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(54) Title: SUSPENSION FOR A HEARING DEVICE RECEIVER

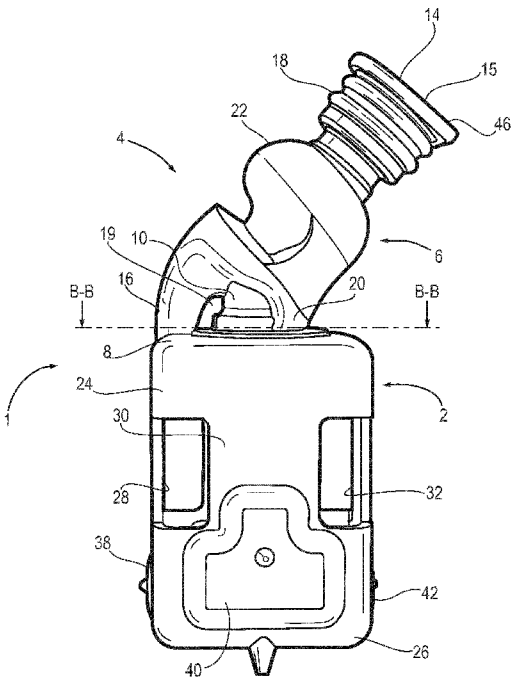

Fig. 1

(57) Abstract: A suspension for a receiver in a hearing device, the suspension comprising a receiver holding part, and a damping structure with a body and a receiver base, the body comprising a first body part. The damping structure has an inner surface forming a sound duct in the damping structure, the sound duct extending through the first body part, the damping structure having a first opening at a first sound duct end, the first opening configured for connecting an output port of the receiver to the sound duct, the damping structure having a second opening at a second sound duct end, the sound duct providing a sound path for conveying sound energy from the receiver through the damping structure to the second opening, the first body part extending from the receiver base,wherein the damping structure comprises at least a first damping element connecting the body and the receiver base separate from and in parallel to the first body part.

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SUSPENSION FOR A HEARING DEVICE RECEIVER

The present specification relates to a suspension for a hearing device receiver and to a method for producing a hearing device with such a suspension. Additionally, the present specification relates to a hearing device comprising such a suspension.

BACKGROUND

A hearing device comprises a microphone which receives acoustic signals. The received acoustic signals are processed where the processing may include amplification of the acoustic signals. The signal processing may preferably be digital. The processed signals are transmitted to a receiver of the hearing device which converts the processed signals into an acoustic output signal e.g. with a larger amplitude at certain frequencies. The receiver broadcasts the acoustic output signal towards the tympanic membrane of a user of the hearing device.

The broadcasting of the acoustic output signal can cause the receiver and the hearing device to vibrate which vibrations may be transmitted back to the microphone resulting in an unwanted feedback loop thereby putting a limitation on the amplification which the hearing device may deliver to the user.

Suspensions for hearing device receivers are known in the art, see for example international patent applications published under WO 2004/008803, WO 2007/011421 and WO 2012/062761.

SUMMARY

Accordingly, there is a need to reduce the transmission of vibrations generated by the receiver to the rest of the hearing device and it is an object of the present invention to provide a suspension for a hearing device receiver with an improved reduction of vibrations.

The above-mentioned and other objects are fulfilled by a suspension for a receiver in a hearing device, the suspension comprising a receiver holding part, and a damping structure with a body and a receiver base, the body comprising a first body part. The damping structure has an inner surface forming a sound duct in the damping structure, the sound duct extending through the first body part, the damping structure having a first opening at a first sound duct end. The first opening may be configured for connecting an output port of the receiver to the sound duct. The damping structure has a second opening at a second sound duct end, the sound duct providing a sound path

for conveying sound energy from the receiver through the damping structure to the second opening, the first body part extending from the receiver base. The damping structure comprises at least a first damping element. The first damping element may extend separate from and/or in parallel to the first body part. The first damping element may connect the body and the receiver base separate from and/or in parallel to the first body part.

Also disclosed is a hearing device comprising a hearing device receiver, a hearing device structural frame and a suspension as described herein, wherein the hearing device receiver is mounted in the suspension. An output port of the receiver may be positioned in a first opening of the sound duct of the hearing device damping structure.

It is an advantage of the present invention that a suspension for a hearing device receiver is obtained that reduce the transmission of vibrations generated by the receiver to the rest of the hearing device, and thus to the microphone of the hearing device.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the present invention will become readily apparent to those skilled in the art by the following detailed description of exemplary embodiments thereof with reference to the attached drawings, in which:

Fig. 1 is a schematic first side view of an exemplary suspension according to the invention,

Fig. 2 is a schematic second side view of the suspension in Fig. 1,

Fig. 3 is a schematic third side view of the suspension in Fig. 1,

Fig. 4 is a schematic perspective view of the suspension in Fig. 1,

Fig. 5 schematically illustrates a side view of an exemplary hearing device structural frame comprising a suspension according to the invention,

Fig. 6 schematically illustrates an exemplary cut view through the suspension along the line A-A in Fig. 3,

Fig. 7 schematically illustrates an end view of the receiver suspension in Fig. 1,

Fig. 8 schematically illustrates a first cross section perpendicular to the sound duct along the line B-B in Fig. 1,

Fig. 9 schematically illustrates a first cross section perpendicular to the sound duct of an exemplary suspension, and

Fig. 10 schematically illustrates an exemplary suspension

DETAILED DESCRIPTION

The figures are schematic and simplified for clarity, and they merely show details which are essential to the understanding of the invention, while other details have been left out. Throughout, the same reference numerals are used for identical or corresponding parts.

A suspension with improved damping capabilities for damping vibrations from a hearing device receiver is provided.

The suspension comprises a receiver holding part for holding or accommodating a receiver. The receiver may be attached to or mounted in the receiver holding part by gluing and/or a mechanical pressfit.

The suspension comprises a damping structure for damping or attenuating vibrations transferred from the receiver to other parts of a hearing instrument, such as a structural frame of a hearing instrument.

The suspension has a body and a receiver base. The body has a first body end and a second body end and comprises a first body part and optionally a second body part. The body may comprise a third body part, e.g. between the first body part and the second body part for absorbing a part of the vibrational energy from the receiver.

The damping structure has an inner surface forming a sound duct in the damping structure. The sound duct extends through the first body part. The damping structure has a first opening at a first sound duct end, wherein the first opening is configured for connecting an output port of the receiver to the sound duct. Further, the damping structure has a second opening at a second sound duct end and the sound duct providing a sound path for conveying sound energy from the receiver through the damping structure to the second opening. The sound duct extends along a sound duct axis, and the sound duct axis may be straight or curved. The sound duct may extend through the second body part and/or through a third body part. The sound duct may have a constant or slightly varying (±5%) circular cross section from the first opening to the second opening. The first opening may be centered or substantially centered in the receiver base. An outport port of the receiver may be mounted to the first

opening/receiver base, e.g. by gluing, welding and/or press-fit. Thus, the receiver base may form at least a part of the receiver holding part.

The sound duct may have a first sound duct part in the first body part. The sound duct may have a second sound duct part in the second body part. A first longitudinal axis of the first sound duct part in the first body part and a second longitudinal axis of a second sound duct part in the second body part form an angle, such as in the range from 5° to 75°. The angle between the first longitudinal axis and the second longitudinal axis may be in the range from 10° to 60°, such as from 15° to 45°.

The first body part extends from the receiver base and has a first outer surface.

The receiver base may have a rectangular or squared cross-section perpendicular to the first longitudinal, e.g. with rounded corners. The sound duct may be centered in the receiver base.

The second body part has a second outer surface. The second body part may be positioned between the second sound duct end and the first body part, the sound duct extending through the second body part. The second outer surface may be a corrugated second outer surface.

The damping structure comprises one or more damping elements including a first damping element. The first damping element has a first damping surface. The first damping element may connect the body and the receiver base separate from and in parallel to the first body part. The first damping element may extend from the receiver base to the body forming a gap between the first damping element and the first body part.

It may be desired to reduce the thickness of one or more damping elements, such as the first damping element in order to reduce transfer of vibrations from the receiver base to the body through the damping element. The first damping element may in a first cross section perpendicular to the first longitudinal axis cover or span an area of less than 10% of a receiver base area. The receiver base area may be defined as the maximum area spanned by the receiver base perpendicular to the first longitudinal axis.

The first damping element may in one or more cross-sections including a first cross section perpendicular to the first longitudinal axis cover or span an area in the range from 0.5 mm^2 to 10 mm^2. The first damping element in the first cross section may have an area of at least 1 mm^2. The gap between the first damping element and the first

body part may in one or more cross-sections perpendicular to the first longitudinal axis, e.g. the first cross-section be larger than 0.2 mm. The gap between the first damping element and the first body part may in the first cross-section be in the range from 0.3 mm to 10 mm, such as in the range from 1 mm to 5 mm.

The first damping element may extend or at least partly extend from a corner section of the receiver base. A corner section of the receiver base is an area defined by points in a cross section of the receiver base perpendicular to the first longitudinal axis, the points being within a corner distance from the corner. The corner distance may be 4 mm or less than 4 mm, such as 3 mm or less than 3 mm. In an exemplary suspension, the corner distance may be 2 mm or less than 2 mm.

The first damping element may extend or at least partly extend from an edge section of the receiver base. An edge section of the receiver base is an area defined by points in a cross section of the receiver base perpendicular to the first longitudinal axis, the points being within an edge distance from the receiver base edge. The edge distance may be 4 mm or less than 4 mm, such as 3 mm or less than 3 mm. In an exemplary suspension, the edge distance may be 2 mm or less than 2 mm.

One or more damping elements extending or at least partly extending from corner and/or edge sections of the receiver base provide improved damping capabilities of the suspension.

The damping structure may comprise a second damping element having a second damping surface. The second damping element may be comprised or integrated in the first body part, i.e. the first body part may comprise a second damping element. The second damping element may be formed as protrusions, bulges, recesses or a combination thereof in the first outer surface of the first body part, resulting in a non-cylindrical first body part.

In one or more exemplary suspensions, the second damping element may extend separate from and/or in parallel to the first body part. In one or more exemplary suspensions, the second damping element may connect the body and the receiver base separate from and/or in parallel to the first body part. The second damping element may extend from the receiver base to the body forming a gap between the second damping element and the first body part.

One or more damping elements, such as one or more of the first damping element, the second damping element, a third damping element and a fourth damping element, may

extend as a protrusion or finger from the body of the damping structure. Thus, one or more damping elements, such as one or more of the first damping element, the second damping element, the third damping element and the fourth damping element, may be an elongated damping element. A damping element protruding from the body, such as the first damping element and/or the second damping element, may comprise a support point or surface configured for contacting a point or outer surface of a receiver housing, e.g. when the receiver is mounted in the receiver holding part/receiver base.

One or more damping elements, such as the third damping element and/or the fourth damping element, may comprise a support point or surface configured for contacting a point or surface of a hearing device structural frame or hearing device housing or other hearing device components, when the suspension is mounted in the hearing device.

One or more damping elements, such as one or more of the first damping element, the second damping element, the third damping element and the fourth damping element, may extend from the body of the damping structure, such as from a body part different from the first body part, e.g. from the second body part or from the third body part. The first damping element and/or the second damping element may extend separate from and/or in parallel to the first body part.

Thus, the first body part, e.g. comprising the second damping element, may have an irregular or non-circular first outer surface in one or more cross-sections perpendicular to the first longitudinal axis or the sound duct axis. The second damping element may extend from the receiver base. The first outer surface of the first body part may in one or more cross-sections perpendicular to the sound duct be non-circular, such as oval, egg-shaped, or irregular.

In one or more cross-sections perpendicular to the sound duct, the first outer surface of the first body part may comprise a first concave section and/or a second concave section.

The first body part may in the first cross section span an area of at least 1 mm^2. A first distance from a first point on the first outer surface surface to the inner surface in the first cross section may be less than 2 mm. A second distance from a second point on the first outer surface to the inner surface in the first cross section may be larger than 2 mm such as in the range from 3 mm to 20 mm.

The second damping element may extend or at least partly extend from a corner section of the receiver base. The second damping element may extend from a corner

section of the receiver base different from and/or diagonal to the corner section from which the first damping element extends, i.e. the first damping element may extend or at least partly extend from a first corner section and the second damping element may extend or at least partly extend from a second corner section.

The second damping element may extend or at least partly extend from an edge section of the receiver base.

The receiver holding part may form a receiver compartment. The receiver holding part may comprise a first portion connected to the receiver base part, and a second portion. The first portion and the second portion may be connected by one or a plurality of bridging elements. The second portion may comprise an insertion opening for insertion of a hearing aid receiver in the receiver compartment. The first portion and/or the second portion of the receiver holding part may each comprise one or a plurality of cushioning zones for absorption of mechanical shock.

The damping structure may comprise a mounting element, e.g. at the second opening for mounting the suspension to a structural frame of a hearing device. The mounting element may be a flange or one or more protrusions extending radially from the second longitudinal axis. The mounting element may comprise an inner and/or outer threading at the second body end.

Fig. 1 is a schematic first side view of an exemplary suspension 1. The suspension comprises a receiver holding part 2 and a damping structure 4. The damping structure 4 has a body 6 and a receiver base 8 . The body 6 comprises a first body part 10 extending from the receiver base 8. The damping structure 4 has an inner surface forming a sound duct 11 (see Fig. 6) in the damping structure 4 extending through the first body part 10. The damping structure 4 has a first opening 12 (see Fig. 6 and 8) at a first sound duct end 13, wherein the first opening 12 is configured for connecting an output port of a receiver to the sound duct 11. During assembly, the receiver is positioned inside the receiver holding part 2. The damping structure 4 has a second opening 14 (see Fig. 6) at a second sound duct end 15. Thus, the sound duct provides a sound path for conveying sound energy from the receiver, positioned inside or otherwise mounted to the receiver holding part 2, through the damping structure to the second opening 14. The sound duct 11 of the suspension 1 has a constant circular cross section from the first opening 12 to the second opening 14. The sound duct radius depends on the receiver type and is in illustrated suspension 1 in the range from 0.75 mm to 1.5 mm.

The damping structure 4 comprises a first damping element 16 connecting the body 6 and the receiver base 8 separate from and in parallel to the first body part 10.

The body 6 comprises a second body part 18 positioned between the second sound duct end 15 and the first body part 10. The sound duct 11 extends through the second body part 18 and the second body part 18 has a corrugated second outer surface.

The first damping element 16 extends from the receiver base 8 to the body 6 in parallel to the first body part 10 forming a gap 19 between the first damping element 16 and the first body part 10, the gap 19 having a maximum gap or gap opening larger than 1 mm. Separating the first damping element 16 from the first body part 10 provides improved damping of one or more selected frequencies or frequency ranges.

In the suspension 1 illustrated in Fig. 1, the first body part 10 comprises a second damping element 20 extending from the receiver base 8. In the suspension 1, the second damping element 20 is integrated in the first body part 10 and a first outer surface of the first body part in a cross section perpendicular to the sound duct is non-circular.

The body 6 comprises a third body part 22 between the first body part 10 and the second body part 18. The third body part 22 is absorbing a part of the vibrational energy from the receiver positioned inside the receiver holding part 2.

In the suspension illustrated in Fig. 1, the receiver holding part 2 forms a receiver compartment and comprises a first portion 24 connected to the receiver base part 8, and a second portion 26. The first portion 24 and the second portion 26 are connected by a plurality of bridge elements 28, 30, 32, 34.

The second portion 26 of the receiver holding part 2 comprises one or a plurality of cushion structures 38, 40, 42, 44, e.g. configured for absorbing mechanical shock.

The damping structure 4 comprises a mounting element 46 at the second sound duct end 15. The mounting element 46 is configured for mounting the suspension 1 to a structural frame of a hearing device and in the illustrated suspension 1 takes the form of a flange.

Figs. 2 and 3 are schematic second and third side views of the suspension 1 in Fig. 1, The second body part 18 has one or more annular bulges 48 forming a corrugated second outer surface of the second body part 18 along the sound duct 11.

Fig. 4 is a schematic perspective view of the suspension 1 in Fig. 1. The second portion 26 forms an insertion opening 36 for insertion of a hearing aid receiver in the receiver compartment formed by the receiver holding part 2.

Fig. 5 schematically illustrates a side view of an exemplary hearing device structural frame 50 with a suspension 1 mounted thereon. A behind-the-ear hearing device may then accommodate a hearing device structural frame 50 and a suspension 1, wherein the hearing device receiver is to be mounted in the suspension 1.

Fig. 6 schematically illustrates an exemplary cut view through the suspension along the line A-A in Fig. 3. A first longitudinal axis X_1 of a first sound duct part in the first body part 10, and a second longitudinal axis X_2 of a second sound duct part in the second body part 18 forms an angle φ of 42°. In general, a first longitudinal axis X_1 of a first sound duct part in the first body part, and a second longitudinal axis X_2 of a second sound duct part in the second body part may form an angle φ in the range from 15° to 55°, such as from 35° to 50°, advantageously from 40° to 45°. The sound duct 11 has a substantially constant cross-sectional circular shape and constant cross sectional area from the first sound duct end 13 to the second sound duct end 15.

Fig. 7 schematically illustrates an end view of the receiver suspension 1 in Fig. 1. A receiver (not shown) may be mounted in the receiver compartment formed by the receiver holding part 2 through the insertion opening 36 such that an output port of the receiver is fitted into the first opening 12 for feeding sound from the receiver into the sound duct 11.

Fig. 8 schematically illustrates a first cross section perpendicular to the sound duct along the line B-B in Fig. 1. The first damping element 16 covers an area $A_{1,damp1}$ in the first cross-section of less than 10% of a receiver base area A_{base} being the maximum area spanned by the receiver base 8 perpendicular to the first longitudinal axis X_1. The receiver base area A_{base} may be in the range from 20 mm^2 to 200 mm^2. The first body part 10 and the second damping element 20 are integrated, and the first outer surface of the first body part 10 has a non-circular shape in the first cross section. The first damping element 16 extends from a corner section 52 of the receiver base 8 within a corner distance of 3 mm from a receiver base corner 53. The first outer surface of the first body part 10 comprises a first concave section 54 and optionally a second concave section 56.

Fig. 9 schematically illustrates a first cross section perpendicular to the sound duct of an exemplary suspension 1'. The first damping element 16 extends from an edge

section 60 of the receiver base within an edge distance of 3 mm from the receiver base edge 62.

Fig. 10 illustrates an exemplary suspension 1'' according to the invention. The suspension is shown mounted within a hearing device housing 64. The hearing device housing 64 is depicted as a section in order to more clearly illustrate the positioning of the receiver suspension 1''. A receiver 65 is mounted in the suspension 1''. The suspension 1'' comprises a receiver holding part 2 and a damping structure 4. The damping structure 4 has a body 6 and a receiver base 8. The body 6 comprises a first body part 10 extending from the receiver base 8. The damping structure 4 has an inner surface forming a sound duct in the damping structure 4 extending through the first body part 10. The damping structure 4 has a first opening at a first sound duct end 13 in the receiver base 8/receiver holding part 2. The receiver base 8 with the first opening is configured for mounting the receiver 65 to the suspension 1'' and for connecting an output port 65A of the receiver to the sound duct 11. The receiver output of the receiver may as illustrated comprise a tube portion with an end forming the output port 65A. The tube portion facilitates mounting to the suspension by extending slightly into the sound duct 11. Thus, the sound duct 11 provides a sound path for conveying sound energy from the receiver 65 mounted to the receiver holding part 2, through the damping structure to the second opening (not shown).

The damping structure 4 comprises a first damping element 16 and optionally a second damping element 20 extending from a second body part 18 separate from and in parallel to the first body part 10. In the suspension 1'', the first damping element 16 and the second damping element 20 each extend as a protrusion from the body (second body part 18) of the damping structure, each protrusion having a distal end. The first damping element 16 and the second damping element 20 comprise respective first support surface 66 and second support surface 68 each configured for contacting or supporting on a point or outer surface of receiver housing 69 when the receiver 65 is mounted in the suspension. The first support surface 66 may be arranged near or at the distal end of the first damping element 16. The second support surface 68 may be arranged near or at the distal end of the second damping element 20. Further, the damping structure 4 optionally comprises one or more damping elements configured for contacting a point or surface of a hearing device structural frame or hearing device housing when the suspension is mounted in the hearing device. The damping structure comprises a third damping element 70 protruding from the body and comprising a third support surface 72 for contacting a point or surface of a hearing device structural frame

or hearing device housing when the suspension is mounted in the hearing device. The third support surface 72 may be arranged near or at the distal end of the third damping element 70. Optionally, the damping structure comprises a fourth damping element 74 protruding from the body (e.g. second body part) and comprising a fourth support surface 76 for contacting a point or surface of a hearing device structural frame or hearing device housing when the suspension is mounted in the hearing device. The fourth support surface 76 may be arranged near or at the distal end of the fourth damping element 74. The receiver may have a first electrical terminal 73A and a second electrical terminal 73B configured for electrical connection to the hearing aid circuitry (not shown).

LIST OF REFERENCES

1, 1', 1''	suspension
2	receiver holding part
4	damping structure
6	body of damping structure
8	receiver base
10	first body part
11	sound duct
12	first opening of sound duct
13	first sound duct end
14	second opening of sound duct
15	second sound duct end
16	first damping element
18	second body part
19	gap
20	second damping element
22	third body part
24	first portion of receiver holding part
26	second portion of receiver holding part
28	first bridge element of receiver holding part
30	second bridge element of receiver holding part
32	third bridge element of receiver holding part
34	fourth bridge element of receiver holding part
36	insertion opening for receiver unit
38	first shock-absorbing cushion structure of receiver chamber
40	second shock-absorbing cushion structure of receiver chamber
42	third shock-absorbing cushion structure of receiver chamber
44	fourth shock-absorbing cushion structure of receiver chamber
46	mounting element
48	annular bulge
50	hearing instrument structural frame
52	corner section of receiver base
53	receiver base corner
54	first concave section
56	second concave section

60	edge section of receiver base
62	receiver base edge
64	hearing device housing
65	receiver
65A	output port of receiver
66	first support surface
68	second support surface
69	receiver housing
70	third damping element
72	third support surface
73A	first electrical terminal
73B	second electrical terminal
74	fourth damping element
76	fourth support surface
$A_{1, damp1,}$	area of first damping element in first cross-section
A_{base}	receiver base area

CLAIMS

1. A suspension for a receiver in a hearing device, the suspension comprising:

- a receiver holding part, and
- a damping structure with a body and a receiver base, the body comprising a first body part, the damping structure having an inner surface forming a sound duct in the damping structure, the sound duct extending through the first body part, the damping structure having a first opening at a first sound duct end, the first opening configured for connecting an output port of the receiver to the sound duct, the damping structure having a second opening at a second sound duct end, the sound duct providing a sound path for conveying sound energy from the receiver through the damping structure to the second opening, the first body part extending from the receiver base,

wherein the damping structure comprises at least a first damping element extending separate from and in parallel to the first body part.

2. Suspension according to claim 1, wherein the first damping element connects the body and the receiver base separate from and in parallel to the first body part.

3. Suspension according to any of claims 1-2, wherein the body comprises a second body part positioned between the second sound duct end and the first body part, the sound duct extending through the second body part and the second body part having a corrugated second outer surface.

4. Suspension according to any of claims 1-3, wherein the first damping element extends from the receiver base to the body forming a gap between the first damping element and the first body part.

5. Suspension according to any of the preceding claims, wherein the first body part comprises a second damping element extending from the receiver base.

6. Suspension according to any of the claims 1-4, wherein the damping structure comprises a second damping element extending separate from and in parallel to the first body part.

7. Suspension according to any of the preceding claims, wherein a first longitudinal axis of a first sound duct part in the first body part, and a second longitudinal axis of a second sound duct part in the second body part form an angle in the range from 15° to 45°.

8. Suspension according to claim 5, wherein the first damping element, in a first cross section, perpendicular to the first longitudinal axis covers an area of less than 10% of a receiver base area.

9. Suspension according to any of the preceding claims as dependent on claim 2, wherein the body comprises a third body part between the first body part and the second body part for absorbing a part of the vibrational energy from the receiver.

10. Suspension according to any of the preceding claims, wherein a first outer surface of the first body part in a cross section perpendicular to the sound duct is non-circular.

11. Suspension according to any of the preceding claims, wherein the receiver holding part forms a receiver compartment and comprises a first portion connected to the receiver base part, and a second portion, wherein the first portion and the second portion are connected by a plurality of bridging elements.

12. Suspension according to claim 11, wherein the second portion comprises an insertion opening for insertion of a hearing aid receiver in the receiver compartment.

13. Suspension according to any of claims 11-12, wherein the second portion of the receiver holding part comprises a plurality of cushioning zones for absorbtion of mechanical shock.

14. Suspension according to any of the preceding claims, wherein the damping structure comprises a mounting element at the second opening for mounting the suspension to a structural frame of a hearing device.

15. A hearing device comprising a hearing device receiver, a hearing device structural frame and a suspension according to one of the preceding claims, wherein the hearing device receiver is mounted in the suspension.

16. Hearing device according to claim 15, wherein the output port of the receiver is positioned in the first opening of the sound duct.

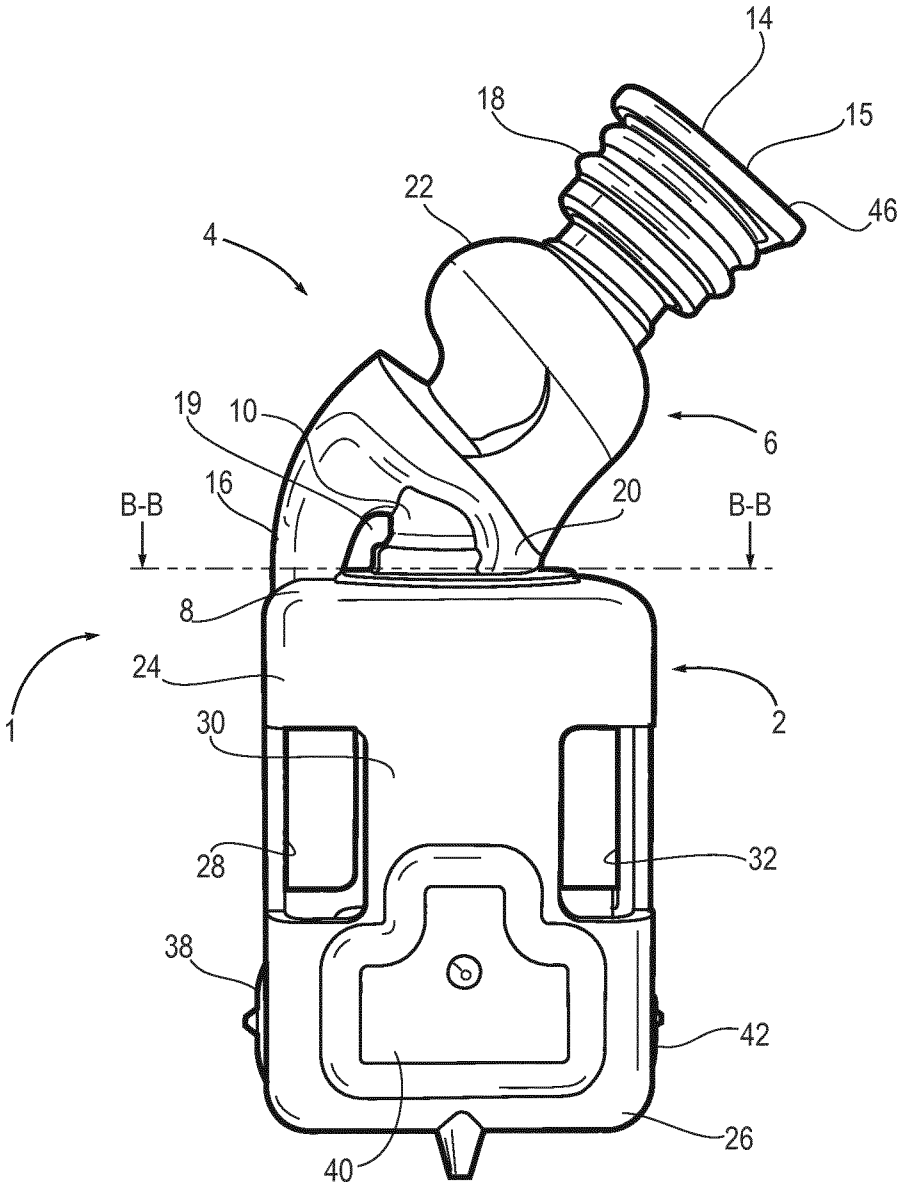

Fig. 1

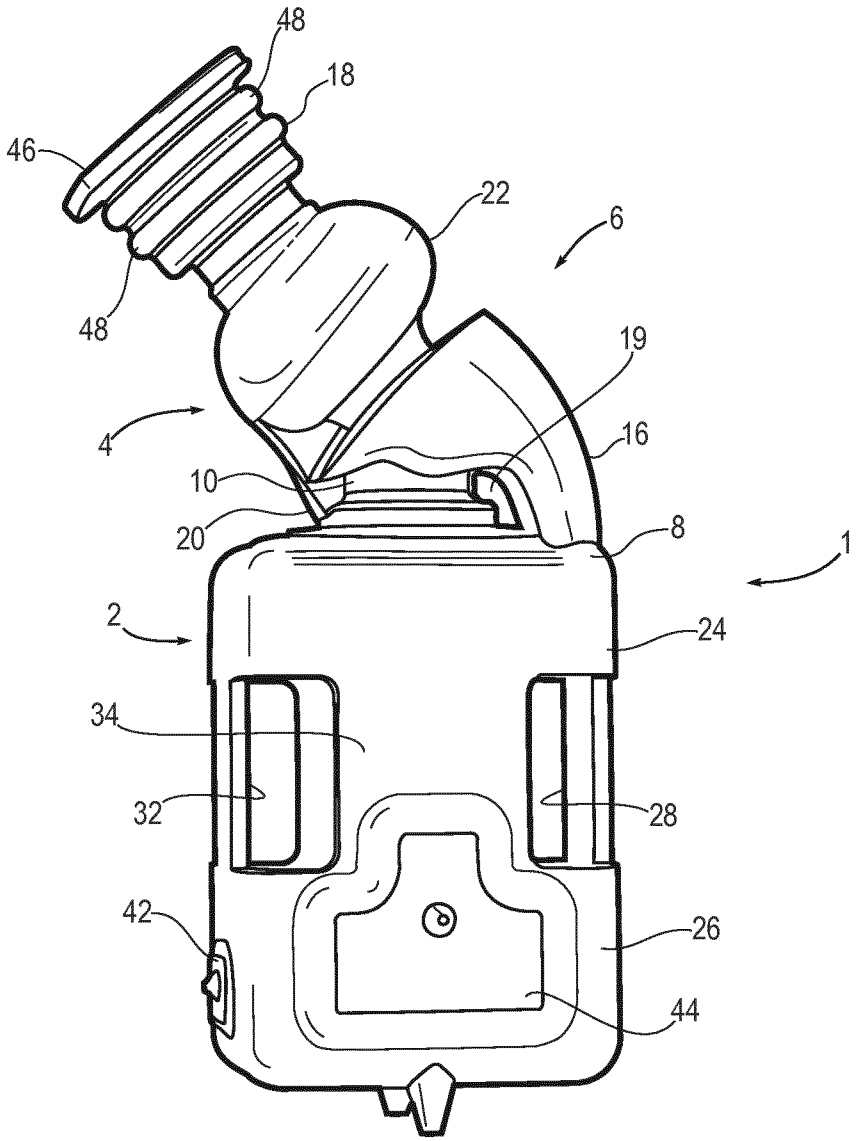

Fig. 2

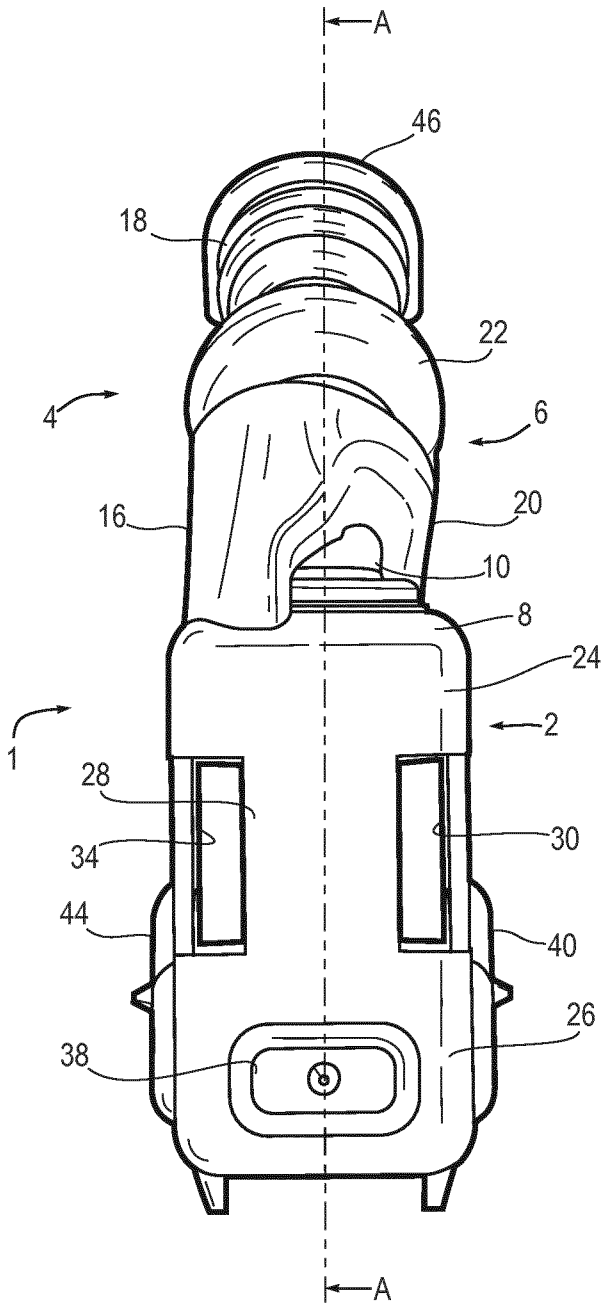

Fig. 3

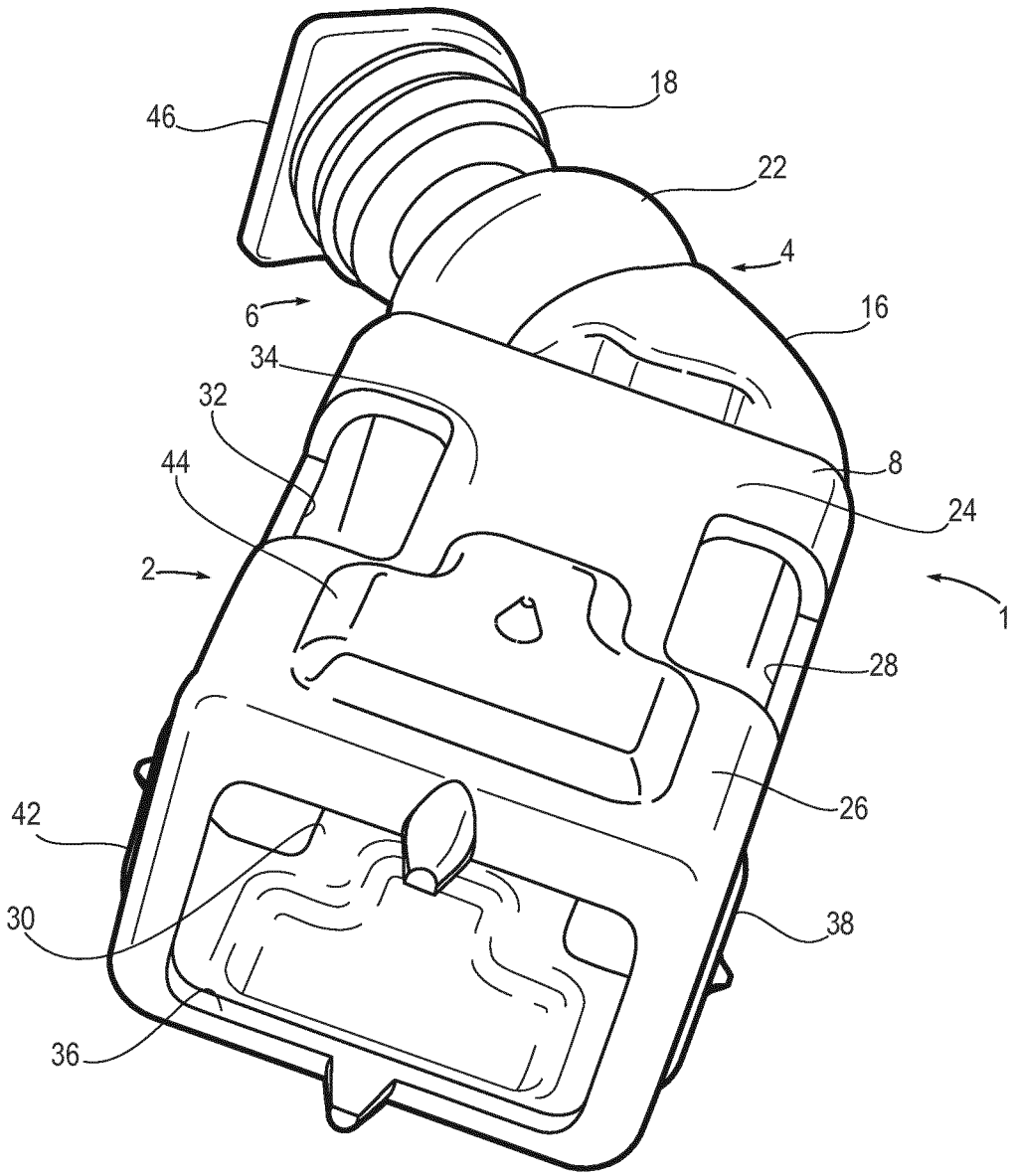

Fig. 4

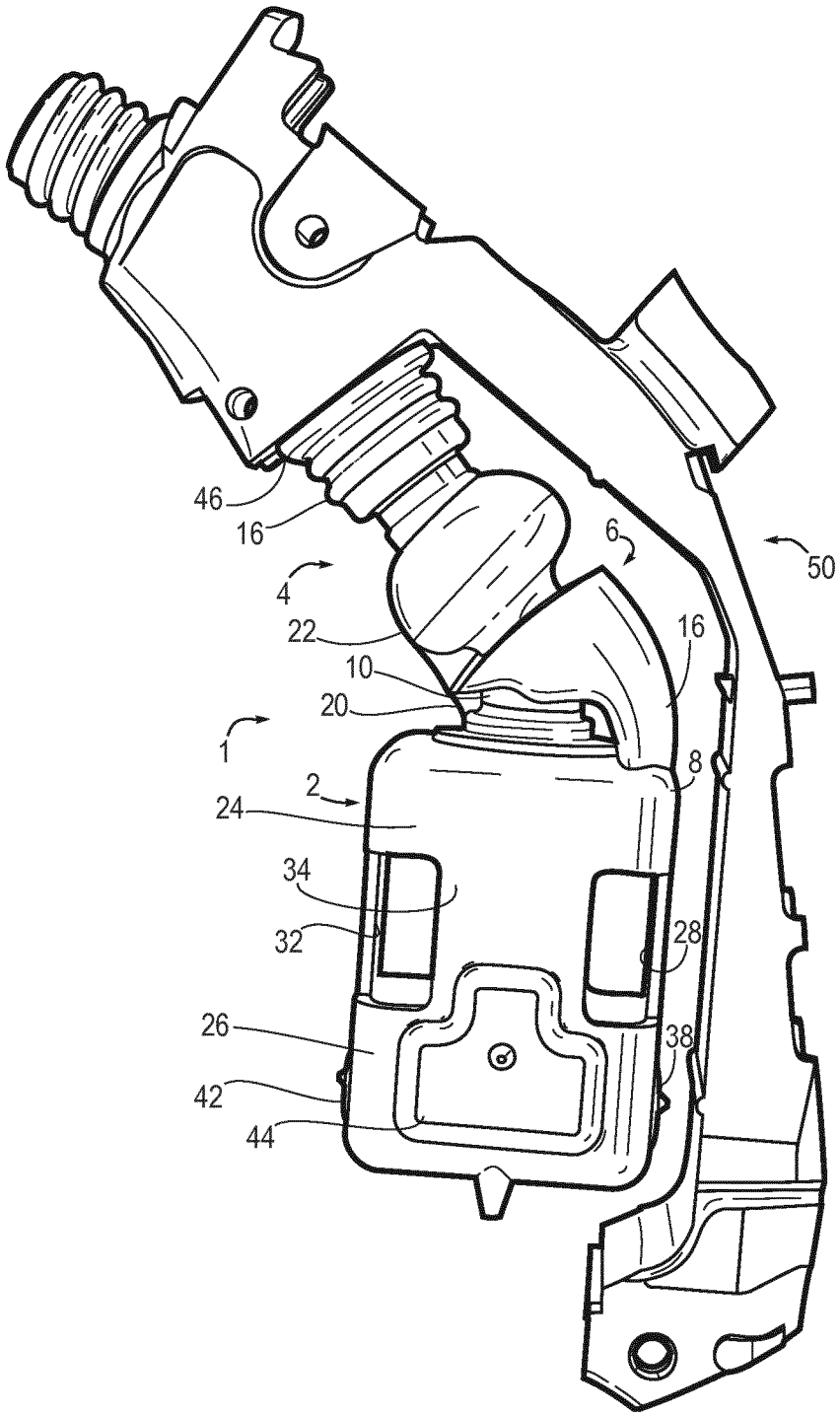

Fig. 5

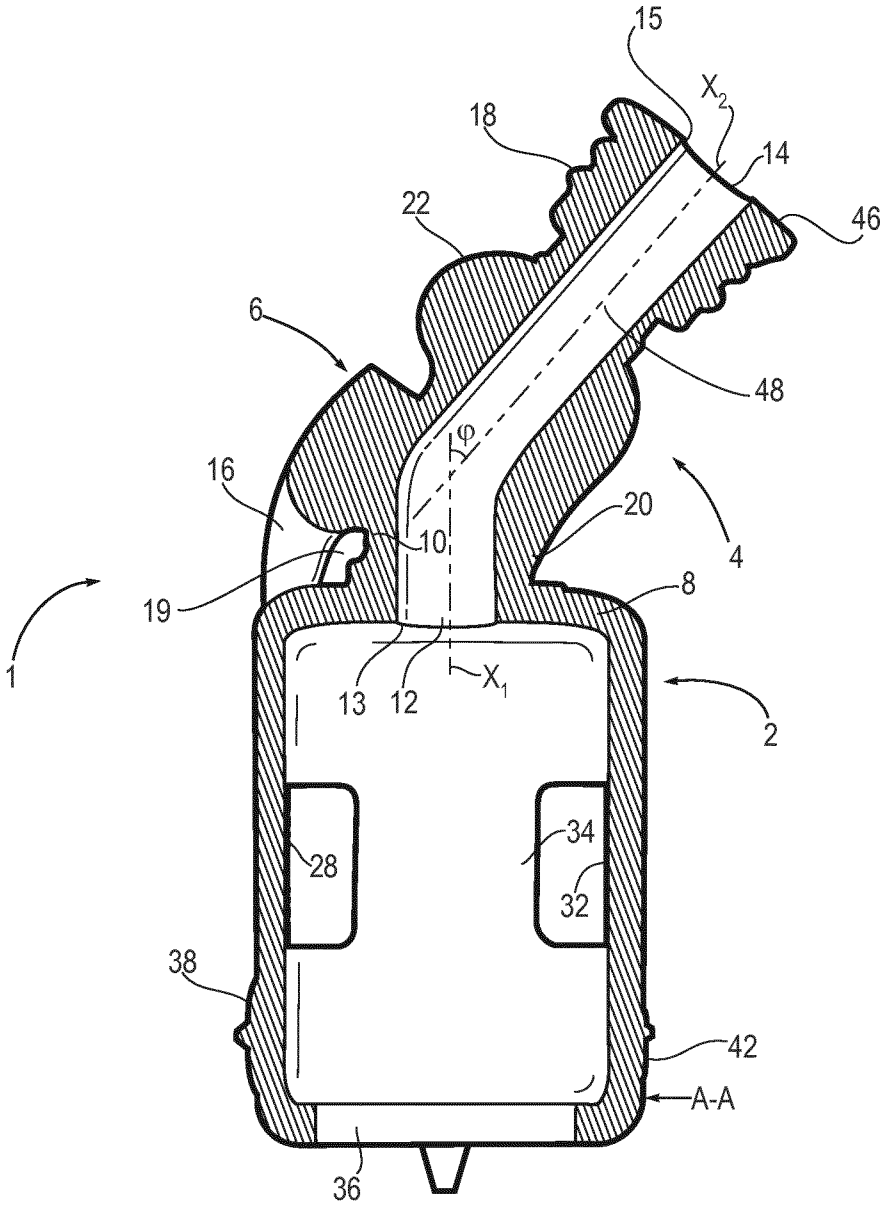

Fig. 6

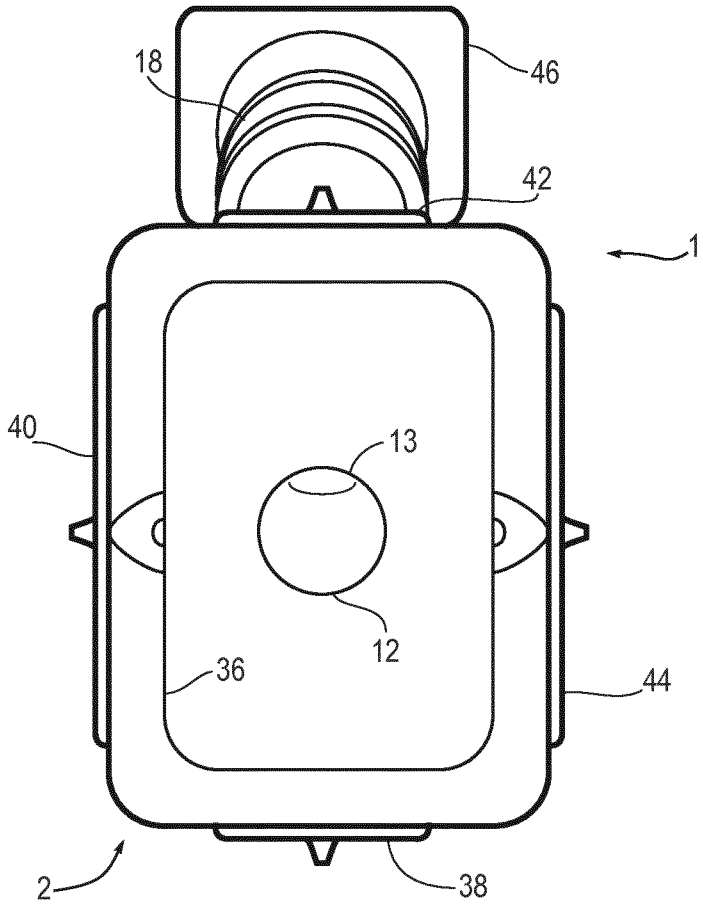

Fig. 7

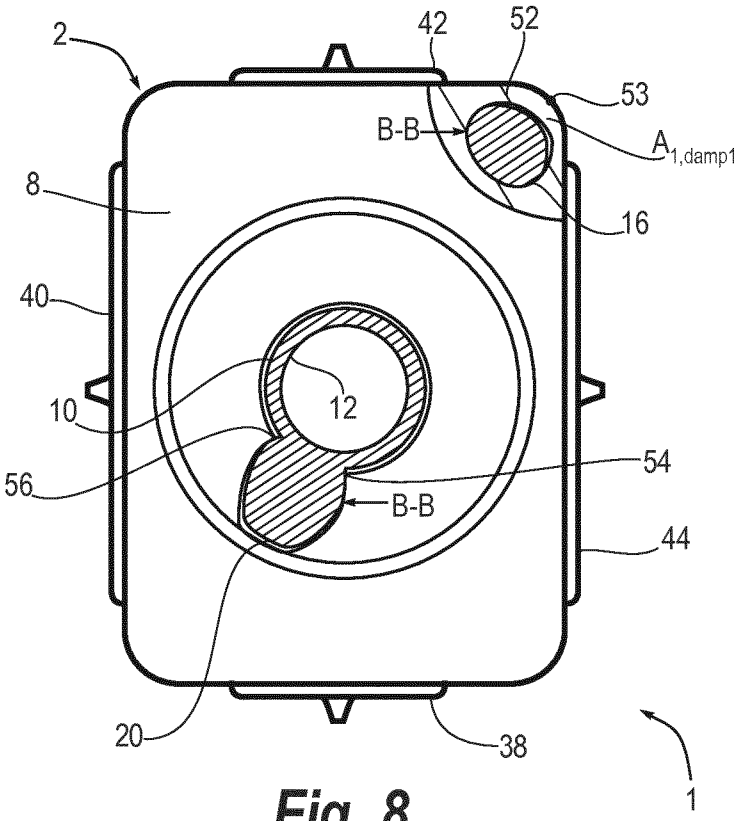
2
42
52
53
B-B
$A_{1,damp1}$
8
16
40
10
12
54
56
B-B
44
20
38
1

Fig. 8

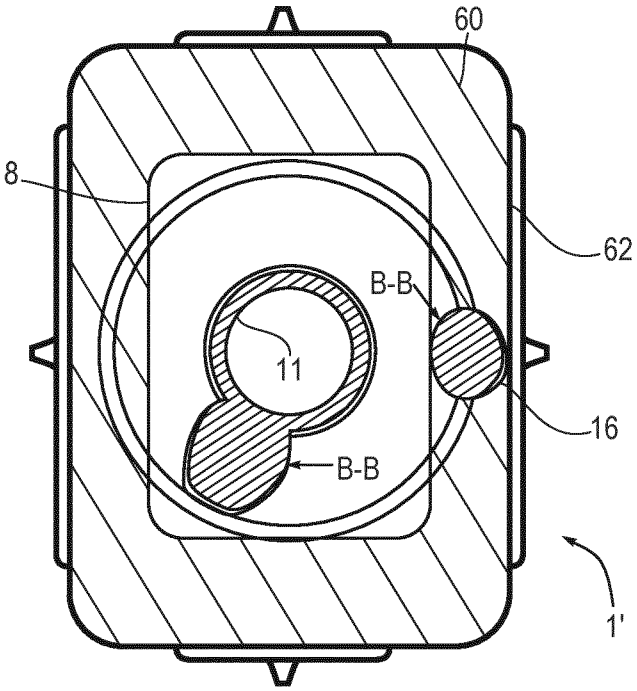
60
8
62
B-B
11
16
B-B
1'

Fig. 9

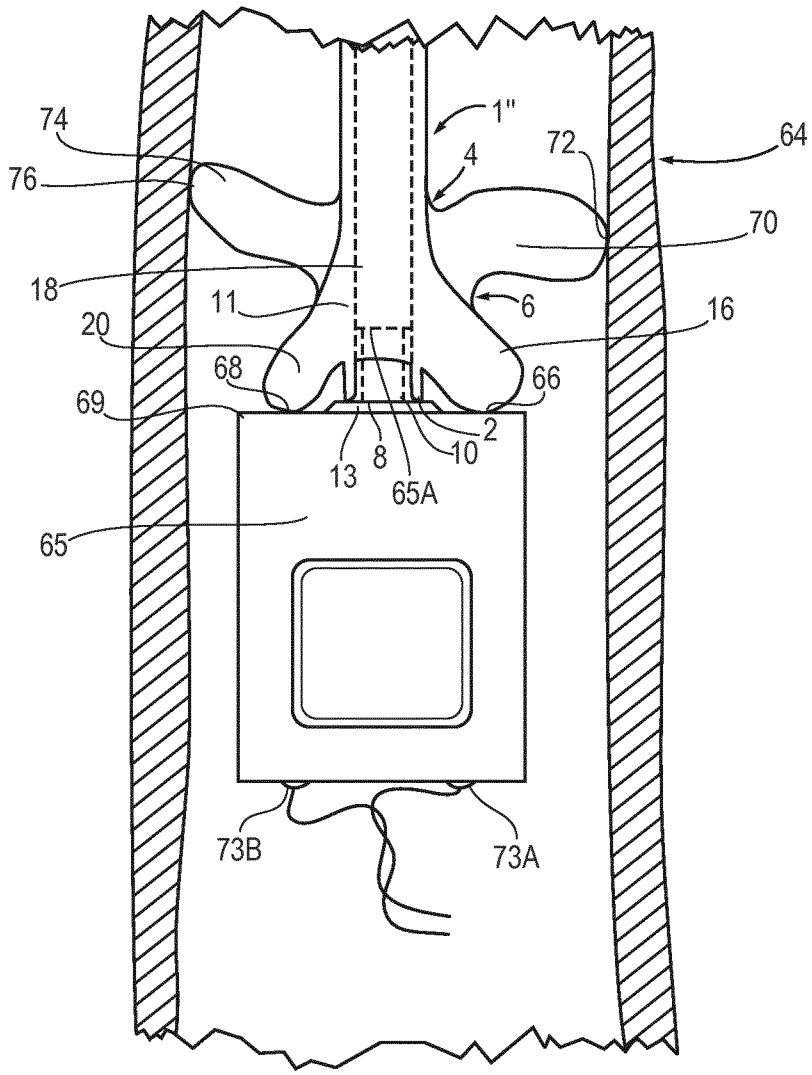

Fig. 10