



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.09.2022 Bulletin 2022/39

(51) International Patent Classification (IPC):
H04R 1/10 (2006.01) H04R 25/02 (2006.01)

(21) Application number: **21164466.1**

(52) Cooperative Patent Classification (CPC):
H04R 1/1016; H04R 1/1041; H04R 25/02;
H04R 2460/11

(22) Date of filing: **24.03.2021**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Sonova AG**
8712 Stäfa (CH)

(72) Inventor: **KUIPERS, Erwin**
8712 Staefa (CH)

(74) Representative: **Liedtke & Partner Patentanwälte**
Gerhart-Hauptmann-Straße 10/11
99096 Erfurt (DE)

(54) **METHOD OF OPENING A VENT OF A HEARING DEVICE DURING INSERTION OR REMOVAL**

(57) The invention relates to a method of operating a hearing device having an earpiece (1) configured to be worn in an ear canal (2) of a user, wherein a vent (3) is provided in the earpiece (1), the vent (3) connecting a distal side (D) of the earpiece (1) to a medial side (M) thereof, wherein a vent valve (4) is arranged in the vent (3), the vent valve (4) configured to have an open position

in which the vent (3) is open and a closed position in which the vent (3) is closed, the method comprising opening and/or keeping open the vent valve (4) during insertion of the earpiece (1) into the ear canal (2) and/or during removal of the earpiece (1) from the ear canal (2). Moreover, the invention relates to a hearing device.

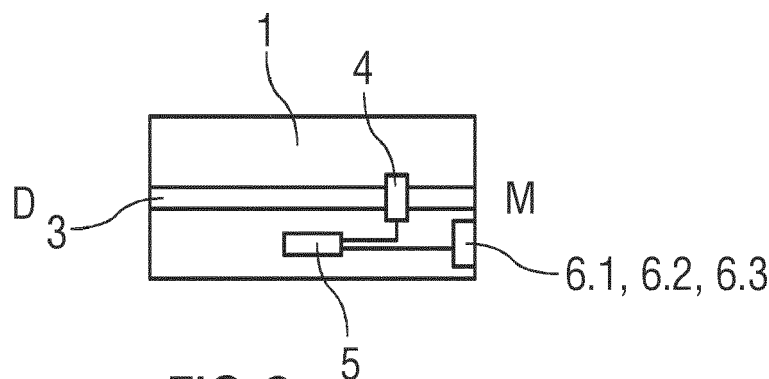


FIG 2

Description

Technical Field

[0001] The invention relates to a hearing device and to a method of operating a hearing device.

Background of the Invention

[0002] Hearing devices are used to improve the hearing capability and/or communication capability of users. Such hearing devices may be configured to process a received input sound signal (e.g., ambient sound) and then provide the processed input sound signal to the user. Hearing systems, ear buds or hearables come today in three fundamentally different form factors. First, behind-the-ear ("BTE") devices with all electric and electronic components including microphone and transducers behind a pinna, second, in-the-ear ("ITE") devices with all electric and electronic components including microphone and transducers being in a concha and/or an ear canal, and third, receiver-in-the-canal ("RIC") devices, which have all components except a receiver (also referred to as a speaker) behind the pinna while the receiver is placed in the ear canal as an ITE component.

[0003] Tight fit eartips or earpieces without any vent can lead to over-pressure in the ear canal while inserting the earpiece and thus to discomfort. Experienced users of hearing instruments may deal with this by pulling at the outer ear with one hand so as to open up the ear canal beside the earpiece so that air can flow into the residual ear canal and then inserting the otoplastic with the other hand.

[0004] Removal of a tightly fitting earpiece from the ear may lead to underpressure which may complicate the removal and also cause discomfort to the user.

Summary of the Invention

[0005] It is an object of the present invention to provide an improved hearing device and an improved method of operating a hearing device

[0006] The object is achieved by a method according to claim 1 and by a hearing device according to claim 10.

[0007] Preferred embodiments of the invention are given in the dependent claims.

[0008] According to the invention a method of operating a hearing device is proposed, the hearing device having an earpiece configured to be worn at least partially in an ear canal of a user, wherein a vent is provided in the earpiece, the vent connecting a distal side of the earpiece to a medial side thereof, wherein a vent valve is arranged in the vent, the vent valve configured to have an open position in which the vent is open and a closed position in which the vent is closed, the method comprising opening and/or keeping open the vent valve during insertion of the earpiece into the ear and/or during removal of the earpiece from the ear canal.

[0009] In an exemplary embodiment, the earpiece may have more than one vent with one or more of these vents having a vent valve, in particular only one these vents having a vent valve.

[0010] When the earpiece is in place, the vent is configured to connect a residual ear canal, i.e. the part of the ear canal in the medial direction from the inserted earpiece, with the ambient atmosphere.

[0011] The open position and the closed position in the context of the present invention shall be understood that the vent is more open in the open position than in the closed position, including the case of being fully open but not necessarily requiring this. Moreover, it shall be understood that the vent is more closed in the closed position than in the open position, including the case of being fully closed but not necessarily requiring this.

[0012] Opening or keeping open the vent valve during insertion of the earpiece into the ear canal and/or for a predetermined time period after booting the hearing device and/or during removal of the earpiece from the ear canal aims at having the vent valve open before the earpiece is inserted or removed and/or to prevent pressure or underpressure building up during insertion or removal.

[0013] In an exemplary embodiment, the method comprises an in-ear detection step comprising detecting whether the earpiece is at least partially located in or being inserted into an ear canal.

[0014] In an exemplary embodiment, the in-ear detection step is carried out using at least one proximity sensor, e.g. an optical sensor, an infrared sensor or a photoplethysmography sensor, and/or at least one pressure sensor and/or at least one canal microphone. A canal microphone is a microphone directed toward the medial side of the earpiece so as to pick up sound from the residual ear canal.

[0015] In an exemplary embodiment, the method comprises detecting a user's intent to insert the earpiece into the ear canal and/or to remove the earpiece from the ear canal and to preemptively open the vent valve upon such detection.

[0016] In an exemplary embodiment, switching the hearing device on is interpreted as the user's intent to insert the earpiece into the ear canal, wherein the vent valve is opened and/or kept open for a predetermined time period after switching the hearing device on, e.g. while the hearing device is being booted.

[0017] Booting of the hearing device is to be understood as a start process upon switching on the hearing device, performed by a processor or controller within the hearing device until the hearing device is ready to be used.

[0018] In an exemplary embodiment, the predetermined time period is two seconds or more.

[0019] In an exemplary embodiment, detecting the user's intent to remove the earpiece from the ear canal is carried out using at least one force sensor.

[0020] In an exemplary embodiment, the force sensor is arranged in or at a cable for connecting the earpiece

with a behind the ear part and/or in or at a shell removal line attached to a shell of the earpiece.

[0021] In an exemplary embodiment, detecting the user's intent to remove the earpiece from the ear canal is carried out by gesture detection using at least one sensor.

[0022] In an exemplary embodiment, the at least one sensor used by gesture detection is a LIDAR, a camera, a capacitive sensor or a time-of-flight sensor.

[0023] According to an aspect of the present invention, a hearing device is proposed, the hearing device having an earpiece configured to be worn at least partially in an ear canal of a user, wherein a vent is provided in the earpiece, the vent connecting a distal side of the earpiece to a medial side thereof, wherein a vent valve is arranged in the vent, the vent valve configured to have an open position in which the vent is open and a closed position in which the vent is closed, and a control unit configured to perform the method as described above.

[0024] In an exemplary embodiment, the hearing device further comprises at least one proximity sensor, e.g. an optical sensor, an infrared sensor or a photoplethysmography sensor, and/or at least one pressure sensor and/or at least one canal microphone configured to allow the control unit to perform an in-ear-detection step.

[0025] In an exemplary embodiment, the hearing device further comprises at least one force sensor for detecting a user's intent to remove the earpiece from the ear canal.

[0026] In an exemplary embodiment, the force sensor is arranged in or at a cable for connecting the earpiece with a behind the ear part and/or in or at a shell removal line attached to a shell of the earpiece.

[0027] In an exemplary embodiment, the hearing device further comprises at least one sensor for detecting a user's intent to remove the earpiece from the ear canal by gesture detection.

[0028] In an exemplary embodiment, the sensor is a LIDAR and/or a camera and/or a capacitive sensor and/or a time-of-flight sensor.

[0029] The hearing device may be configured as a behind-the-ear device, as an in-the-ear device or as a receiver-in-the-canal device.

[0030] Moreover, the hearing device may be configured as an ear bud.

[0031] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

Brief Description of the Drawings

[0032] The present invention will become more fully understood from the detailed description given herein-

below and the accompanying drawings which are given by way of illustration only, and thus, are not limitative of the present invention, and wherein:

- 5 Figure 1 is a schematic view of a hearing device comprising an earpiece configured to be worn in an ear canal of a user, wherein a vent having a vent valve is provided in the earpiece,
- 10 Figure 2 is a schematic view of an exemplary embodiment of a hearing device additionally having a sensor which can be configured as a proximity sensor and/or as a pressure sensor and/or as a canal microphone to allow for in-ear detection,
- 15 Figure 3 is a schematic view of an exemplary embodiment of a hearing device additionally having a force sensor arranged in or at a cable and/or arranged in or at a shell removal line, and
- 20 Figure 4 is a schematic view of an exemplary embodiment of a hearing device additionally having at least one sensor for gesture detection.
- 25

[0033] Corresponding parts are marked with the same reference symbols in all figures.

Detailed Description of Preferred Embodiments

[0034] Figure 1 is a schematic view of a hearing device comprising an earpiece 1 configured to be worn in an ear canal 2 of a user, wherein a vent 3 is provided in the earpiece 1, the vent 3 connecting a distal side D of the earpiece 1 to a medial side M thereof, wherein a vent valve 4 is arranged in the vent 3, the vent valve 4 configured to have an open position in which the vent 3 is open and a closed position in which the vent 3 is closed, and a control unit 5 configured to perform a method as described in the following.

[0035] For hearing devices involving a vent valve 4, a method of operating a hearing device is proposed that ensures that the vent valve 4 is in an open state during earpiece 1 insertion and/or removal.

[0036] For example, the method may comprise that the vent valve 4 is opened and/or remains open for a predetermined time, e.g. two or more seconds, after booting the hearing device.

50 **[0037]** If this method is used, the hearing device could, depending on the characteristics of the acoustic environment or depending on user actions, e.g. starting music streaming from a wirelessly connected mobile device, close the vent valve 4 before the earpiece 1 is inserted.

55 **[0038]** Therefore, in an exemplary embodiment, the method may comprise an in-ear detection, i.e. a method with which the hearing device can determine whether the earpiece 1 is inserted in an ear or not. This may be

achieved using at least one proximity sensor 6.1 and/or at least one pressure sensor 6.2 and/or at least one canal microphone 6.3 and/or by other means.

[0039] Figure 2 is a schematic view of an exemplary embodiment of a hearing device similar to the one of figure 1 but additionally having a sensor which can be configured as a proximity sensor 6.1 and/or as a pressure sensor 6.2 and/or as a canal microphone 6.3 to allow for the in-ear detection.

[0040] In an exemplary embodiment, the method may comprise opening the vent valve 4 and/or keeping the vent valve 4 open during removal or prior to removal of the earpiece 1 from the ear canal 2, e.g. when the user intends to remove the earpiece 1. In an exemplary embodiment, the user's intent of removal prior to actual removal may be detected using a force sensor 7 arranged in a cable 8.1 for connecting the earpiece 1 with a behind the ear part and/or by a force sensor 7 arranged in or at a shell removal line 8.2 attached to a shell of the earpiece 1 and/or by gesture control using at least one sensor 9 such as a LIDAR, a camera or a capacitive sensor.

[0041] Figure 3 is a schematic view of an exemplary embodiment of a hearing device similar to the one of figure 1 but additionally having a force sensor 7 arranged in or at a cable 8.1 for connecting the earpiece 1 with a behind the ear part and/or arranged in or at a shell removal line 8.2 attached to a shell of the earpiece 1.

[0042] Figure 4 is a schematic view of an exemplary embodiment of a hearing device similar to the one of figure 1 but additionally having at least one sensor 9 such as a LIDAR, a camera or a capacitive sensor for gesture detection.

[0043] Due to the method according to the invention the user experiences less discomfort due to overpressure or underpressure during insertion of the earpiece 1 into the ear canal 2 or during removal of the earpiece 1 from the ear canal 2.

[0044] The skilled person readily understands that the embodiments shown in the drawings and described above may be combined with each other. In particular, the hearing device may have one or more ways for in-ear detection and one or more ways for detecting the user's intent of removal.

List of References

[0045]

- 1 earpiece
- 2 ear canal
- 3 vent
- 4 vent valve
- 5 control unit
- 6.1 proximity sensor
- 6.2 pressure sensor
- 6.3 canal microphone
- 7 force sensor
- 8.1 cable

- 8.2 shell removal line
- 9 sensor
- D distal side
- M medial side

Claims

1. A method of operating a hearing device having an earpiece (1) configured to be worn at least partially in an ear canal (2) of a user, wherein a vent (3) is provided in the earpiece (1), the vent (3) connecting a distal side (D) of the earpiece (1) to a medial side (M) thereof, wherein a vent valve (4) is arranged in the vent (3), the vent valve (4) configured to have an open position in which the vent (3) is open and a closed position in which the vent (3) is closed, the method comprising opening and/or keeping open the vent valve (4) during insertion of the earpiece (1) into the ear and/or during removal of the earpiece (1) from the ear canal (2).
2. The method according to claim 1, comprising an in-ear detection step comprising detecting whether the earpiece (1) is at least partially located in or being inserted into an ear canal (2).
3. The method according to claim 2, wherein the in-ear detection step is carried out using at least one proximity sensor (6.1) and/or at least one pressure sensor (6.2) and/or at least one canal microphone (6.3).
4. The method according to any one of the preceding claims, comprising detecting a user's intent to insert the earpiece (1) into the ear canal (2) and/or to remove the earpiece (1) from the ear canal (2) and to preemptively open the vent valve (4) upon such detection.
5. The method according to claim 4, wherein switching the hearing device on is interpreted as the user's intent to insert the earpiece (1) into the ear canal (2), wherein the vent valve (4) is opened and/or kept open for a predetermined time period after switching the hearing device on.
6. The method of claim 5, wherein the predetermined time period is two seconds or more.
7. The method according to claim 4, wherein detecting the user's intent to remove the earpiece (1) from the ear canal (2) is carried out using at least one force sensor (7) or at least one sensor (9) of the group of a LIDAR, a camera, a capacitive sensor and a time-of-flight sensor.
8. The method according to claim 7, wherein the force sensor (7) is arranged in or at a cable (8.1) for con-

necting the earpiece (1) with a behind the ear part and/or in or at a shell removal line (8.2) attached to a shell of the earpiece (1).

9. The method according to any one of claims 7 or 8, wherein detecting the user's intent to remove the earpiece (1) from the ear canal (2) is carried out by gesture detection using the at least one sensor (9). 5

10. A hearing device having an earpiece (1) configured to be worn at least partially in an ear canal (2) of a user, wherein a vent (3) is provided in the earpiece (1), the vent (3) connecting a distal side (D) of the earpiece (1) to a medial side (M) thereof, wherein a vent valve (4) is arranged in the vent (3), the vent valve (4) configured to have an open position in which the vent (3) is open and a closed position in which the vent (3) is closed, and a control unit (5) configured to perform the method according to any one of the preceding claims. 10
15
20

11. The hearing device of claim 10, further comprising at least one proximity sensor (6.1) and/or at least one pressure sensor (6.2) and/or at least one canal microphone (6.3) configured to allow the control unit (5) to perform an in-ear-detection step. 25

12. The hearing device according to claim 10 or 11, further comprising at least one force sensor (7) for detecting a user's intent to remove the earpiece (1) from the ear canal (2). 30

13. The hearing device according to claim 12, wherein the force sensor (7) is arranged in or at a cable (8.1) for connecting the earpiece (1) with a behind the ear part and/or in or at a shell removal line (8.2) attached to a shell of the earpiece (1). 35

14. The hearing device according to any one of the claims 10 to 13, further comprising at least one sensor (9) for detecting a user's intent to remove the earpiece (1) from the ear canal (2) by gesture detection. 40

15. The hearing device according to claim 14, wherein the sensor (9) is a LIDAR and/or a camera and/or a capacitive sensor and/or a time-of-flight sensor. 45

50

55

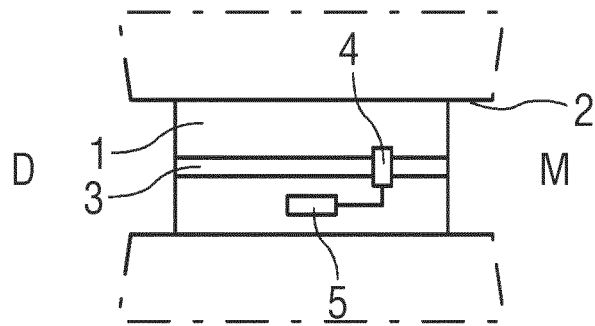


FIG 1

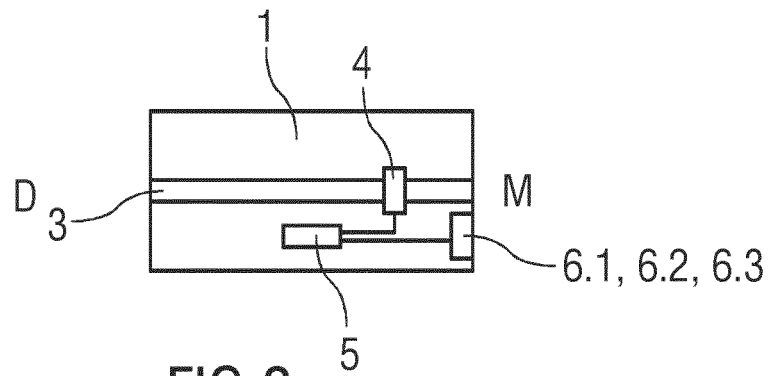


FIG 2

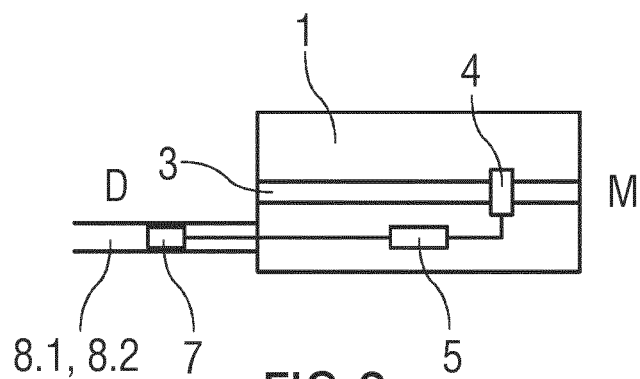


FIG 3

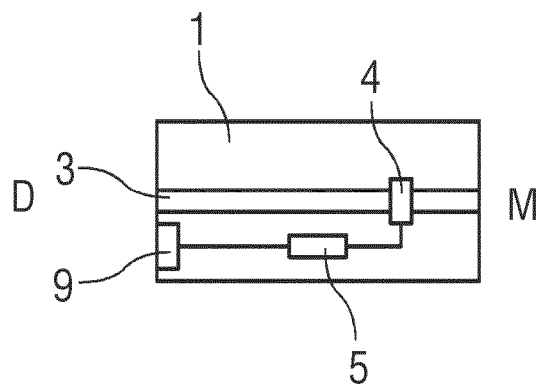


FIG 4



EUROPEAN SEARCH REPORT

Application Number
EP 21 16 4466

5

10

15

20

25

30

35

40

45

50

55

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 2020/314560 A1 (KUIPERS ERWIN [CH]) 1 October 2020 (2020-10-01) * paragraphs [0001], [0041]; figure 2 * * paragraphs [0015], [0016], [0046] *	1-8, 10-13,15	INV. H04R1/10 H04R25/02
X	US 2019/215621 A1 (ALBAHRI SHEHAB [US] ET AL) 11 July 2019 (2019-07-11) * paragraphs [0016], [0023], [0031], [0032]; figure 1 * * paragraph [0042] *	1-4,7, 9-11,14, 15	
X	EP 2 928 203 A1 (OTICON AS [DK]) 7 October 2015 (2015-10-07) * paragraph [0088] - paragraph [0089]; figure 2 *	1,10	
			TECHNICAL FIELDS SEARCHED (IPC)
			H04R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 1 September 2021	Examiner Betgen, Benjamin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 16 4466

5 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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-09-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2020314560 A1	01-10-2020	US 2020314560 A1	01-10-2020
		US 2021051419 A1	18-02-2021
-----	-----	-----	-----
US 2019215621 A1	11-07-2019	CN 110022506 A	16-07-2019
		CN 209930451 U	10-01-2020
		DE 102018221807 A1	11-07-2019
		DE 202018107147 U1	16-01-2019
		US 2019215621 A1	11-07-2019
-----	-----	-----	-----
EP 2928203 A1	07-10-2015	CN 104980866 A	14-10-2015
		EP 2928203 A1	07-10-2015
		US 2015289069 A1	08-10-2015
-----	-----	-----	-----