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(54) **HEARING DEVICE**

(57) The invention relates to a hearing device. The hearing device comprises an outer shell, the outer shell defining an outer compartment. The hearing device further comprises a receiver, and a rechargeable battery electrically connected to the receiver. Finally, the hearing device comprises a sealed inner compartment arranged in the outer compartment, wherein the receiver and the rechargeable battery are both arranged in the sealed inner compartment.

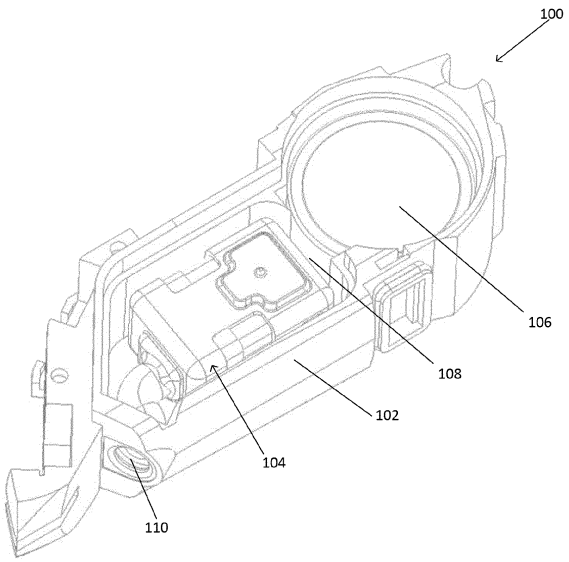

FIG. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a hearing device. More particularly, the invention relates to a hearing device comprising a rechargeable battery.

BACKGROUND OF THE INVENTION

[0002] Hearing devices, such as hearing aids and ear buds, are increasingly being made with rechargeable batteries for convenience and environmental reasons. Improvements in rechargeable battery technology has made it possible to achieve batteries with high capacity and high voltage in a compact package. However, these advances necessitate the rechargeable batteries be encapsulated.

[0003] At the same time, there is a push to miniaturize hearing device, while maintaining performance.

[0004] Hence, an improved hearing device would be advantageous, and in particular a more efficient and/or improved hearing device with a rechargeable battery would be advantageous.

OBJECT OF THE INVENTION

[0005] It is an objective of the present innovation to overcome the presented limitations in the prior art. In particular, it is an objective to provide a compact hearing device, which at the same time is sealed to prevent ingress of moisture.

[0006] It is a further object of the present invention to provide an alternative to the prior art.

SUMMARY OF THE INVENTION

[0007] Thus, the above-described object and several other objects are intended to be obtained in a first aspect of the invention by providing a hearing device. The hearing device comprises an outer shell, the outer shell defining an outer compartment. The hearing device further comprises a receiver, and a rechargeable battery. Finally, the hearing device comprises a sealed inner compartment arranged in the outer compartment, wherein the receiver and the rechargeable battery are both arranged in the sealed inner compartment. In this way, a good acoustic sealing of the receiver may be achieved, eliminating or reducing sound leakage from the receiver out of the hearing device and/or to one or more optional microphone(s) of the hearing device. Simultaneously, an efficient mechanical and electrical sealing of the rechargeable battery is obtained. Sealing both the receiver and the battery in a single inner compartment achieves a particularly space efficient and/or mechanically simple solution. The microphone(s) may be arranged in the outer compartment outside the inner compartment.

[0008] In embodiments of the hearing device according to the invention, the sealed inner compartment is airtight. In this way, the receiver and the rechargeable battery may be sealed from humidity and contamination from ambient air, thus limiting corrosion or other types of degradation of the device. By "airtight" it is meant that at atmospheric pressure the gas flow of atmospheric gas between the inside and outside of the inner compartment will be substantially zero.

[0009] In embodiments of the hearing device according to the invention, the sealed inner compartment is watertight. In this way, the hearing device may be more resilient to influence from fluids, such as rain, sweat, etc. By "watertight" it is meant that the sealed inner compartment fulfills the requirements of at least the IP67 rating.

[0010] In embodiments of the hearing device according to the invention, the receiver and rechargeable battery combined take up at least 40% of a volume of the sealed inner compartment, such as at least 50% of the volume of the sealed inner compartment, or even at least 60% of the volume of the sealed inner compartment.

[0011] In embodiments of the hearing device according to the invention, the hearing device further comprises a power management circuit arranged in the sealed inner compartment.

[0012] In embodiments of the hearing device according to the invention, the sealed inner compartment is fixed to the housing frame.

[0013] In embodiments of the hearing device according to the invention, the sealed inner compartment is fixed by an adhesive to the housing frame.

[0014] In embodiments of the hearing device according to the invention, the sealed inner compartment is fixed to the housing frame by one or more of heat soldering, ultrasonic welding, interference fit, and snap fit.

[0015] In embodiments of the hearing device according to the invention, the sealed inner compartment is integrally formed in the housing frame.

[0016] In embodiments of the hearing device according to the invention, the hearing device further comprises a magnetic induction (MI) coil arranged in the outer compartment, outside the sealed inner compartment.

[0017] In embodiments of the hearing device according to the invention, hearing device further comprises a magnetic induction (MI) coil arranged in the sealed inner compartment.

[0018] In embodiments of the hearing device according to the invention, the hearing device further comprises an inductive charging coil, the inductive charging coil being arranged inside the sealed inner compartment.

[0019] In embodiments of the hearing device according to the invention, the hearing device further comprises a printed circuit board assembly (PCBA), the printed circuit board assembly being arranged in the outer compartment, outside the sealed inner compartment.

[0020] In embodiments of the hearing device according to the invention, the hearing device further comprises a signal processor, the signal processor being arranged in the outer compartment, outside the sealed inner com-

partment. The signal processor is coupled to the microphone(s) to process audio signals by frequency dependent amplification based on a user's frequency dependent hearing loss. The signal processor is coupled to the receiver so that the receiver may generate an audible acoustic signal representing sound captured by the microphone(s) compensated for the user's hearing loss.

[0021] In embodiments of the hearing device according to the invention, the sealed inner compartment is made from metal, plastic, composites, or a combination thereof.

[0022] In embodiments of the hearing device according to the invention, the sealed inner compartment comprises a lid.

[0023] In embodiments of the hearing device according to the invention, the sealed inner compartment comprises one or more openings for electrical connections between units of the hearing device arranged in the sealed inner compartment and units in the outer compartment, outside the sealed inner compartment.

[0024] In embodiments of the hearing device according to the invention, the one or more openings comprises sealings, the sealings being arranged to seal with respect to sound and/or humidity leakage along the electrical connections.

[0025] In embodiments of the hearing device according to the invention, the sealings are separate from the sealed inner compartment.

[0026] In embodiments of the hearing device according to the invention, the sealings are molded using two-component moulding together with the plastic frame.

[0027] In embodiments of the hearing device according to the invention, the hearing device is a hearing aid.

[0028] In embodiments of the hearing device according to the invention, the hearing aid is a behind-the-ear, BTE, hearing aid.

[0029] In embodiments of the hearing device according to the invention, the hearing device is an ear bud.

[0030] This and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE FIGURES

[0031] The hearing device according to the invention will now be described in more detail with regard to the accompanying figures. The figures show one way of implementing the present invention and is not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

Figure 1 is an embodiment of a hearing device according to the invention,

Figure 2 is another embodiment of the hearing device according to the invention,

Figure 3a, 3b, and 3c illustrate details of embodiments of the invention, and

Figure 4 shows a schematic illustration of a hearing aid of the invention.

DETAILED DESCRIPTION OF AN EMBODIMENT

[0032] Figure 1 illustrates a partly assembled hearing device 100 according to an embodiment of the invention. The hearing device 100 is here illustrated as a behind-the-ear (BTE) hearing aid. The hearing device 100 comprises an outer shell (not shown) that defines an outer compartment. The outer shell is mounted onto and supported internally by a housing frame 102. Thus, in this case, the housing frame 102 defines an inner limit of the outer compartment. A sealed inner compartment 108 is arranged within the outer compartment and is configured to hold a receiver 104 and a rechargeable battery 106. The receiver 104 comprises a speaker, which in this embodiment is in communication with a wearer via a sound port 110 and a sound tube connected thereto (not shown). Sealing the inner compartment 108 solves both protecting the rechargeable battery 106 from the surroundings and protecting the receiver 104, in a space efficient way. Thus, the hearing device 100 may be reduced in size while maintaining a desired level of protection of both the battery 106 and receiver 104. For instance, it is seen from the figure that no wall is needed between the rechargeable battery 106 and receiver 104, which directly enables a space saving. Not shown in the figure is the sealing lid for sealing the inner compartment 108 and an optional printed circuit board assembly (PCBA) arranged in the outer compartment, outside the sealed inner compartment. Other components of the hearing device 100 may then also be arranged outside the sealed inner compartment, such as one of more of a microphone, a push button, a volume control, a magnetic induction (MI) coil, and a wireless antenna.

[0033] Figure 2 shows another embodiment of the hearing device 100 according to the invention. This embodiment relates to the embodiment of figure 1, where like reference numerals refer to like parts, and only the differences will be described here. In this embodiment, a power management circuit 220 is arranged on top of the rechargeable battery 106, i.e. within the sealed inner compartment 108. The power management circuit 220 may be arranged in a metal housing for noise protection. An advantage of this embodiment is that the power management circuit 220 is then also environmentally protected inside the sealed inner compartment 108. The power management circuit 220 arranged in the sealed inner compartment may optionally comprise a MI coil. In other embodiments, the MI coil may be arranged in the outer compartment.

[0034] Figure 3a shows details of the housing frame 102 according to embodiments of the invention. These embodiments relate to the embodiments of figures 1 and 2, where like reference numerals refer to like parts. The

housing frame 102 shown is similar to the housing frames 102 of figure 1 and 2, but shown without the receiver 104 and rechargeable battery 106 mounted. The inner compartment is seen in this embodiment to comprise a receiver section 330 suitable for housing the receiver 104, and a battery section 332 suitable for housing the rechargeable battery 106. The receiver section 330 and the battery section 332 are seen to be connected via a narrowing 334. Thus, the two sections 330, 332 are open towards each other and not separated by wall. This is advantageous for reducing the dimensions of the assembled hearing device 100. Naturally, a separating wall may optionally be introduced without deviating from the scope of the invention. To enable sealing the inner compartment 108, a top opening 336 of the housing frame 102 may be shaped with an architecture such as an edge for placement, fixation, and sealing of a lid. For instance, a recessed edge part may be arranged along the top opening 336 of the housing frame 102. In figure 3b, a lid 338 is shown to match up with the top opening 336 of the housing frame 102. Mounting the lid 338 on the housing frame 102 may for instance be achieved by use of an adhesive to fixate the lid 338 and seal the inner compartment 108. Alternatively, the lid 338 may be mounted with ultrasonic welding, ultra-violet (UV) cured glue, a press fitting, or the like. The lid 338 may for instance be made from a metal, a polymer, or a composite material. Figure 3c shows a bottom side 340 of the housing frame 102. In some embodiments, the housing frame 102 and the bottom side 340 are integrally formed, for instance by casting or moulding.

[0035] Fig. 4 shows a schematic illustration of a hearing device 100 according to the invention. The shown hearing device 100 is a behind the ear hearing aid configured for placement behind a user's ear. The hearing device 100 comprises an outer shell 114, which defines an outer compartment 118. A sealed inner compartment 108 is arranged in the outer compartment 118.

[0036] The hearing device 100 comprises multiple microphones 112 arranged in the outer compartment 118 outside the inner compartment 108. The microphones 112 are configured for capturing sound and providing an electric input signal representing the captured sound. The hearing device 100 comprises a signal processor 116 arranged in the outer compartment 118 outside the inner compartment 108. The signal processor 116 is coupled to the microphones 112 and configured for processing the electric input signal to provide an electric output signal based on the electric input signal.

[0037] The hearing device 100 comprises an antenna 120, preferably an MI coil, configured for wireless communication, i.e. transmission and/or reception of wireless signals, with another hearing device and/or an external device, such as a smart phone or external microphone. The antenna 120 is coupled to a wireless communication device, such as a radio. In the shown embodiments the wireless communication device is incorporated in the signal processor 116 but it may also be provided by a separate unit, such as a radio chip. The signal processor 116 may also process signals received by the antenna 120 so that the electric output signal may be based on both the electric input signal and received wireless signals.

[0038] The hearing device 100 comprises a rechargeable battery 106 arranged in the inner compartment 108. The hearing device 100 further comprises a receiver 104 arranged in the inner compartment 108. The receiver 104 is coupled to the signal processor 116 and is configured for generating an acoustic signal based on the electric output signal. The sealed inner compartment 108 is provided with an electrical interface 122, which allows for coupling between electric components arranged inside the inner compartment 108, such as the rechargeable battery 106 and the receiver 104, and electric components arranged outside the inner compartment 108, such as the microphones 112, the signal processor 116, and the antenna 120, while maintaining the seal of the inner compartment 108.

[0039] Some or all of the electric components arranged outside the inner compartment 108, such as the microphones 112, the signal processor 116, and the antenna 120, may be provided on and/or in a printed circuit board assembly (PCBA) arranged outside the inner compartment 108.

[0040] Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms "comprising" or "comprises" do not exclude other possible elements or steps. Also, the mentioning of references such as "a" or "an" etc. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in different claims does not exclude that a combination of features is not possible and advantageous.

Claims

1. A hearing device comprising:

- an outer shell, the outer shell defining an outer compartment,
- a receiver,
- a rechargeable battery, and
- a sealed inner compartment arranged in the outer compartment, wherein the receiver and the rechargeable battery are both arranged in the sealed inner compartment.

2. The hearing device according to claim 1, wherein

the receiver and rechargeable battery combined take up at least 40% of a volume of the sealed inner compartment, such as at least 50% of the volume of the sealed inner compartment, or even at least 60% of the volume of the sealed inner compartment.

3. The hearing device according to any one of the preceding claims, wherein the hearing device further comprises a power management circuit arranged in the sealed inner compartment.

4. The hearing device according to any one of the preceding claims, wherein the sealed inner compartment is fixed to a housing frame.

5. The hearing device according to any one of the preceding claims, wherein the hearing device further comprises a magnetic induction (MI) coil, wherein the MI coil is arranged in the outer compartment, outside the sealed inner compartment or is arranged in the sealed inner compartment.

6. The hearing device according to any one of the preceding claims, wherein the hearing device further comprises an inductive charging coil, the inductive charging coil being arranged inside the sealed inner compartment.

7. The hearing device according to any one of the preceding claims, wherein the hearing device further comprises a printed circuit board assembly (PCBA), the printed circuit board assembly being arranged in the outer compartment, outside the sealed inner compartment.

8. The hearing device according to any one of the preceding claims, wherein the sealed inner compartment comprises one or more openings for electrical connections between units of the hearing device arranged in the sealed inner compartment and units in the outer compartment, outside the sealed inner compartment.

9. The hearing device according to claim 8, wherein the one or more openings comprises sealings, the sealings being arranged to seal with respect to sound and/or humidity leakage along the electrical connections.

10. The hearing device according to any one of claims 8 and 9, wherein the sealings are separate from the sealed inner compartment.

11. The hearing device according to any one of claims 8-10, wherein the sealings are molded using two-component moulding together with the plastic frame.

12. The hearing device according to any one of the preceding claims, further comprising a signal processor arranged in the outer compartment outside the sealed inner compartment.

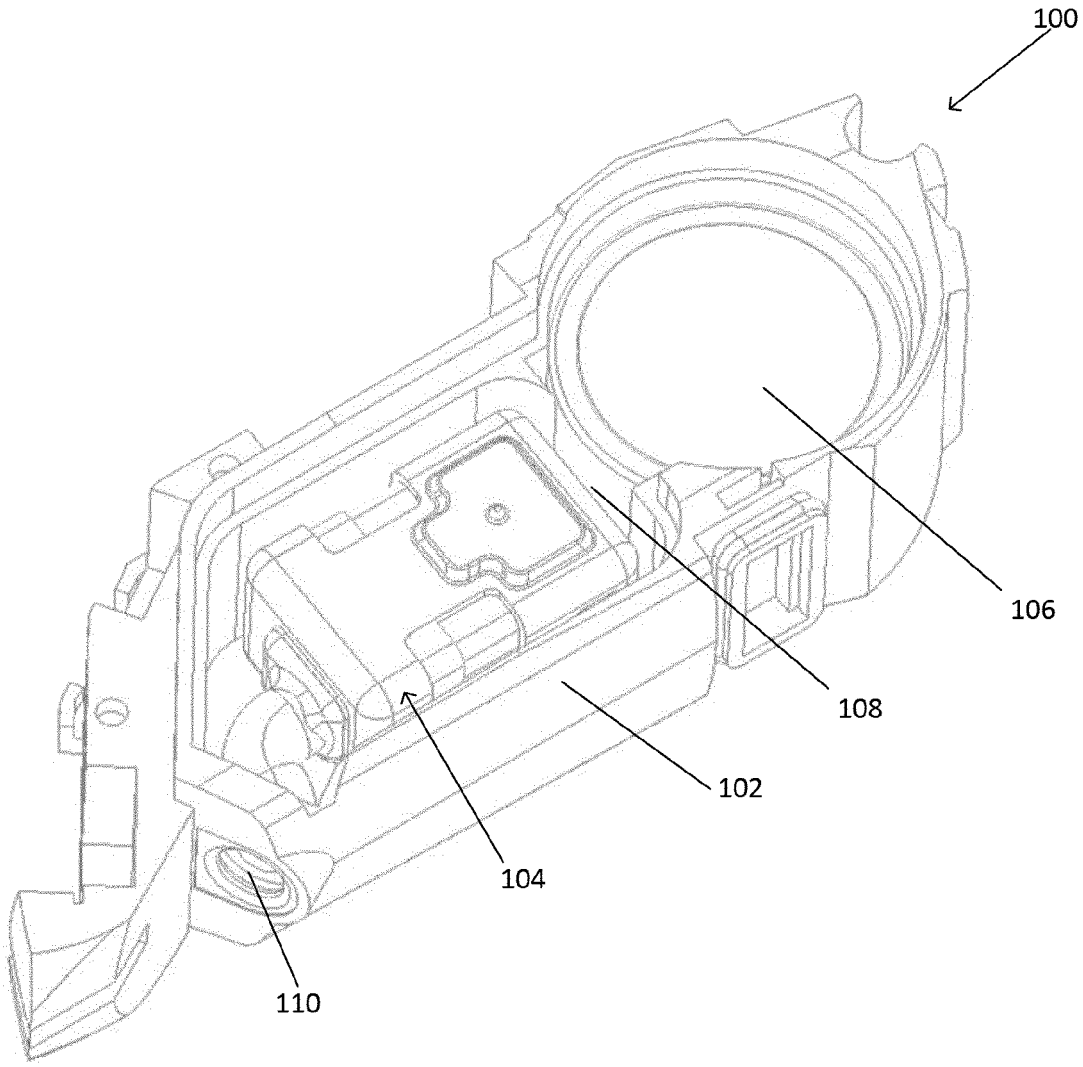

FIG. 1

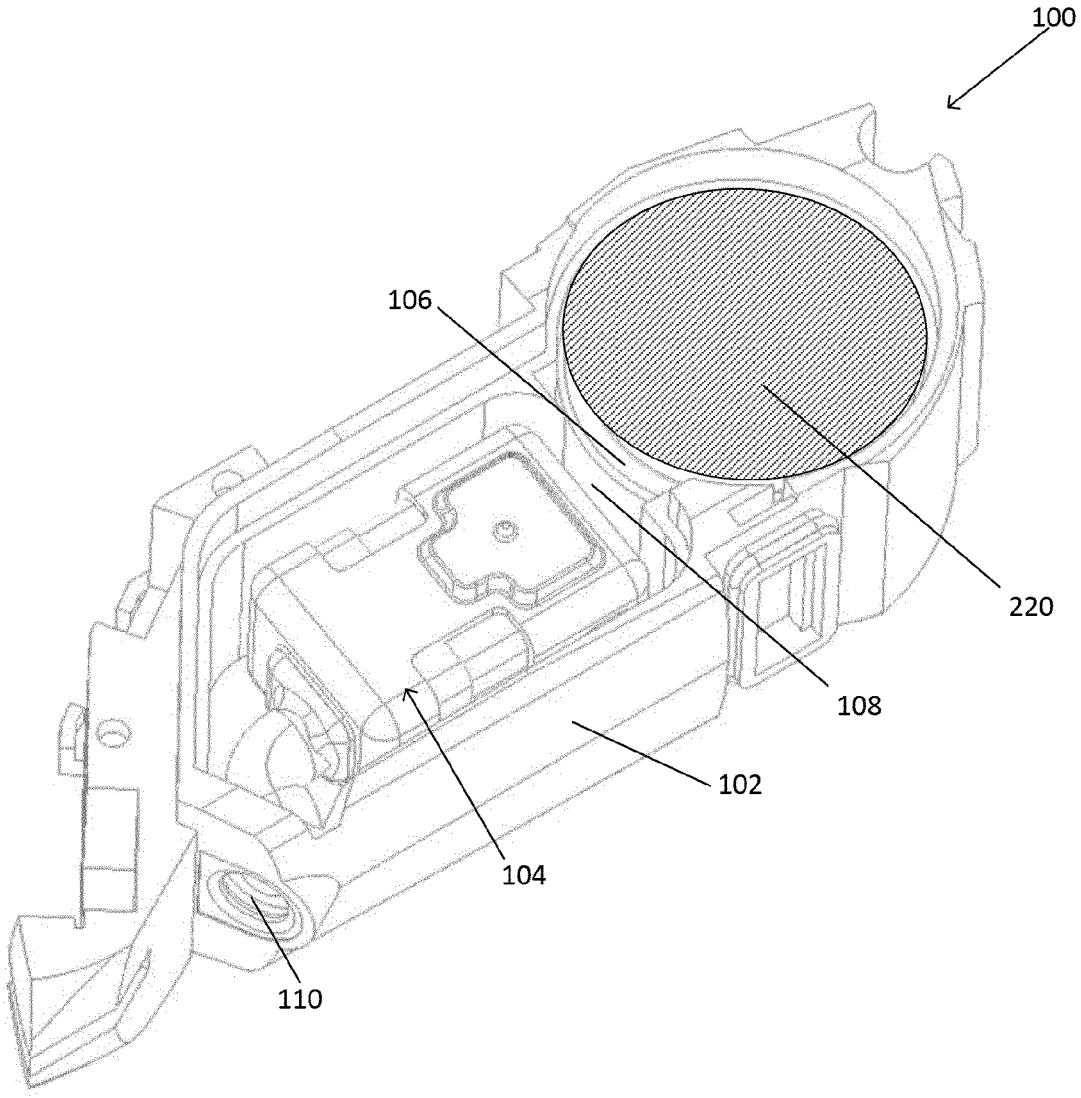

FIG. 2

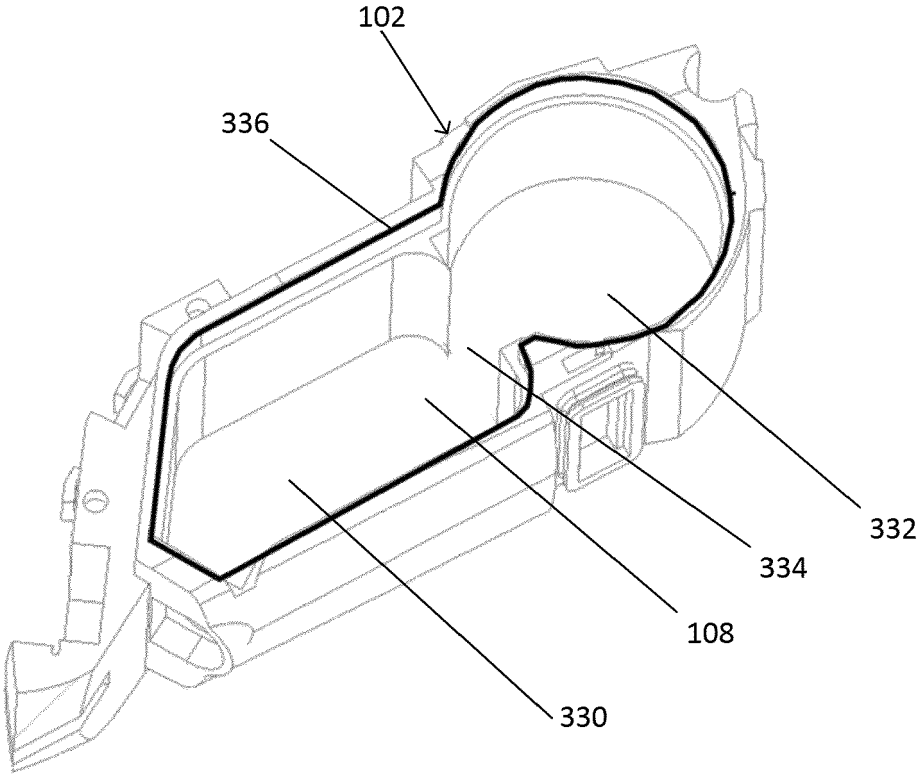

FIG. 3a

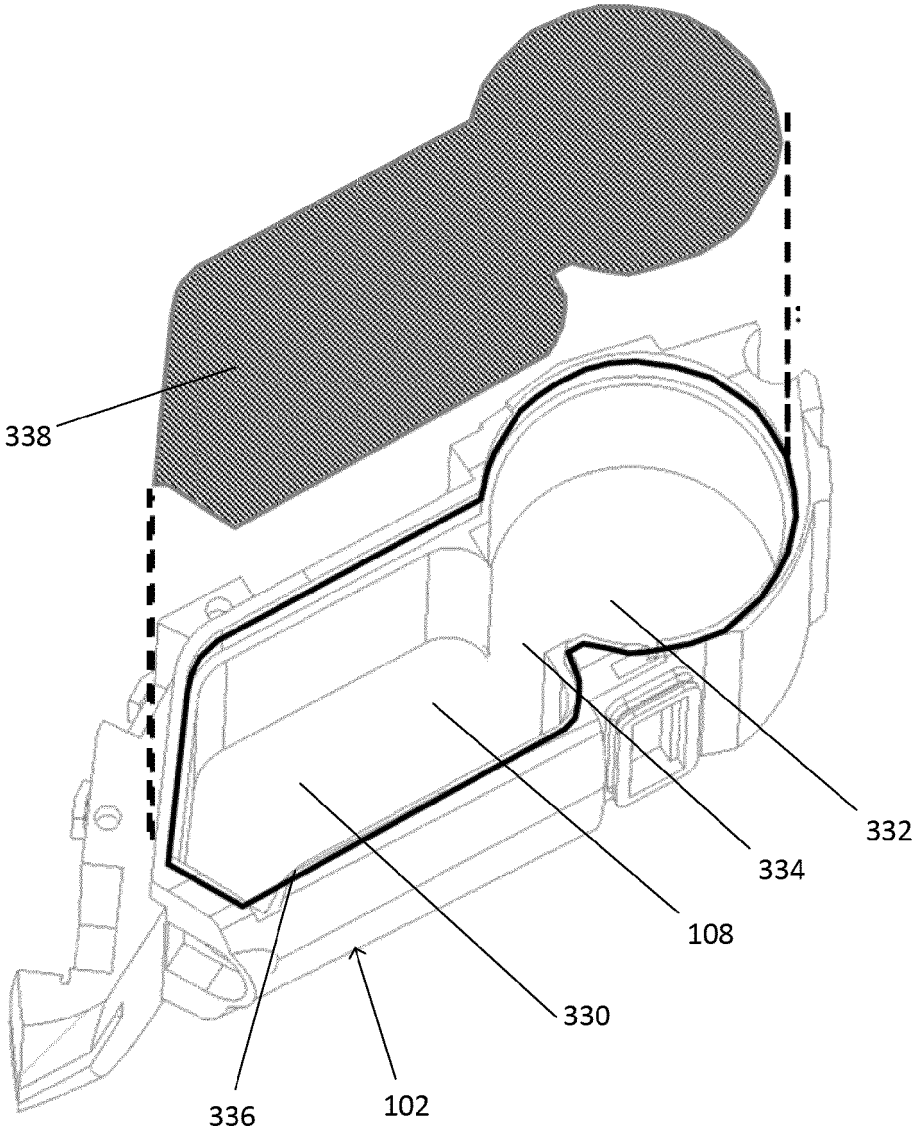

FIG. 3b

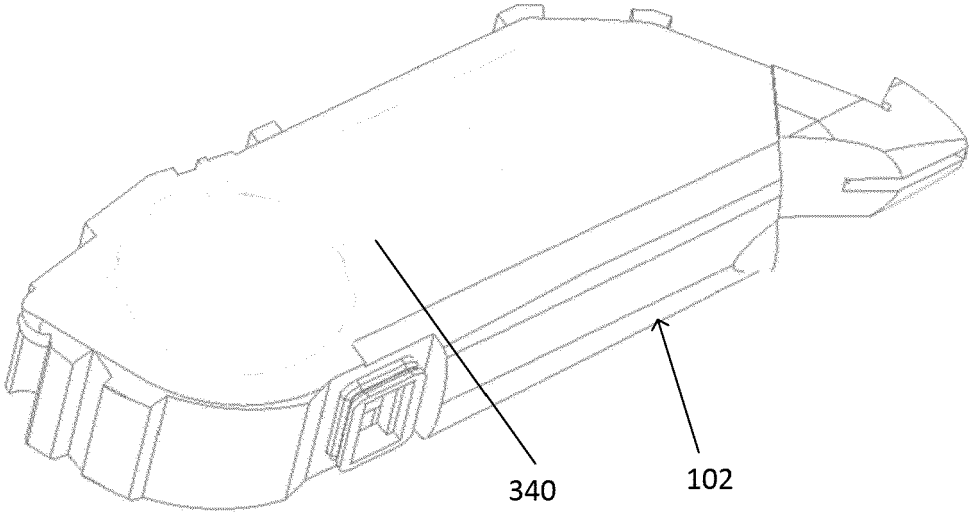

FIG. 3c

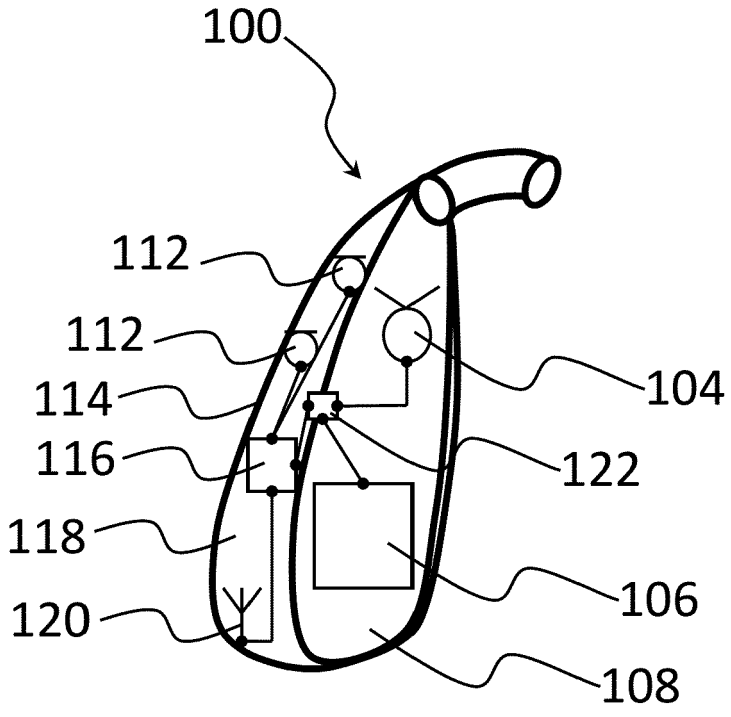

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 21 17 7424

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2015/256941 A1 (BYMASTER BRETT [US] ET AL) 10 September 2015 (2015-09-10) * paragraphs [0002], [0115] - paragraph [0119]; figures 9A-11 * * paragraph [0104] *	1-12	INV. H04R25/00
X	WO 2021/041843 A1 (STARKEY LABS INC [US]) 4 March 2021 (2021-03-04) * paragraph [0017] - paragraph [0022] *	1,2	
X	US 2009/208045 A1 (REITHINGER JURGEN [DE] ET AL) 20 August 2009 (2009-08-20)	1	
A	* paragraph [0044] - paragraph [0048]; figures 4A-4B * * paragraph [0024] - paragraph [0026] *	11	

TECHNICAL FIELDS SEARCHED (IPC)
H04R

2 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 December 2021	Will, Robert

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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08-12-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015256941 A1	10-09-2015	EP 2898705 A1	29-07-2015
		US 2015256941 A1	10-09-2015
		WO 2013077932 A1	30-05-2013
WO 2021041843 A1	04-03-2021	NONE	
US 2009208045 A1	20-08-2009	AT 524025 T	15-09-2011
		DE 102008009284 A1	27-08-2009
		DK 2091269 T3	12-12-2011
		EP 2091269 A2	19-08-2009
		US 2009208045 A1	20-08-2009

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