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- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

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(54) **Title:** DAMPER SCREEN FOR RECEIVER

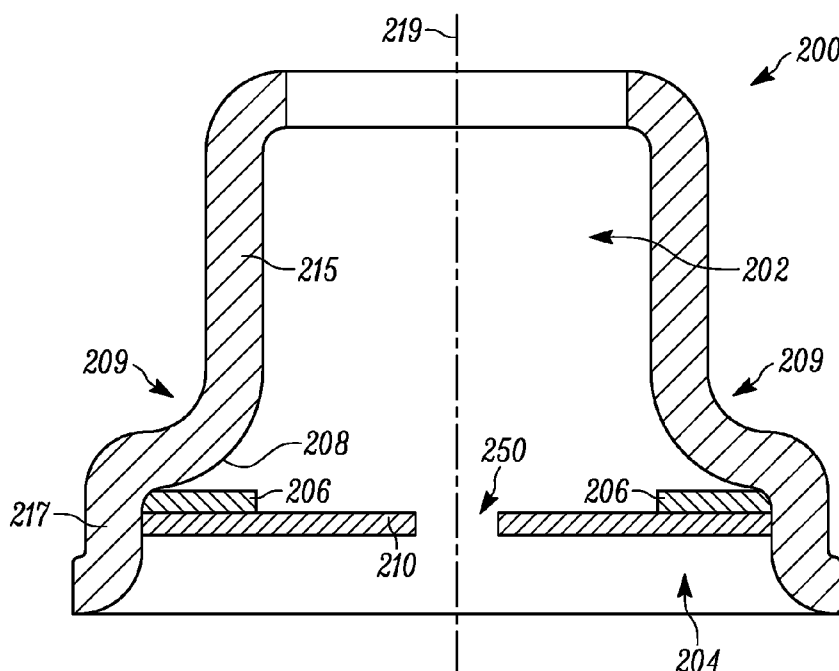


FIG. 7

(57) **Abstract:** An acoustic receiver assembly includes a housing with a receiver structure, e.g. a moving armature loudspeaker, configured to convert an electrical signal into sound energy that emanates through a channel of a sound tube coupled to the housing. A acoustical damping screen is disposed across the channel. One or more characteristics of the screen may be selected to control a peak resonance of sound produced by the receiver and reduce total harmonic distortion (THD) of the receiver, such as material, e.g. cloth, or size, shape, number or location of openings in the screen.

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SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, **Published:**
GW, KM, ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

DAMPER SCREEN FOR RECEIVER

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims benefits under 35 U.S.C. 119(e) to U.S. Provisional Application No. 62/254,804 entitled “Damper Screen for Receiver” filed on November 13, 2015, naming Erik Wiederholtz et al. as inventors, the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] This application relates to acoustic receivers and, more specifically to optimizing the performance characteristics of these devices.

BACKGROUND

[0003] Different types of acoustic devices (e.g., used in hearing instruments such as hearing aids or other suitable devices) have been used through the years. Acoustic receivers (or speakers) are one type of acoustic device. A receiver takes an electrical signal (e.g., from a signal source such as a microphone or other suitable sources) and converts the electrical signal into sound energy.

[0004] Various types of receivers exist. In a balanced armature receiver, an electrical coil is excited by an electrical signal in the presence of magnets. The electrical signal produces a changing magnetic field, which moves an armature, which moves a diaphragm to produce sound. In a dynamic receiver, an electrical coil is also excited by the current. The electrical coil moves, and this moves a diaphragm, which produces sound.

[0005] In a receiver, sound commonly exits through a sound tube. The receiver response is typically considered to be the response (sound pressure) at the output of the receiver as measured against the frequency. Typically, this response curve has a higher or resonance peak at a resonant frequency. Previous approaches have attempted to control the resonance peaks in a number of ways, but these approaches have various drawbacks.

[0006] Total harmonic distortion (THD) is also an issue in these devices. THD is sometimes considered to be the ratio of the sum of the powers of all harmonic components of the sound waveform to the power of the fundamental frequency of the sound waveform.

Previous approaches have attempted to reduce THD, but these approaches also have limitations.

[0007] Accordingly, the problems associated with the previous approaches have resulted in some user dissatisfaction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a more complete understanding of the disclosure, reference should be made to the following detailed description and accompanying drawings wherein:

[0009] FIG. 1 is a side cutaway block diagram of an acoustic receiver;

[0010] FIG. 2 is a side cutaway view of a sound tube with a damper element;

[0011] FIG. 3 is a perspective view of the sound tube of FIG. 2;

[0012] FIG. 4 is another perspective view of the sound tube of FIG. 2;

[0013] FIG. 5 is an exploded perspective view of the sound tube of FIG. 2;

[0014] FIG. 6 is a perspective view of the sound tube of FIG. 2 connected to an acoustic receiver;

[0015] FIG. 7 is a side cutaway view of a sound tube with another example of a damper element;

[0016] FIG. 8 is a graph showing response curves for an acoustic receiver; and

[0017] FIG. 9 is a block diagram of an acoustic device.

[0018] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity. It will be appreciated further that certain actions and/or steps may be described or depicted in a particular order of occurrence while those skilled in the art will understand that such order or sequence is not actually required. It will also be understood that the terms and expressions used herein have the ordinary meaning as is accorded to such terms and expressions with respect to their corresponding respective areas of inquiry and study except where specific meanings have otherwise been set forth herein.

DETAILED DESCRIPTION

[0019] The present disclosure provides approaches to control the damping of acoustic signals produced by a speaker or receiver. In some implementations, these approaches also reduce total harmonic distortion (THD) and provide ingress protection for internal elements of the speaker. The receivers, damping structures, and/or sound tubes provided herein are easy to assemble and produce products with cost efficiencies and savings compared to previous approaches.

[0020] In one example, an acoustic receiver assembly includes a housing with a receiver structure, where the receiver structure is configured to convert an electrical signal into sound energy. A sound tube is coupled to the housing and is configured to receive the sound energy produced by the receiver structure. The sound tube has a channel extending therethrough. The sound tube includes a main body portion with a first wall, an upper body portion with a second wall, and a portion connecting the first wall and the second wall. The first wall is at a first distance from an axis extending through the channel and the second wall is at a second distance from the axis. The second distance is greater than the first distance. A screen extends across the channel to separate a first portion of the channel from a second portion of the channel.

[0021] In one or more embodiments of the above acoustic receiver assembly, the screen is configured to have characteristics that adjust a peak resonance of the sound energy passing through the screen, and reduce total harmonic distortion (THD) of the acoustic receiver assembly to a value that is less than is produced in the absence of the screen. The screen is configured to reduce the THD by reducing air velocity in the sound tube. The screen is coupled to the portion interconnecting the first wall and the second wall. The screen is made of cloth. The screen has a resistive opening extending therethrough. The screen is disposed on or held by a frame. A second screen is disposed in the sound tube.

[0022] In one or more embodiments of the above acoustic receiver assembly, the receiver structure includes a balanced armature. The receiver structure includes an armature having a movable portion disposed between two magnets. The movable portion of the armature is linked to a movable portion of a diaphragm that separates a front volume of the housing from a back volume of the housing.

[0023] In another example, an acoustic device includes a signal source and an acoustic receiver assembly coupled to the signal source. The acoustic receiver assembly includes a housing with a receiver structure, where the receiver structure is configured to convert an electrical signal into sound energy. A sound tube is coupled to the housing and is configured to receive the sound energy produced by the receiver structure. The sound tube has a channel extending therethrough. The sound tube includes a main body portion with a first wall, an upper body portion with a second wall, and a portion connecting the first wall and the second wall. The first wall is at a first distance from an axis extending through the channel and the second wall is at a second distance from the axis. The second distance is greater than the first distance. A screen extends across the channel to separate a first portion of the channel from a second portion of the channel.

[0024] In one or more embodiments of the above acoustic device, the screen is coupled to the portion interconnecting the first wall and the second wall. The receiver structure includes a balanced armature with a movable portion disposed between two magnets. The screen is made of cloth. The screen has a resistive opening extending therethrough.

[0025] Referring now to FIG. 1, one example of an acoustic receiver 100 (also referred to as an acoustic receiver assembly) with a sound tube having a damper is described. The acoustic receiver 100 includes a housing with a hollow sound tube 101 that permits transmission of acoustic pressure from within the housing to an exterior thereof. The sound tube 101 includes a hollow main body portion 102 and a hollow upper body portion 104. More specifically, both have walls that form a channel through which sound passes. A hollow (in this example, ring-like) damper support structure 106 couples to a surface 108 of a wall of the sound tube to bisect the channel. The ring may be square, rectangular, circular or elliptical to mention a few examples. Across the damper support structure 106 is a screen 110 (which couples to the damper support structure 106).

[0026] In this example, a receiver structure 103 in the form of a balanced armature receiver or speaker structure resides in a housing 120. The balanced armature receiver structure 103 includes a diaphragm 122, a drive rod 124, an armature 126, a coil 128, and magnets 130. In this balanced armature receiver structure 103, the electrical coil 128 is excited by an electrical signal in the presence of the magnets 130. The diaphragm separates an interior of the housing into a front volume and a back volume. The sound tube is

communicatively coupled to the front volume and the armature, coil, and a yoke retaining the magnets retained are disposed in the back volume. The electrical signal produces a changing magnetic field, which moves the armature 126, moving the drive rod 124, which moves a diaphragm 122 to produce sound in a front volume 132. Sound (labeled using the arrow labeled 134) exits a slit 136 in the housing 120 into the sound tube 101, passes through the screen 110 and out of the exit 138.

[0027] It will also be appreciated that the receiver or speaker structure 103 could also be a dynamic speaker where an electrical coil is also excited by the current. The electrical coil moves, and this moves a diaphragm, which produces sound to the hollow upper body 104.

[0028] In one example, the screen 110 is a cloth screen. In one example, a woven cloth is used. In other examples, a non-woven cloth is used. In addition, multiple screens could be used in the sound tube. One effect of the screen is to reduce turbulence of the sound and/or the velocity of the air flow in the sound tube 101, which improves THD. In one example, THD is reduced from approximately 30% to approximately 1%. Other examples are possible.

[0029] The size, shape, number, and location of openings can be adjusted to vary the amount of resonant peak damping as well as the type of cloth or other material used. As shown in graph 150 of FIG. 8, the undamped response curve for the acoustic receiver or speaker 100 may be a curve 152. A first curve 154 represents modest damping by the screen relative to curve 152 for the undamped response. A second curve 156 represents more aggressive damping relative to that represented by the curve 152. And, a curve 159 represents much more aggressive damping characterized by relatively significant damping of the magnitude of the sound pressure with increasing frequency. The above-mentioned factors (e.g., size, shape, number, and location of openings as well as the type of cloth or other material) can be selected or adjusted to produce a desired frequency response for a particular user or device. These characteristics are also adjusted or selected to vary the THD of the receiver.

[0030] In FIGS. 2-6, a sound tube 200 includes a hollow main body portion 202 that communicates with a hollow upper body portion 204. The main body 202 and the upper body 204 form a channel through which sound passes. A hollow (in this example, ring-like) damper support structure or frame 206 couples to a surface 208 of the upper body 204.

Across the damper support structure 206 is a screen 210 (which couples to the damper support structure 206). The screen 210 extends across the channel to separate a first portion of the channel from a second portion of the channel. In one example, the screen 210 is disposed on or held by the frame 206. In one example, the frame 206 is a mechanical frame. In another example, the frame 206 is a layer of adhesive.

[0031] The main body portion 202 is formed by a wall or walls 215 and the upper body portion 204 is formed in part by a wall or walls 217. In this example, the walls for each of the portions 202 and 204 are single, circular walls. It will be understood that other shapes having multiple walls may be used. An axis 219 extends through the center of the sound tube 200. The wall 217 of the upper body portion 204 is at a greater distance from the axis than the wall 215 of the main body portion 202.

[0032] As shown in FIG. 2, a portion 209 connects the wall 215 and the wall 217. The screen 210 is coupled to the portion interconnecting the wall 215 and the wall 217. In particular, the upper body portion has a lip 209 interconnecting the wall of the main body portion 202 to the wall of the upper body portion 204 with the surface 208. In this example, the lip 209 is generally orthogonal to the wall 215 of the main body portion 202 and extends outward from the wall 215. The lip 209 is also generally orthogonal to wall 217 of the upper body portion 204. The lip 209 includes a surface 208 to which the damper support structure 206 may be fastened (e.g., with glue). The configuration of the lip and its positioning within the sound tube 200 provide strength for holding the support structure 206 in place.

[0033] In one example, the screen 210 is a cloth screen. In one example, a woven cloth is used. Alternatively, a non-woven cloth may be used. In addition, multiple screens could be used in the sound tube. One effect of the screen is to reduce turbulence of the sound and/or velocity of the air flow in the sound tube 200, which improves THD. In one example, THD was reduced from approximately 30% to approximately 1%. Other examples are possible. As mentioned, the size, shape, number, and location of openings in the screen, and type of cloth, characteristics of the cloth can be adjusted or selected to provide the desired amount of resonant peak damping and THD reduction.

[0034] In FIG. 6, the sound tube 200 is shown connected to the housing 270 of an acoustic receiver assembly. The acoustic receiver assembly may include the elements described with respect to the acoustic receiver assembly 100 of FIG. 1.

[0035] FIG. 7 illustrates another example of a sound tube. The sound tube 200 in FIG. 7 is similar to the sound tube in FIGS. 2-6 except that the screen includes a reduced number of openings. In FIG. 7, a resistive perforation 250 extends through the screen 210. The purpose of the perforation 250 is to provide damping. Use of a single or reduced number of openings may prevent clogging due to cerumen (i.e., ear wax) accumulation, especially when a large amount of damping is required.

[0036] The resistive perforation 250 may be constructed of common die-cut layers with a precision laser hole, etched metal layer or other approach. In one example, the hole or opening size can be less than 0.010 inches in diameter. Other examples are possible.

[0037] FIG. 9 illustrates an example of an acoustic device 900 including a damped receiver. The acoustic device 900 includes a signal source 902 that is communicatively coupled to one or more acoustic receivers 100 as noted above. In particular, the acoustic receiver 100 includes a sound tube having a screen that is configured to improve THD by reducing the turbulence of sound and/or the velocity of air flow in the sound tube as described herein. The signal source 902 can be any suitable source of acoustic input such as a microphone, an acoustic sensor, recorded music, etc. As such, the signal source 902 also includes amplifiers or other processing circuitry to process an acoustic input into an electrical signal 904 as known in the art. The signal source 902 then feeds the electrical signal 904 to the acoustic receiver 100, which in turn converts the electrical signal 904 into sound. Further, while one acoustic receiver 100 is shown in FIG. 9, in other examples, multiple acoustic receivers can be connected in series or in parallel to be tuned or adjust the produced sound.

[0038] Embodiments of this disclosure are described herein, including the best mode known to the inventors for carrying out the embodiments of the disclosure. It should be understood that the illustrated embodiments are exemplary only, and should not be taken as limiting the scope of the embodiments of the disclosure.

CLAIMS

What is claimed is:

1. An acoustic receiver assembly comprising:
a housing with a receiver structure, the receiver structure configured to convert an electrical signal into sound energy;
a sound tube that is coupled to the housing and configured to receive the sound energy produced by the receiver structure, the sound tube having a channel extending therethrough, the sound tube including a main body portion with a first wall, an upper body portion with a second wall, and a portion connecting the first wall and the second wall;
wherein the first wall is at a first distance from an axis extending through the channel and the second wall is at a second distance from the axis, the second distance being greater than the first distance; and
wherein a screen extends across the channel to separate a first portion of the channel from a second portion of the channel.
2. The acoustic receiver assembly of claim 1, wherein the screen is configured to have characteristics that adjust a peak resonance of the sound energy passing through the screen, and reduce total harmonic distortion (THD) of the acoustic receiver assembly to a value that is less than is produced in the absence of the screen.
3. The acoustic receiver assembly of claim 1, wherein the screen is comprised of cloth.
4. The acoustic receiver assembly of claim 2, wherein the screen is configured to reduce the THD by reducing air velocity in the sound tube.
5. The acoustic receiver assembly of claim 1, wherein the receiver structure comprises a balanced armature.
6. The acoustic receiver assembly of claim 1, wherein the screen comprises a resistive opening extending therethrough.

7. The acoustic receiver assembly of claim 1, wherein the screen is disposed on or held by a frame.

8. The acoustic receiver assembly of claim 1, further comprising a second screen disposed in the sound tube.

9. The acoustic receiver assembly of claim 1, wherein the screen is coupled to the portion interconnecting the first wall and the second wall.

10. The acoustic receiver assembly of claim 1, wherein the receiver structure comprises an armature having a movable portion disposed between two magnets, the movable portion of the armature linked to a movable portion of a diaphragm that separates a front volume of the housing from a back volume of the housing.

11. An acoustic device comprising:
a signal source; and
an acoustic receiver assembly coupled to the signal source, the acoustic receiver assembly comprising:
a housing with a receiver structure, the receiver structure configured to convert an electrical signal into sound energy;
a sound tube that is coupled to the housing and configured to receive the sound energy produced by the receiver structure, the sound tube having a channel extending therethrough, the sound tube including a main body portion with a first wall, an upper body portion with a second wall, and a portion connecting the first wall and the second wall;
wherein the first wall is at a first distance from an axis extending through the channel and the second wall is at a second distance from the axis, the second distance being greater than the first distance; and
wherein a screen extends across the channel to separate a first portion of the channel from a second portion of the channel.

12. The acoustic device of claim 11, wherein the receiver structure comprises a balanced armature with a movable portion disposed between two magnets.

13. The acoustic device of claim 11, wherein the screen is comprised of cloth.
14. The acoustic device of claim 13, wherein the screen comprises a resistive opening extending therethrough.
15. The acoustic device of claim 11, wherein the screen is coupled to the portion interconnecting the first wall and the second wall.

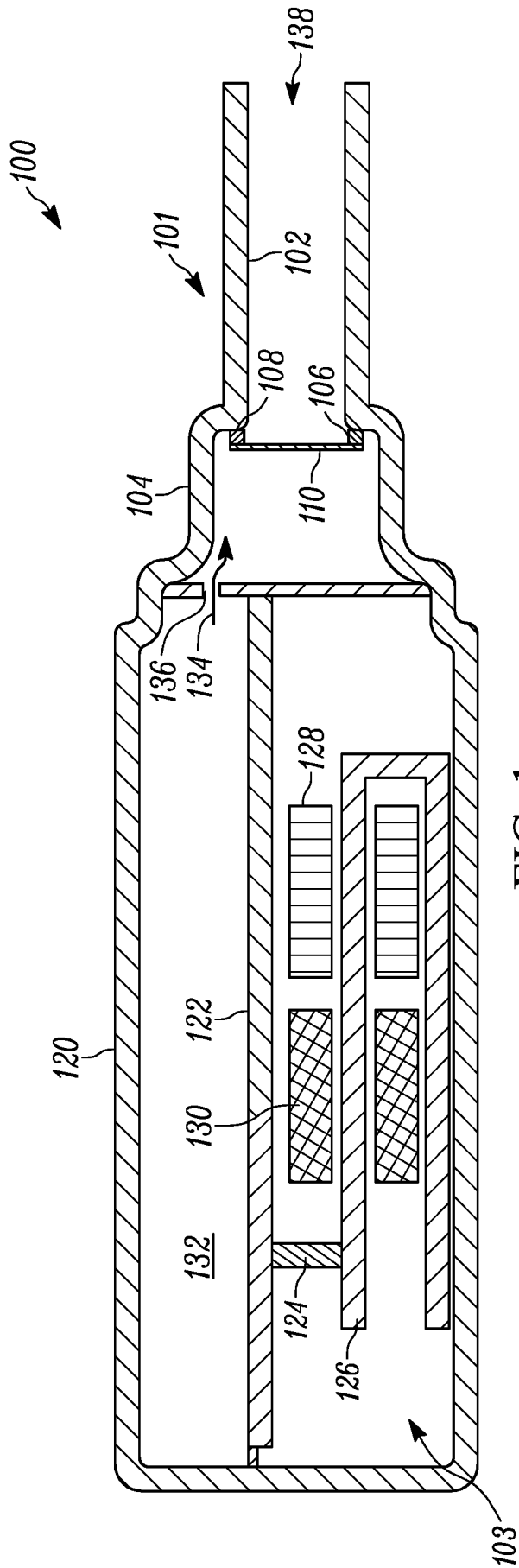


FIG. 1

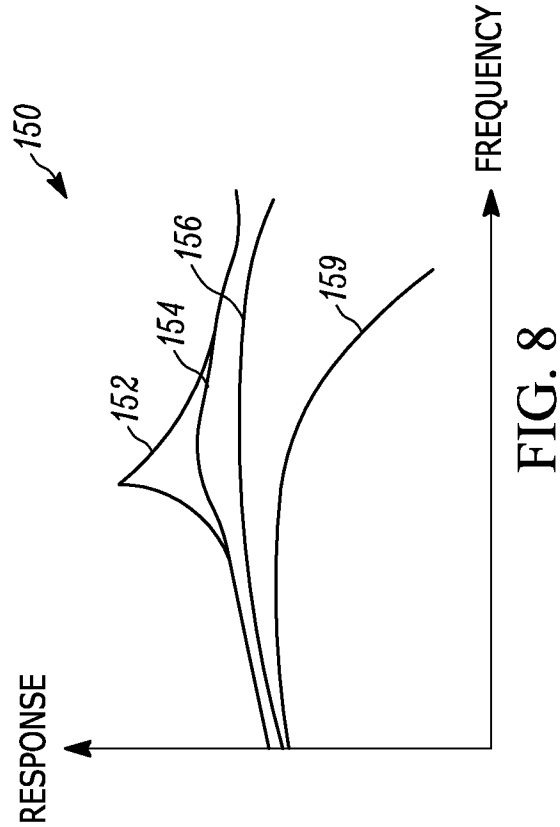


FIG. 8

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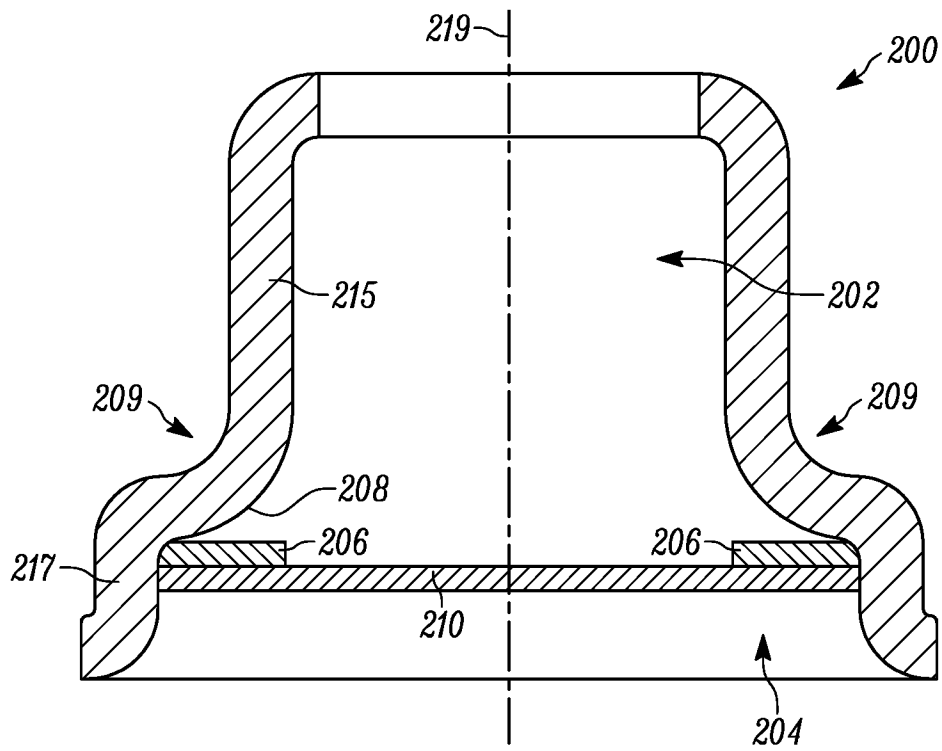


FIG. 2

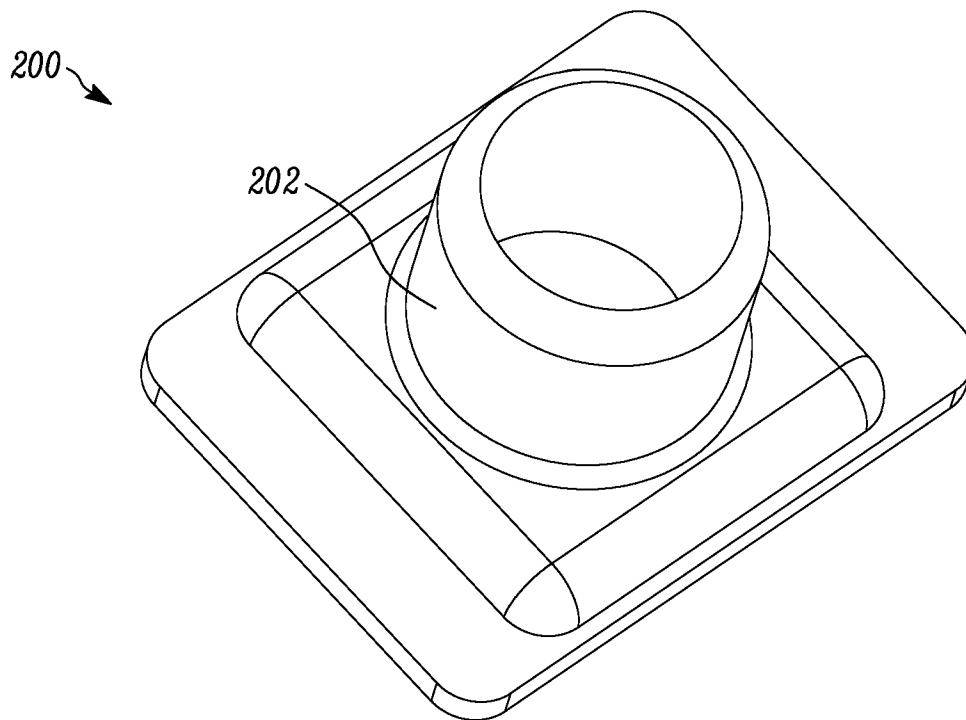


FIG. 3

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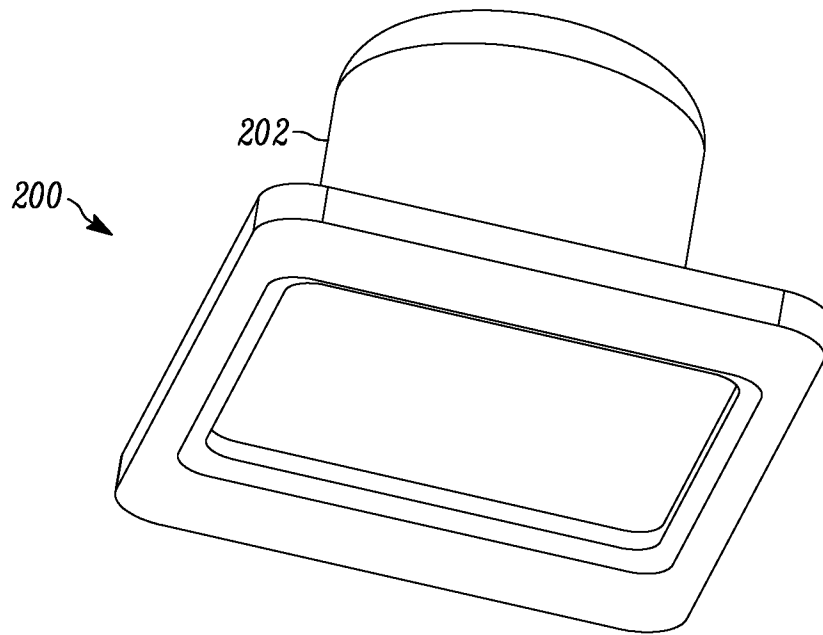


FIG. 4

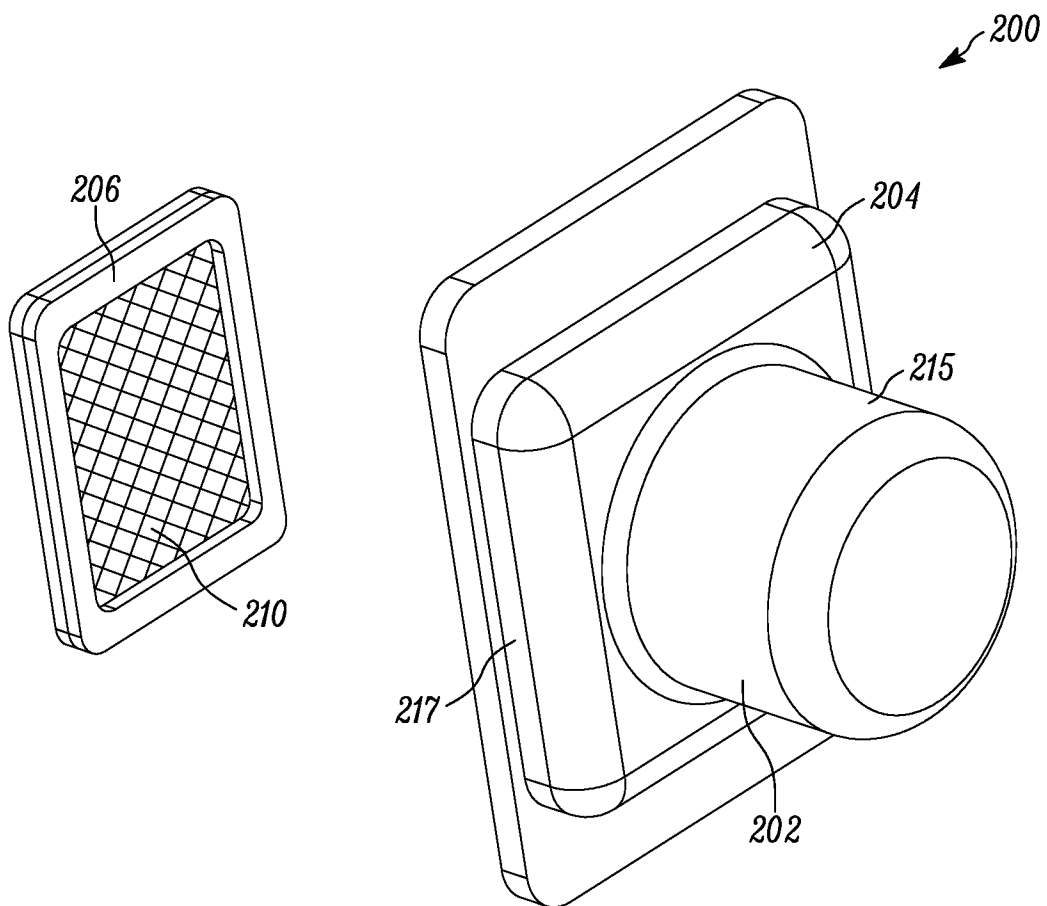


FIG. 5

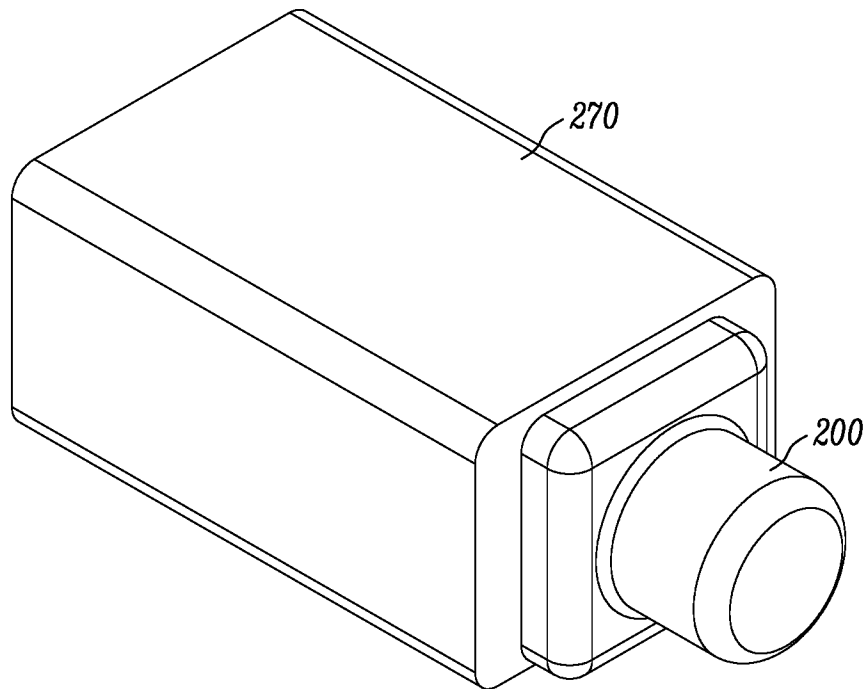


FIG. 6

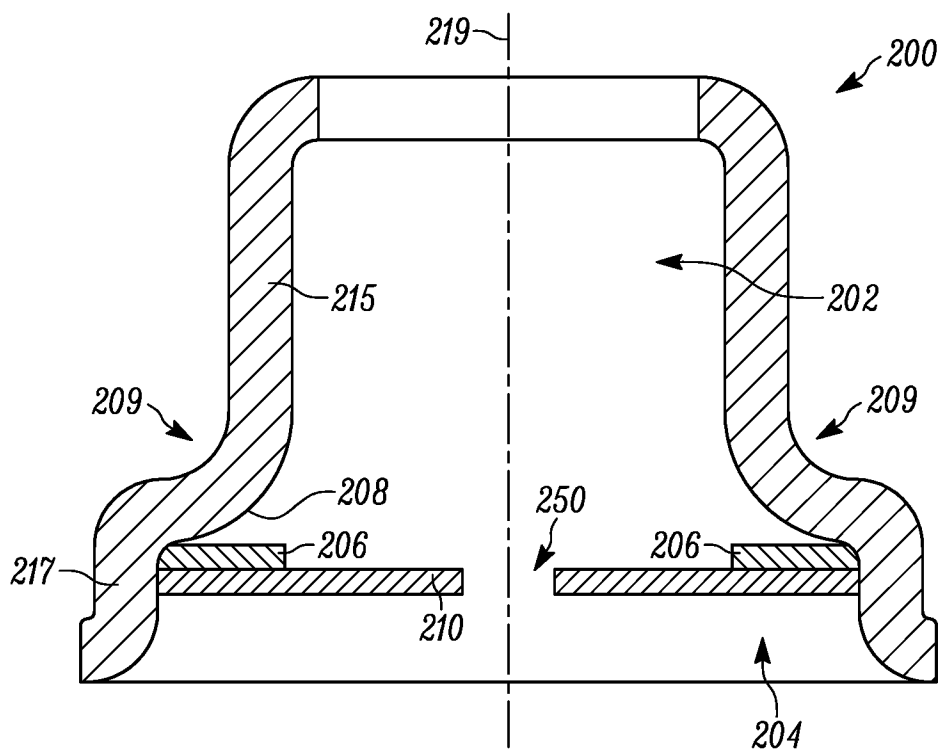


FIG. 7

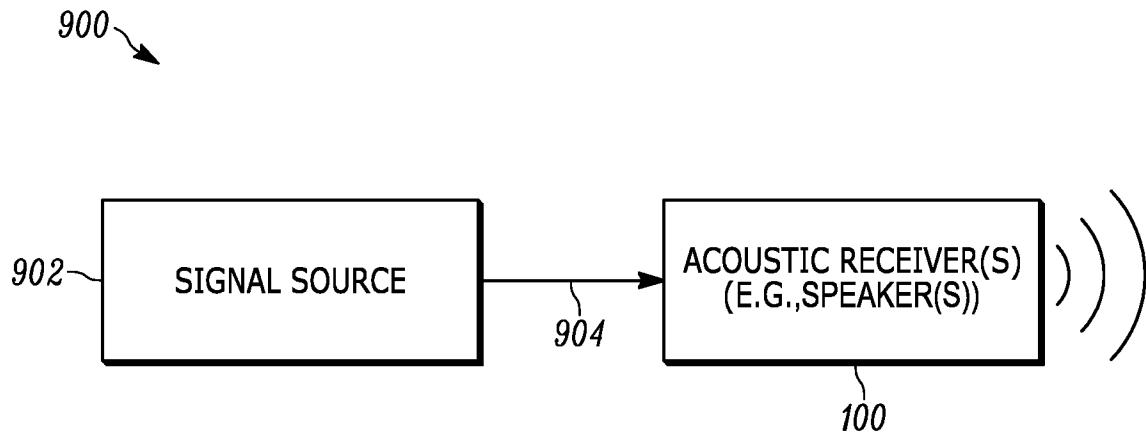


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/061500

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04R1/28

ADD. H04R1/10 H04R11/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2011/182455 A1 (WICKSTROM TIMOTHY K [US] ET AL) 28 July 2011 (2011-07-28) paragraph [0043] - paragraph [0044]; figures 8-9 paragraph [0072] - paragraph [0078] paragraph [0045] - paragraph [0048] -----	1-7,9-15
X	US 2009/147981 A1 (BLANCHARD MARK A [US] ET AL) 11 June 2009 (2009-06-11) paragraph [0043] - paragraph [0046]; figures 7-10 paragraph [0052] - paragraph [0053] ----- -/-	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27 January 2017

Date of mailing of the international search report

08/02/2017

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Will, Robert

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/061500

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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