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(54) **IN EAR HEARING DEVICE WITH A HOUSING ENCLOSING ACOUSTICALLY COUPLED VOLUME PORTIONS**

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DISPOSITIF AUDITIF INTRA-AURICULAIRE DOTÉ D'UN BOÎTIER RENFERMANT DES PARTIES DE VOLUME COUPLÉES ACOUSTIQUEMENT

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EP 3 849 206 B1

Description

TECHNICAL FIELD

[0001] This disclosure relates to a hearing device, and more specifically to a hearing device comprising an acoustic transducer acoustically coupling a first volume portion and a second volume portion inside a housing configured to be at least partially inserted into an ear canal, according to the preamble of claim 1.

BACKGROUND

[0002] Hearing devices may be used to improve the hearing capability or communication capability of a user, for instance by compensating a hearing loss of a hearing-impaired user, in which case the hearing device is commonly referred to as a hearing instrument such as a hearing aid, or hearing prosthesis. A hearing device may also be used to produce a sound in a user's ear canal. Sound may be communicated by a wire or wirelessly to a hearing device, which may reproduce the sound in the user's ear canal. Different types of hearing devices can be distinguished by the position at which they are intended to be worn at an ear of a user. For instance, earbuds, earphones, and hearing instruments such as in-the-ear (ITE) hearing aids, invisible-in-the-canal (IIC) hearing aids, and completely-in-the-canal (CIC) hearing aids, commonly comprise a housing intended to be worn at a position at the ear at least partially inserted inside the ear canal. Such an earpiece housing typically accommodates an acoustic transducer with an oscillator element configured to produce sound waves. Examples include dynamic "moving coil" transducers, and balanced armature transducers. Other types of hearing devices, for instance receiver-in-the-canal (RIC) hearing aids, also comprise such an earpiece housing, and an additional housing configured to be worn at a wearing position behind the ear to accommodate other functional components of the hearing device.

[0003] The acoustic design of the earpiece housing can have significant influence on the acoustic performance of the hearing device. In some hearing devices, the acoustic transducer is disposed inside the housing such that the inner housing volume is divided into a first volume portion and a second volume portion acoustically coupled by the oscillator element. Inherent trade-offs need to be considered, specifically in the design of the second volume portion behind the acoustic transducer. Important acoustic parameters that are desired to be tweaked by the acoustic design can include the low-frequency sensitivity and the mechano-acoustic resonance peak of the output sound. For both parameters, a constant value would be highly desirable. On the one hand, leaving the second volume portion behind the acoustic transducer open to the ambient environment can be useful to improve the low-frequency sensitivity. As a negative side effect, however, the mechano-acoustic resonance peak can then largely depend on the specific acoustic load impedance at the hearing device, which varies with individual parameters, such as the ear geometry and the quality of the sealing between the housing and the ear canal. On the other hand, fully closing the second volume portion with respect to the ambient environment can keep the mechano-acoustic resonance peak constant. But then the low-frequency sensitivity can depend strongly on the specific acoustic load impedance.

[0004] As an interim solution, the second volume portion may be vented towards the ambient environment by an acoustic port. The acoustic port may provide an acoustic impedance corresponding to an acoustic mass. This can render both the mechano-acoustic resonance peak and the low-frequency sensitivity level more independent of the acoustic load impedance. EP 3 177 033 A1 discloses a hearing device in which two volume portions separated by the acoustic transducer are each acoustically coupled to the ambient environment by a respective acoustic port in the housing. The resulting benefit may be paid, however, by a dip in the frequency response. The origin of the frequency dip can be a Helmholtz resonance between a predominantly reactive and/or inductive acoustic port and a predominantly capacitive second volume behind the acoustic transducer. An acoustic resistance may be placed in parallel to the respective acoustic port. The frequency damping can thus be controlled to a certain extent. The resulting effect, however, can depend on various other constraints such as the housing geometry. Therefore, it would be desirable to provide additional and/or alternative possibilities to influence the acoustic performance of the hearing device in order to enhance the degrees of freedom and/or the effectiveness of the acoustic design for its customization to the desired acoustic parameter values.

US 2017/0223443 A1 discloses an earphone with a housing formed by two shells defining a rear acoustic chamber and a front acoustic chamber on either side of an acoustic transducer, and a nozzle leading to the front acoustic chamber to release sound waves into the ear canal. The shell defining the rear acoustic chamber includes one or both of a reactive element and a resistive element acoustically coupling the rear acoustic chamber with an environment external to the earphone. A pressure equalization (PEQ) port acoustically couples the front acoustic chamber and the rear acoustic chamber. A resistive mesh is positioned at the PEQ port.

GB 2493206 A discloses an earphone comprising a front-housing and a rear housing enclosing a microspeaker between a front volume and a rear volume, and an outlet port in an elongate ear-canal extension leading to the front volume. The rear housing is provided with a rear vent bearing an acoustic resistor between the rear volume and the external ambient. The front volume and the rear volume are interconnected by a U-shaped channel in which an acoustic resistor is placed.

SUMMARY

[0005] It is an object of the present disclosure to avoid at least one of the above mentioned disadvantages and to equip a hearing device with an acoustic design adapted to a desired acoustic performance, in particular with regard to a reduced dependency of the output sound on the acoustic load impedance and/or an optimized frequency response. It is another object to propose an adaption of the hearing device to the desired acoustic performance which can be implemented in a multifaceted way, in particular to comply with constraints in the acoustic design which may vary among different types of hearing devices. It is a further object to propose an acoustic design that can be employed for a stable performance of a feedback and/or feedforward control loop implemented with the hearing device, in particular to enable an invariance of the acoustic properties to a degree required for active noise cancelling (ANC). It is another object to propose an acoustic design yielding a rather uniform sound delivery of the hearing device when inserted in different ear canals and/or when repeatedly positioned inside an ear canal, at least at a particular frequency range. It is a further object to provide acoustical constituent parts for a hearing device by which a desired performance of output sound can be ensured, at least within a desired frequency range.

[0006] At least one of these objects can be achieved by a hearing device comprising the features of patent claim 1. Advantageous embodiments of the invention are defined by the dependent claims.

[0007] Accordingly, the invention proposes a hearing device comprising an acoustic transducer having an oscillator element configured to generate sound waves. The hearing device further comprises a housing configured to be at least partially inserted into an ear canal, the housing enclosing the acoustic transducer inside an inner volume of the housing. The acoustic transducer is included in a partition separating the inner volume into a first volume portion and a second volume portion such that the first volume portion and the second volume portion are acoustically coupled by the acoustic transducer. The hearing device further comprises a sound outlet provided at the housing and leading to the first volume portion, the sound outlet configured to release sound waves from the first volume portion into the ear canal. The hearing device further comprises an acoustic port provided at the housing, the acoustic port acoustically coupling the inner volume to an ambient environment outside the inner volume. The hearing device further comprises a first resistive member and a second resistive member, each resistive member comprising a first terminal and a second terminal and configured to attenuate sound waves between the first terminal and the second terminal. The first terminal of the first resistive member is acoustically connected to the acoustic transducer via the first volume portion, and the first terminal of the second resistive member is acoustically connected to the acoustic transducer via the second volume portion. The partition includes the first resistive member placed in parallel to the acoustic transducer. The second resistive member is disposed inside the second volume portion, wherein the partition is a first partition and a second partition is provided in the second volume portion, the second partition separating the second volume portion into a first volume section and a second volume section, wherein the second partition includes the second resistive member, or the partition includes an inner acoustic port acoustically coupling the first volume portion and the second volume portion, wherein the first resistive member and the second resistive member are disposed at the inner acoustic port and the acoustic port acoustically coupling the inner volume to the ambient environment is acoustically connected to the inner acoustic port.

[0008] On the one hand, it has been found that the arrangement of the at least two resistive members with the first terminal acoustically connected to the acoustic transducer via the different volume portions can account for a stabilization of the frequency response and output impedance of the hearing device. Such a stabilization can be particularly effective by including the first resistive member in the partition, which can thus contribute to the acoustical coupling between the volume portions in a steady and customizable way. The second resistive member can then be advantageously employed for a customization of the acoustic coupling between the second volume portion and the ambient environment allowing a further stabilization of the acoustic properties. On the other hand, the proposed arrangement of the at least two resistive members can be implemented in a variety of different ways, some instances of which described in the following disclosure, allowing to select an implementation most appropriate for a certain type of hearing device and to match the customization with specific device properties, for instance a given geometry of the housing and/or specific acoustic components included in the housing and/or a desired acoustic functionality of the hearing device such as, for instance, active noise control (ANC).

[0009] In order to provide the acoustic connection via the second volume portion, the first terminal of the second resistive member may be disposed at the second volume portion. In order to provide the acoustic connection via the first volume portion, the first terminal of the first resistive member may be disposed at the first volume portion or at an inner acoustic port, which may be acoustically connected to the first volume portion. The acoustic transducer may be included in the partition such that the first volume portion is in front of the acoustic transducer and the second volume portion is behind the acoustic transducer.

[0010] The first volume portion and the second volume portion can be acoustically coupled via the first resistive member. To this end, the second terminal of the first resistive member may be oriented toward the second volume portion. In particular, the second terminal of the first resistive member may be disposed at the second volume portion or at an inner acoustic port acoustically coupling the first volume portion and the second volume portion.

[0011] The second volume portion and the ambient environment can be acoustically coupled via the second resistive member. In some implementations, the second resistive member is placed in series with the acoustic port. The series placement can be advantageous as compared to the parallel placement in that it can be provided in different ways and therefore allow a larger degree of freedom for the customization of the hearing device to the desired acoustic properties.

[0012] In some implementations, the second resistive member is disposed inside the second volume portion. Such an arrangement may be implemented in a series placement of the second resistive member with respect to the acoustic port. In the series placement, the second terminal of the second resistive member may be acoustically connected with the ambient environment via the acoustic port, in some instances via the second volume portion and the acoustic port. The second terminal of the second resistive member may be oriented toward the acoustic port.

[0013] In some implementations, the partition is a first partition, wherein a second partition is provided in the second volume portion, the second partition separating the second volume portion into a first volume section and a second volume section, wherein the second partition includes the second resistive member. In this way, a series placement of the second resistive member with the acoustic port may be implemented. In addition, the acoustic properties can be further customized, in particular with a desired stabilization of the frequency response and/or of the output impedance, by selecting an appropriate volumetric ratio of the volume sections and/or by accommodating electric and/or acoustic components in a selected volume section.

[0014] The first resistive member and/or second resistive member can comprise a sound resistive body between the first terminal and the second terminal. The acoustic properties can be customized by a material and/or size of the sound resistive body. A desired effect of the customization may be increased by filling a larger volumetric portion with the sound resistive body. In order to provide such a larger volumetric portion, the sound resistive body may be at least partially disposed inside the inner volume, preferably at least partially inside the second volume portion. In some implementations, the sound resistive body fills at least one fifth of the second volume portion. In some implementations, the customization effect may be further enhanced by the sound resistive body filling at least one half of the second volume portion. Additional electric and/or acoustic components may be provided in the second volume portion which may be surrounded by the sound resistive body filling the respective volume portion.

[0015] In some implementations, the sound resistive body comprises a porous material. Such a material, for instance a foam, may be included in the inner volume rather effortlessly and can enable a large customization effect.

[0016] In some implementations, the partition includes an inner acoustic port acoustically coupling the first volume portion and the second volume portion, wherein the first resistive member and the second resistive member are disposed at the inner acoustic port. The inner acoustic port comprises a tubular element extending between the first volume portion and the second volume portion. The tubular element comprises two open ends opposing each other. The first open end leads to the first volume portion and the second open end leads to the second volume portion. The first resistive member may be disposed at the first open end of the tubular element. The second resistive member may be disposed at the second open end of the tubular element. Alternatively, the first resistive member and/or the second resistive member may be disposed inside the tubular element, in particular at a distance to the first open end and/or the second open end.

[0017] In some implementations, the acoustic port acoustically coupling the inner volume to the ambient environment is acoustically connected to the inner acoustic port. The acoustic port then may lead from the inner acoustic port to the ambient environment. In particular, the acoustic port may be acoustically connected to the inner acoustic port at a position between the first resistive member and the second resistive member. The position at which the acoustic port leads from the inner acoustic port to the ambient environment may thus be provided between the first resistive member and the second resistive member. In this way, a series placement of the first resistive member with the acoustic port can be implemented, in addition to a series placement of the second resistive member with the acoustic port and an acoustic coupling between the volume portions via the first and second resistive members, which can further enhance the customization effect of the acoustic properties, in particular for a stable frequency response and/or output impedance. Moreover, adjusting the geometry of the inner acoustic port can allow further customization, for instance by selecting an appropriate value of an acoustic mass defined by the inner acoustic port in accordance with a desired frequency response. The acoustic port acoustically coupling the inner volume to the ambient environment may also be designated as an outer acoustic port.

[0018] In order to provide an acoustic coupling between the inner volume and the ambient environment, the acoustic port can comprise an aperture in the housing, the aperture leading from the inner volume toward the ambient environment. The acoustic port may lead to the second volume portion such that the acoustic port acoustically couples the second volume portion to the ambient environment. The acoustic port may also lead to the first volume portion such that the acoustic port acoustically couples the first volume portion to the ambient environment. In some implementations, the acoustic port is a first acoustic port acoustically coupling the second volume portion to the ambient environment, the hearing device further comprising a second acoustic port acoustically coupling the first volume portion to the ambient environment.

[0019] In some implementations, the acoustic port is a reactive member. The reactive member may comprise a tubular element. The reactive member can be configured to interact with the inner volume and/or with the ambient environment within at least one resonance frequency. The resonance frequency can depend on an acoustic mass of the acoustic port. The acoustic mass of the acoustic port may be defined by the tubular element, in particular by a length and/or cross section of an aperture surrounded by the tubular element and/or a sound conducting medium inside the aperture. Adjusting the acoustic mass thus allows to further customize the acoustic properties, in particular with regard to a stabilized frequency response and/or output impedance.

[0020] In some implementations, the acoustic transducer comprises a transducer housing accommodating the oscillator element. The transducer housing can be included in the partition. The transducer housing can comprise a front port acoustically coupling the oscillator element to the first volume portion and a rear port acoustically coupling the oscillator element to the second volume portion. The transducer housing can accommodate further components of the acoustic transducer, in particular components required to move the oscillator element for generating sound waves. In some instances, an acoustic resistance can be provided at the rear port and/or inside the rear port.

[0021] In some implementations, the acoustic transducer comprises a speaker driver including the oscillator element. The speaker driver can further comprise a voice coil mechanically connected to oscillator element and a magnet configured to move the voice coil. In particular, the acoustic transducer may be a moving coil driver. In some implementations, the acoustic transducer may be a balanced armature driver.

[0022] In some implementations, the hearing device comprises a feedback control circuit and/or a feedforward control circuit. The feedback control circuit and/or feedforward control circuit can be configured to modify the sound waves generated by the acoustic transducer depending a microphone signal, in particular after a processing of the microphone signal. The processing of the microphone signal can comprise at least one of a filtering, adding, subtracting, and amplifying of the microphone signal. In some implementations, feedback control circuit and/or feedforward control circuit is configured to provide an active noise control (ANC) or active noise reduction (ANR) of the sound waves generated by the acoustic transducer. A stable behaviour of the hearing device adapted for the feedback control and/or feedforward control, in particular with respect to the frequency response and/or output impedance, may be provided by a customization of the acoustic properties in accordance with the present disclosure.

[0023] The feedback control circuit and/or feedforward control circuit can each comprise a microphone configured to provide the microphone signal. The microphone can be an ear canal microphone. In some implementations, a microphone is provided in the inner volume. In particular, the microphone of the feedback control circuit may be provided in the second volume portion. The microphone of the feedback control circuit may be provided in the first volume portion. In some implementations, the microphone is provided outside the inner volume, in particular at a region outside the housing positioned at an inner ear canal region when the housing is at least partially inserted in the ear canal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. In the drawings:

Figs. 1 - 5	are schematic cross sections of a respective hearing device comprising a housing partially inserted into an ear canal, the housing accommodating an acoustic transducer; and
Figs. 6A - 6F	schematically illustrate a respective acoustic component that can be used in a hearing device illustrated in Figs. 1 - 5.

DETAILED DESCRIPTION OF THE DRAWINGS

[0025] FIG. 1 depicts a hearing device 101. Hearing device 101 comprises a housing 111. Housing 111 is an earpiece housing configured for partial insertion into an ear canal 11 along an ear canal wall 12, as schematically illustrated. Housing 111 encloses an inner volume 116. An acoustic transducer 151 is accommodated in inner volume 116.

[0026] Hearing device 101 may include additional components as may serve a particular implementation. For instance, hearing device 101 may include a processing unit, which may include a memory. Hearing device 101 may include a signal processing circuitry configured to process an audio signal which is output by acoustic transducer 151. Hearing device 101 may include a feedback control circuit and/or a feedforward control circuit connected to acoustic transducer 151. The feedback control circuit and/or the feedforward control circuit can comprise a microphone, in particular an ear canal microphone, configured to detect sound inside the ear canal and to provide an audio signal based on the detected sound. The feedback control circuit and/or feedforward control circuit may be configured to perform an active noise control (ANC) of the sound waves generated by acoustic transducer 151, for instance based on an evaluation of the audio signal. Hearing device 101 may also include at least one microphone, in particular a microphone configured to detect sound from the ambient environment outside the ear canal, and/or an inertial sensor and/or an optical sensor and/or a temperature sensor and/or an electromagnetic field sensor and/or a biometric sensor and/or other components commonly provided in a hearing device. Those components may be accommodated in inner volume 116 or outside housing 111 or they may be provided by a separate unit, which may be communicatively coupled with acoustic transducer 151.

[0027] A customization of the acoustic properties of inner volume 116 can be beneficial for many reasons. For instance, it can be desirable to account for a desired frequency response and/or output impedance with regard to specific electro-acoustic components included in housing 111. To illustrate, a stable performance of a feedback control circuit and/or a feedforward control circuit connected to acoustic transducer 151 may be effectuated by such a customization to allow a reliable active noise control (ANC) controlled by the circuit. A customization of the acoustic properties can also be useful to enable a stable and reproducible acoustic performance of the hearing device in different hearing situations and for different users of the hearing device. Various implementations, by which such a customization can be achieved, are described in the description that follows.

[0028] FIG. 1 schematically depicts housing 111. The geometry of housing 111 may be modified according to specific technical constraints and/or user requirements. Housing 111 comprises a front wall 112, a rear wall 113 opposing front wall 112, and a side wall 114 connecting front wall 112 and rear wall 113. Front wall 112 at least partially faces ear canal 11 after insertion of the housing. Acoustic transducer 151 is disposed between a first volume portion 117 and a second volume portion 118 of inner volume 116. In the illustrated example, acoustic transducer 151 is spaced from side wall 114. The spacing is provided such that acoustic transducer 151 extends over a center portion of a cross-section of inner volume 116. First volume portion 117 is located in front of acoustic transducer 151, more particularly between acoustic transducer 151 and front wall 112. Second volume portion 118 is located behind acoustic transducer 151, more particularly between acoustic transducer 151 and rear wall 113.

[0029] A partition 115 is provided between first volume portion 117 and second volume portion 118. Partition 115 separates inner volume 116 into first volume portion 117 and second volume portion 118. Partition 115 comprises acoustic transducer 151. Partition 115 further comprises a resistive member 131. In this way, acoustic transducer 151 and resistive member 131 at least partially separate inner volume 116 into first volume portion 117 and second volume portion 118.

[0030] Partition 115 extends over a cross-section of inner volume 116 surrounded by side wall 114. Housing 111 comprises a first housing portion 127 enclosing first volume portion 117. First housing portion 127 comprises rear wall 113 and a portion of side wall 114 extending between rear wall 113 and partition 115. Housing 111 comprises a second housing portion 128 enclosing second volume portion 118. Second housing portion 128 comprises front wall 112 and a portion of side wall 114 extending between front wall 112 and partition 115. A size and/or ratio of volume portions 117, 118 and/or a position of partition 115 inside inner volume 116 can be selected in accordance with a desired customization of the acoustic properties at the acoustic pathway of sound waves passing inside inner volume 116.

[0031] In the illustrated example, acoustic transducer 151 comprises a speaker driver 152. Driver 152 comprises an oscillator element 153, for instance a membrane, and an oscillation drive 154. Oscillator element 153 provides an acoustical coupling between first volume portion 117 and second volume portion 118. Sound waves can traverse partition 115 through oscillator element 153. Oscillator element 153 is configured to transfer pressure variations caused by the sound waves between first volume portion 117 and second volume portion 118. Oscillation drive 154 comprises a magnet 155 and a voice coil 156. Voice coil 156 is mechanically connected to oscillator element 153. Voice coil 156 is constrained to move axially through a cylindrical gap in magnet 155. A variable magnetic field can be created by providing a changing electric current through voice coil 156. The variable magnetic field can cause voice coil 155 to move back and forth inside the cylindrical gap by a magnetic interaction between magnet 155 and voice coil 156. A corresponding movement of oscillator element 153 coupled to voice coil 156 can produce sound waves emanating from an oscillating area of oscillator element 153.

[0032] In other examples, a different type of a moving coil driver and/or other types of sound wave generators may be provided in the place of driver 152, for instance a balanced armature driver. Generally, acoustic transducer 151 may be provided inside inner volume 116 without a transducer housing, as illustrated in FIG. 1, or may comprise a transducer housing accommodating driver 152 and/or oscillator element 153, as illustrated below in FIGS. 3 and 4. In some instances, partition 115 may comprise oscillator element 153 of acoustic transducer 151, which may be provided without a transducer housing. In some instances, partition 115 may comprise a transducer housing of acoustic transducer 151.

[0033] A sound outlet 122 is provided at first housing portion 127. Sound outlet 122 leads from inner volume 116 to an exterior of housing 111. Sound waves can be released from inner volume 116 to the exterior through sound outlet 122. In the illustrated example, sound outlet 122 is arranged in front of acoustic transducer 151 such that oscillator element 153 faces sound outlet 122. In the illustrated example, sound outlet 122 is a spout. Spout 122 has an open rear end adjoining an aperture in front wall 112 and an open front end opposing the rear end. The open front end is free. Sound waves can be released to the exterior through the open front end.

[0034] In some implementations, housing 111 comprises a sealing member 123 configured to contact an ear canal wall 12 of ear canal 11. In the illustrated example, sealing member 123 is positioned at first housing portion 127. Sealing member 123 may be provided by an elastic member and/or by a portion of housing 111 configured to contact ear canal wall 12. At the contact, sealing member 123 may form an acoustical seal with ear canal wall 12. The acoustical seal can acoustically isolate the open front end of sound outlet 122 in ear canal 11 from an ambient environment outside ear canal 11, at least to some extent. In this way, ambient sound from the ambient environment outside ear canal 11 can be at least partially blocked from entering an inner region of ear canal 11.

[0035] Resistive member 131 is located between first volume portion 117 and second volume portion 118. Resistive member 131 provides an acoustical coupling between first volume portion 117 and second volume portion 118. Resistive member 131 is placed in parallel to acoustic transducer 151. An acoustic pathway between first volume portion 117 and second volume portion 118 thus extends through acoustic transducer 151, and, in parallel, through resistive member 131. Sound waves can traverse partition 115 through resistive member 131 and acoustic transducer 151.

[0036] Resistive member 131 comprises a first terminal 132 oriented toward first volume portion 117. First terminal 132 is acoustically connected to acoustic transducer 151 via first volume portion 117. First terminal 132 adjoins first volume portion 117. First terminal 132 is placed in a sequence with acoustic transducer 151 through first volume portion 117 located in between. Resistive member 131 comprises a second terminal 133 oriented toward second volume portion 118. Second terminal 133 is acoustically connected to acoustic transducer 151 via second volume portion 118. Second terminal 133 adjoins second volume portion 118. Second terminal 133 is placed in a sequence with acoustic transducer 151 through second volume portion 118.

[0037] Resistive member 131 is configured to attenuate sound waves passing between first terminal 132 and second terminal 133. For this purpose, resistive member 131 is configured to dissipate a proportion of acoustic energy that impinges on first terminal 132 and/or second terminal 133 and/or that passes through resistive member 131 in any direction between first terminal 132 and second terminal 133. Resistive member 131 can comprise a sound resistive body between first terminal 132 and second terminal 133. The sound resistive body can comprise, for instance, a grid structure such as a wire mesh and/or a damping material such as a cloth, a foam and/or another porous material. Resistive member 131 can provide a customization of acoustic properties at the acoustic pathway of sound waves passing inside inner volume 116, in particular with respect to a desired frequency response and/or output impedance measurable at sound outlet 122.

[0038] An acoustic port 135 is provided at housing 111. Acoustic port 135 acoustically couples inner volume 116 with an ambient environment outside inner volume 116. Acoustic port 135 comprises an aperture inside housing 111 through which the acoustical coupling is provided. In some implementations, acoustic port 135 comprises a tubular element 136 surrounding the aperture. The aperture can define an acoustic mass of the acoustic port. In particular, a length and/or cross section of tubular element 136 surrounding the aperture can be selected corresponding to a desired acoustic mass of acoustic port 135.

[0039] An acoustic mass of acoustic port 135 can interact with inner volume 116 and/or the ambient environment to establish a resonant acoustic circuit having at least one resonance at a resonance frequency. The resonance frequency depends on the acoustic mass. Acoustic port 135 thus provides a reactive member between inner volume 116 and the ambient environment. Alternatively or complementary, acoustic port 135 can be configured to relieve air pressure that could be built up within inner volume 116 and/or within the ear canal to the ambient environment. Acoustic port 135 can thus provide a further customization of acoustic properties at the acoustic pathway of sound waves passing inside inner volume 116, in particular with respect to a desired frequency response and/or output impedance measurable at sound outlet 122.

[0040] In the illustrated example, acoustic port 135 is disposed at second housing portion 128 enclosing second volume portion 118. Acoustic port 135 thus acoustically couples second volume portion 118 with the ambient environment in order to provide a reactive member between second volume portion 118 and the ambient environment and/or to provide relieve of air pressure that could be built up within second volume portion 118.

[0041] Resistive member 131 is a first resistive member. A second resistive member 171 comprises a first terminal 172 acoustically connected to acoustic transducer 151 via second volume portion 118. First terminal 172 is placed in a sequence with acoustic transducer 151 through second volume portion 118. First terminal 172 is oriented toward acoustic transducer 151. Second resistive member 171 comprises a second terminal 173 acoustically connected to acoustic port 135 via second volume portion 118. Second terminal 173 of second resistive member 171 is placed in a sequence with acoustic port 135 through second volume portion 118. Second terminal 173 is oriented toward acoustic port 135. First terminal 172 and second terminal 173 adjoin second volume portion 118. Second resistive member 171 can provide a further customization of acoustic properties inside inner volume 116, in particular with respect to a desired frequency response and/or output impedance measurable at sound outlet 122.

[0042] Second terminal 173 of second resistive member 171 is placed in series with acoustic port 135. Sound waves can pass through both second resistive member 171 and acoustic port 135 during propagation of the sound waves in a propagation direction. For instance, sound waves generated by acoustic transducer 151 can pass through second resistive member 171, and successively, after attenuation provided by second resistive member 171, through acoustic port 135. As a result, a synergetic customization effect of the acoustic properties of the sound waves can be obtained by second resistive member 171 providing a predominantly resistive effect, and acoustic port 135 providing a predominantly reactive effect and/or pressure relieve effect.

[0043] Second resistive member 171 is disposed inside second volume portion 118 enclosed by second housing portion 128. Second terminal 173 of second resistive member 171 is spaced from acoustic port 135 such that it has a distance from acoustic port 135 inside second volume portion 118. First terminal 172 of second resistive member 171 is spaced from acoustic transducer 151 such that it has a distance from acoustic transducer 151 inside second volume portion 118.

[0044] Partition 115 is a first partition. A second partition 175 provided inside second volume portion 118 comprises second resistive member 171. Partition 115 is spaced from acoustic port 135 and from acoustic transducer 151. Second partition 175 separates second volume portion 118 in a first volume section 177 and a second volume section 178. First volume section 177 and second volume section 178 are acoustically coupled by second resistive member 171. Second partition 175 can be configured to acoustically isolate first volume section 177 and second volume section 178 except for the acoustical coupling provided by second resistive member 171.

[0045] Acoustic transducer 151 adjoins first volume section 177 of second volume portion 118 such that oscillator element 153 is acoustically connected to first volume section 177. First resistive member 131 adjoins first volume section 177 at second terminal 133. Acoustic port 135 adjoins second volume section 178 of second volume portion 118 such that acoustic port 135 is acoustically connected to second volume section 178. First volume section 177 is delimited by a portion of housing 111 extending between first partition 115 and second partition 175. Second volume section 178 is delimited by a portion of housing 111 extending between second partition 175 and acoustic port 135. A size and/or ratio of volume sections 177, 178 of second volume portion 118 and/or a position of second partition 175 inside second volume portion 118 can influence the acoustic properties at the acoustic pathway of sound waves passing inside inner volume 116. Second partition 175 can thus provide a further customization of the acoustic properties.

[0046] FIG. 2 schematically depicts a hearing device 201. A partition 215 separating inner volume 116 into first volume portion 117 and second volume portion 118 extends between front wall 112 and rear wall 113. In the illustrated example, partition 215 substantially extends in parallel to side wall 114. Partition 215 comprises acoustic transducer 151 and resistive member 131. Oscillator element 153 faces side wall 114. First terminal 132 and second terminal 133 of resistive member 131 also face side wall 114.

[0047] FIG. 3 schematically depicts a hearing device 231 comprising an acoustic transducer 251. Acoustic transducer 251 comprises driver 152 and a transducer housing 161 accommodating driver 152 in an inner volume of transducer housing 161. Transducer housing 161 comprises a transducer front port 162 and a transducer rear port 163 opposing each other. In the illustrated example, transducer front port 162 faces front wall 112 and transducer rear port 163 faces rear wall 113. Oscillator element 153 is disposed between transducer front port 162 and transducer rear port 163 such that sound waves emanated from oscillator element 153 can pass through transducer front port 162 and transducer rear port 163.

[0048] Transducer front port 162 and/or transducer rear port 163 comprise an aperture inside transducer housing 161. The aperture allows a pressure relief of the sound waves produced inside transducer housing 161. In some implementations, transducer front port 162 and/or transducer rear port 163 may comprise a tubular element surrounding the aperture. Transducer front port 162 and/or transducer rear port 163 can thus provide a reactive member in the above described way. First terminal 132 of resistive member 131 is acoustically connected to transducer front port 162 via first volume portion 117. Second terminal 172 of second resistive member 171 is acoustically connected to transducer rear port 163 via second volume portion 118.

[0049] FIG. 4 schematically depicts a hearing device 251. A resistive member 211 is disposed inside transducer rear port 163. Resistive member 211 comprises a first terminal facing oscillator element 153 and a second terminal facing second volume portion 118. Resistive member 211 of transducer rear port 163 can thus be employed to modify the acoustic coupling provided by transducer rear port 163 in order to customize the acoustic properties inside inner volume 116. For instance, predominantly reactive properties of transducer rear port 163 may thus be modified such that transducer rear port 163 also exhibits resistive properties, at least to a certain extent. Resistive member 211 of transducer rear port 163 is spaced from acoustic port 135 at a distance in second volume portion 118. Resistive member 211 of transducer rear port 163 is also spaced from second resistive member 171 at a distance in second volume portion 118.

[0050] A resistive member 221 is provided at acoustic port 135. Resistive member 221 is disposed inside tubular element 136. Resistive member 221 comprises a first terminal facing second volume portion 118 and a second terminal facing the ambient environment. Resistive member 211 can be employed to modify the acoustic coupling with the ambient environment provided by acoustic port 135. Thus, acoustic properties inside inner volume 116 can be further customized. For instance, predominantly reactive properties of acoustic port 135 may thus be modified such that acoustic port 135 also exhibits resistive properties, at least to a certain extent.

[0051] Partition 115 comprises an aperture 215. Aperture 215 constitutes an inner acoustic port between first volume portion 117 and second volume portion 118. First volume portion 117 and second volume portion 118 are thus acoustically coupled by aperture 215 allowing further customization of the acoustic properties inside inner volume 116.

[0052] FIG. 5 schematically depicts a hearing device 601. An inner acoustic port 615 is provided at partition 115. Inner acoustic port 615 acoustically couples first volume portion 117 and second volume portion 118 in inner volume 116. Inner acoustic port 615 can comprise a tubular element 616. An acoustic mass of inner acoustic port 615 may be determined by a length and/or cross section of tubular element 616. First resistive member 131 is provided at a front end of inner acoustic port 615 adjoining first volume portion 117. First terminal 132 of first resistive member 131 is acoustically connected to acoustic transducer 151 through first volume portion 117.

[0053] An acoustic port 635 is provided at housing 111. Acoustic port 635 is an outer acoustic port comprising an aperture inside housing 111. Acoustic port 635 acoustically couples the ambient environment outside inner volume 116 to inner acoustic port 615. Acoustic port 635 may comprise an acoustic mass in addition to the acoustic mass of inner acoustic port 615. To this end, acoustic port 635 can comprise a tubular element 636. Alternatively, acoustic port 635 may be provided by an aperture in housing 111 having a negligible acoustic mass, for instance by providing the aperture with a comparatively large diameter. Second terminal 133 of first resistive member 131 is oriented toward second volume portion 118. Second terminal 133 of first resistive member 131 is acoustically connected to the ambient environment via inner acoustic port 615 and outer acoustic port 635.

[0054] A second resistive member 671 is provided in addition to first resistive member 131. Second resistive member 671 is provided at a rear end of inner acoustic port 615 adjoining second volume portion 117. Second resistive member 671 comprises a first terminal 672 acoustically connected to acoustic transducer 151 via second volume portion 118. Second resistive member 671 comprises a second terminal 673 facing second terminal 133 of first resistive member 131. Second terminal 673 of second resistive member 671 is oriented toward first volume portion 117. First resistive member 131 and second resistive member 671 are spaced from outer acoustic port 635 by inner acoustic port 615 passing in between. Second terminal 673 of second resistive member 671 is acoustically connected to the ambient environment through inner acoustic port 615 and outer acoustic port 635. Second terminal 673 of second resistive member 671 is placed in series with acoustic port 635. Sound waves can pass through both second resistive member 671 and acoustic port 635 in a sequence. In such a manner, acoustic properties can be further customized inside inner volume 116.

[0055] The features described above in conjunction with FIG. 1 to FIG. 5, in particular any of resistive members 131, 171, 211, 221, 671 and/or acoustic ports 135, 615, 635 may be combined with any other of those features to customize the acoustic properties inside inner volume 116, in particular for achieving a desired frequency response and/or output impedance for electro-acoustic components included in housing 111.

[0056] FIG. 6A schematically illustrates an acoustic component 901. Acoustic component 901 is a resistive member configured to attenuate sound waves passing between a first terminal 902 and a second terminal 903. Resistive member 901 comprises a sound resistive body 905. Sound resistive body 905 can be composed of a sound damping material, such as a cloth and/or a foam, and/or a grid structure, such as a wire mesh. Sound resistive body 905 can thus provide an increased sound resistance as compared to a sound conducting medium, such as air, surrounding sound resistive body 905. Sound resistive body 905 comprises a first face 906 and a second face 907 oriented in different directions. First terminal 902 is provided at first face 906 and second terminal 903 is provided at second face 907. Resistive member 901 may be employed in the place of any resistive members 131, 171, 211, 221, 671 described above.

[0057] FIG. 6B schematically illustrates another acoustic component 911. Acoustic component 911 is a reactive member configured to interact with an acoustic environment. Reactive member 911 has an acoustic mass acoustically coupling the acoustic environment between a first terminal 912 and a second terminal 913 of reactive member 911. To this end, reactive member 911 may provide at least one resonance frequency defined by the acoustic mass. Reactive member 911 comprises a tubular element 915 extending between first terminal 912 and a second terminal 913. Tubular element 915 has a first open end 916 and a second open end 917. First terminal 912 is provided at an aperture defined by first open end 916, and second terminal 913 is provided at an aperture defined by second open end 917. Tubular element 915 is filled by a sound conducting medium such as air. The acoustic mass of reactive member 911 can be defined by a length and/or cross section of tubular element 915 and/or the properties of the sound conducting medium. Reactive member 911 may be employed in the place of any acoustic ports 135, 615, 635 described above.

[0058] FIG. 6C schematically illustrates another acoustic component 921. Acoustic component 921 comprises tubular element 915. A cross section of an inner volume of tubular element 915 is filled with sound resistive body 905 at a first part 926 of acoustic component 921 extending over part of a length of tubular element 915. Sound resistive body 905 closes first end 916 of tubular element 915. First part 926 constitutes a resistive member. A second part 927 of acoustic component 921 extending over a remaining part of the length of tubular element 915 is filled with the sound conducting medium. Second part 927 thus constitutes a reactive member. Reactive member 927 may be employed in the place of any acoustic ports 135, 615, 635 described above. First part 926 provides an increased acoustic resistance as compared to second part 927. Second part 926 provides an increased acoustic reactance as compared to first part 926. A first terminal 922 of reactive member 927 adjoins second terminal 903 of resistive member 926. Resistive member 926 is thus placed in series with reactive member 927 between first terminal 902 and second terminal 913 of acoustic component 921.

[0059] FIG. 6D schematically illustrates another acoustic component 941. Acoustic component 941 comprises tubular element 915. A first fraction 948 of a cross section of an inner volume of tubular element 915 is filled with a sound resistive body 945. First cross sectional fraction 948 constitutes a first part of acoustic component 941 extending over the length of tubular element 915. First cross sectional fraction 948 thus constitutes a resistive member. In the illustrated example, first cross sectional fraction 948 fills a first half of the cross section of the inner volume of tubular element 915. A second fraction 949 of a cross section of an inner volume of tubular element 915 is filled with the sound conducting medium over the length of tubular element 915. Second cross sectional fraction 949 thus constitutes a reactive member. Reactive member 949 may be employed in the place of any acoustic ports 135, 615, 635 described above. First cross sectional fraction 948 provides an increased acoustic resistance as compared to second cross sectional fraction 949. Second cross sectional fraction 949 provides an increased acoustic reactance as compared to first cross sectional fraction 948. Resistive member 948 and reactive member 949 are placed in parallel between first end 916 and second end 917 of tubular element 915.

[0060] First end 916 of tubular element 915 is a first face of acoustic component 941. Second end 917 of tubular element 915 is a second face of acoustic component 941 opposing the first face. First face 916 comprises a first part 942. First part 942 is a first terminal of resistive member 948. First part 942 of first face 916 thus constitutes a first terminal of acoustic component 941. Second face 917 comprises a first part 943. First part 943 of second face 917 is a second terminal of resistive member 948. First part 943 of second face 917 thus constitutes a second terminal of acoustic component 941. Sound waves can be attenuated between first terminal 942 and second terminal 943. In the illustrated example, first terminal 942 and second terminal 943 have a semi-circular shape. First face 916 comprises a second part 944. Second part 944 of first face 916 is a first terminal of reactive member 949. Second part 944 of first face 916 thus constitutes a third terminal of acoustic component 941. Second face 917 comprises a second part 945. Second part 945 of second face 917 is a second terminal of reactive member 949. Second part 945 of second face 917 thus constitutes a fourth terminal of acoustic component 941. Acoustic component 941 can provide a reactive acoustical coupling with the ambient environment between third terminal 944 and fourth terminal 945. First terminal 942 and third terminal 944 of acoustic component 941 are disposed in parallel to one another. First terminal 942 and third terminal 944 are thus acoustically decoupled. Third terminal 944 and fourth terminal 945 of acoustic component 941 are disposed in parallel to one another. Third terminal 944 and fourth terminal 945 are thus acoustically decoupled.

[0061] FIG. 6E schematically illustrates another acoustic component 951. Acoustic component 951 comprises tubular element 915. At the first part 926 of acoustic component 951, the cross section of an inner volume of tubular element 915 is filled with sound resistive body 905. First terminal 902 of resistive member 926 is a first terminal of acoustic component 951. Sound resistive body 905 is a first sound resistive body. A second part 957 of acoustic component 951 extends over a remaining part of the length of tubular element 915. Second part 957 comprises a first fraction 958 of a cross section of an inner volume of tubular element 915. Second part 957 is filled with a second sound resistive body 955. Second sound resistive body 955 adjoins first sound resistive body 905 at a second part 954 of second face 907. A resistive member is thus provided by the series placement of first sound resistive body 905 and second sound resistive body 955. In particular, first sound resistive body 905 and second sound resistive body 955 can be joined at the second part 954 of second face 907 of first sound resistive body 905 such that they form an integral element constituting resistive member 905, 955. First part 943 of second face 917 of tubular element 915 is a second terminal of resistive member 905, 955. First part 943 of second face 917 thus constitutes a second terminal of acoustic component 951. Sound waves can be attenuated between first terminal 902 and second terminal 943. A second resistive portion of resistive member 905, 955 extends between first terminal 902 and second terminal 943.

[0062] Second part 957 of acoustic component 951 comprises a second cross sectional fraction 959 of tubular element 915. Second part 957 is filled with the sound conducting medium. Second cross sectional fraction 959 thus constitutes a reactive member. Reactive member 959 may be employed in the place of any acoustic ports 135, 615, 635 described above. First part 926 and first cross sectional fraction 958 of second part 957 of acoustic component 951 provide an increased acoustic resistance as compared to second cross sectional fraction 959 of second part 957. Second cross sectional fraction 959 of second part 957 provides an increased acoustic reactance as compared to first part 926 and first cross sectional fraction 958 of second part 957. Reactive member 959 adjoins sound resistive body 905 at a first part 953 of second face 907. Terminal 903 provided at second face 907 of first sound resistive body 905 thus constitutes a third terminal of resistive member 905, 955 placed in series with reactive member 959. Sound waves can be attenuated between first terminal 902 and third terminal 903. A first resistive portion of resistive member 905, 955 extends between first terminal 902 and third terminal 903 of resistive member 905, 955. A first face 943, 953 of resistive member 905, 955 comprises first part 953 and second part 943. Resistive member 905, 955 thus comprises first face 906 and second face 943, 953 oriented in opposite directions. Second face 943, 953 comprises first part 953 and second part 943.

[0063] Third terminal 903 of resistive member 905, 955 adjoins a first terminal of reactive member 959. A second terminal of reactive member 959 is provided at second part 945 of second face 917 of tubular element 915. Second terminal 945 of reactive member 959 is a third terminal of acoustic component 951. Acoustic component 951 thus comprises a series placement of the first resistive portion of resistive member 905, 955 with reactive member 959, which is placed in parallel with the second resistive portion of resistive member 905, 955.

[0064] FIG. 6F schematically illustrates another acoustic component 971. Acoustic component 971 comprises sound resistive body 905. Sound resistive body 905 is a first sound resistive body. A second sound resistive body 975 has a first terminal 976 at a first face and a second terminal 977 at a second face. First face 976 and second face 977 are oriented in different directions. First face 976 of second sound resistive body 975 adjoins a second part 978 of second face 907 of first sound resistive body 905. Thus, a resistive member is provided by the series placement of sound resistive bodies 905, 975. Sound waves can be attenuated between first terminal 902 of first sound resistive body 905 and a second terminal 977 of second sound resistive body 975. In particular, first sound resistive body 905 and second sound resistive body 975 can be joined at the second part 978 of second face 907 of first sound resistive body 905 such that they form an integral element constituting resistive member 905, 975. First terminal 902 of first sound resistive body 905 constitutes a first terminal of acoustic component 971. Second terminal 977 of second sound resistive body 975 constitutes a second terminal of acoustic component 971. A second resistive portion of resistive member 905, 975 extends between first terminal 902 of first sound resistive body 905 and second terminal 977 of second sound resistive body 975.

[0065] A reactive member 970 has a first terminal 972 adjoining a first part 979 of second face 907 of first sound resistive body 905. Reactive member 970 may be employed in the place of any acoustic ports 135, 615, 635 described above. A first resistive portion of resistive member 905, 975 extends between first terminal 902 and first part 979 of second face 907 of first sound resistive body 905 adjoined by reactive member 970. Sound waves can be attenuated between first terminal 902 and first part 979 of second terminal 903. Reactive member 970 may comprise a tubular element extending between an open first end, at which first terminal 972 is provided, and an open second end, at which a second terminal 973 is provided. Second terminal of reactive member 970 thus constitutes a third terminal of acoustic component 971. Acoustic component 971 thus comprises a series placement of the first resistive portion of resistive member 905, 975 with reactive member 970, which is placed in parallel with the second resistive portion of resistive member 905, 975. Resistive member 905, 975 comprises first face 906 and second face 977, 979 oriented in opposite directions. Second face 977, 979 comprises two parts including first part 979 of second face 907 of first sound resistive body 905 and second face 977 of second sound resistive body 975.

[0066] Acoustic components 912 - 971 illustrated in FIGS. 6C - 6F may be employed in the place of any resistive members 131, 171, 211, 221, 671 and/or in the place of any acoustic ports 135, 615, 635 described above.

[0067] While the principles of the disclosure have been described above in connection with specific devices and methods, it is to be clearly understood that this description is made only by way of example and not as limitation on the scope of the invention. The above described preferred embodiments are intended to illustrate the principles of the invention, but not to limit the scope of the invention. Various other embodiments and modifications to those preferred embodiments may be made by those skilled in the art without departing from the scope of the present invention that is solely defined by the claims.

Claims

1. A hearing device comprising

- an acoustic transducer (151, 251) having an oscillator element (153) configured to generate sound waves;
- a housing (111) configured to be at least partially inserted into an ear canal, the housing (111) enclosing the acoustic transducer (151, 251) inside an inner volume (116) of the housing (111), wherein the acoustic transducer (151, 251) is included in a partition (115) separating the inner volume (116) into a first volume portion (117) and a second volume portion (118) such that the first volume portion and the second volume portion are acoustically coupled by the acoustic transducer (151, 251);
- a sound outlet (122) provided at the housing (111) and leading to the first volume portion (117), the sound outlet configured to release sound waves from the first volume portion into the ear canal; and
- an acoustic port (135,635) provided at the housing (111), the acoustic port acoustically coupling the inner volume (116) to an ambient environment outside the inner volume;
- a first resistive member (131) and a second

resistive member (171,671), each resistive member comprising a first terminal and a second terminal and configured to attenuate sound waves between the first terminal and the second terminal, wherein the first terminal of the first resistive member is acoustically connected to the acoustic transducer (151, 251) via the first volume portion and the first terminal of the second resistive member is acoustically connected to the acoustic transducer (151, 251) via the second volume portion and wherein the partition includes the first resistive member placed in parallel to the acoustic transducer (151, 251), **characterized in that**

the second resistive member is disposed inside the second volume portion, wherein the partition is a first partition and a second partition (175) is provided in the second volume portion the second partition separating the second volume portion into a first volume section (177) and a second volume section (178), wherein the second partition includes the second resistive member (171), or that the partition includes an inner acoustic port (615) acoustically coupling the first volume portion and the second volume portion, wherein the first resistive member and the second resistive member are disposed at the inner acoustic port (615) and the acoustic port acoustically coupling the inner volume to the ambient environment is acoustically connected to the inner acoustic port (615).

2. The hearing device according to any of the preceding claims, **characterized in that** the second resistive member comprises a sound resistive body between the first terminal and the second terminal

3. The hearing device according to the preceding claim, **characterized in that** the sound resistive body comprises a porous material

4. Cr. The hearing device according to any of the preceding claims, **characterized in that** the acoustic port comprises a tubular element (136, 915)

Patentansprüche

1. Hörgerät, umfassend:

- einen Schallwandler (151, 251) mit einem Oszillatorelement (153), das ausgestaltet ist, um Schallwellen zu generieren;
- ein Gehäuse (111), das ausgestaltet ist, um mindestens teilweise in einen Ohrkanal eingeführt zu werden, wobei das Gehäuse (111) den Schallwandler (151, 251) in einem Innenvolumen (116) des Gehäuses (111) umschließt, wobei der Schallwandler (151, 251) in eine Abschottung (115) eingeschlossen ist, welche das Innenvolumen (116) in einen ersten Volumenabschnitt (117) und einen zweiten Volumenabschnitt (118) trennt, so dass der erste Volumenabschnitt und der zweite Volumenabschnitt durch den Schallwandler (151, 251) akustisch gekoppelt sind;
- einen Schallauslass (122), der an dem Gehäuse (111) bereitgestellt ist und zu dem ersten Volumenabschnitt (117) führt, wobei der Schallauslass ausgestaltet ist, um Schallwellen aus dem ersten Volumenabschnitt in den Ohrkanal freizusetzen; und
- eine Schallöffnung (135, 635), die an dem Gehäuse (111) bereitgestellt wird, wobei die Schallöffnung akustisch das Innenvolumen (116) an eine umliegende Umgebung koppelt, die außerhalb des Innenvolumens liegt;
- ein erstes Widerstandselement (131) und ein zweites Widerstandselement (171, 671), wobei jedes Widerstandselement einen ersten Anschluss und einen zweiten Anschluss umfasst und ausgestaltet ist, um Schallwellen zwischen dem ersten Anschluss und dem zweiten Anschluss zu dämpfen, wobei der erste Anschluss des ersten Widerstandselements über den ersten Volumenabschnitt akustisch mit dem Schallwandler (151, 251) verbunden ist, und der erste Anschluss des zweiten Widerstandselements über den zweiten Volumenabschnitt akustisch mit dem Schallwandler (151, 251) verbunden ist, und wobei die Abschottung das erste Widerstandselement einschließt, das parallel zu dem Schallwandler (151, 251) platziert ist, **dadurch gekennzeichnet, dass**
das zweite Widerstandselement innerhalb des zweiten Volumenabschnitts angeordnet ist, wobei die Abschottung eine erste Abschottung ist, und eine zweite Abschottung (175) in dem zweiten Volumenabschnitt bereitgestellt wird, wobei die zweite Abschottung den zweiten Volumenabschnitt in ein erstes Volumensegment (177) und ein zweites Volumensegment (178) trennt, wobei die zweite Abschottung das zweite Widerstandselement (171) einschließt,
oder dass die Abschottung eine innere Schallöffnung (615) einschließt, die den ersten Volumenabschnitt und den zweiten Volumenabschnitt akustisch koppelt, wobei das erste Widerstandselement und das zweite Widerstandselement an der inneren Schallöffnung (615) angeordnet sind und die Schallöffnung, die das Innenvolumen akustisch an die umliegende Umgebung koppelt, akustisch mit der inneren

Schallöffnung (615) verbunden ist.

2. Hörgerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das zweite Widerstandselement einen Schallwiderstandskörper zwischen dem ersten Anschluss und dem zweiten Anschluss umfasst.

3. Hörgerät nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** der Schallwiderstandskörper ein poröses Material umfasst.

4. Hörgerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Schallöffnung ein rohrförmiges Element (136, 915) umfasst.

Revendications

1. Dispositif auditif comprenant

- un transducteur acoustique (151, 251) comportant un élément oscillateur (153) configuré pour générer des ondes sonores ;
- un boîtier (111) configuré pour être au moins partiellement inséré dans un conduit auditif, le boîtier (111) renfermant le transducteur acoustique (151, 251) à l'intérieur d'un volume interne (116) du boîtier (111), dans lequel le transducteur acoustique (151, 251) est inclus dans une cloison (115) séparant le volume interne (116) en une première partie de volume (117) et une seconde partie de volume (118) de telle sorte que la première partie de volume et la seconde partie de volume soient acoustiquement couplées par le transducteur acoustique (151, 251) ;
- une sortie sonore (122) prévue au niveau du boîtier (111) et menant à la première partie de volume (117), la sortie sonore étant configurée pour libérer des ondes sonores de la première partie de volume dans le conduit auditif ; et
- un port acoustique (135, 635) situé au niveau du boîtier (111), le port acoustique couplant acoustiquement le volume interne (116) à un environnement ambiant à l'extérieur du volume interne ;
- un premier élément résistif (131) et un second élément résistif (171, 671), chaque élément résistif comprenant une première borne et une seconde borne et étant configuré pour atténuer des ondes sonores entre la première borne et la seconde borne, dans lequel la première borne du premier élément résistif est connectée acoustiquement au transducteur acoustique (151, 251) par le biais de la première partie de volume, et la première borne du second élément résistif est connectée acoustiquement au transducteur acoustique (151, 251) par le biais de la seconde partie de volume, et dans lequel la cloison comporte le premier élément résistif placé parallèlement au transducteur acoustique (151, 251), **caractérisé en ce que** le second élément résistif est disposé à l'intérieur de la seconde partie de volume, dans lequel la cloison est une première cloison et une seconde cloison (175) est prévue dans la seconde partie de volume, la seconde cloison séparant la seconde partie de volume en une première section de volume (177) et une seconde section de volume (178), dans lequel la seconde cloison comporte le second élément résistif (171), ou **en ce que**

la cloison comporte un port acoustique interne (615) couplant acoustiquement la première partie de volume et la seconde partie de volume, dans lequel le premier élément résistif et le second élément résistif sont disposés au niveau du port acoustique interne (615) et le port acoustique couplant acoustiquement le volume interne à l'environnement ambiant est relié acoustiquement au port acoustique interne (615).

2. Dispositif auditif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le second élément résistif comprend un corps résistif au son entre la première borne et la seconde borne.

3. Dispositif auditif selon la revendication précédente, **caractérisé en ce que** le corps résistif au son comprend un matériau poreux.

4. Dispositif auditif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le port acoustique comprend un élément tubulaire (136, 915).

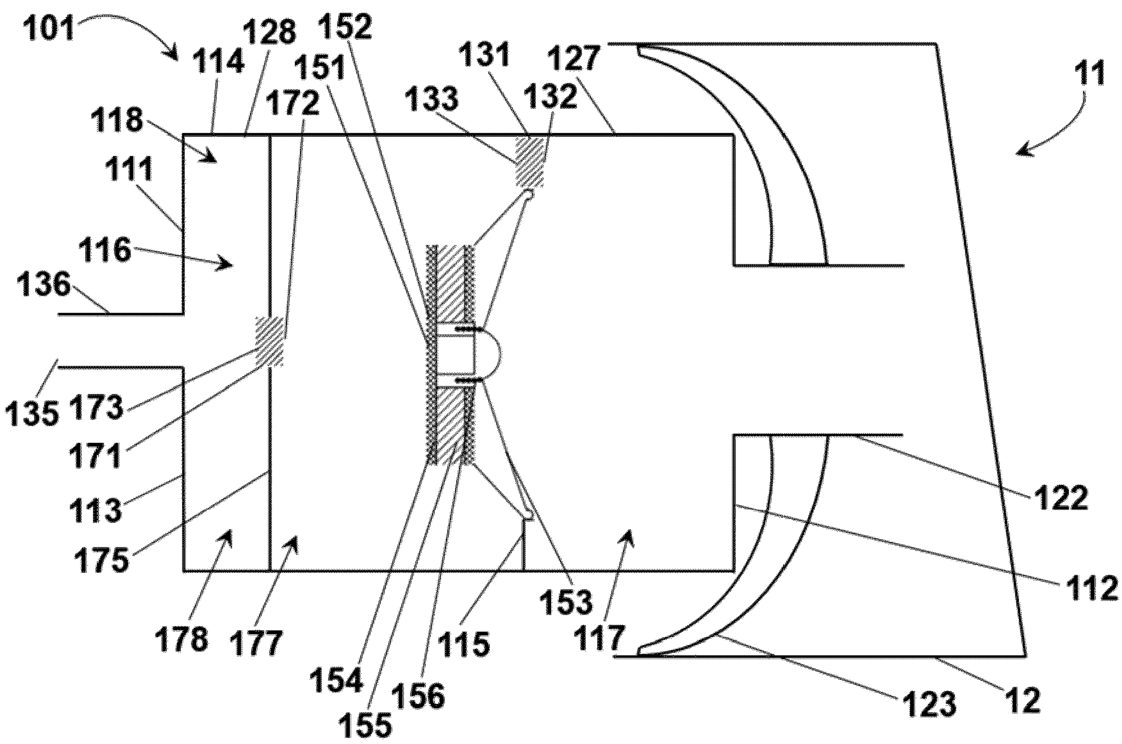
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Fig. 1

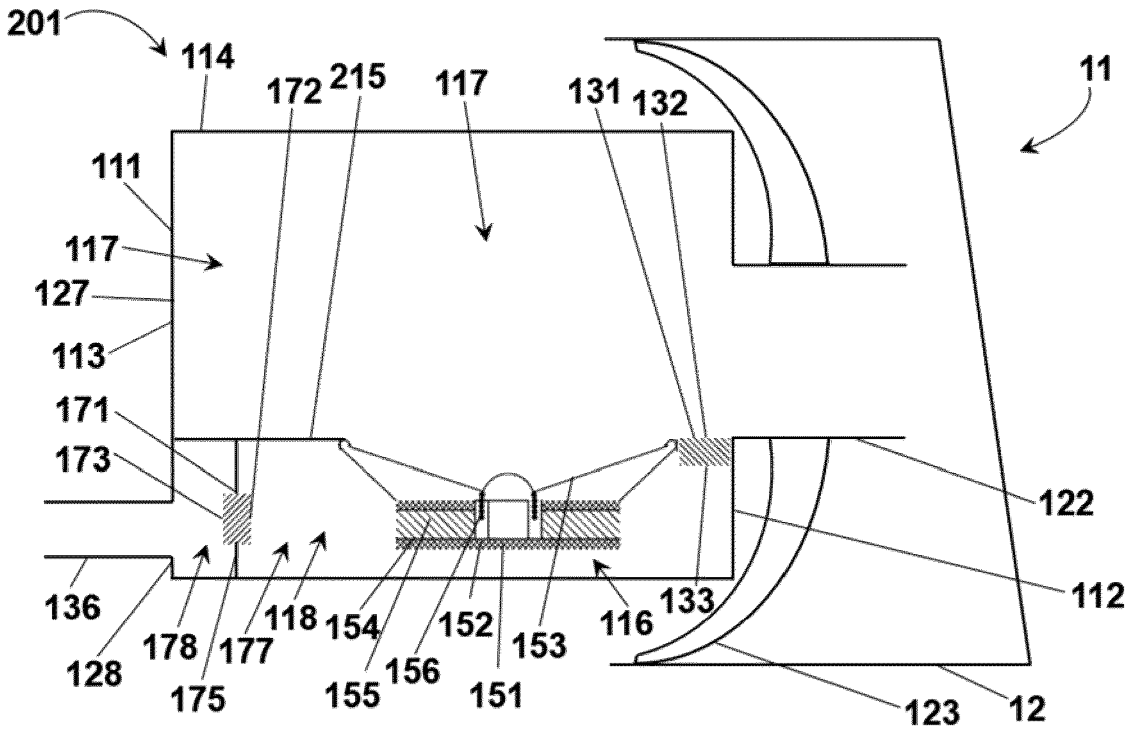
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Fig. 2

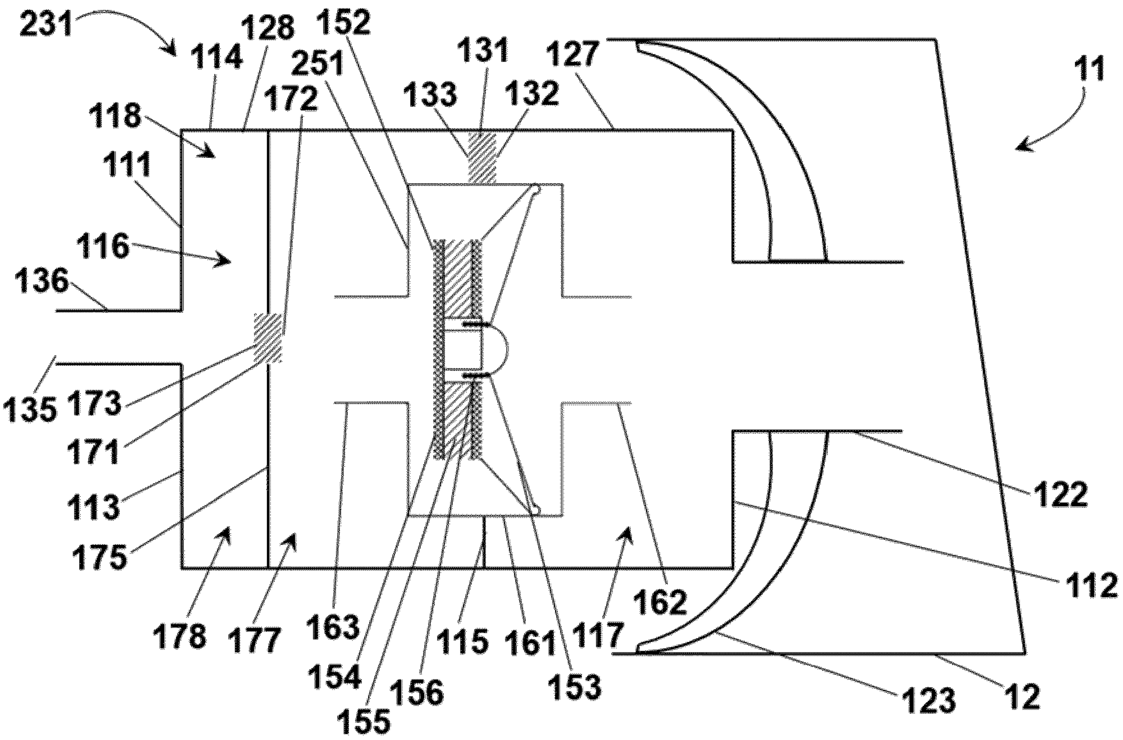
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Fig. 3

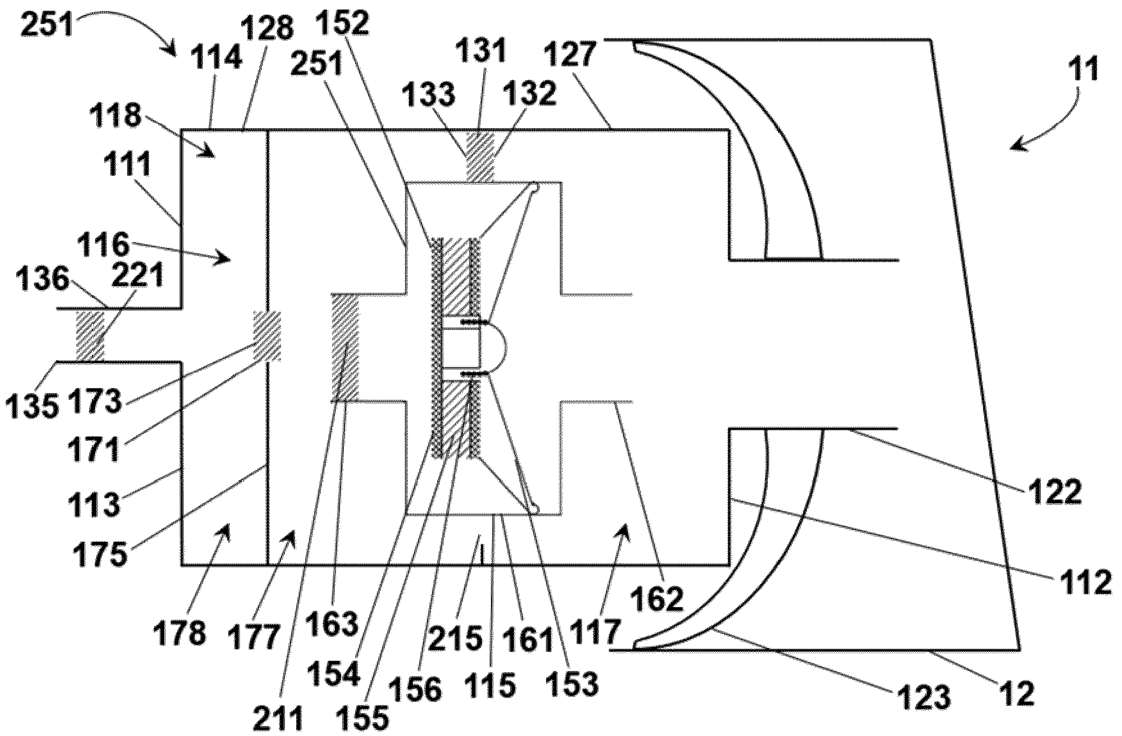
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Fig. 4

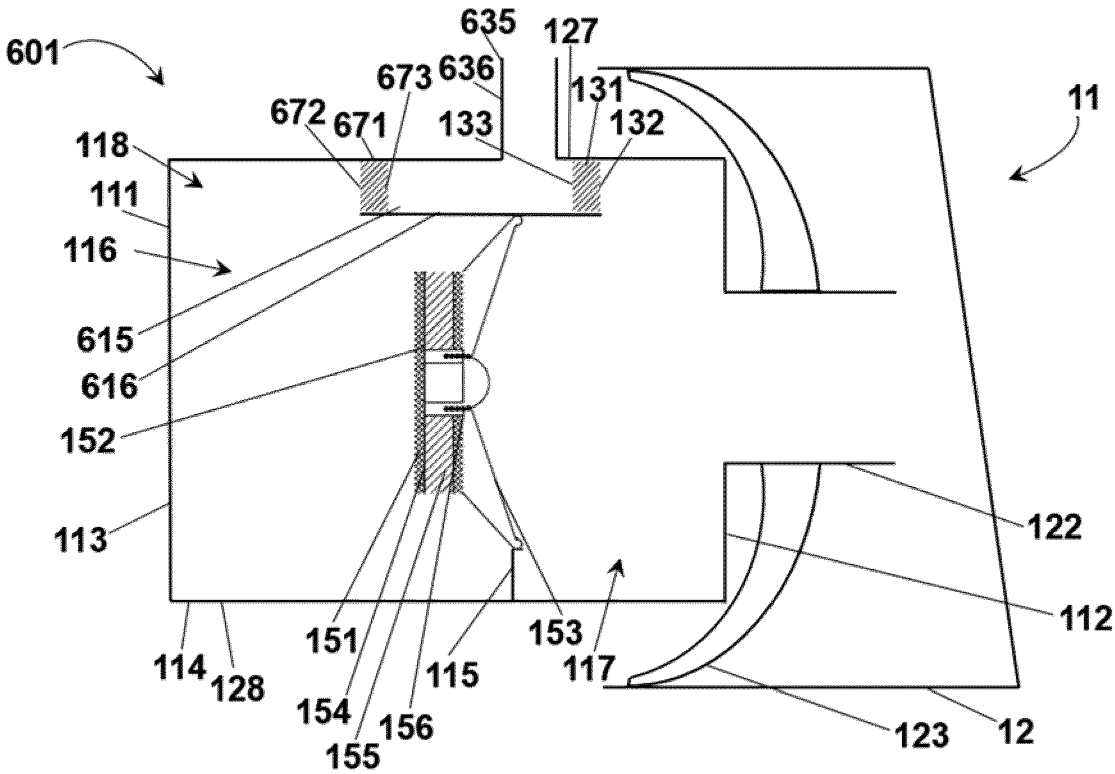
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Fig. 5

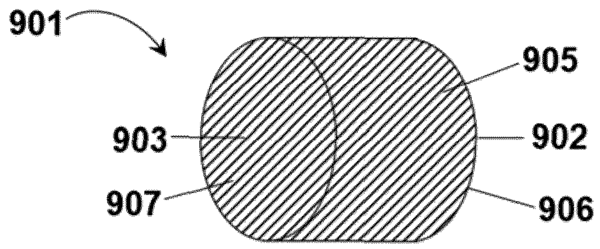

Fig. 6A

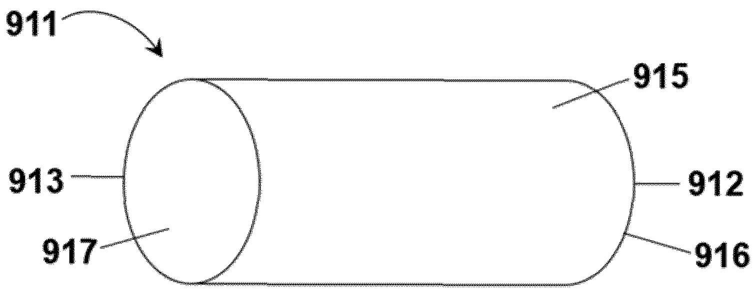

Fig. 6B

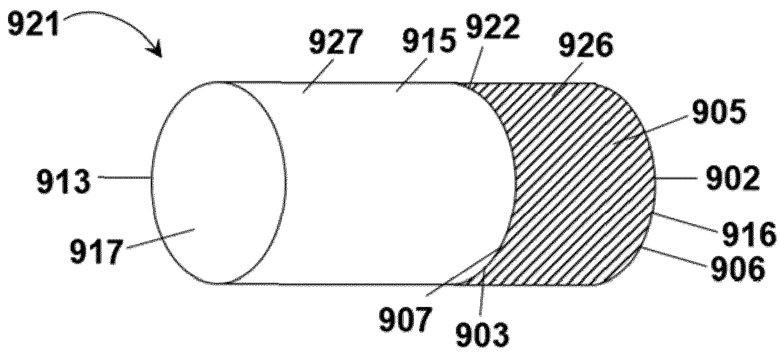

Fig. 6C

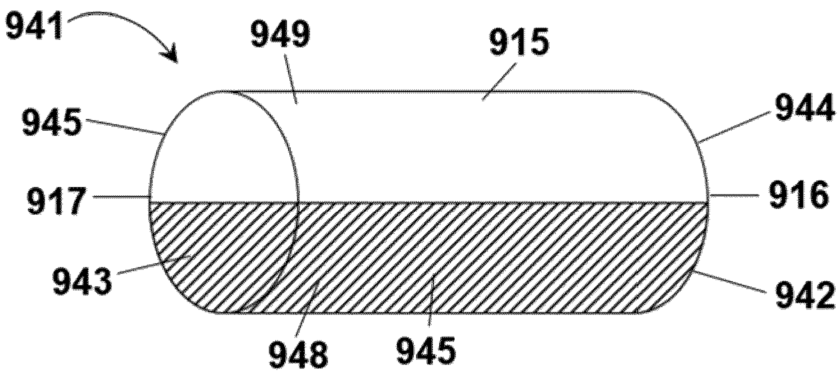

Fig. 6D

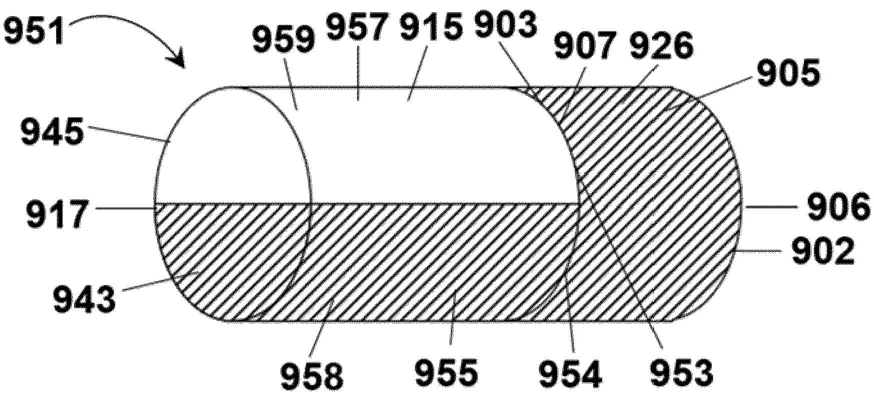

Fig. 6E

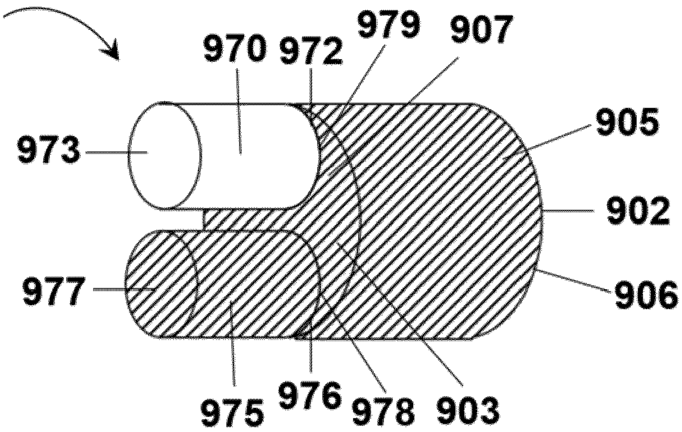

Fig. 6F

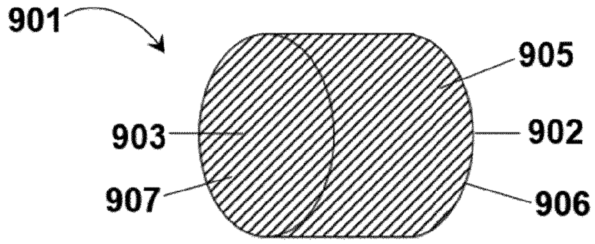

Fig. 11A

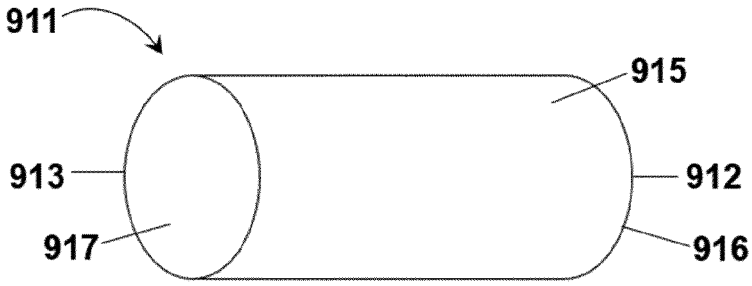

Fig. 11B

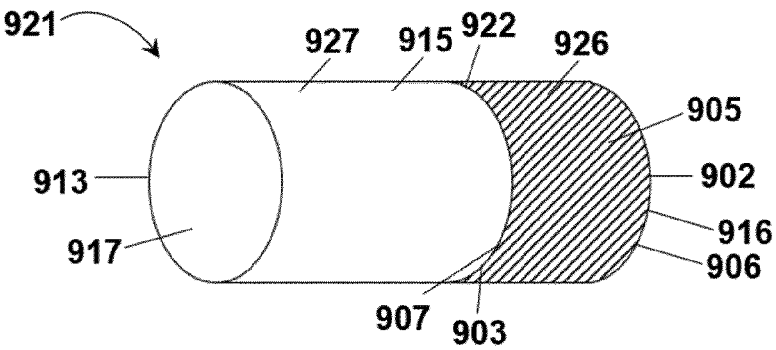

Fig. 11C

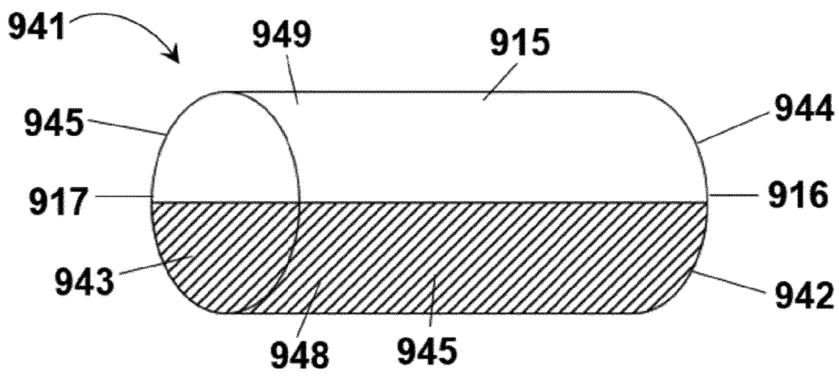

Fig. 11D

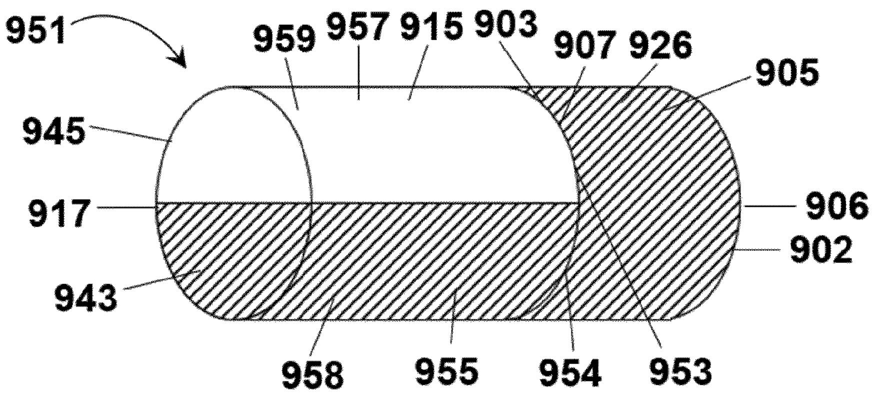

Fig. 11E

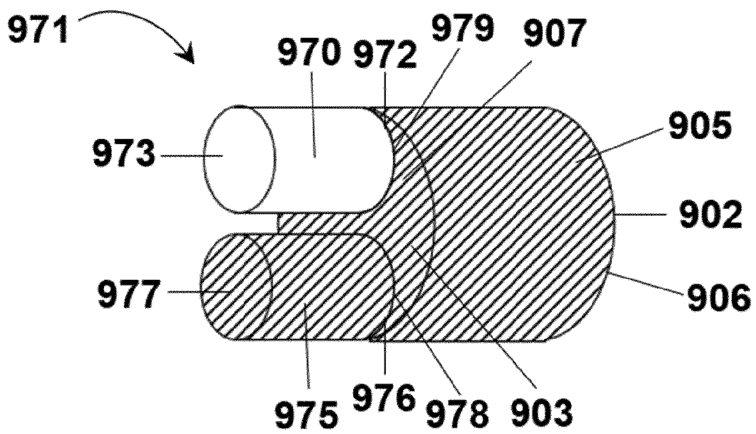

Fig. 11F

REFERENCES CITED IN THE DESCRIPTION

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