequency-dependent vector between 0 and 1, where a high coherence at a particular frequency indicates a high degree of coherence at this frequency, and can therefore be used to analyze test signal frequencies in the ASM and ECM signals whereby a high coherence indicates the presence of the test signal in the ambient environment (indicating

leakage past the acoustic barrier).

[0118] Other approaches such as frequency spectrum analysis and RMS levels can also be used to determine if the earpiece is sealed correctly. Using a non-difference comparison approach such as coherence or cross-correlation between the ASM and ECM signals to determine sealing is more reliable than taking the level difference of the ASM and ECM signals. Using the cross correlation rather than a level differencing approach improves the accuracy and minimizes errors which may occur due to user non-speech body noise, such as teeth chatter, sneezes, coughs, etcetera. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0119] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment. In the non-limiting example, when a seal is essentially detected as being low, for example the calculated sound isolation of the system is 3 dB or less, a signal is sent to a seal varying device (e.g., 1500) to vary the seal, in this case increase (i.e. increase the sound isolation of the system) the seal value. The signal can be instructions to send a current over a period of time to an actuator, which can decrease the overall volume of the system (hence increasing the pressure and effectively the sealing). For example a slider actuator such as the P-653 PILine® can be used. Which has the dimensions of 15 mm by 11 mm by 8 mm, which includes an attached electronics control board, and has a mass of 1 gram. General operation uses 5V and about 100 mamps with a typical speed of 50 to 90 mm/sec. Note that the max force of about 0.15 N but such systems can be tailored to enable pumping beyond atmospheric pressure (e.g., can increase the max force). The non limiting example illustrated in FIGS. 15A and 15B shows a slider actuator 1500, with a moving slide 1510, having attached a pumping arm 1560, with a hole 1550 covering bump 1520. Upon receipt of a signal1505 the actuator can move 1570 such that the bump 1520 covers the hole 1550 in a bellows 1530 pump. The actuation compresses the miniature bellows 1530 pushing 1590 gas through the one-way valve 1540, upon the back stroke the bump 1520 uncovers the hole 1550 and air rushes back into the bellows 1530 for the next pump. For example if the stroke length is 2 mm and the pump arm 1560 contact area is about 9 mm 2 then each stroke moves 18 mm 3 of volume. If an inflation system 1570 needs to be inflated more (e.g., more gas to increase sealing) then each stroke can provide an additional volume of gas of 18 mm 3 into the system increasing the inflation system 1580. If the inflation system is initially empty (e.g., needs 1000 mm 3 of gas volume to inflate) then about 56 strokes would be needed for inflation, which is about 110 mm one direction stroke length or about 2 seconds at P-653 PILine speeds. The number of oscillations and stroke length can be determined according to the signal 1505 sent, which can be specifically tailored depending upon the electronics controlling the actuators. Note that PI-653 is an example only. Other actuation

systems can be used and controlled by signal 1505.

[0120] FIG. 16 illustrates a block diagram of controlled sealing in response to a seal fail signal and/or a request for increased seal attenuation. For example, a command signal 1600 is received (e.g., a seal fail signal in which a default attenuation value is attached for example 15 dB, or a signal requesting an additional amount of attenuation) by a processor. The command signal specifies an additional amount of attenuation or that the seal has failed. An attenuation needed N is identified 1610. For example if the current attenuation is 5 dB loss at f=500 Hz, at a pressure of 0.1 bar, and a command signal is received requesting a 10 dB loss at 500 Hz, then an experimental table is queried to find the pressure needed P which is then subtracted from the current pressure to obtain an increase in pressure DP needed. The increase in pressure is converted into a volume of gas increase needed (e.g., again referring to experimental tables based upon the inflation system volume). The volume of gas increase needed can then be directly linked with the number of cycles of an actuator pump M, 1620. The number of requested cycles **M** can then be sent 1630 to the actuator control circuit to pump the designated number of cycles. The system can then retest the attenuation 1640 and if refinements are needed the process can start again.

[0121] 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. For example, if words such as "orthogonal", "perpendicular" are used the intended meaning is "substantially orthogonal" and "substantially perpendicular" respectively. Additionally although specific numbers may be quoted in the claims, it is intended that a number close to the one stated is also within the intended scope, i.e. any stated number (e.g., 90 degrees) should be interpreted to be "about" the value of the stated number (e.g., about 90 degrees).

[0122] 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.

IN THE U.S. PATENT AND TRADEMARK OFFICE

First Named Inventor: John Usher		Conf.: 5671
Appl. No.:	17/182,570	Art Unit: 2654
Filed:	02/23/2021	Examiner: Kim, Paul
For:	ACOUSTIC SEALING ANALYSIS SYSTEM	

2nd Amendment After Allowance Under 37 CFR 1.312

Commissioner of Patents
Alexandria, VA 22313-1450

DATE: 3 Jan. 2023

The Office issued a notice of allowance 23 Dec. 2022. Prior to final payment of the issue fee Applicant has noticed two additional grammatical issues, corrected herein. Thus, Applicants submit the second attached marked-up and clean version of the specification to address typographical errors, in particular in paragraphs [0001] and formula (2) [0071] where Sxx should be Sxy.

The minor amendment does not require an additional search, does not require more than a cursory review of the record, and do not involve materially added work on the part of the Office. However, should the Examiner believe that anything further is necessary in order to place the application in better condition for allowance, the Examiner is respectfully requested to contact the undersigned representative at the telephone number listed below.

Respectfully submitted,
TECHIYA LLC

Date: January 3, 2023

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Marked Specification

ACOUSTIC SEALING ANALYSIS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application ~~is a continuation of U.S. Patent Application Ser. No. 17/182,570, filed 23 Feb. 2021, which~~ is a continuation of U.S. Patent Application Ser. No. 16/838,277, filed April 2, 2020, which is a continuation of U.S. Patent Application Ser. No. 16/414,136, filed May 16, 2019, which is a continuation of U.S. Patent Application Ser. No. 15/700,511, filed September 11, 2017, which is a continuation of U.S. Patent Application Ser. No. 14/827,332, filed August 17, 2015, now U.S. Patent No. 9,781,530, which is a continuation of U.S. Patent Application Ser. No. 14/054,015, filed October 15, 2013, now U.S. Patent No. 9,113,267, which is a Divisional Application of U.S. Application Ser. No. 12/555,864, filed September 9, 2009, now U.S. Patent No. 8,600,067 and claims the benefit of U.S. Provisional Patent Application No. 61/098,250 filed September 19, 2008. The disclosure of all the aforementioned references are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to testing the seal of an orifice-inserted device, and more particularly, though not exclusively, to a device and method for determining if an earpiece is sealed correctly in an ear canal.

BACKGROUND OF THE INVENTION

[0003] It can be difficult to communicate using an earpiece or earphone device in the presence of high-level background sounds. In many earpiece designs a transducer is placed near the ear canal opening. Ambient sound from the surrounding environment enters the ear canal with the audio content from the transducer. Environmental sounds such as traffic, construction, and nearby conversations can degrade the quality of the audio content.

[0004] Although audio processing technologies can adequately suppress noise, the earpiece is generally sound agnostic and cannot differentiate sounds. Thus, one method to prevent ambient sound from entering the ear is to seal or provide an acoustic barrier at the opening of the ear canal. Sealing minimizes ambient sound leakage into the ear canal, and under the correct conditions can provide a level of noise suppression under high background noise conditions. Certain types of acoustic software (e.g., communication in a noisy environment via an ear canal microphone) may require some minimum noise isolation from the ambient

sound to provide adequate performance to the user. Additionally, user conditions may change substantially during the operation of the earpiece, and in some circumstances, the earpiece may become misaligned or may be fit incorrectly such that it is not sealed correctly. A method of seal detection is needed to optimize performance.

SUMMARY OF THE INVENTION

[0005] Broadly stated, embodiments are directed to a device and method to determine if an earpiece is sealing within the design specification of the device.

[0006] In one embodiment, the device can include a sealing section forming an acoustic barrier between a first volume and a second volume. An ear canal receiver (ECR) can be configured to generate an acoustic signal in the first volume. An Ear Canal Microphone (ECM) in the first volume can be configured to measure the acoustic signal in the first volume. The first acoustic signal emitted by the ECR can be cross-correlated with the first acoustic signal detected with the ECM to determine if the sealing section is sealed properly.

[0007] At least one exemplary embodiment is directed to a method of detecting sealing integrity of an earpiece comprising the steps of: providing a test signal; generating an acoustic signal corresponding to the test signal incident on an ear canal side of a sealing section; converting the acoustic signal incident on a first side of the sealing section to an electrical signal; and cross- correlating the test signal to the electrical signal where the earpiece is sealed correctly when a cross-correlation between the test signal and the electrical signal is above a threshold.

[0008] At least one exemplary embodiment is directed to a method of adjusting attenuation of an earpiece comprising the steps of: relating cross-correlation of a test signal and a measured acoustic signal in an ear canal of a user to an attenuation level of a sealing section of the earpiece; comparing the attenuation level of the sealing section of the earpiece to a minimum attenuation value; and adjusting a pressure of the sealing section to meet the minimum attenuation value.

[0009] At least one exemplary embodiment is directed to a device comprising: a sealing section configured to seal a user's orifice, where the sealing section is configured to produce an acoustic seal between a first side of the sealing section and a second side of the sealing section; a transducer configured to generate a first acoustic signal incident on the first side of the sealing section; and a first microphone configured to measure a second acoustic signal incident on the second side of the sealing section, where the second acoustic signal

includes at least a portion of the first acoustic signal that has passed from the first side to the second side of the sealing section where the first acoustic signal is compared to the second acoustic signal to determine if the sealing section is sealed.

[0010] Further areas of applicability of exemplary embodiments of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Exemplary embodiments of the present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0012] FIG. 1 is a diagram of an earpiece inserted in an ear canal in accordance with an exemplary embodiment;

[0013] FIG. 2 is a block diagram of optional components of an earpiece in accordance with an exemplary embodiment;

[0014] FIG. 3 is a flowchart of a method for checking an ear seal in accordance with an exemplary embodiment;

[0015] FIG. 4 is a flowchart to determine acoustic seal integrity of an earpiece in accordance with the exemplary embodiment.

[0016] FIG. 5 is a flowchart of a method to estimate the instantaneous cross-correlation between a first and second audio signal.

[0017] FIG. 6 is a flowchart to determine when to emit a test signal in accordance with an exemplary embodiment;

[0018] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention;

[0019] FIG. 8 is a block diagram for a method of adjusting the IMS system in accordance with at least one exemplary embodiment;

[0020] FIG. 9 is a block diagram for a method of adjusting IMS pressure in accordance with at least one exemplary embodiment;

[0021] FIG. 10 illustrates a sample relationship between EarSeal attenuation and XCorr in accordance with at least one exemplary embodiment;

[0022] FIG. 11 illustrates a flowchart of an exemplary method to determine a test signal fundamental;

[0023] FIG. 12 illustrates a flowchart of an exemplary embodiment to determine tonal presence in audio content;

[0024] FIG. 13 illustrates a flowchart of a method to determine when to emit the test signal;

[0025] FIG. 14 illustrates a flowchart of an exemplary method to determine acoustic seal integrity;

[0026] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment; and

[0027] FIG. 16 illustrates the sending of a signal to an inflation controller upon detection of a seal fail to modify the seal pressure in accordance with at least one exemplary embodiment.

DETAILED DESCRIPTION

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

[0029] Exemplary embodiments are directed to or can be operatively used on various wired or wireless orifice inserted devices for example earpiece devices (e.g., earbuds, headphones, ear terminals, behind the ear devices or other acoustic devices as known by one of ordinary skill, and equivalents).

[0030] Processes, techniques, apparatus, and materials as known by one of ordinary skill in the art may not be discussed in detail but are intended to be part of the enabling description where appropriate. For example specific computer code may not be listed for achieving each of the steps discussed, however one of ordinary skill would be able, without undo experimentation, to write such code given the enabling disclosure herein. Such code is intended to fall within the scope of at least one exemplary embodiment.

[0031] Additionally exemplary embodiments are not limited to earpieces, for example some functionality can be implemented on other systems with speakers and/or microphones for example computer systems, PDAs, BlackBerry® smart phones, cell and mobile phones, and any other device that emits or measures acoustic energy. Additionally, exemplary embodiments can be used with digital and non-digital acoustic

systems. Additionally various receivers and microphones can be used, for example MEMs transducers, diaphragm transducers, for example Knowles' FG and EG series transducers.

[0032] Notice 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 or further defined in the following figures.

[0033] 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.

[0034] 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.

[0035] At least one exemplary embodiment of the invention is directed to an earpiece for sealing or partially sealing an ear. FIG. 1 is a diagram of an earpiece inserted in an ear canal 124 in accordance with at least one exemplary embodiment of the invention. FIG. 1 also illustrates portions of the ear including pinna 128, ear canal 124 and eardrum 126. As illustrated, the earpiece comprises an electronic housing unit 100 and a sealing unit 108. The earpiece depicts an electro-acoustical assembly for an in-the-ear acoustic assembly, as it would typically be placed in an ear canal 124 of a user 130. The earpiece is an in-ear earpiece, behind the ear earpiece, receiver in the ear, partial-fit device, or any other suitable earpiece type. The earpiece can partially or fully occlude the ear canal 124.

[0036] The earpiece includes an Ambient Sound Microphone (ASM) 120 to capture ambient sound, an Ear Canal Receiver (ECR) 114 to deliver audio to an ear canal124, and an Ear Canal Microphone (ECM) 106 to capture and assess a sound exposure level within the ear canal 124. The earpiece can partially or fully occlude the ear canal 124 to provide various degrees of acoustic isolation. The assembly is designed to be inserted into the user's ear canal 124, and to form an acoustic seal with the walls of the ear canal 124 at a location between the entrance to the ear canal 124 and the tympanic membrane (or ear drum) 126. In general, such a seal is typically achieved by means of a soft and compliant housing of the sealing unit 108. Additionally, the sealing unit 108 can be a pressurized expandable element that fills a portion of the available local space.

[0037] Sealing unit 108 is an acoustic barrier having a first side corresponding to ear canal124 and a second

side corresponding to the ambient environment. In at least one exemplary embodiment, sealing unit 108 includes an ear canal microphone tube 110 and an ear canal receiver tube 112. Sealing unit 108 creates a closed cavity of approximately 5 cc or less between the first side of sealing unit 108 and the tympanic membrane 126 in ear canal124. In at least one exemplary embodiment the sealing facilitates using the ECR (speaker) 114 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 126 resulting from the sound field at the entrance to the ear canal 124. This seal is also a basis for a sound isolating performance of the electro-acoustic assembly.

[0038] In at least one exemplary embodiment and in broader context, the second side of sealing unit 108 corresponds to the side adjacent to electronic housing unit 100. Ambient sound microphone 120 is housed in electronic housing unit 100 and is exposed to the ambient environment for receiving sound from the ambient environment around the user.

[0039] The electronic housing unit 100 can include various system components such as a microprocessor 116, memory 104, battery 102, ECM 106, ASM 120, ECR, 114, and user interface 122, or these components can reside in a separate system or interface operatively connected. Microprocessor 116 (or processor 116) can be a logic circuit, a digital signal processor, controller, or the like for performing calculations and operations for the earpiece. Microprocessor 116 is operatively coupled to memory 104, ECM 106, ASM 120, ECR 114, and user interface 122. An optional wire 118 can provide an external connection to the earpiece. Battery 102 powers the circuits and transducers of the earpiece. Battery 102 can be a rechargeable or replaceable battery.

[0040] In at least one exemplary embodiment, electronic housing unit 100 is adjacent to sealing unit 108. Openings in electronic housing unit 100 receive ECM tube 110 and ECR tube 112 to respectively couple to ECM 106 and ECR 114. ECR tube 112 and ECM tube 110 acoustically couple signals to and from ear canal 124. For example, ECR 114 outputs an acoustic signal through ECR tube 112 and into ear canal 124 where it is received by the tympanic membrane 126 of the user of the earpiece. Conversely, ECM 106 receives an acoustic signal present in ear canal124 though ECM tube 110.

[0041] One function of ECM 106 is that of measuring the sound pressure level in the ear canal cavity 124 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 the earpiece. In one arrangement, ASM 120 is used to monitor sound pressure at the entrance to the occluded or partially occluded ear canal 124. All transducers shown can receive or transmit

audio signals to a processor 116 that undertakes audio signal processing and provides a transceiver for audio via the wired (wire 118) or a wireless communication path. Note also that the acoustic signals can be stored for later retrieval.

[0042] In at least one exemplary embodiment the earpiece can be constructed to actively monitor a sound pressure level both inside and outside an ear canal 124. In at least one exemplary embodiment monitored data can be used to enhance spatial and timbral sound quality while maintaining supervision to ensure safe sound reproduction levels. In at least one exemplary embodiment an earpiece can facilitate at least one of conducting listening tests, filtering sounds in the environment, monitoring warning sounds in the environment, presenting notification based on identified warning sounds, maintaining constant audio content to ambient sound levels, and filtering sound in accordance with a Personalized Hearing Level (PHL).

[0043] The earpiece can generate an Ear Canal Transfer Function (ECTF) to model the ear canal 124 using ECR 114 and ECM 106, as well as an Outer Ear Canal Transfer function (OETF) using ASM 120. For instance, the ECR 114 can deliver an impulse within the ear canal124 and generate the ECTF via cross correlation of the impulse with the impulse response of the ear canal 124. The earpiece can also determine a sealing profile with the user's ear to compensate for any leakage. In at least one exemplary embodiment the earpiece can use either the ASM 120 or the ECM 106 to monitor the sound pressure level, which can then be used in a Sound Pressure Level Dosimeter calculation, to estimate sound exposure and recovery times. This permits the earpiece to safely administer and monitor sound exposure to the ear.

[0044] Referring to FIG. 2, a block diagram of an earpiece 201 in accordance with an exemplary embodiment is shown. A power supply 205 (e.g., USB power connection, hearing aid battery (batteries)) powers components of the earpiece 201 including microprocessor 206 (or processor 206, e.g., Texas Instruments TMS320C6713) and a data communication system 216 (e.g., RF or Bluetooth communication chip). As illustrated, the earpiece 201 includes the processor 206 operatively coupled to data communication system 216, ASM 210, ECR 212, and ECM 208. Data communication system 216 may include one or more Analog to Digital Converters and Digital to Analog Converters (DAC). The processor 206 can utilize computing technologies such as a microprocessor, Application Specific Integrated Chip (ASIC), and/or digital signal processor (DSP) with associated Random Access Memory (RAM) 202 and Read Only Memory (ROM) 204. Other memory types such as Flash, non-volatile memory, SRAM, DRAM or other like technologies can be used for storage with processor 206. The processor 206 can also include a clock to record a time stamp.

[0045] In general, data communication system 216 is a communication pathway to components of the earpiece 201 and components external to the earpiece 201. The communication link can be wired or wireless. In at least one exemplary embodiment, data communication system 216 is configured to communicate with ECM 208, ASM 210, visual display 218, and user control interface 214 of the earpiece 201. As shown, user control interface 214 can be wired or wirelessly connected. In at least one exemplary embodiment, data communication system 216 is capable of communication to devices exterior to the earpiece 201 such as the user's mobile phone 234, a second earpiece 222, and a portable media player 228. Portable media player 228 can be controlled by a manual user control 230.

[0046] The user's mobile phone 234 includes a mobile phone communication system 224. A microprocessor 226 is operatively coupled to mobile phone communication system 224. As illustrated multiple devices can be wirelessly connected to one another such as an earpiece 220 worn by another person to the user's mobile phone. Similarly, the user's mobile phone 234 can be connected to the data communication system 216 of the earpiece 201 as well as the second earpiece 222. This connection would allow one or more people to listen and respond to a call on the user's mobile phone 234 through their respective earpieces.

[0047] As illustrated, a data communication system 216 can include a voice operated control (VOX) module to provide voice control to one or more subsystems, such as a voice recognition system, a voice dictation system, a voice recorder, or any other voice related processor. The VOX module can also serve as a switch to indicate to the subsystem a presence of spoken voice and a voice activity level of the spoken voice. The VOX can be a hardware component implemented by discrete or analog electronic components or a software component. In one arrangement, the processor 206 can provide functionality of the VOX by way of software, such as program code, assembly language, or machine language.

[0048] The RAM 202 stores program instructions for execution on the processor 206 as well as captured audio processing data. For instance, memory RAM 202 and ROM 204 can be off-chip and external to the processor 206 and include a data buffer to temporarily capture the ambient sound and the internal sound, and a storage memory to save from the data buffer the recent portion of the history in a compressed format responsive to a directive by the processor. In at least one exemplary embodiment, the data buffer can be a circular buffer that temporarily stores audio sound at a current time point to a previous time point. It should also be noted that the data buffer is operatively connected with processor 206 to provide high speed data access. The storage memory can be non-volatile memory such as SRAM to store captured or compressed audio data.

[0049] Data communication system 216 includes an audio interface operatively coupled to the processor

206 and the VOX to receive audio content, for example from portable media player 228, a cell phone, or any other communication device, and deliver the audio content to the processor 206. The processor 206 responsive to detecting voice-operated events from the VOX can adjust the audio content delivered to the ear canal of the user of the earpiece. For instance, the processor 206 (or the VOX of data communication system 216) can lower a volume of the audio content responsive to detecting an event for transmitting the acute sound to the ear canal of the user. The processor 206 by way of the ECM 208 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 based on voice operating decisions made by the VOX of data communication system 216.

[0050] The earpiece 201 and data communication system 216 can further include a transceiver that can support singly or in combination any number of wireless access technologies including without limitation Bluetooth™, Wireless Fidelity (WiFi), Worldwide Interoperability for Microwave Access (WiMAX), and/or other short or long range communication protocols. The transceiver can also provide support for dynamic downloading over-the-air to the earpiece 201. It should be noted also that next generation access technologies can also be used in exemplary embodiments.

[0051] Data communication system 216 can also include a location receiver that utilizes common technology such as a common GPS (Global Positioning System) receiver that can intercept satellite signals and therefrom determine a location fix of the earpiece 201.

[0052] The power supply 205 utilizes common power management technologies such as replaceable batteries, supply regulation technologies, and charging system technologies for supplying energy to the components of the earpiece 201 and to facilitate portable applications. A motor (not shown) can be a single supply motor driver coupled to the power supply 205 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.

[0053] Microprocessor 206 is operatively connected with an EarSeal Inflation Management System 232 to control the degree to which the sealing unit 108 is inflated or deflated. In one exemplary embodiment, sealing unit 108 comprises an expandable element (e.g., inflatable balloon mechanism), whereby a cavity can be filled with air or a liquid to change the degree of acoustic isolation between the internal ear canal space 124 and the ambient environment. Alternately, a passive system for sealing ear canal 124 is used such as a flexible rubber or a silicon sealing unit or a foam plug. In one exemplary embodiment, the passive

system is a balloon mechanism that is filled with air or liquid. The balloon mechanism conforms to the shape and size of an ear canal and includes a restorative force module that applies a pressure to the balloon mechanism for sealing the ear canal cavity.

[0054] The earpiece is 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 are reused in different form factors for the master and slave devices.

[0055] Referring to FIG. 3, a flowchart illustrates a method for an acoustic sealing analysis system in accordance with an exemplary embodiment. In general, a first volume is acoustically isolated from a second volume. The test determines if the two volumes have sufficient acoustic isolation from one another. For example, cars are designed to have a quiet interior. Users of an automobile do not want to be subjected to the noise of the external environment. Thus, a car interior (first volume) is acoustically isolated from the external environment outside of the automobile. Similarly, an earpiece having a sealing unit such as described in FIG. 1 will create a first volume (the ear canal) that is acoustically isolated from the ambient environment of the user (second volume). In either example, the acoustic sealing analysis system determines if there is sufficient acoustic isolation for the application. In the earpiece example, random or periodic testing of the seal may be beneficial because a new seal is formed in the ear canal when the device is put in the ear or it may shift over time depending on user activity.

[0056] The method begins at step 302. A test signal is acquired in a step 304. For example, the test signal can be stored in memory or generated by a microprocessor. The test signal is provided to the acoustic transducer. The acoustic transducer or loudspeaker (such as an ECR) emits an acoustic signal corresponding to the test signal within the first volume in a step 306. The acoustic field in the first volume is detected by an Ear Canal Microphone (ECM) in a step 308. The acoustic loading on both the ECR and ECM will change depending on the degree of acoustic sealing, thereby affecting the degree magnitude of the radiated ECR signal detected by the ECM. In general, as the degree of ear seal decreases, the effect of lumped air mass coupled to the ECR and ECM will decrease thereby increasing in Thevenin capacitance, which effectively reduces the transfer of low frequency emitted sound from the ECR to the ECM.

[0057] In one exemplary embodiment, the test signal and the acoustic signal emitted by the loudspeaker into the first volume is a single frequency sine wave signal for testing leakage from one volume to another.

[0058] The degree of sealing between the first and second acoustic volumes is determined in a step 310 and the process ends at step 312. The cross-correlation between the emitted test signal and detected ECM signal is taken. In at least one exemplary embodiment, the test signal and the measured acoustic signal emitted by the loudspeaker are conditioned using a time delay and frequency dependent filter. The ear-seal is determined to be low (or "leaky") if the cross- correlated signals are below a predetermined value. In at least one exemplary embodiment, automatic adjustments to the sealing section are made (such as deflating and re-inflating the sealing balloon to reseal the sealing section including retesting). Alternately, an audible sound, vocal response, or visual response can be provided to let the user know that the earpiece is sealed correctly or incorrectly.

[0059] Referring to FIG. 1, the earpiece is used as an example to illustrate a test sequence as disclosed in FIG. 3. Sealing unit 108 occludes an opening of ear canal 124 creating a first volume (ear canal124) and a second volume (the ambient environment). Sealing unit 108 has a first side exposed to ear canal 124 and a second side is exposed to or corresponds to the ambient environment external to the ear.

[0060] In at least one exemplary embodiment, processor 116 is configured to receive a test signal in memory 104. Processor 116 generates the test signal and provides the test signal to Ear Canal Receiver 114 (ECR 114). ECR 114 emits the test signal into Ear Canal Receiver Tube (ECR Tube 112). The test signal propagates through ECR tube 112 and into ear canal 124. Ear Canal Microphone tube 110 (ECM tube 110) is configured to receive an acoustic signal incident on the first side of sealing unit 108. The test signal in ear canal 124 propagates through ECM tube 110 and is received by Ear Canal Microphone 106 (ECM 106). ECM 106 is configured to measure the test signal in ear canal124 and provide the measured test signal to processor 116.

[0061] As shown, electronic housing unit 100 of the earpiece is adjacent to the second side of sealing unit 108. Electronic housing unit 100 is exposed to the ambient environment and for purposes of acoustic sealing analysis is considered the second side of sealing unit 108. Electronic housing unit 100 includes Ambient Sound Microphone 120 (ASM 120), which is configured to measure sounds in the ambient environment. Thus, ASM 120 receives and measures an ambient signal corresponding to a signal incident on the second side of sealing unit 108. ASM 120 provides the measured ambient signal to processor 116.

[0062] Ideally, sealing unit 108 is an acoustic barrier preventing the test signal or very little of the test signal from getting past sealing unit 108 and into the ambient environment. Conversely, sealing unit 108 if improperly sealed will pass some of the test signal. Processor 116 compares the test signal to the signal

provided by ECM 106 corresponding to the acoustic signal in ear canal124. In particular, processor 116 undertakes the cross-correlation between emitted test signal and the ECM signal.

[0063] Referring to FIG. 4, a flowchart of an exemplary method to determine the acoustic seal integrity of an earpiece in accordance with an exemplary embodiment is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user. This allows unobtrusive (periodic or non-periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0064] In at least one exemplary embodiment, an audio content is provided in a step 402. A step 404 stores the test signal in a test signal data buffer. For example, a single frequency sine wave is stored in the test signal data buffer. The output (or alternatively--input) of the test signal data buffer is optionally delayed by digital delay unit 406. The function of delay unit 406 is to time- align the emitted test signal with the ECM signal so the cross-correlation is sensitive to changes in ear seal.

[0065] A step 408 stores the test ECM signal in a test signal data buffer. The output (or alternatively--input) of the ECM signal buffer can be filtered with a low-pass filter 410. The low pass filter can be configured so that the pass-band covers the frequency of the test signal. In one exemplary configuration, the low-pass filter can be a cascaded bi-quad IIR type filter with the cut-off frequency equal to 10Hz greater than the test signal frequency.

[0066] A step 412 cross-correlates the optionally delayed test signal buffer with the low-pass filtered ECM signal buffer. An exemplary method for the cross-correlation algorithm is described in FIG. 5. The instantaneous cross-correlation (i.e. the cross-correlation at zero-lag) value from step 412 is compared with the cross-correlation threshold value 414 using comparator unit 416. If the instantaneous cross-correlation of the two signal buffers is less than the threshold value 414, then the seal test status is set to FAIL 418 (i.e. an ear-seal leak is detected); otherwise, if the cross-correlation is suitably high, the seal test status is set to PASS 420.

[0067] Referring to FIG. 5, a flowchart of an exemplary embodiment to determine the instantaneous cross-correlation between a first audio signal and a second audio signal is illustrated. The process begins at step 500. In at least one exemplary embodiment, the first audio signal is the test signal (i.e. a sine wave) and the second signal is the low-pass-filtered ECM signal.

[0068] The correlation between two signals x and y at time k using an exponential window is defined as:

[0069] $$p(k) = \frac{S_{xy}(k)}{\sqrt{S_{xx}(k)_{yy}(k)}} \quad (1)$$

[0070] Where

[0071] $$S_{x[[x]]\underline{\prime}}(k) = \sum_{l=0}^{\infty} ce^{-\eta^l} x_{k-l} y_{k-l} \quad (2)$$

$$c = 1 - e^{-\eta}$$

[0072] And S_{xx} and S_{yy} are defined similarly as in (2) (replacing y with x for S_{xx} etc.).

[0073] It can be shown (see Aarts et al, 2001) that (1) can be approximated with the recursion:

[0074] $$\hat{\rho}(k) = \hat{\rho}(k-1) + \gamma[\partial_k - \beta_k \hat{\rho}(k-1)] \quad (3)$$

$$\partial_k = 2x_k y_k$$

$$\beta_k = \alpha x_k^2 \alpha^{-1} y_k^2$$

[0075] Where

$$\alpha = \frac{y_{RMS}}{x_{RMS}} \quad (4)$$

$$\gamma = \frac{ce^{\eta}}{2x_{RMS} y_{RMS}}$$

[0077] The cross-correlation estimate using the above recursion is modified for block-wise processing rather than the sample-by-sample basis. This modification replaces the sample values (i.e. x(k) and y(k)) with values for the N-length block mean, i.e.

[0078]

$$x(k) = \frac{1}{N} \sum_{l=0}^{N-1} x(k-l)$$

[0079] Furthermore, the numerator for y is replaced with a small constant and so is α (replacing α with a constant effectively un-normalizes the correlation estimate). It is found that the modified un-normalized block-wise cross-correlation accurately estimates the cross-correlation compared with using the standard cross-correlation for two signals.

[0080] The modified block-wise fast cross-correlation algorithm, as summarized in FIG. 5, comprises the following steps:

1. A first signal buffer 502 is accumulated. This signal buffer corresponds to the emitted test signal (i.e. the sine wave).
2. The RMS level of the first buffer is calculated 504 (x_{RMS})
3. The mean level of the first buffer is calculated 506.
4. A second signal buffer 508 is accumulated. This signal buffer corresponds to the filtered ECM signal.
5. The RMS level of the second buffer is calculated 510 (y_{RMS}).
6. The mean level of the second buffer is calculated 512.
7. In step 514, γ (gamma) is approximated as:

$$\gamma = \frac{\Gamma}{2x_{RMS}y_{RMS}}$$

Where Γ is a small constant, e.g. 10E-3.

8. In step 516,∂_k (delta) calculated as twice the product of the first signal buffer mean and the second signal buffer mean.
9. In step 518, beta is calculated as the sum of the square of the mean value of the first buffer with the sum of the square of the mean value of the second buffer.
10. In step 520, the new temporary estimate of the correlation newRho_temp is calculated as: newRho_temp=(delta-beta*rho_old))
11. In step 522, the new estimate of the correlation newRho is updated by summing the previous estimate of the correlation with the product of gamma and the temporary estimate of the correlation newRho_temp.
12. In step 524, the "old" value of the correlation is set to the newest correlation estimate, ready for the next iteration of the update algorithm.
13. In step 526, the current correlation estimate between the emitted test signal and the received and filtered ECM signal is set as equal to the value of newRho.

[0081] Referring to FIG. 6, a flowchart of a method to determine when to emit the test signal is shown. The test signal is emitted when the test can be performed unobtrusively to the user and also provides an accurate test. In at least one exemplary embodiment, a test event to determine if an earpiece is sealed correctly is

initiated via a timing methodology. In a first timing scenario, the test event occurs after a delay of a first predetermined time period when the RMS of the Audio Content (AC) is less than a RMS threshold. In a second timing scenario, the delay of the first predetermined time period is allowed to lapse without the test event occurring when the RMS of the audio content is greater than the RMS threshold. A second predetermined time period is started where the test event occurs when the RMS of the audio content is less than the RMS threshold. The test event is then initiated when the second predetermined time period is exceeded independent of the RMS of the audio content.

[0082] A test sequence is initiated in a step 602. The previous seal test event resets the first digital timer in a step 604. A time delay is generated by the loop comprising steps 606 and 608. The first digital timer is time incremented in the step 606. After each added time increment, the first digital timer is compared against a digital_timer_threshold1. The first digital timer is time incremented (after the time has advanced another increment) after the comparison in the step 608 if the first digital timer is less than the digital_timer_threshold1.

[0083] A second digital timer is reset in a step 610 when the first digital timer is greater than the digital_timer_threshold1. The second digital timer is time incremented in a step 612. Audio content (AC) from a signal buffer is retrieved in a step 614. The audio content can be filtered through a low pass filter in an optional step 616. The RMS of the audio content is calculated in a step 618. The calculated RMS of the audio content is compared against an RMS_threshold 622 in a step 620. The second digital timer is compared against a digital_timer_threshold2 in a step 624 if the RMS of the audio content is greater than the RMS_threshold. The second digital timer is time incremented (after the time has advanced another increment) when the second digital timer is less than digital_timer_threshold2 in the step of 624.

[0084] The audio content signal is mixed with the test signal when the RMS of the audio content is less than the RMS_threshold in a step 626. Also, the audio content signal is mixed with the test signal when the second digital timer is greater than digital_timer_threshold2 in the step 624. The modified audio signal (having the test signal mixed in) is emitted by the ECR in a step 628 for testing the sealing section of the earpiece. The first digital timer is then reset in the step 604 to begin a timing sequence for another sealing section test.

[0085] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention. The estimated un-normalized cross-correlation between the ECM signal and the test signal (i.e. sine wave) is shown for different sine wave frequencies from 30-80Hz. Three different curves are provided corresponding

to a good fit (i.e. a tight optimal seal providing approximately 20-30 dB of acoustic attenuation), mid or partial seal (i.e. an ear-seal that could be characterized as "half in" providing approximately 10-15 dB of acoustic attenuation), and a poor seal (i.e. an ear-seal providing less than 10 dB of acoustic attenuation). At lower test frequencies, the change in correlation is more pronounced as the degree of ear seal fitting is changed from "good" to "mid" and "poor". From the data, the threshold used to determine whether the ear seal can be characterized as "good" is approximately -20 dB, (i.e. 0.85 of FIG. 10 which corresponds to the value for XCorr_threshold 414 in FIG. 4).

[0086] In at least one exemplary embodiment, the test signal for testing a seal of a sealing section is less than 200 hertz. The frequency of the emitted test signal is chosen to satisfy the requirements of being able to reveal small degradations in ear seal quality. It is also beneficial if the selected test signal frequency can be acoustically masked by reproduced audio to minimize detection of the test by an earpiece user. Both of these criteria are met using a test signal frequency below 200 Hz. The sensitivity is highest from the measured data at frequencies below 50 Hz. Conversely, as the test signal frequency increases the cross-correlation difference between a "good" and "bad" acoustic seal decreases. For example, with a 40Hz test tone, the cross-correlation for a "good" ear seal is -8 dB, and for a bad ear seal it is -68 dB (i.e. a 60 dB difference). At a test signal frequency of 80Hz, the cross-correlation for a "good" ear seal is -8 dB and for a bad ear seal it is -38 dB (i.e. a 30 dB difference). Thus, above 200Hz the cross- correlation difference between a "good" and "bad" acoustic seal is further reduced thereby reducing the sensitivity of the test.

[0087] Using the cross-correlation rather than a level differencing approach improves the accuracy and minimizes errors which occur due to user non-speech body noise, such as teeth chatter; sneezes, coughs, etc. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0088] FIG. 8 is a flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) in accordance with an exemplary embodiment. The IMS is adjusted depending on the degree of acoustic sealing provided by an earpiece. The method begins at step 802. The acoustic sealing is measured as disclosed in FIG. 7 and the result provided in a step 804 to determine the cross-correlation (XCorr) between a test signal and corresponding ECM signal. In general, the higher the cross-correlation, the higher the degree of acoustic sealing. An exemplary graph showing the relationship between XCorr and acoustic sealing is given in FIG. 10. The degree of acoustic sealing is determined from known XCorr using a look-up (or "hash") table or using a formula (e.g. of a polynomial form) that maps the acoustic sealing to the known XCorr value. The ambient sound level is measured in a step 806. The ambient sound level corresponds to

the noise level in proximity to the user. In general, a higher degree of attenuation is desired when the ambient sound levels are high. Conversely, at low ambient sound levels the attenuation level of the IMS may be less of an issue and comfort more of a factor. The IMS is adjusted in a step 808 to meet the attenuation needs. In general, inflating the IMS increases attenuation while deflating the IMS decreases attenuation. The method terminates at step 810.

[0089] Referring to FIG. 9, a more detailed flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) is shown. In general, the attenuation increases when the pressure in the IMS is raised thereby allowing a degree of control to make adjustments. For example, an adjustment is made to increase attenuation when the background noise level rises or a seal check produces a failed result. Adjustments are made until the seal check passes. The pressure level adjustments of the IMS will fall within a comfort range of a user (e.g., between 0.1 bar and 0.3 bar gauge pressure). Typically, the pressure level is set at a minimum level to achieve a predetermined attenuation level.

[0090] The method begins at step 902. The degree of acoustic sealing is determined from cross-correlation between the ECM signal and the generated test signal. The XCorr value is provided in a step 904. In step 906, the attenuation provided by the IMS is calculated (equation) or looked up (table) from data such as that shown in FIG. 10. In one exemplary embodiment, the desired attenuation value is dependant on the ambient sound level of the user. In another exemplary embodiment, the desired attenuation value is dependant on the ear-canal sound level of the user. In yet another exemplary embodiment, the desired attenuation value is dependant on the level of audio content (e.g. speech or music audio) reproduced with the earphone device. In all of the above examples, the desired attenuation value is determined by one or more of the embodiments in a step 907.

[0091] The difference between the degree of acoustic sealing determined in step 906 and the desired attenuation value determined in step 907 is calculated in step 908. The difference value in step 908 is used to determine the change in pressure of the IMS necessary to minimize the difference value in a step 910. In at least one exemplary embodiment, the difference value of the attenuation is converted into a corresponding pressure value change (e.g. in milli-Bars) using a similar look-up table or equation method as described previously. The pressure change in the IMS is then affected with step 912 to meet the desired attenuation level. For example if the desired attenuation is a decrease of 10 dB in sound across the earpiece in the ear canal, then a pressure of a variable volume inflatable system can have a gauge pressure of about 0.15 bar. If the desired attenuation is a decrease of 20 dB across the earpiece in the ear canal then the gauge pressure can be increased to about 0.25 bar, where an increased pressure is associated with an increase in attenuation. An

experimental table for each earpiece can be generated in a standard devised experimental setup (e.g. impedance tunnel) and referred to when changes are needed. The method ends at step 914.

[0092] Referring to FIG. 11, a flowchart of an exemplary method to determine a test signal fundamental is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user or made pleasant such that the user is unaware that the test signal is being played. This allows unobtrusive (periodic or non- periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0093] In at least one exemplary embodiment, an audio content 1102 is provided. A step 1104 stores audio content 1102 in a data buffer. In this example, audio content 1102 is music played from a media player and received via a wired or wireless connection to at least one earpiece in the user's ear. An alternate example would be that audio content 1102 is a speech audio signal from a portable telephone device or the like.

[0094] A step 1106 determines if the buffer of audio content 1102 comprises a strong tonal signal component. Mixing the test signal having a similar fundamental frequency as audio content 1102 will mask the test signal when played to the user. Thus, the test signal is musically in harmony with the reproduced music and results in very little perceptual degradation in sound quality.

[0095] A step 1108 determines whether to update or generate the first fundamental tone for the test signal. The test signal is not updated or generated if buffered audio content 402 does not contain a strong tonal signal component. A return to step 1104 fills the buffer with the next audio content 402 for analysis.

[0096] A step 1110 analyzes the buffer of data of audio content 1102 when it has been determined that it contains a strong tonal signal component. Step 1110 determines the fundamental frequency of the tonal signal. The fundamental tone, often referred to as the fundamental and abbreviate f_0 is the lowest frequency in a harmonic series. The fundamental frequency (also called a natural frequency) of a periodic signal is the inverse of the pitch period length. The pitch period is the smallest repeating unit of a signal. The fundamental frequency of the tonal signal can be calculated using an autocorrelation analysis.

[0097] In one exemplary embodiment, a mathematical operation 1114 is performed where the frequency component of the test signal is limited to a frequency range below a lower minimum and upper maximum frequency range. Fund_ratio is calculated, which is defined as a ratio of the determined fundamental frequency (F_fund) of the tonal signal from step 1110 to an upper threshold value F_fund_threshold 1112, which in one exemplary embodiment, is a fixed constant equal to approximately 100Hz. In general,

F_fund_threshold 1112 is chosen to be a low frequency value which is above the lowest (or -3 dB) frequency that a transducer can reproduce, but below a predetermined frequency. In a comparison step 1116, if the estimated F-fund is higher than the F_fund_threshold 1112 (ratio > 1), then F_fund is reduced by an integer multiple to be below F_fund_threshold 1112 corresponding to the mathematical operation of step 1118. Otherwise, the test signal fundamental is equal to F_fund as shown in step 1120. Although not shown, the calculated test signal fundamental is compared and determined to be greater than a predetermined threshold.

[0098] Referring to FIG. 1, in at least one exemplary embodiment, processor 116 is configured to receive or generate audio content. As mentioned previously, the audio content can from external devices such as a portable phone or a media player. Memory 104 can be used as a buffer for the audio content. Processor 116 is configured to receive the buffer of audio content from memory 104. The steps and calculations of the block diagram of FIG. 4 are then performed by processor 116. The result being one of the identification of a strong tonal signal component in the buffer of audio content and the test signal fundamental or loading the buffer with new audio content and starting the process again.

[0099] Referring to FIG. 12, a flowchart of an exemplary embodiment to determine tonal presence in audio content is shown. In particular, the exemplary embodiment relates to step 1106 of FIG. 11 that analyzes audio content stored in a buffer. The method begins at step 1202. A step 1204 gets the audio content stored in an audio signal buffer hereinafter called the audio signal. A filter step 1206 filters the audio signal to a frequency range of interest that relates to a sealing test frequency. For example, a band pass filter in the range of 20Hz to 500Hz could be used to filter the audio signal where the test signal is in the lower audio frequency range. An auto-correlation step 1208 analyzes the audio signal where a strong tonal signal component is represented by peaks in the analysis results. A step 1210 generates Absolute(Acorr) which is a number representing the absolute magnitude of the peaks from the analysis. For example, Absolute(Acorr) can be the square of the results from the auto-correlation.

[0100] A crest_factor_Acorr 1218 is generated from the results by calculating an RMS value 1214 (or time-averaged peak value) and peak value 1216 (or time averaged peak value). In at least one exemplary embodiment, the crest_factor_Acorr 1218 is the ratio of the peak value to the RMS value of an absolute auto-correlation sequence of the audio signal.

[0101] A comparison step 1222 is then performed. A strong tonal presence is identified when crest_factor_Acorr 1218 is greater than a threshold Crest_factor_Acorr_threshold 1220. Identification of the

strong tonal presence indicates the audio signal would facilitate masking of the test signal to determine sealing of the device (step 1226). The audio signal is not used in conjunction with the test signal if crest_factor_Acorr 1218 is less than Crest_factor_Acorr_threshold 1220 (step 1224). The process would begin again loading a next sequence of the audio signal into the buffer for review.

[0102] Referring to FIG. 1, as mentioned previously, audio content is stored in a buffer, for example memory 104. The audio content in the buffer is provided to processor 116. In at least one exemplary embodiment, processor 116, runs the analysis as described in the block diagram of FIG. 12 thereby determining if a strong tonal presence is found in the audio content in the buffer. New audio content is loaded into the buffer (memory 104) if a strong tonal presence is not found beginning the procedure again.

[0103] Referring to FIG. 13, a flowchart of a method to determine when to emit the test signal is shown. The method begins at step 1302. The test signal is emitted when the test can be performed unobtrusively to the user and also provide an accurate test. In a step 1304, an audio signal is retrieved from a buffer. In at least one exemplary embodiment, the audio signal is received from an ECM or an ASM. The audio signal is measured to determine when the sound level is low in the ear canal, the ambient environment, or both. In general, the test signal is emitted when the sound level is low.

[0104] A filter step 1306 band pass filters the audio signal. In one exemplary embodiment, filter step 1306 filters the audio signal from 50 Hz to 150Hz which corresponds to a frequency range of the test signal. In a step 1308, the RMS of the audio signal is calculated. The audio signal is analyzed to detect when the energy within an audio frequency range is below a threshold RMS_threshold 1310. The RMS of the audio signal is the signal level in the volume being measured. A comparison step 1312 compares the measured RMS level of the filtered audio signal against RMS_threshold 1310. In a step 1314, a test signal is emitted when the measured RMS value is less than RMS_threshold 1310. No test signal is emitted when the RMS of the audio signal is greater than RMS_threshold 1310. The method ends at step 1316.

[0105] Referring to FIG. 14, a flowchart of an exemplary method to determine acoustic seal integrity is illustrated. For example, an earpiece seal integrity corresponds to a full or partial acoustic barrier between a first volume (ear canal) and a second volume (ambient environment). In one exemplary embodiment, the degree of acoustic seal integrity is expressed as either a PASS or FAIL status, where FAIL indicates that the acoustic seal is compromised relative to a normal operating acoustic seal. For example, an earpiece that has performed the seal test and determined that the sealing unit is not sealed correctly in the ear canal of the user can provide a signal or message indicating the problem. The user can then remove, reinsert, and retest the

earpiece to ensure that the seal is within normal operating specifications.

[0106] The method begins at step 1402. An acoustic test signal is provided in a first volume. In a step 1404 a transducer measures the acoustic test signal and stores it in a signal buffer. In a step 1406, a second transducer in a second volume isolated from the first volume by an acoustic barrier measures a second acoustic signal in the second volume. A portion of the acoustic test signal passes the acoustic barrier into the second volume. The amount of the acoustic test signal passing the acoustic barrier is a measure of the seal provided by the acoustic barrier.

[0107] In a filter step 1408, the measured acoustic test signal in the first volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals that are not part of the test. The measured signal from the first volume is heretofore called the first volume signal. Similarly, in a step 1410, the measured signal in the second volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals not related to the test (outside the frequency range) in the second volume. The measured signal from the second volume is heretofore called the second volume signal.

[0108] A correlation, cross-correlation, or coherence analysis is performed on the first volume signal and the second volume signal. The correlation, cross-correlation, or coherence analysis is a measure of the similarity of the signals in the first and second volumes. In particular, the non- difference analysis measures the acoustic test signal leaking past the acoustic barrier by identifying the portion of the second volume signal that is similar to the acoustic test signal in the first volume.

[0109] In at least one exemplary embodiment, a correlation step 1412 is performed comprising a cross-correlation of the first volume signal and the second volume signal. In a step 1414, the peak of the cross-correlation is identified. The peak of the cross-correlation is Absolute(XCorr). In a mathematical step 1418, the Lag-time of Peak 1420 and the Magnitude of Peak 1422 is calculated. The Lag-time of Peak 1420 is a measure of the time delay between receiving the signals in the first and second volumes. In particular, the first volume signal should be received before the second volume signal. The Magnitude of Peak 1422 corresponds to the similarity between the signals in the first and second volumes. Thus, a larger number for Magnitude of Peak relates to more leakage of the acoustic test signal getting past the acoustic barrier.

[0110] Two comparisons are performed that determine if the acoustic barrier is sealed correctly based on the measured and calculated data from the first and second volumes. In a comparison step 1426, the measured Lag-time of Peak is compared against Target Lag Limits 1424. The measured lag-time should fall within the

predetermined range (Target Lag Limits 1424) for the seal test to be valid. If the Lag-time of Peak is within the appropriate range then a logic 1 is provided to AND function 1432, otherwise a logic 0 is provided. In a second comparison step 1428, the Magnitude of Peak is compared against a Peak_threshold 1430. If the Magnitude of Peak is greater than the Peak_threshold 1430 a logic 1 is provided to AND function 1432. This indicates that a significant portion of the acoustic test signal is present in the second volume measurement, otherwise a logic 0 is provided. A FAIL output 1434 corresponds to a logic 1 at the output of AND function 1432. The FAIL occurs when the Lag-time of Peak is within the predetermined range and the Magnitude of Peak is greater than the Peak_threshold indicating that the acoustic barrier is sealed improperly. All other conditions indicate a PASS output 1434 and the acoustic barrier is sealed correctly.

[0111] In at least one exemplary embodiment and referring briefly to FIG. 1, an earpiece is tested to determine if sealing unit 108 is sealed correctly to the ear canal of the user. Sealing unit 108 creates a first volume in ear canal 124 and a second volume outside the ear canal 124 in the ambient environment. A masking approach is used to perform seal testing unobtrusively to the user. The user is listening to music or speech (audio content) provided to ear canal124 from ECR 114.

[0112] The music or speech is buffered in memory 104 or memory in processor 116. Processor 116 analyzes the audio content in the buffer to identify a strong tonal content. A test signal can be created once audio content with strong tonal content is found. The test signal will have at least one fundamental pitch corresponding to the strong tonal content and optionally further harmonics. Processor 116 also analyzes the measured signals from ECM 106 and ASM 120 to determine when to emit the test signal. Processor 116 monitors and compares the sound level in the ambient environment and ear canal124. Processor 116 will provide the generated test signal to ECR 114 during an optimum time for test accuracy such as when the ambient sound level is low, the ear canal sound level is low, or both. Also, processor 116 will not output the test signal if there is audio content similar to the test signal in the ear canal or ambient environment.

[0113] Processor 116 monitors the test conditions and then provides the test signal to ECR 114 when an accurate sealing test can be performed. ECR 114 outputs an acoustic test signal which may or may not have other audio content. ECM 106 and ASM 120 respectively measure acoustic signals in ear canal 124 and the ambient environment. Processor 116 is operatively coupled to ECM 106 and ASM 120. The measured signals are buffered in memory 104.

[0114] In an exemplary embodiment, a cross-correlation is used to measure the similarity between the

signals in ear canal124 and the ambient environment. Processor 116 performs the cross-correlation calculations using the measured acoustic signals from ECM 106 and ASM 120. In particular, the cross-correlation is used to identify and compare the acoustic test signal present in the two volumes separated by the acoustic barrier. A cross-correlation between ASM and ECM signals is defined according to the following equation (5):

$$XCorr(n,l) = \sum_{n=0}^{N} ASM(n)ECM(n-l), \quad (5)$$

Where: l=0, 1, 2, … N

[0115] Where ASM(n) is the nth sample of the ASM signal, and ECM(n- l) is the (n- l)th sample of the ECM signal. A peak of the absolute cross-correlation is estimated using a peak- picking function and also the lag time at which this peak occurs (i.e. the index I at which this occurs). Thus, the Lag-time of Peak and the Magnitude of Peak are known and respectively compared against a Target Lag Limit range and a Peak Threshold. The user of the earpiece is notified or warned that sealing unit 108 is improperly sealed by processor 116 if the measured Lag-time of Peak is within the Target Lag Limit range and the Magnitude of Peak is greater than the Peak Threshold.

[0116] Like Correlation and Cross-Correlation, a coherence function is also a measure of similarity between two signals. Coherence is another non-difference comparison approach that can be used for detecting acoustic seal integrity. Coherence is defined as:

$$\gamma^2{}_{xy} = \frac{|G_{xy}(f)|^2}{G_{xx}(f)G_{yy}(f)} \quad (6)$$

[0117] Where Gxy is the cross-spectrum of two signals (e.g. the ASM and ECM signals), and can be calculated by first computing the cross-correlation in equation (5), applying a window function, for example a Hanning window, and transforming to the frequency domain, for example via an FFT. Gxx or Gyy is the auto-power spectrum of either the ASM or ECM signals, and can be calculated by first computing the auto-correlation (using equation 5, but where the two input signals are both from either the ASM or ECM and transforming to the frequency domain. The coherence function gives a frequency-dependent vector between 0 and 1, where a high coherence at a particular frequency indicates a high degree of coherence at this frequency, and can therefore be used to analyze test signal frequencies in the ASM and ECM signals whereby a high coherence indicates the presence of the test signal in the ambient environment (indicating

leakage past the acoustic barrier).

[0118] Other approaches such as frequency spectrum analysis and RMS levels can also be used to determine if the earpiece is sealed correctly. Using a non-difference comparison approach such as coherence or cross-correlation between the ASM and ECM signals to determine sealing is more reliable than taking the level difference of the ASM and ECM signals. Using the cross correlation rather than a level differencing approach improves the accuracy and minimizes errors which may occur due to user non-speech body noise, such as teeth chatter, sneezes, coughs, etcetera. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0119] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment. In the non-limiting example, when a seal is essentially detected as being low, for example the calculated sound isolation of the system is 3 dB or less, a signal is sent to a seal varying device (e.g., 1500) to vary the seal, in this case increase (i.e. increase the sound isolation of the system) the seal value. The signal can be instructions to send a current over a period of time to an actuator, which can decrease the overall volume of the system (hence increasing the pressure and effectively the sealing). For example a slider actuator such as the P-653 PILine® can be used. Which has the dimensions of 15 mm by 11 mm by 8 mm, which includes an attached electronics control board, and has a mass of 1 gram. General operation uses 5V and about 100 mamps with a typical speed of 50 to 90 mm/sec. Note that the max force of about 0.15 N but such systems can be tailored to enable pumping beyond atmospheric pressure (e.g., can increase the max force). The non limiting example illustrated in FIGS. 15A and 15B shows a slider actuator 1500, with a moving slide 1510, having attached a pumping arm 1560, with a hole 1550 covering bump 1520. Upon receipt of a signal1505 the actuator can move 1570 such that the bump 1520 covers the hole 1550 in a bellows 1530 pump. The actuation compresses the miniature bellows 1530 pushing 1590 gas through the one-way valve 1540, upon the back stroke the bump 1520 uncovers the hole 1550 and air rushes back into the bellows 1530 for the next pump. For example if the stroke length is 2 mm and the pump arm 1560 contact area is about 9 mm 2 then each stroke moves 18 mm 3 of volume. If an inflation system 1570 needs to be inflated more (e.g., more gas to increase sealing) then each stroke can provide an additional volume of gas of 18 mm 3 into the system increasing the inflation system 1580. If the inflation system is initially empty (e.g., needs 1000 mm 3 of gas volume to inflate) then about 56 strokes would be needed for inflation, which is about 110 mm one direction stroke length or about 2 seconds at P-653 PILine speeds. The number of oscillations and stroke length can be determined according to the signal 1505 sent, which can be specifically tailored depending

upon the electronics controlling the actuators. Note that PI-653 is an example only. Other actuation systems can be used and controlled by signal 1505.

[0120] FIG. 16 illustrates a block diagram of controlled sealing in response to a seal fail signal and/or a request for increased seal attenuation. For example, a command signal 1600 is received (e.g., a seal fail signal in which a default attenuation value is attached for example 15 dB, or a signal requesting an additional amount of attenuation) by a processor. The command signal specifies an additional amount of attenuation or that the seal has failed. An attenuation needed N is identified 1610. For example if the current attenuation is 5 dB loss at f=500 Hz, at a pressure of 0.1 bar, and a command signal is received requesting a 10 dB loss at 500 Hz, then an experimental table is queried to find the pressure needed P which is then subtracted from the current pressure to obtain an increase in pressure DP needed. The increase in pressure is converted into a volume of gas increase needed (e.g., again referring to experimental tables based upon the inflation system volume). The volume of gas increase needed can then be directly linked with the number of cycles of an actuator pump M, 1620. The number of requested cycles **M** can then be sent 1630 to the actuator control circuit to pump the designated number of cycles. The system can then retest the attenuation 1640 and if refinements are needed the process can start again.

[0121] 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. For example, if words such as "orthogonal", "perpendicular" are used the intended meaning is "substantially orthogonal" and "substantially perpendicular" respectively. Additionally although specific numbers may be quoted in the claims, it is intended that a number close to the one stated is also within the intended scope, i.e. any stated number (e.g., 90 degrees) should be interpreted to be "about" the value of the stated number (e.g., about 90 degrees).

[0122] 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.

ACOUSTIC SEALING ANALYSIS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Patent Application Ser. No. 16/838,277, filed April 2, 2020, which is a continuation of U.S. Patent Application Ser. No. 16/414,136, filed May 16, 2019, which is a continuation of U.S. Patent Application Ser. No. 15/700,511, filed September 11, 2017, which is a continuation of U.S. Patent Application Ser. No. 14/827,332, filed August 17, 2015, now U.S. Patent No. 9,781,530, which is a continuation of U.S. Patent Application Ser. No. 14/054,015, filed October 15, 2013, now U.S. Patent No. 9,113,267, which is a Divisional Application of U.S. Application Ser. No. 12/555,864, filed September 9, 2009, now U.S. Patent No. 8,600,067 and claims the benefit of U.S. Provisional Patent Application No. 61/098,250 filed September 19, 2008. The disclosure of all the aforementioned references are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to testing the seal of an orifice-inserted device, and more particularly, though not exclusively, to a device and method for determining if an earpiece is sealed correctly in an ear canal.

BACKGROUND OF THE INVENTION

[0003] It can be difficult to communicate using an earpiece or earphone device in the presence of high-level background sounds. In many earpiece designs a transducer is placed near the ear canal opening. Ambient sound from the surrounding environment enters the ear canal with the audio content from the transducer. Environmental sounds such as traffic, construction, and nearby conversations can degrade the quality of the audio content.

[0004] Although audio processing technologies can adequately suppress noise, the earpiece is generally sound agnostic and cannot differentiate sounds. Thus, one method to prevent ambient sound from entering the ear is to seal or provide an acoustic barrier at the opening of the ear canal. Sealing minimizes ambient sound leakage into the ear canal, and under the correct conditions can provide a level of noise suppression under high background noise conditions. Certain types of acoustic software (e.g., communication in a noisy environment via an ear canal microphone) may require some minimum noise isolation from the ambient

sound to provide adequate performance to the user. Additionally, user conditions may change substantially

during the operation of the earpiece, and in some circumstances, the earpiece may become misaligned or may be fit incorrectly such that it is not sealed correctly. A method of seal detection is needed to optimize performance.

SUMMARY OF THE INVENTION

[0005] Broadly stated, embodiments are directed to a device and method to determine if an earpiece is sealing within the design specification of the device.

[0006] In one embodiment, the device can include a sealing section forming an acoustic barrier between a first volume and a second volume. An ear canal receiver (ECR) can be configured to generate an acoustic signal in the first volume. An Ear Canal Microphone (ECM) in the first volume can be configured to measure the acoustic signal in the first volume. The first acoustic signal emitted by the ECR can be cross-correlated with the first acoustic signal detected with the ECM to determine if the sealing section is sealed properly.

[0007] At least one exemplary embodiment is directed to a method of detecting sealing integrity of an earpiece comprising the steps of: providing a test signal; generating an acoustic signal corresponding to the test signal incident on an ear canal side of a sealing section; converting the acoustic signal incident on a first side of the sealing section to an electrical signal; and cross- correlating the test signal to the electrical signal where the earpiece is sealed correctly when a cross-correlation between the test signal and the electrical signal is above a threshold.

[0008] At least one exemplary embodiment is directed to a method of adjusting attenuation of an earpiece comprising the steps of: relating cross-correlation of a test signal and a measured acoustic signal in an ear canal of a user to an attenuation level of a sealing section of the earpiece; comparing the attenuation level of the sealing section of the earpiece to a minimum attenuation value; and adjusting a pressure of the sealing section to meet the minimum attenuation value.

[0009] At least one exemplary embodiment is directed to a device comprising: a sealing section configured to seal a user's orifice, where the sealing section is configured to produce an acoustic seal between a first side of the sealing section and a second side of the sealing section; a transducer configured to generate a first acoustic signal incident on the first side of the sealing section; and a first microphone configured to measure a second acoustic signal incident on the second side of the sealing section, where the second acoustic signal

includes at least a portion of the first acoustic signal that has passed from the first side to the second side of the sealing section where the first acoustic signal is compared to the second acoustic signal to determine if the sealing section is sealed.

[0010] Further areas of applicability of exemplary embodiments of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Exemplary embodiments of the present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0012] FIG. 1 is a diagram of an earpiece inserted in an ear canal in accordance with an exemplary embodiment;

[0013] FIG. 2 is a block diagram of optional components of an earpiece in accordance with an exemplary embodiment;

[0014] FIG. 3 is a flowchart of a method for checking an ear seal in accordance with an exemplary embodiment;

[0015] FIG. 4 is a flowchart to determine acoustic seal integrity of an earpiece in accordance with the exemplary embodiment.

[0016] FIG. 5 is a flowchart of a method to estimate the instantaneous cross-correlation between a first and second audio signal.

[0017] FIG. 6 is a flowchart to determine when to emit a test signal in accordance with an exemplary embodiment;

[0018] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention;

[0019] FIG. 8 is a block diagram for a method of adjusting the IMS system in accordance with at least one exemplary embodiment;

[0020] FIG. 9 is a block diagram for a method of adjusting IMS pressure in accordance with at least one exemplary embodiment;

[0021] FIG. 10 illustrates a sample relationship between EarSeal attenuation and XCorr in accordance with at least one exemplary embodiment;

[0022] FIG. 11 illustrates a flowchart of an exemplary method to determine a test signal fundamental;

[0023] FIG. 12 illustrates a flowchart of an exemplary embodiment to determine tonal presence in audio content;

[0024] FIG. 13 illustrates a flowchart of a method to determine when to emit the test signal;

[0025] FIG. 14 illustrates a flowchart of an exemplary method to determine acoustic seal integrity;

[0026] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment; and

[0027] FIG. 16 illustrates the sending of a signal to an inflation controller upon detection of a seal fail to modify the seal pressure in accordance with at least one exemplary embodiment.

DETAILED DESCRIPTION

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

[0029] Exemplary embodiments are directed to or can be operatively used on various wired or wireless orifice inserted devices for example earpiece devices (e.g., earbuds, headphones, ear terminals, behind the ear devices or other acoustic devices as known by one of ordinary skill, and equivalents).

[0030] Processes, techniques, apparatus, and materials as known by one of ordinary skill in the art may not be discussed in detail but are intended to be part of the enabling description where appropriate. For example specific computer code may not be listed for achieving each of the steps discussed, however one of ordinary skill would be able, without undo experimentation, to write such code given the enabling disclosure herein. Such code is intended to fall within the scope of at least one exemplary embodiment.

[0031] Additionally exemplary embodiments are not limited to earpieces, for example some functionality can be implemented on other systems with speakers and/or microphones for example computer systems, PDAs, BlackBerry® smart phones, cell and mobile phones, and any other device that emits or measures acoustic energy. Additionally, exemplary embodiments can be used with digital and non-digital acoustic systems. Additionally various receivers and microphones can be used, for example MEMs transducers,

diaphragm transducers, for example Knowles' FG and EG series transducers.

[0032] Notice 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 or further defined in the following figures.

[0033] 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.

[0034] 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.

[0035] At least one exemplary embodiment of the invention is directed to an earpiece for sealing or partially sealing an ear. FIG. 1 is a diagram of an earpiece inserted in an ear canal 124 in accordance with at least one exemplary embodiment of the invention. FIG. 1 also illustrates portions of the ear including pinna 128, ear canal 124 and eardrum 126. As illustrated, the earpiece comprises an electronic housing unit 100 and a sealing unit 108. The earpiece depicts an electro-acoustical assembly for an in-the-ear acoustic assembly, as it would typically be placed in an ear canal 124 of a user 130. The earpiece is an in-ear earpiece, behind the ear earpiece, receiver in the ear, partial-fit device, or any other suitable earpiece type. The earpiece can partially or fully occlude the ear canal 124.

[0036] The earpiece includes an Ambient Sound Microphone (ASM) 120 to capture ambient sound, an Ear Canal Receiver (ECR) 114 to deliver audio to an ear canal124, and an Ear Canal Microphone (ECM) 106 to capture and assess a sound exposure level within the ear canal 124. The earpiece can partially or fully occlude the ear canal 124 to provide various degrees of acoustic isolation. The assembly is designed to be inserted into the user's ear canal 124, and to form an acoustic seal with the walls of the ear canal 124 at a location between the entrance to the ear canal 124 and the tympanic membrane (or ear drum) 126. In general, such a seal is typically achieved by means of a soft and compliant housing of the sealing unit 108. Additionally, the sealing unit 108 can be a pressurized expandable element that fills a portion of the available local space.

[0037] Sealing unit 108 is an acoustic barrier having a first side corresponding to ear canal124 and a second

side corresponding to the ambient environment. In at least one exemplary embodiment, sealing unit 108

includes an ear canal microphone tube 110 and an ear canal receiver tube 112. Sealing unit 108 creates a closed cavity of approximately 5 cc or less between the first side of sealing unit 108 and the tympanic membrane 126 in ear canal124. In at least one exemplary embodiment the sealing facilitates using the ECR (speaker) 114 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 126 resulting from the sound field at the entrance to the ear canal 124. This seal is also a basis for a sound isolating performance of the electro-acoustic assembly.

[0038] In at least one exemplary embodiment and in broader context, the second side of sealing unit 108 corresponds to the side adjacent to electronic housing unit 100. Ambient sound microphone 120 is housed in electronic housing unit 100 and is exposed to the ambient environment for receiving sound from the ambient environment around the user.

[0039] The electronic housing unit 100 can include various system components such as a microprocessor 116, memory 104, battery 102, ECM 106, ASM 120, ECR, 114, and user interface 122, or these components can reside in a separate system or interface operatively connected. Microprocessor 116 (or processor 116) can be a logic circuit, a digital signal processor, controller, or the like for performing calculations and operations for the earpiece. Microprocessor 116 is operatively coupled to memory 104, ECM 106, ASM 120, ECR 114, and user interface 122. An optional wire 118 can provide an external connection to the earpiece. Battery 102 powers the circuits and transducers of the earpiece. Battery 102 can be a rechargeable or replaceable battery.

[0040] In at least one exemplary embodiment, electronic housing unit 100 is adjacent to sealing unit 108. Openings in electronic housing unit 100 receive ECM tube 110 and ECR tube 112 to respectively couple to ECM 106 and ECR 114. ECR tube 112 and ECM tube 110 acoustically couple signals to and from ear canal 124. For example, ECR 114 outputs an acoustic signal through ECR tube 112 and into ear canal 124 where it is received by the tympanic membrane 126 of the user of the earpiece. Conversely, ECM 106 receives an acoustic signal present in ear canal124 though ECM tube 110.

[0041] One function of ECM 106 is that of measuring the sound pressure level in the ear canal cavity 124 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 the earpiece. In one arrangement, ASM 120 is used to monitor sound pressure at the entrance to the occluded or partially occluded ear canal 124. All transducers shown can receive or transmit

audio signals to a processor 116 that undertakes audio signal processing and provides a transceiver for audio

via the wired (wire 118) or a wireless communication path. Note also that the acoustic signals can be stored for later retrieval.

[0042] In at least one exemplary embodiment the earpiece can be constructed to actively monitor a sound pressure level both inside and outside an ear canal 124. In at least one exemplary embodiment monitored data can be used to enhance spatial and timbral sound quality while maintaining supervision to ensure safe sound reproduction levels. In at least one exemplary embodiment an earpiece can facilitate at least one of conducting listening tests, filtering sounds in the environment, monitoring warning sounds in the environment, presenting notification based on identified warning sounds, maintaining constant audio content to ambient sound levels, and filtering sound in accordance with a Personalized Hearing Level (PHL).

[0043] The earpiece can generate an Ear Canal Transfer Function (ECTF) to model the ear canal 124 using ECR 114 and ECM 106, as well as an Outer Ear Canal Transfer function (OETF) using ASM 120. For instance, the ECR 114 can deliver an impulse within the ear canal124 and generate the ECTF via cross correlation of the impulse with the impulse response of the ear canal 124. The earpiece can also determine a sealing profile with the user's ear to compensate for any leakage. In at least one exemplary embodiment the earpiece can use either the ASM 120 or the ECM 106 to monitor the sound pressure level, which can then be used in a Sound Pressure Level Dosimeter calculation, to estimate sound exposure and recovery times. This permits the earpiece to safely administer and monitor sound exposure to the ear.

[0044] Referring to FIG. 2, a block diagram of an earpiece 201 in accordance with an exemplary embodiment is shown. A power supply 205 (e.g., USB power connection, hearing aid battery (batteries)) powers components of the earpiece 201 including microprocessor 206 (or processor 206, e.g., Texas Instruments TMS320C6713) and a data communication system 216 (e.g., RF or Bluetooth communication chip). As illustrated, the earpiece 201 includes the processor 206 operatively coupled to data communication system 216, ASM 210, ECR 212, and ECM 208. Data communication system 216 may include one or more Analog to Digital Converters and Digital to Analog Converters (DAC). The processor 206 can utilize computing technologies such as a microprocessor, Application Specific Integrated Chip (ASIC), and/or digital signal processor (DSP) with associated Random Access Memory (RAM) 202 and Read Only Memory (ROM) 204. Other memory types such as Flash, non-volatile memory, SRAM, DRAM or other like technologies can be used for storage with processor 206. The processor 206 can also include a clock to record a time stamp.

[0045] In general, data communication system 216 is a communication pathway to components of the earpiece 201 and components external to the earpiece 201. The communication link can be wired or

wireless. In at least one exemplary embodiment, data communication system 216 is configured to communicate with ECM 208, ASM 210, visual display 218, and user control interface 214 of the earpiece 201. As shown, user control interface 214 can be wired or wirelessly connected. In at least one exemplary embodiment, data communication system 216 is capable of communication to devices exterior to the earpiece 201 such as the user's mobile phone 234, a second earpiece 222, and a portable media player 228. Portable media player 228 can be controlled by a manual user control 230.

[0046] The user's mobile phone 234 includes a mobile phone communication system 224. A microprocessor 226 is operatively coupled to mobile phone communication system 224. As illustrated multiple devices can be wirelessly connected to one another such as an earpiece 220 worn by another person to the user's mobile phone. Similarly, the user's mobile phone 234 can be connected to the data communication system 216 of the earpiece 201 as well as the second earpiece 222. This connection would allow one or more people to listen and respond to a call on the user's mobile phone 234 through their respective earpieces.

[0047] As illustrated, a data communication system 216 can include a voice operated control (VOX) module to provide voice control to one or more subsystems, such as a voice recognition system, a voice dictation system, a voice recorder, or any other voice related processor. The VOX module can also serve as a switch to indicate to the subsystem a presence of spoken voice and a voice activity level of the spoken voice. The VOX can be a hardware component implemented by discrete or analog electronic components or a software component. In one arrangement, the processor 206 can provide functionality of the VOX by way of software, such as program code, assembly language, or machine language.

[0048] The RAM 202 stores program instructions for execution on the processor 206 as well as captured audio processing data. For instance, memory RAM 202 and ROM 204 can be off-chip and external to the processor 206 and include a data buffer to temporarily capture the ambient sound and the internal sound, and a storage memory to save from the data buffer the recent portion of the history in a compressed format responsive to a directive by the processor. In at least one exemplary embodiment, the data buffer can be a circular buffer that temporarily stores audio sound at a current time point to a previous time point. It should also be noted that the data buffer is operatively connected with processor 206 to provide high speed data access. The storage memory can be non-volatile memory such as SRAM to store captured or compressed audio data.

[0049] Data communication system 216 includes an audio interface operatively coupled to the processor

206 and the VOX to receive audio content, for example from portable media player 228, a cell phone, or

any other communication device, and deliver the audio content to the processor 206. The processor 206 responsive to detecting voice-operated events from the VOX can adjust the audio content delivered to the ear canal of the user of the earpiece. For instance, the processor 206 (or the VOX of data communication system 216) can lower a volume of the audio content responsive to detecting an event for transmitting the acute sound to the ear canal of the user. The processor 206 by way of the ECM 208 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 based on voice operating decisions made by the VOX of data communication system 216.

[0050] The earpiece 201 and data communication system 216 can further include a transceiver that can support singly or in combination any number of wireless access technologies including without limitation Bluetooth™, Wireless Fidelity (WiFi), Worldwide Interoperability for Microwave Access (WiMAX), and/or other short or long range communication protocols. The transceiver can also provide support for dynamic downloading over-the-air to the earpiece 201. It should be noted also that next generation access technologies can also be used in exemplary embodiments.

[0051] Data communication system 216 can also include a location receiver that utilizes common technology such as a common GPS (Global Positioning System) receiver that can intercept satellite signals and therefrom determine a location fix of the earpiece 201.

[0052] The power supply 205 utilizes common power management technologies such as replaceable batteries, supply regulation technologies, and charging system technologies for supplying energy to the components of the earpiece 201 and to facilitate portable applications. A motor (not shown) can be a single supply motor driver coupled to the power supply 205 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.

[0053] Microprocessor 206 is operatively connected with an EarSeal Inflation Management System 232 to control the degree to which the sealing unit 108 is inflated or deflated. In one exemplary embodiment, sealing unit 108 comprises an expandable element (e.g., inflatable balloon mechanism), whereby a cavity can be filled with air or a liquid to change the degree of acoustic isolation between the internal ear canal space 124 and the ambient environment. Alternately, a passive system for sealing ear canal 124 is used such as a flexible rubber or a silicon sealing unit or a foam plug. In one exemplary embodiment, the passive

system is a balloon mechanism that is filled with air or liquid. The balloon mechanism conforms to the

shape and size of an ear canal and includes a restorative force module that applies a pressure to the balloon mechanism for sealing the ear canal cavity.

[0054] The earpiece is 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 are reused in different form factors for the master and slave devices.

[0055] Referring to FIG. 3, a flowchart illustrates a method for an acoustic sealing analysis system in accordance with an exemplary embodiment. In general, a first volume is acoustically isolated from a second volume. The test determines if the two volumes have sufficient acoustic isolation from one another. For example, cars are designed to have a quiet interior. Users of an automobile do not want to be subjected to the noise of the external environment. Thus, a car interior (first volume) is acoustically isolated from the external environment outside of the automobile. Similarly, an earpiece having a sealing unit such as described in FIG. 1 will create a first volume (the ear canal) that is acoustically isolated from the ambient environment of the user (second volume). In either example, the acoustic sealing analysis system determines if there is sufficient acoustic isolation for the application. In the earpiece example, random or periodic testing of the seal may be beneficial because a new seal is formed in the ear canal when the device is put in the ear or it may shift over time depending on user activity.

[0056] The method begins at step 302. A test signal is acquired in a step 304. For example, the test signal can be stored in memory or generated by a microprocessor. The test signal is provided to the acoustic transducer. The acoustic transducer or loudspeaker (such as an ECR) emits an acoustic signal corresponding to the test signal within the first volume in a step 306. The acoustic field in the first volume is detected by an Ear Canal Microphone (ECM) in a step 308. The acoustic loading on both the ECR and ECM will change depending on the degree of acoustic sealing, thereby affecting the degree magnitude of the radiated ECR signal detected by the ECM. In general, as the degree of ear seal decreases, the effect of lumped air mass coupled to the ECR and ECM will decrease thereby increasing in Thevenin capacitance, which effectively reduces the transfer of low frequency emitted sound from the ECR to the ECM.

[0057] In one exemplary embodiment, the test signal and the acoustic signal emitted by the loudspeaker into the first volume is a single frequency sine wave signal for testing leakage from one volume to another.

[0058] The degree of sealing between the first and second acoustic volumes is determined in a step 310 and

the process ends at step 312. The cross-correlation between the emitted test signal and detected ECM signal is taken. In at least one exemplary embodiment, the test signal and the measured acoustic signal emitted by the loudspeaker are conditioned using a time delay and frequency dependent filter. The ear-seal is determined to be low (or "leaky") if the cross- correlated signals are below a predetermined value. In at least one exemplary embodiment, automatic adjustments to the sealing section are made (such as deflating and re-inflating the sealing balloon to reseal the sealing section including retesting). Alternately, an audible sound, vocal response, or visual response can be provided to let the user know that the earpiece is sealed correctly or incorrectly.

[0059] Referring to FIG. 1, the earpiece is used as an example to illustrate a test sequence as disclosed in FIG. 3. Sealing unit 108 occludes an opening of ear canal 124 creating a first volume (ear canal124) and a second volume (the ambient environment). Sealing unit 108 has a first side exposed to ear canal 124 and a second side is exposed to or corresponds to the ambient environment external to the ear.

[0060] In at least one exemplary embodiment, processor 116 is configured to receive a test signal in memory 104. Processor 116 generates the test signal and provides the test signal to Ear Canal Receiver 114 (ECR 114). ECR 114 emits the test signal into Ear Canal Receiver Tube (ECR Tube 112). The test signal propagates through ECR tube 112 and into ear canal 124. Ear Canal Microphone tube 110 (ECM tube 110) is configured to receive an acoustic signal incident on the first side of sealing unit 108. The test signal in ear canal 124 propagates through ECM tube 110 and is received by Ear Canal Microphone 106 (ECM 106). ECM 106 is configured to measure the test signal in ear canal124 and provide the measured test signal to processor 116.

[0061] As shown, electronic housing unit 100 of the earpiece is adjacent to the second side of sealing unit 108. Electronic housing unit 100 is exposed to the ambient environment and for purposes of acoustic sealing analysis is considered the second side of sealing unit 108. Electronic housing unit 100 includes Ambient Sound Microphone 120 (ASM 120), which is configured to measure sounds in the ambient environment. Thus, ASM 120 receives and measures an ambient signal corresponding to a signal incident on the second side of sealing unit 108. ASM 120 provides the measured ambient signal to processor 116.

[0062] Ideally, sealing unit 108 is an acoustic barrier preventing the test signal or very little of the test signal from getting past sealing unit 108 and into the ambient environment. Conversely, sealing unit 108 if improperly sealed will pass some of the test signal. Processor 116 compares the test signal to the signal

provided by ECM 106 corresponding to the acoustic signal in ear canal124. In particular, processor 116

undertakes the cross-correlation between emitted test signal and the ECM signal.

[0063] Referring to FIG. 4, a flowchart of an exemplary method to determine the acoustic seal integrity of an earpiece in accordance with an exemplary embodiment is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user. This allows unobtrusive (periodic or non-periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0064] In at least one exemplary embodiment, an audio content is provided in a step 402. A step 404 stores the test signal in a test signal data buffer. For example, a single frequency sine wave is stored in the test signal data buffer. The output (or alternatively--input) of the test signal data buffer is optionally delayed by digital delay unit 406. The function of delay unit 406 is to time- align the emitted test signal with the ECM signal so the cross-correlation is sensitive to changes in ear seal.

[0065] A step 408 stores the test ECM signal in a test signal data buffer. The output (or alternatively--input) of the ECM signal buffer can be filtered with a low-pass filter 410. The low pass filter can be configured so that the pass-band covers the frequency of the test signal. In one exemplary configuration, the low-pass filter can be a cascaded bi-quad IIR type filter with the cut-off frequency equal to 10Hz greater than the test signal frequency.

[0066] A step 412 cross-correlates the optionally delayed test signal buffer with the low-pass filtered ECM signal buffer. An exemplary method for the cross-correlation algorithm is described in FIG. 5. The instantaneous cross-correlation (i.e. the cross-correlation at zero-lag) value from step 412 is compared with the cross-correlation threshold value 414 using comparator unit 416. If the instantaneous cross-correlation of the two signal buffers is less than the threshold value 414, then the seal test status is set to FAIL 418 (i.e. an ear-seal leak is detected); otherwise, if the cross-correlation is suitably high, the seal test status is set to PASS 420.

[0067] Referring to FIG. 5, a flowchart of an exemplary embodiment to determine the instantaneous cross-correlation between a first audio signal and a second audio signal is illustrated. The process begins at step 500. In at least one exemplary embodiment, the first audio signal is the test signal (i.e. a sine wave) and the second signal is the low-pass-filtered ECM signal.

[0068] The correlation between two signals x and y at time k using an exponential window is defined as:

[0069] $$p(k) = \frac{S_{xy}(k)}{\sqrt{S_{xx}(k)_{yy}(k)}} \quad (1)$$

[0070] Where

[0071] $$S_{xy}(k) = \sum_{l=0}^{\infty} ce^{-\eta^l} x_{k-l} y_{k-l} \quad (2)$$

$$c = 1 - e^{-\eta}$$

[0072] And S_{xx} and S_{yy} are defined similarly as in (2) (replacing y with x for S_{xx} etc.).

[0073] It can be shown (see Aarts et al, 2001) that (1) can be approximated with the recursion:

[0074] $$\hat{\rho}(k) = \hat{\rho}(k-1) + \gamma[\partial_k - \beta_k \hat{\rho}(k-1)] \quad (3)$$

$$\partial_k = 2x_k y_k$$

$$\beta_k = \alpha x_k^2 \alpha^{-1} y_k^2$$

[0075] Where

$$\alpha = \frac{y_{RMS}}{x_{RMS}} \quad (4)$$

$$\gamma = \frac{ce^{\eta}}{2x_{RMS} y_{RMS}}$$

[0077] The cross-correlation estimate using the above recursion is modified for block-wise processing rather than the sample-by-sample basis. This modification replaces the sample values (i.e. x(k) and y(k)) with values for the N-length block mean, i.e.

[0078]

$$x(k) = \frac{1}{N} \sum_{l=0}^{N-1} x(k-l)$$

[0079] Furthermore, the numerator for y is replaced with a small constant and so is α (replacing α with a constant effectively un-normalizes the correlation estimate). It is found that the modified un-normalized

block-wise cross-correlation accurately estimates the cross-correlation compared with using the standard cross-correlation for two signals.

[0080] The modified block-wise fast cross-correlation algorithm, as summarized in FIG. 5, comprises the following steps:

1. A first signal buffer 502 is accumulated. This signal buffer corresponds to the emitted test signal (i.e. the sine wave).
2. The RMS level of the first buffer is calculated 504 (x_{RMS})
3. The mean level of the first buffer is calculated 506.
4. A second signal buffer 508 is accumulated. This signal buffer corresponds to the filtered ECM signal.
5. The RMS level of the second buffer is calculated 510 (y_{RMS}).
6. The mean level of the second buffer is calculated 512.
7. In step 514, γ (gamma) is approximated as:

$$\gamma = \frac{\Gamma}{2x_{RMS}y_{RMS}}$$

Where Γ is a small constant, e.g. 10E-3.

8. In step 516,∂_k (delta) calculated as twice the product of the first signal buffer mean and the second signal buffer mean.
9. In step 518, beta is calculated as the sum of the square of the mean value of the first buffer with the sum of the square of the mean value of the second buffer.
10. In step 520, the new temporary estimate of the correlation newRho_temp is calculated as: newRho_temp=(delta-beta*rho_old))
11. In step 522, the new estimate of the correlation newRho is updated by summing the previous estimate of the correlation with the product of gamma and the temporary estimate of the correlation newRho_temp.
12. In step 524, the "old" value of the correlation is set to the newest correlation estimate, ready for the next iteration of the update algorithm.
13. In step 526, the current correlation estimate between the emitted test signal and the received and filtered ECM signal is set as equal to the value of newRho.

[0081] Referring to FIG. 6, a flowchart of a method to determine when to emit the test signal is shown. The test signal is emitted when the test can be performed unobtrusively to the user and also provides an accurate test. In at least one exemplary embodiment, a test event to determine if an earpiece is sealed correctly is

initiated via a timing methodology. In a first timing scenario, the test event occurs after a delay of a first predetermined time period when the RMS of the Audio Content (AC) is less than a RMS threshold. In a

second timing scenario, the delay of the first predetermined time period is allowed to lapse without the test event occurring when the RMS of the audio content is greater than the RMS threshold. A second predetermined time period is started where the test event occurs when the RMS of the audio content is less than the RMS threshold. The test event is then initiated when the second predetermined time period is exceeded independent of the RMS of the audio content.

[0082] A test sequence is initiated in a step 602. The previous seal test event resets the first digital timer in a step 604. A time delay is generated by the loop comprising steps 606 and 608. The first digital timer is time incremented in the step 606. After each added time increment, the first digital timer is compared against a digital_timer_threshold1. The first digital timer is time incremented (after the time has advanced another increment) after the comparison in the step 608 if the first digital timer is less than the digital_timer_threshold1.

[0083] A second digital timer is reset in a step 610 when the first digital timer is greater than the digital_timer_threshold1. The second digital timer is time incremented in a step 612. Audio content (AC) from a signal buffer is retrieved in a step 614. The audio content can be filtered through a low pass filter in an optional step 616. The RMS of the audio content is calculated in a step 618. The calculated RMS of the audio content is compared against an RMS_threshold 622 in a step 620. The second digital timer is compared against a digital_timer_threshold2 in a step 624 if the RMS of the audio content is greater than the RMS_threshold. The second digital timer is time incremented (after the time has advanced another increment) when the second digital timer is less than digital_timer_threshold2 in the step of 624.

[0084] The audio content signal is mixed with the test signal when the RMS of the audio content is less than the RMS_threshold in a step 626. Also, the audio content signal is mixed with the test signal when the second digital timer is greater than digital_timer_threshold2 in the step 624. The modified audio signal (having the test signal mixed in) is emitted by the ECR in a step 628 for testing the sealing section of the earpiece. The first digital timer is then reset in the step 604 to begin a timing sequence for another sealing section test.

[0085] FIG. 7 is a graph illustrating different seal measurements in accordance with the present invention. The estimated un-normalized cross-correlation between the ECM signal and the test signal (i.e. sine wave) is shown for different sine wave frequencies from 30-80Hz. Three different curves are provided corresponding

to a good fit (i.e. a tight optimal seal providing approximately 20-30 dB of acoustic attenuation), mid or partial seal (i.e. an ear-seal that could be characterized as "half in" providing approximately 10-15 dB of

acoustic attenuation), and a poor seal (i.e. an ear-seal providing less than 10 dB of acoustic attenuation). At lower test frequencies, the change in correlation is more pronounced as the degree of ear seal fitting is changed from "good" to "mid" and "poor". From the data, the threshold used to determine whether the ear seal can be characterized as "good" is approximately -20 dB, (i.e. 0.85 of FIG. 10 which corresponds to the value for XCorr_threshold 414 in FIG. 4).

[0086] In at least one exemplary embodiment, the test signal for testing a seal of a sealing section is less than 200 hertz. The frequency of the emitted test signal is chosen to satisfy the requirements of being able to reveal small degradations in ear seal quality. It is also beneficial if the selected test signal frequency can be acoustically masked by reproduced audio to minimize detection of the test by an earpiece user. Both of these criteria are met using a test signal frequency below 200 Hz. The sensitivity is highest from the measured data at frequencies below 50 Hz. Conversely, as the test signal frequency increases the cross-correlation difference between a "good" and "bad" acoustic seal decreases. For example, with a 40Hz test tone, the cross-correlation for a "good" ear seal is -8 dB, and for a bad ear seal it is -68 dB (i.e. a 60 dB difference). At a test signal frequency of 80Hz, the cross-correlation for a "good" ear seal is -8 dB and for a bad ear seal it is -38 dB (i.e. a 30 dB difference). Thus, above 200Hz the cross- correlation difference between a "good" and "bad" acoustic seal is further reduced thereby reducing the sensitivity of the test.

[0087] Using the cross-correlation rather than a level differencing approach improves the accuracy and minimizes errors which occur due to user non-speech body noise, such as teeth chatter; sneezes, coughs, etc. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0088] FIG. 8 is a flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) in accordance with an exemplary embodiment. The IMS is adjusted depending on the degree of acoustic sealing provided by an earpiece. The method begins at step 802. The acoustic sealing is measured as disclosed in FIG. 7 and the result provided in a step 804 to determine the cross-correlation (XCorr) between a test signal and corresponding ECM signal. In general, the higher the cross-correlation, the higher the degree of acoustic sealing. An exemplary graph showing the relationship between XCorr and acoustic sealing is given in FIG. 10. The degree of acoustic sealing is determined from known XCorr using a look-up (or "hash") table or using a formula (e.g. of a polynomial form) that maps the acoustic sealing to the known XCorr value. The ambient sound level is measured in a step 806. The ambient sound level corresponds to

the noise level in proximity to the user. In general, a higher degree of attenuation is desired when the ambient sound levels are high. Conversely, at low ambient sound levels the attenuation level of the IMS

may be less of an issue and comfort more of a factor. The IMS is adjusted in a step 808 to meet the attenuation needs. In general, inflating the IMS increases attenuation while deflating the IMS decreases attenuation. The method terminates at step 810.

[0089] Referring to FIG. 9, a more detailed flowchart to adjust the degree of acoustic sealing of an Inflation Management System (IMS) is shown. In general, the attenuation increases when the pressure in the IMS is raised thereby allowing a degree of control to make adjustments. For example, an adjustment is made to increase attenuation when the background noise level rises or a seal check produces a failed result. Adjustments are made until the seal check passes. The pressure level adjustments of the IMS will fall within a comfort range of a user (e.g., between 0.1 bar and 0.3 bar gauge pressure). Typically, the pressure level is set at a minimum level to achieve a predetermined attenuation level.

[0090] The method begins at step 902. The degree of acoustic sealing is determined from cross-correlation between the ECM signal and the generated test signal. The XCorr value is provided in a step 904. In step 906, the attenuation provided by the IMS is calculated (equation) or looked up (table) from data such as that shown in FIG. 10. In one exemplary embodiment, the desired attenuation value is dependant on the ambient sound level of the user. In another exemplary embodiment, the desired attenuation value is dependant on the ear-canal sound level of the user. In yet another exemplary embodiment, the desired attenuation value is dependant on the level of audio content (e.g. speech or music audio) reproduced with the earphone device. In all of the above examples, the desired attenuation value is determined by one or more of the embodiments in a step 907.

[0091] The difference between the degree of acoustic sealing determined in step 906 and the desired attenuation value determined in step 907 is calculated in step 908. The difference value in step 908 is used to determine the change in pressure of the IMS necessary to minimize the difference value in a step 910. In at least one exemplary embodiment, the difference value of the attenuation is converted into a corresponding pressure value change (e.g. in milli-Bars) using a similar look-up table or equation method as described previously. The pressure change in the IMS is then affected with step 912 to meet the desired attenuation level. For example if the desired attenuation is a decrease of 10 dB in sound across the earpiece in the ear canal, then a pressure of a variable volume inflatable system can have a gauge pressure of about 0.15 bar. If the desired attenuation is a decrease of 20 dB across the earpiece in the ear canal then the gauge pressure can be increased to about 0.25 bar, where an increased pressure is associated with an increase in attenuation. An

experimental table for each earpiece can be generated in a standard devised experimental setup (e.g. impedance tunnel) and referred to when changes are needed. The method ends at step 914.

[0092] Referring to FIG. 11, a flowchart of an exemplary method to determine a test signal fundamental is illustrated. In at least one embodiment of an acoustic sealing analysis system, the test signal is masked or used in a manner undetectable by the user or made pleasant such that the user is unaware that the test signal is being played. This allows unobtrusive (periodic or non- periodic) testing to determine if a device is sealed correctly ensuring optimum system performance and more importantly user safety.

[0093] In at least one exemplary embodiment, an audio content 1102 is provided. A step 1104 stores audio content 1102 in a data buffer. In this example, audio content 1102 is music played from a media player and received via a wired or wireless connection to at least one earpiece in the user's ear. An alternate example would be that audio content 1102 is a speech audio signal from a portable telephone device or the like.

[0094] A step 1106 determines if the buffer of audio content 1102 comprises a strong tonal signal component. Mixing the test signal having a similar fundamental frequency as audio content 1102 will mask the test signal when played to the user. Thus, the test signal is musically in harmony with the reproduced music and results in very little perceptual degradation in sound quality.

[0095] A step 1108 determines whether to update or generate the first fundamental tone for the test signal. The test signal is not updated or generated if buffered audio content 402 does not contain a strong tonal signal component. A return to step 1104 fills the buffer with the next audio content 402 for analysis.

[0096] A step 1110 analyzes the buffer of data of audio content 1102 when it has been determined that it contains a strong tonal signal component. Step 1110 determines the fundamental frequency of the tonal signal. The fundamental tone, often referred to as the fundamental and abbreviate f_0 is the lowest frequency in a harmonic series. The fundamental frequency (also called a natural frequency) of a periodic signal is the inverse of the pitch period length. The pitch period is the smallest repeating unit of a signal. The fundamental frequency of the tonal signal can be calculated using an autocorrelation analysis.

[0097] In one exemplary embodiment, a mathematical operation 1114 is performed where the frequency component of the test signal is limited to a frequency range below a lower minimum and upper maximum frequency range. Fund_ratio is calculated, which is defined as a ratio of the determined fundamental frequency (F_fund) of the tonal signal from step 1110 to an upper threshold value F_fund_threshold 1112, which in one exemplary embodiment, is a fixed constant equal to approximately 100Hz. In general,

F_fund_threshold 1112 is chosen to be a low frequency value which is above the lowest (or -3 dB) frequency that a transducer can reproduce, but below a predetermined frequency. In a comparison step 1116,

if the estimated F-fund is higher than the F_fund_threshold 1112 (ratio > 1), then F_fund is reduced by an integer multiple to be below F_fund_threshold 1112 corresponding to the mathematical operation of step 1118. Otherwise, the test signal fundamental is equal to F_fund as shown in step 1120. Although not shown, the calculated test signal fundamental is compared and determined to be greater than a predetermined threshold.

[0098] Referring to FIG. 1, in at least one exemplary embodiment, processor 116 is configured to receive or generate audio content. As mentioned previously, the audio content can from external devices such as a portable phone or a media player. Memory 104 can be used as a buffer for the audio content. Processor 116 is configured to receive the buffer of audio content from memory 104. The steps and calculations of the block diagram of FIG. 4 are then performed by processor 116. The result being one of the identification of a strong tonal signal component in the buffer of audio content and the test signal fundamental or loading the buffer with new audio content and starting the process again.

[0099] Referring to FIG. 12, a flowchart of an exemplary embodiment to determine tonal presence in audio content is shown. In particular, the exemplary embodiment relates to step 1106 of FIG. 11 that analyzes audio content stored in a buffer. The method begins at step 1202. A step 1204 gets the audio content stored in an audio signal buffer hereinafter called the audio signal. A filter step 1206 filters the audio signal to a frequency range of interest that relates to a sealing test frequency. For example, a band pass filter in the range of 20Hz to 500Hz could be used to filter the audio signal where the test signal is in the lower audio frequency range. An auto-correlation step 1208 analyzes the audio signal where a strong tonal signal component is represented by peaks in the analysis results. A step 1210 generates Absolute(Acorr) which is a number representing the absolute magnitude of the peaks from the analysis. For example, Absolute(Acorr) can be the square of the results from the auto-correlation.

[0100] A crest_factor_Acorr 1218 is generated from the results by calculating an RMS value 1214 (or time-averaged peak value) and peak value 1216 (or time averaged peak value). In at least one exemplary embodiment, the crest_factor_Acorr 1218 is the ratio of the peak value to the RMS value of an absolute auto-correlation sequence of the audio signal.

[0101] A comparison step 1222 is then performed. A strong tonal presence is identified when crest_factor_Acorr 1218 is greater than a threshold Crest_factor_Acorr_threshold 1220. Identification of the strong tonal presence indicates the audio signal would facilitate masking of the test signal to determine sealing of the device (step 1226). The audio signal is not used in conjunction with the test signal if

crest_factor_Acorr 1218 is less than Crest_factor_Acorr_threshold 1220 (step 1224). The process would begin again loading a next sequence of the audio signal into the buffer for review.

[0102] Referring to FIG. 1, as mentioned previously, audio content is stored in a buffer, for example memory 104. The audio content in the buffer is provided to processor 116. In at least one exemplary embodiment, processor 116, runs the analysis as described in the block diagram of FIG. 12 thereby determining if a strong tonal presence is found in the audio content in the buffer. New audio content is loaded into the buffer (memory 104) if a strong tonal presence is not found beginning the procedure again.

[0103] Referring to FIG. 13, a flowchart of a method to determine when to emit the test signal is shown. The method begins at step 1302. The test signal is emitted when the test can be performed unobtrusively to the user and also provide an accurate test. In a step 1304, an audio signal is retrieved from a buffer. In at least one exemplary embodiment, the audio signal is received from an ECM or an ASM. The audio signal is measured to determine when the sound level is low in the ear canal, the ambient environment, or both. In general, the test signal is emitted when the sound level is low.

[0104] A filter step 1306 band pass filters the audio signal. In one exemplary embodiment, filter step 1306 filters the audio signal from 50 Hz to 150Hz which corresponds to a frequency range of the test signal. In a step 1308, the RMS of the audio signal is calculated. The audio signal is analyzed to detect when the energy within an audio frequency range is below a threshold RMS_threshold 1310. The RMS of the audio signal is the signal level in the volume being measured. A comparison step 1312 compares the measured RMS level of the filtered audio signal against RMS_threshold 1310. In a step 1314, a test signal is emitted when the measured RMS value is less than RMS_threshold 1310. No test signal is emitted when the RMS of the audio signal is greater than RMS_threshold 1310. The method ends at step 1316.

[0105] Referring to FIG. 14, a flowchart of an exemplary method to determine acoustic seal integrity is illustrated. For example, an earpiece seal integrity corresponds to a full or partial acoustic barrier between a first volume (ear canal) and a second volume (ambient environment). In one exemplary embodiment, the degree of acoustic seal integrity is expressed as either a PASS or FAIL status, where FAIL indicates that the acoustic seal is compromised relative to a normal operating acoustic seal. For example, an earpiece that has performed the seal test and determined that the sealing unit is not sealed correctly in the ear canal of the user can provide a signal or message indicating the problem. The user can then remove, reinsert, and retest the

earpiece to ensure that the seal is within normal operating specifications.

[0106] The method begins at step 1402. An acoustic test signal is provided in a first volume. In a step 1404 a transducer measures the acoustic test signal and stores it in a signal buffer. In a step 1406, a second transducer in a second volume isolated from the first volume by an acoustic barrier measures a second acoustic signal in the second volume. A portion of the acoustic test signal passes the acoustic barrier into the second volume. The amount of the acoustic test signal passing the acoustic barrier is a measure of the seal provided by the acoustic barrier.

[0107] In a filter step 1408, the measured acoustic test signal in the first volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals that are not part of the test. The measured signal from the first volume is heretofore called the first volume signal. Similarly, in a step 1410, the measured signal in the second volume is filtered in a frequency range corresponding to the acoustic test signal to remove signals not related to the test (outside the frequency range) in the second volume. The measured signal from the second volume is heretofore called the second volume signal.

[0108] A correlation, cross-correlation, or coherence analysis is performed on the first volume signal and the second volume signal. The correlation, cross-correlation, or coherence analysis is a measure of the similarity of the signals in the first and second volumes. In particular, the non- difference analysis measures the acoustic test signal leaking past the acoustic barrier by identifying the portion of the second volume signal that is similar to the acoustic test signal in the first volume.

[0109] In at least one exemplary embodiment, a correlation step 1412 is performed comprising a cross-correlation of the first volume signal and the second volume signal. In a step 1414, the peak of the cross-correlation is identified. The peak of the cross-correlation is Absolute(XCorr). In a mathematical step 1418, the Lag-time of Peak 1420 and the Magnitude of Peak 1422 is calculated. The Lag-time of Peak 1420 is a measure of the time delay between receiving the signals in the first and second volumes. In particular, the first volume signal should be received before the second volume signal. The Magnitude of Peak 1422 corresponds to the similarity between the signals in the first and second volumes. Thus, a larger number for Magnitude of Peak relates to more leakage of the acoustic test signal getting past the acoustic barrier.

[0110] Two comparisons are performed that determine if the acoustic barrier is sealed correctly based on the measured and calculated data from the first and second volumes. In a comparison step 1426, the measured Lag-time of Peak is compared against Target Lag Limits 1424. The measured lag-time should fall within the

predetermined range (Target Lag Limits 1424) for the seal test to be valid. If the Lag-time of Peak is within the appropriate range then a logic 1 is provided to AND function 1432, otherwise a logic 0 is provided. In a

second comparison step 1428, the Magnitude of Peak is compared against a Peak_threshold 1430. If the Magnitude of Peak is greater than the Peak_threshold 1430 a logic 1 is provided to AND function 1432. This indicates that a significant portion of the acoustic test signal is present in the second volume measurement, otherwise a logic 0 is provided. A FAIL output 1434 corresponds to a logic 1 at the output of AND function 1432. The FAIL occurs when the Lag-time of Peak is within the predetermined range and the Magnitude of Peak is greater than the Peak_threshold indicating that the acoustic barrier is sealed improperly. All other conditions indicate a PASS output 1434 and the acoustic barrier is sealed correctly.

[0111] In at least one exemplary embodiment and referring briefly to FIG. 1, an earpiece is tested to determine if sealing unit 108 is sealed correctly to the ear canal of the user. Sealing unit 108 creates a first volume in ear canal 124 and a second volume outside the ear canal 124 in the ambient environment. A masking approach is used to perform seal testing unobtrusively to the user. The user is listening to music or speech (audio content) provided to ear canal124 from ECR 114.

[0112] The music or speech is buffered in memory 104 or memory in processor 116. Processor 116 analyzes the audio content in the buffer to identify a strong tonal content. A test signal can be created once audio content with strong tonal content is found. The test signal will have at least one fundamental pitch corresponding to the strong tonal content and optionally further harmonics. Processor 116 also analyzes the measured signals from ECM 106 and ASM 120 to determine when to emit the test signal. Processor 116 monitors and compares the sound level in the ambient environment and ear canal124. Processor 116 will provide the generated test signal to ECR 114 during an optimum time for test accuracy such as when the ambient sound level is low, the ear canal sound level is low, or both. Also, processor 116 will not output the test signal if there is audio content similar to the test signal in the ear canal or ambient environment.

[0113] Processor 116 monitors the test conditions and then provides the test signal to ECR 114 when an accurate sealing test can be performed. ECR 114 outputs an acoustic test signal which may or may not have other audio content. ECM 106 and ASM 120 respectively measure acoustic signals in ear canal 124 and the ambient environment. Processor 116 is operatively coupled to ECM 106 and ASM 120. The measured signals are buffered in memory 104.

[0114] In an exemplary embodiment, a cross-correlation is used to measure the similarity between the

signals in ear canal124 and the ambient environment. Processor 116 performs the cross-correlation calculations using the measured acoustic signals from ECM 106 and ASM 120. In particular, the cross-

correlation is used to identify and compare the acoustic test signal present in the two volumes separated by the acoustic barrier. A cross-correlation between ASM and ECM signals is defined according to the following equation (5):

$$XCorr(n,l) = \sum_{n=0}^{N} ASM(n)ECM(n-l), \quad (5)$$

Where: l=0, 1, 2, … N

[0115] Where ASM(n) is the nth sample of the ASM signal, and ECM(n- l) is the (n- l)th sample of the ECM signal. A peak of the absolute cross-correlation is estimated using a peak- picking function and also the lag time at which this peak occurs (i.e. the index I at which this occurs). Thus, the Lag-time of Peak and the Magnitude of Peak are known and respectively compared against a Target Lag Limit range and a Peak Threshold. The user of the earpiece is notified or warned that sealing unit 108 is improperly sealed by processor 116 if the measured Lag-time of Peak is within the Target Lag Limit range and the Magnitude of Peak is greater than the Peak Threshold.

[0116] Like Correlation and Cross-Correlation, a coherence function is also a measure of similarity between two signals. Coherence is another non-difference comparison approach that can be used for detecting acoustic seal integrity. Coherence is defined as:

$$\gamma^2{}_{xy} = \frac{|G_{xy}(f)|^2}{G_{xx}(f)G_{yy}(f)} \quad (6)$$

[0117] Where Gxy is the cross-spectrum of two signals (e.g. the ASM and ECM signals), and can be calculated by first computing the cross-correlation in equation (5), applying a window function, for example a Hanning window, and transforming to the frequency domain, for example via an FFT. Gxx or Gyy is the auto-power spectrum of either the ASM or ECM signals, and can be calculated by first computing the auto-correlation (using equation 5, but where the two input signals are both from either the ASM or ECM and transforming to the frequency domain. The coherence function gives a frequency-dependent vector between 0 and 1, where a high coherence at a particular frequency indicates a high degree of coherence at this frequency, and can therefore be used to analyze test signal frequencies in the ASM and ECM signals whereby a high coherence indicates the presence of the test signal in the ambient environment (indicating

leakage past the acoustic barrier).

[0118] Other approaches such as frequency spectrum analysis and RMS levels can also be used to determine if the earpiece is sealed correctly. Using a non-difference comparison approach such as coherence or cross-correlation between the ASM and ECM signals to determine sealing is more reliable than taking the level difference of the ASM and ECM signals. Using the cross correlation rather than a level differencing approach improves the accuracy and minimizes errors which may occur due to user non-speech body noise, such as teeth chatter, sneezes, coughs, etcetera. Furthermore, such non-speech user generated noise would generate a larger sound level in the ear canal than on the outside of the same ear canal producing inaccurate results.

[0119] FIGS. 15A and 15B illustrate a method of varying the seal of an inflation system in accordance with at least one exemplary embodiment. In the non-limiting example, when a seal is essentially detected as being low, for example the calculated sound isolation of the system is 3 dB or less, a signal is sent to a seal varying device (e.g., 1500) to vary the seal, in this case increase (i.e. increase the sound isolation of the system) the seal value. The signal can be instructions to send a current over a period of time to an actuator, which can decrease the overall volume of the system (hence increasing the pressure and effectively the sealing). For example a slider actuator such as the P-653 PILine® can be used. Which has the dimensions of 15 mm by 11 mm by 8 mm, which includes an attached electronics control board, and has a mass of 1 gram. General operation uses 5V and about 100 mamps with a typical speed of 50 to 90 mm/sec. Note that the max force of about 0.15 N but such systems can be tailored to enable pumping beyond atmospheric pressure (e.g., can increase the max force). The non limiting example illustrated in FIGS. 15A and 15B shows a slider actuator 1500, with a moving slide 1510, having attached a pumping arm 1560, with a hole 1550 covering bump 1520. Upon receipt of a signal1505 the actuator can move 1570 such that the bump 1520 covers the hole 1550 in a bellows 1530 pump. The actuation compresses the miniature bellows 1530 pushing 1590 gas through the one-way valve 1540, upon the back stroke the bump 1520 uncovers the hole 1550 and air rushes back into the bellows 1530 for the next pump. For example if the stroke length is 2 mm and the pump arm 1560 contact area is about 9 mm 2 then each stroke moves 18 mm 3 of volume. If an inflation system 1570 needs to be inflated more (e.g., more gas to increase sealing) then each stroke can provide an additional volume of gas of 18 mm 3 into the system increasing the inflation system 1580. If the inflation system is initially empty (e.g., needs 1000 mm 3 of gas volume to inflate) then about 56 strokes would be needed for inflation, which is about 110 mm one direction stroke length or about 2 seconds at P-653 PILine speeds. The number of oscillations and stroke length can be determined according to the signal 1505 sent, which can be specifically tailored depending upon the electronics controlling the actuators. Note that PI-653 is an example only. Other actuation systems can be used and controlled by signal 1505.

[0120] FIG. 16 illustrates a block diagram of controlled sealing in response to a seal fail signal and/or a request for increased seal attenuation. For example, a command signal 1600 is received (e.g., a seal fail signal in which a default attenuation value is attached for example 15 dB, or a signal requesting an additional amount of attenuation) by a processor. The command signal specifies an additional amount of attenuation or that the seal has failed. An attenuation needed N is identified 1610. For example if the current attenuation is 5 dB loss at f=500 Hz, at a pressure of 0.1 bar, and a command signal is received requesting a 10 dB loss at 500 Hz, then an experimental table is queried to find the pressure needed P which is then subtracted from the current pressure to obtain an increase in pressure DP needed. The increase in pressure is converted into a volume of gas increase needed (e.g., again referring to experimental tables based upon the inflation system volume). The volume of gas increase needed can then be directly linked with the number of cycles of an actuator pump M, 1620. The number of requested cycles **M** can then be sent 1630 to the actuator control circuit to pump the designated number of cycles. The system can then retest the attenuation 1640 and if refinements are needed the process can start again.

[0121] 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. For example, if words such as "orthogonal", "perpendicular" are used the intended meaning is "substantially orthogonal" and "substantially perpendicular" respectively. Additionally although specific numbers may be quoted in the claims, it is intended that a number close to the one stated is also within the intended scope, i.e. any stated number (e.g., 90 degrees) should be interpreted to be "about" the value of the stated number (e.g., about 90 degrees).

[0122] 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.

Electronic Acknowledgement Receipt

EFS ID:	47304647
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	11472-36-3_CONT-16838277
Receipt Date:	03-JAN-2023
Filing Date:	23-FEB-2021
Time Stamp:	09:32:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment after Notice of Allowance (Rule 312)	17182570_312-amndt-2nd.pdf	115762 abe1f862d42246edcea9de80537858da276bdcff	no	1

Warnings:

Information:					
2	Applicant Arguments/Remarks Made in an Amendment	17182570-SPEC-Marked-2nd312.pdf	395823 af7a110c27c61b612462d4549cf629342f2e07b1	no	25
Warnings:					
Information:					
3	Specification	17182570-SPEC-Clean-2nd312.pdf	381315 231a7036406b7c3f90d4f1f9c77b0050905d11c7	no	25
Warnings:					
Information:					
		Total Files Size (in bytes):	892900		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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.

National Stage of an International Application under 35 U.S.C. 371

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.

New International Application Filed with the USPTO as a Receiving Office

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.

Doc Code: MFEE.C.AD PTO/SB/47-EFS
Document Description: Maintenance Fee Address Change

FEE ADDRESS INDICATION FORM			
Application Number	17182570	Art Unit	2654
Filing Date	23-Feb-2021	Examiner Name	PAUL KIM
First Name Inventor	John Usher	Attorney Doc. Number	11472-36-3_CONT-16838277

INSTRUCTIONS: In order for the fee address identified on this form to be effective, the issue fee must have been paid for the application listed on this form. Only an address represented by a customer number can be established as the fee address for maintenance fee purposes (hereafter, fee address). A fee address should be established when correspondence related to maintenance fees should be mailed to a different address than the correspondence address for the application. For more information on customer numbers, see the Manual of Patent Examining Procedure (MPEP) § 403.

Please recognize as the Fee Address under the provisions of 37 CFR 1.363 the address associated with:

Customer Number:	154598 Staton Techiya, LLC John Keady 9501 Jagged Creek Ct Delray Beach FL 33446 UNITED STATES (571) 606-1291 yasmin.seyal@techiya.co

Signature :

I certify, in accordance with 37 CFR 1.4(d)(4) that I am an attorney or agent registered to practice before the Patent and Trademark Office who has filed and has been granted power of attorney in this application.

Signature	/Peter A. Chiabotti/	**Date**	01-05-2023
Name	Peter Allen Chiabotti	**Registration Number**	54603

Electronic Patent Application Fee Transmittal

Application Number:	17182570
Filing Date:	23-Feb-2021
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Filer:	Peter Allen Chiabotti/Yoshi Hassan
Attorney Docket Number:	11472-36-3_CONT-16838277

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 APPL ISSUE FEE	2501	1	600	600
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**600**

Electronic Acknowledgement Receipt	
EFS ID:	47320887
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	Peter Allen Chiabotti/Yoshi Hassan
Filer Authorized By:	Peter Allen Chiabotti
Attorney Docket Number:	11472-36-3_CONT-16838277
Receipt Date:	05-JAN-2023
Filing Date:	23-FEB-2021
Time Stamp:	13:23:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$600
RAM confirmation Number	E202315D23354901
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	Issue Fee Payment (PTO-85B)	Web85b.pdf	62593 b1461ee9dbecf0cf5883669f3afa9000a7d9c859	no	2
Warnings:					
Information:					
2	Maintenance Fee Address Change	web85feeaddress.pdf	42303 2fbe7932683c7fb3c237322dfd7fb37ce5b4d5b0	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	40003 3a9154ed826a6156d63c9b5db5fa80e8969fec51	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	144899		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
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.
National Stage of an International Application under 35 U.S.C. 371
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.
New International Application Filed with the USPTO as a Receiving Office
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.

Doc Code: IFEE PTOL/85B-EFS

Document Description: Issue Fee Payment (PTO-85B)

Issue Fee Transmittal Form

Application Number	Filing Date	First Named Inventor	Atty. Docket No.	Confirmation No.
17182570	23-Feb-2021	John Usher	11472-36-3_CONT-1683827	5671

TITLE OF INVENTION :

ACOUSTIC SEALING ANALYSIS SYSTEM

Entity Status	Application Type	Art Unit	Class - Subclass	EXAMINER
Small	Utility under 35 USC 111(a)	2654	059000	PAUL KIM

Issue Fee Due	Publication Due	Total Fee(s) Due	Date Due	Prev. Paid Fee
$600	$0	$600	23-Mar-2023	$0

1.Change of Correspondence Address and/or Indication Of Fee Address (37 CFR 1.33 & 1.363)

Current Correspondence Address:	Current Indicated Fee Address :
150139 Akerman LLP 777 South Flagler Drive Suite 1100 West Tower West Palm Beach FL 33401 UNITED STATES 5616535000 ip@akerman.com	
☐ Change of correspondence address requested, system generated AIA/122-EFS form attached	☒ Fee Address indication requested, system generated SB/47-EFS form attached

2.Entity Status

Change in Entity Status

○ Applicant certifying micro entity status; system generated Micro Entity certification form attached. See 37 CFR 1.29.
Note: Absent a valid certification of micro entity status, issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment. If this box is checked, you will be prompted to choose a micro entity status on the gross income basis (37 CFR 1.29(a)) or the institution of higher education basis (37 CFR 1.29(d)), and make the applicable certification online.

◉ Applicant asserting small entity status. See 37 CFR 1.27.
Note: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

○ Applicant changing to regular undiscounted fee status.
Note: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

Doc Code: IFEE PTOL/85B-EFS

Document Description: Issue Fee Payment (PTO-85B)

3.The Following Fee(s) Are Submitted:

☒ Issue Fee	☐ I authorize USPTO to apply my previously paid issue fee to the current fees due
☐ Publication Fee	☐ The Director is hereby authorized to apply my previously paid issue fee to the current fee due and to charge deficient fees to Deposit Account Number _____
☐ Advance Order - # of copies _____	☐ If **in addition to** the payment of the issue fee amount submitted with this form, there are any discrepancies in any amount(s) due, the Director is authorized to charge any deficiency, or credit any overpayment, to Deposit Account Number _____ . The **issue fee must be submitted** with this form. **If payment of the issue fee does not accompany this form, checking this box and providing a deposit account number will NOT be effective to satisfy full payment of the fee(s) due.**

4.Firm and/or Attorney Names To Be Printed

NOTE: If no name is listed, no name will be printed
For printing on the patent front page, list to be displayed as entered

1. Akerman LLP
2. Peter A. Chiabotti
3.

5.Assignee Name(s) and Residence Data To Be Printed

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

Name	City	State	Country	Category
Staton Techiya LLC	Delray Beach	FLORIDA	UNITED STATES	corporation

6.Signature

I certify, in accordance with 37 CFR 1.4(d)(4) that I am an attorney or agent registered to practice before the Patent and Trademark Office who has filed and has been granted power of attorney in this application. I also certify that this Fee(s) Transmittal form is being transmitted to the USPTO via EFS-WEB on the date indicated below.

Signature	/Peter A. Chiabotti/	**Date**	01-05-2023
Name	Peter Allen Chiabotti	**Registration Number**	54603

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	11472-36-3_CONT-16838277	5671

150139 7590 01/09/2023

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

EXAMINER	
KIM, PAUL	

ART UNIT	PAPER NUMBER
2654	

NOTIFICATION DATE	DELIVERY MODE
01/09/2023	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ip@akerman.com
jp.keady@techiya.co
personics_docketing@cardinal-ip.com

Response to Rule 312 Communication	Application No.	Applicant(s)	
	17/182,570	Usher et al.	
	Examiner	Art Unit	AIA (FITF) Status
	PAUL KIM	2654	Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☑ The amendment filed on 03 January 2023 under 37 CFR 1.312 has been considered, and has been:

a) ☑ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

f) ☐ not entered because the supplemental or corrected Application Data sheet (ADS)

☐ was not accompanied by a petition to accept an unintentionally delayed claim under 37 CFR 1.55 or 27 CFR 1.78;

☐ did not identify the information being changed in accordance with 37 CFR 1.76(c)(2);

☐ was not properly signed in accordance with 37 CFR 1.76(e) (or 37 CFR 1.33(b) for applications filed prior to September 16, 2012).

/PAUL KIM/
Primary Examiner, Art Unit 2654

O.K. TO ENTER – 312
/P.K./ AU 2654
January 3, 2023

IN THE U.S. PATENT AND TRADEMARK OFFICE

First Named Inventor: John Usher		Conf.: 5671
Appl. No.:	17/182,570	Art Unit: 2654
Filed:	02/23/2021	Examiner: Kim, Paul
For:	ACOUSTIC SEALING ANALYSIS SYSTEM	

2nd Amendment After Allowance Under 37 CFR 1.312

Commissioner of Patents
Alexandria, VA 22313-1450

DATE: 3 Jan. 2023

The Office issued a notice of allowance 23 Dec. 2022. Prior to final payment of the issue fee Applicant has noticed two additional grammatical issues, corrected herein. Thus, Applicants submit the second attached marked-up and clean version of the specification to address typographical errors, in particular in paragraphs [0001] and formula (2) [0071] where Sxx should be Sxy.

The minor amendment does not require an additional search, does not require more than a cursory review of the record, and do not involve materially added work on the part of the Office. However, should the Examiner believe that anything further is necessary in order to place the application in better condition for allowance, the Examiner is respectfully requested to contact the undersigned representative at the telephone number listed below.

Respectfully submitted,
TECHIYA LLC

Date: January 3, 2023

/John P. Keady/
John P. Keady, Ph.D (Physics), Ph.D (Comp. Sci), J.D.
Assistant General Counsel: Intellectual Property
and Chief Technical Officer
Staton Techiya LLC
Reg. No. 56,389
571-606-1291

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	02/23/2021	John Usher	11472-36-3_CONT-16838277	5671

150139 7590 02/10/2023

Akerman LLP
777 South Flagler Drive
Suite 1100 West Tower
West Palm Beach, FL 33401

EXAMINER	
KIM, PAUL	

ART UNIT	PAPER NUMBER
2654	

NOTIFICATION DATE	DELIVERY MODE
02/10/2023	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ip@akerman.com
jp.keady@techiya.co
personics_docketing@cardinal-ip.com

Response to Rule 312 Communication	Application No.	Applicant(s)	
	17/182,570	Usher et al.	
	Examiner	Art Unit	AIA (FITF) Status
	PAUL KIM	2654	Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☑ The amendment filed on 30 December 2022 under 37 CFR 1.312 has been considered, and has been:
   - a) ☑ entered.
   - b) ☐ entered as directed to matters of form not affecting the scope of the invention.
   - c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
     Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.
   - d) ☐ disapproved. See explanation below.
   - e) ☐ entered in part. See explanation below.
   - f) ☐ not entered because the supplemental or corrected Application Data sheet (ADS)
     - ☐ was not accompanied by a petition to accept an unintentionally delayed claim under 37 CFR 1.55 or 27 CFR 1.78;
     - ☐ did not identify the information being changed in accordance with 37 CFR 1.76(c)(2);
     - ☐ was not properly signed in accordance with 37 CFR 1.76(e) (or 37 CFR 1.33(b) for applications filed prior to September 16, 2012).

/PAUL KIM/
Primary Examiner, Art Unit 2654

O.K. TO ENTER - 312
/P.K./ AU 2654
December 30, 2022

IN THE U.S. PATENT AND TRADEMARK OFFICE

First Named Inventor: John Usher		Conf.: 5671
Appl. No.:	17/182,570	Art Unit: 2654
Filed:	02/23/2021	Examiner: Kim, Paul
For:	ACOUSTIC SEALING ANALYSIS SYSTEM	

Amendment After Allowance Under 37 CFR 1.312

Commissioner of Patents
Alexandria, VA 22313-1450

DATE: 30 Dec. 2022

The Office issued a notice of allowance 23 Dec. 2022. Applicants submit the attached marked-up and clean version of the specification to address typographical errors, in particular in paragraphs [0079] and [0115].

The minor amendment does not require an additional search, does not require more than a cursory review of the record, and do not involve materially added work on the part of the Office. However, should the Examiner believe that anything further is necessary in order to place the application in better condition for allowance, the Examiner is respectfully requested to contact the undersigned representative at the telephone number listed below.

Respectfully submitted,
TECHIYA LLC

Date: December 30, 2022

/John P. Keady/
John P. Keady, Ph.D (Physics), Ph.D (Comp. Sci), J.D.
Assistant General Counsel: Intellectual Property
and Chief Technical Officer
Staton Techiya LLC
Reg. No. 56,389
571-606-1291

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17182570
	Filing Date	2021-02-23
	First Named Inventor	John Usher
	Art Unit	OPAP
	Examiner Name	UNKNOWN
	Attorney Docket Number	CONT-16838277

	24	20050123146		2005-06-09	Voix et al.	
	25	20040125965		2004-07-01	Alberth Jr., et al.	
	26	20060083395		2006-04-20	Allen et al.	
	27	20110264447		2011-10-27	Visser et al.	
	28	20100296668		2010-11-25	Lee et al.	
	29	20110293103		2011-12-01	Park et al.	
	30	20100061564		2010-03-11	Clemow et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
Change(s) applied to document, /Q.N./ 12/29/2022	1	EP1519625	EP	A2	03/2005	Victorian		
	2	2006037156	WO	A1	04/2006	Mejia et al.		

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

EFS Web 2.1.18

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.K/

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	John Usher
Art Unit	
Examiner Name	Unknown
Attorney Docket Number	CONT-16838277

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	7801318		2010-09-21	Barthel	
	2	8774433		2014-07-08	Goldstein	
	3	7801318		2010-09-21	Barthel, Roland	
Change(s) applied to document, /C.S./ 12/29/2022	4	8401200		03/2013 ~~2009-11-19~~	Tiscareno	
	5	5138722		08/1992 ~~2010-09-21~~	Urella	
	6	5764781		1998-06-09	Ding	
	7	6321070		2001-11-20	Clark	
	8	9293128		2016-03-22	Goldstein	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.K/

Electronic Acknowledgement Receipt

EFS ID:	47961646
Application Number:	17182570
International Application Number:	
Confirmation Number:	5671
Title of Invention:	ACOUSTIC SEALING ANALYSIS SYSTEM
First Named Inventor/Applicant Name:	John Usher
Customer Number:	150139
Filer:	John Patrick Keady
Filer Authorized By:	
Attorney Docket Number:	11472-36-3_CONT-16838277
Receipt Date:	06-MAY-2023
Filing Date:	23-FEB-2021
Time Stamp:	21:42:10
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment after Notice of Allowance (Rule 312)	17182570_312.pdf	166885 e8dd6cc39ee2601564768c928e988d0dfc183a66	no	5

Warnings:

Information:	
Total Files Size (in bytes):	166885

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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.
New International Application Filed with the USPTO as a Receiving Office
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.

IN THE U.S. PATENT AND TRADEMARK OFFICE

First Named Inventor: John Usher		Conf.: 5671
Appl. No.:	17/182,570	Art Unit: 2654
Filed:	02/23/2021	Examiner: Kim, Paul
For:	ACOUSTIC SEALING ANALYSIS SYSTEM	

Amendment After Allowance Under 37 CFR 1.312

Commissioner of Patents
Alexandria, VA 22313-1450

DATE: 30 Dec. 2022

Sir:

Applicant submits herein a clarifying amendment to claim 1, where Applicant clarifies that the processor executes the instructions rather than "is configured to" execute the instructions. No new matter has been added. Applicant respectfully requests that the clarifying amendment be accepted.

Amendment(s) to the Claims begin on page 2 of this paper.

If the Examiner has any questions concerning this application, the Examiner is requested to contact the undersigned at 571-606-1291 in the Washington D.C. Metro area.

Respectfully submitted,
TECHIYA LLC

Date: May 6, 2023

/John P. Keady/
John P. Keady, Ph.D (Physics), Ph.D (Comp. Sci), J.D.
Assistant General Counsel: Intellectual Property
and Chief Technical Officer
Staton Techiya LLC
Reg. No. 56,389

Amendment(s) to the Claim(s):

The listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1.(currently amended) An audio device configured to test a seal of an earphone comprising:

a memory that stores instructions; and

a processor, wherein the processor ~~is configured to~~ executes the instructions to perform operations, the operations comprising:

generating a test signal, wherein the test signal includes multiple frequency components, wherein at least one component lies between a range of 30Hz and 200Hz;

sending the test signal to a speaker of an earphone, wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user;

receiving a first microphone signal from the first microphone;

calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination;

comparing the value to a threshold to determine a seal quality between the first side and the second side;

generating a message to convey the seal quality; and

sending the message to the user.

2.(previously presented) The audio device according to claim 1, wherein the message is an acoustic message.

3(previously presented). The audio device according to claim 1, wherein the message is a visual message sent to a display of the audio device.

4.(previously presented) The audio device according to claim 1, wherein the speaker plays the test signal from the first side.

5.(currently amended) The audio device according to claim 4, wherein the first microphone measures sound from the first side. ~~signal.~~

6.(previously presented) The audio device according to claim 4, wherein the first microphone measures sound from the second side.

7.(previously presented) The audio device according to claim 1, wherein the first signal is the test signal and the second signal is the first microphone signal.

8.(previously presented) The audio device of claim 1, wherein the first signal is the test signal and the second signal is a modified first microphone signal.

9.(previously presented) The audio device of claim 1, wherein the first signal is a modified test signal and the second signal is the first microphone signal.

10.(previously presented) The audio device according to claim 1, wherein the first signal is a modified test signal and the second signal is a modified first microphone signal.

11.(previously presented) The audio device according to claim 8, wherein the modified first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200Hz.

12.(previously presented) The audio device according to claim 10, wherein the first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200Hz.

13.(previously presented) The audio device according to claim 1, wherein the earphone includes a second microphone.

14.(previously presented) The audio device according to claim 13, wherein the operations further comprise:

receiving a second microphone signal from the second microphone.

15.(currently amended) The audio device according to claim 14, wherein the first signal is the first microphone signal and the second signal is the second microphone signal.

16.(previously presented) The audio device of claim 14, wherein the first signal is a modified first microphone signal and the second signal is the second microphone signal.

17.(previously presented) The audio device of claim 14, wherein the first signal is a modified first microphone signal and the second signal is a modified second microphone signal.

18.(previously presented) The audio device of claim 1, wherein the seal quality is good if the value is at or above the threshold value.

19.(previously presented) The audio device of claim 1, wherein the sealing section is composed of at least one of rubber, silicone, a flexible polymer, or a combination thereof.

20.(previously presented) The audio device of claim 1, wherein the sealing section is an eartip.

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/182,570	05/30/2023	11665493	11472-36-3_CONT-16838277	5671

150139 7590 05/10/2023

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ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at https://patentcenter.uspto.gov/. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-888-217-9197.

The USPTO is implementing electronic patent issuance with a transition period, during which period the USPTO will mail a ceremonial paper copy of the electronic patent grant to the correspondence address of record. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at https://certifiedcopycenter.uspto.gov/index.html. The Certified Copy Center may be reached at (800)972-6382.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 223 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

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APPLICATION NO.	ISSUE DATE	PATENT NO.
17/182,570	30-MAY-23	11665493

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EGRANT NOTIFICATION

Your electronic patent grant (eGrant) is now available, which can be accessed via Patent Center at https://patentcenter.uspto.gov

The electronic patent grant is the official patent grant under 35 U.S.C. 153. For more information, please visit https://www.uspto.gov/electronicgrants