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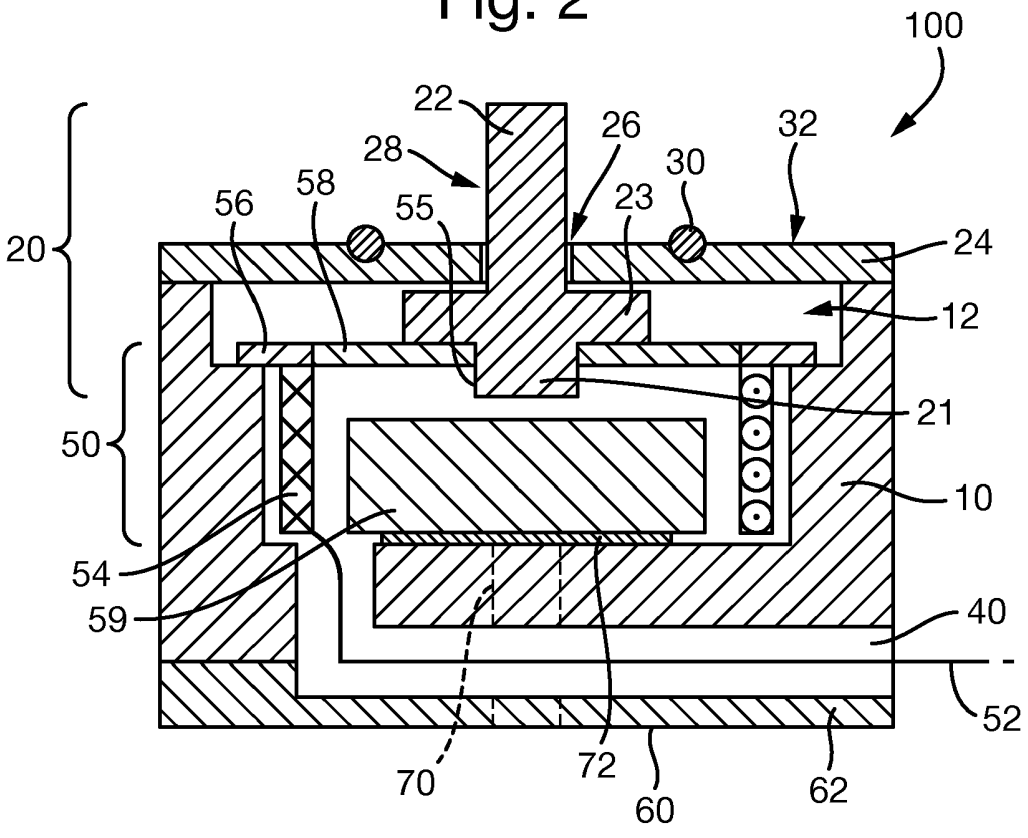
(54) HOUSING FOR CONNECTING A TRANSDUCER FOR A SUBSTRATE

(57) There is disclosed here a housing for connecting an transducer to a substrate, the housing comprising a main body defining a cavity for accommodating the transducer a connecting body for connecting to the transducer and the substrate, and for covering the cavity, the connecting body comprising a protruding member for fastening to a reciprocal form in the substrate.

Fig. 2



EP 3 273 702 A1

Description

[0001] The present invention relates to a housing for connecting a transducer to a substrate, and to transducer assembly comprising such a housing, and to a communication helmet comprising such a transducer assembly.

[0002] It is known to provide an audio transducer for converting electrical energy into sound waves. One such audio transducer is illustrated in Figure 1 and generally indicated at 50, where a coil 54 of conducting wire extends from a diaphragm 58 to surround but be separated from a permanent magnet 59. The coil 54 and diaphragm 58 are suspended on sprung arms 56 which arms 56 are affixed to a housing 53. The coil and diaphragm are thereby free to move relative to the magnet 59, which is fixed to the base of the housing 53. When a fluctuating electrical signal is passed through the coil 54, the coil 54 acts as an electromagnet and is alternatively repulsed and attracted to the magnetic field of the permanent magnet 59. The alternative repulsion and attraction causes the diaphragm to move and the movement of the diaphragm 58 relative to the magnet 53 and housing 53 generates sound waves.

[0003] Audio transducers of this particular form may be referred to as contact transducers or surface transducers on account of their ability to be placed diaphragm down on a substrate and then transmit sound waves into the substrate.

[0004] However, it has been determined by the applicant that the application of such contact transducers to certain substrates can raise issues.

[0005] According to a first aspect of the invention there is provided a housing for connecting a transducer to a substrate, the housing comprising: a main body defining a cavity for accommodating the transducer; a connecting body for connecting to the transducer and the substrate, and for covering the cavity, the connecting body comprising a protruding member for fastening to a reciprocal form in the substrate.

[0006] Such a housing provides a robust form from which the capabilities of the transducer can be exploited. Accordingly the housing tends to enable the transducer to be used in harsh environments. Such environments could be harsh by virtue of exposure to water or moisture, or by virtue of likelihood of dynamic loading.

[0007] The connecting body may comprise: a connecting rod having a first and second member, the first member being for fastening to the transducer, the second member being the protruding member for fastening to a reciprocal form in the substrate, the connecting rod being arranged such that the first member extends towards the cavity and the second member extends away from the cavity, a sealing plate for covering the cavity, the sealing plate comprising an aperture for allowing the second member of the connecting rod to protrude therethrough.

[0008] The provision of a two part connecting body allows for a readily manufactured and assembled connecting body.

[0009] The connecting rod may comprise a collar interposed between the first and second member, the collar being adapted to promote the correct positioning of the connecting rod between the main body and the sealing plate.

[0010] Such a collar facilitates a simple assembly.

[0011] The connecting body may define an outer surface for presenting to the substrate and wherein there is provided a gasket at the outer surface, which surrounds the protruding member.

[0012] Such a provision tends to enable a water-tight seal to be provided once the housing is applied to a substrate. In particular, the gasket can be in the form of a ring surrounding the base of the protruding member.

[0013] The main body may be provided with a channel for securely accommodating transducer cabling at an outer surface of the housing.

[0014] Such provisions for clamping or otherwise securing the cable tend to confer a more reliable electrical connection. For instance the chance of the cable becoming detached during oscillation of the transducer, can be reduced.

[0015] Indeed the housing may further comprise a back plate provided with a channel for accommodating transducer cabling, the back plate being attachable to the main body such that transducer cabling may be contained between the main body channel and the back plate channel.

[0016] The protruding member for fastening to the substrate may be a threaded bolt for fastening to a threaded hole within a substrate.

[0017] As such the housing can be conveniently retrofitted to existing substrates whilst providing a reliable coupling which can tend to transfer oscillations energy efficiently from the transducer to the substrate (via the bolt).

[0018] Further, the threaded bolt may be adapted for fastening to a predetermined hole in a helmet, and still more particularly, may be adapted for fastening to a visor mount hole in a helmet.

[0019] The main body may comprise a hole for allowing ingress of glue so as to secure the transducer during assembly.

[0020] Such a provision helps facilitate manufacture and assembly.

[0021] The cavity of the main body may define a ledge on which sprung arms of the transducer can attach.

[0022] Such a provision helps facilitate manufacture and assembly.

[0023] The protruding member may comprise a frangible section such that under a predetermined load, the protruding member can detach from the housing.

[0024] Such a provision can allow the transducer housing to be sacrificially detached (by way of shearing or breaking away from the protruding member which will tend to be connected to the substrate) in the event that a certain force is applied to the housing, which would not be desirable to have transferred to the substrate.

[0025] The protruding member may be is shorter than the depth of the reciprocal form of the substrate such that

the housing abuts the substrate to provide an axial separation between the protruding member and the substrate.

[0026] Thus the transmittance of forces from the housing to the substrate, along the axis of the protruding member such that the protruding member may breach the substrate, can be mitigated.

[0027] According to a second aspect of the invention there is provided a transducer assembly comprising a housing according to the first aspect of the invention, and a transducer.

[0028] According to a third aspect of the invention there is provided a communication helmet comprising: a helmet for an operator; a transducer assembly according to claim 14, and being mounted on the helmet; and a radio transceiver unit mounted to an operator-wearable item and configured to feed a signal to the transducer assembly.

[0029] So that the invention may be well understood, at least one exemplary embodiment thereof will not be described and with reference to the following figures, of which:

Figure 1 shows a known transducer;

Figure 2 shows a transducer assembly according to the present invention;

Figure 3 shows an alternative connecting rod for a transducer assembly such as shown in Figure 2; and

Figure 4 shows a transducer assembly, such as shown in Figure 2, attached to a helmet.

[0030] Referring to Figure 2 there is shown generally at 100 a transducer assembly.

[0031] The transducer assembly 100 comprises an oscillatory transducer 50 installed in a housing.

[0032] The transducer 50 comprises a planar form comprised by a flexible disc-shaped diaphragm 58 from the periphery of which extend sprung arms 56 in a generally radial direction. Extending in a generally axial direction from the planar form is a coil 54 which defines a tubular structure. Positioned within the tubular structure, but separated therefrom, is a magnet 59. The coil 54 is fed with an electrical signal by cabling 52.

[0033] The diaphragm 58 is adapted so as to have a central aperture 55 therein.

[0034] The housing into which the transducer is installed comprises a main body 10 and a connecting body 20.

[0035] The main body 10 is generally cylindrical at its outer surface and is partially hollow so as to have the general form of a cap. Accordingly the main body 10 defines an internal cavity 12. The cavity 12 has a first section which extends initially into the body 10 and a second section, which has a smaller diameter than the first section and which continues into the body 10 up to a floor of the body 10. The transducer magnet 59 is attached to the floor of the body and is bonded in place with adhesive 72. At the transition between the first and second sections of the cavity there is a step as the diameter between sections changes abruptly, or in alternative language, the wall thickness of the main body 10 increases between the first and second sections of the cavity 12.

[0036] The connecting body 20 comprises a protruding member 22. The connecting body 20 is fastened to the main body 10 and the transducer 50. In particular, the connecting body 20 is fastened to the transducer 50 at the diaphragm 58.

[0037] Further, the connecting body 20 comprises a connecting rod 28 and a sealing plate 24.

[0038] The connecting rod 28 comprises a first member 21 and a second member 22. In the present embodiment both of the first and second members 21, 22 are threaded cylindrical members (bolts) for fastening to a reciprocally threaded aperture or hole.

[0039] The first member 21 extends towards and fastens to the aperture 55 of the diaphragm 58. The second member 22 extends in the opposite direction to the first member 21 and as such protrudes from the assembly 100 and serves to provide the protruding member.

[0040] The connecting rod 28 further comprises a collar 23 interposed between the first and second members, which has a diameter greater than the first member 21 so as to predetermine the extent to which the first member 21 can penetrate into and/or through the diaphragm 58.

[0041] The sealing plate 24 has the general form of a disc comprising a central aperture 26. The diameter of the sealing plate 24 is selected to match the diameter of the cylindrical main body 10. The sealing plate 24 has an outer surface 32 on an external facet of the assembly 100, and an internal surface facing the cavity 12.

[0042] Moreover, the sealing plate 24 is configured to fit over the main body so that the cavity 12 is occluded by the plate 24, but for the aperture 26, and the second member 22 of the connecting rod 28 protrudes through the aperture 26.

[0043] The sealing plate 24 further comprises a gasket 30 which is seated into a groove in the plate 24 but protrudes from the outer surface 32 of the plate 24, albeit to a lesser extent than the second member 22. The gasket 30 surrounds the aperture 26 at a diameter approximately half way between the plate 24 diameter (which is substantially similar to the main body 10 diameter) and the aperture 26 diameter.

[0044] The sealing plate 24 can be fastened to the outer wall of the main body 10 by known means such as screws or adhesive (not shown).

[0045] On the opposing side of the main body 10 to the protruding member 22, the main body 10 is provided with a channel 40 which leads to a hole which communicates with the transducer coil 54. Into this channel 40 can be laid the transducer cable or wire 52.

[0046] Further, the transducer assembly 100 comprises a back plate 60 which is configured to fit onto the main

body 10 in the region of the main body channel 40. The back plate 60 is provided with a channel 62 corresponding to the main body channel 40 and the back plate 60 fits over the main body 10 such that the channels 40 and 62 coincide and thereby accommodate the transducer cabling 52. Such accommodation acts to gently clamp the wire 52 in place and thereby to mitigate vibrations at the connection between the cable and the coil which might tend to disconnect the wire 52.

[0047] The back plate 60 can be fastened to the main body 10 by known means such as screws or adhesive (not shown).

[0048] The main body 10 can be formed by an additive layer manufacturing process, or otherwise by drilling out holes in a block of material.

[0049] The transducer assembly 100 can be assembled by taking the main body 10, affixing the magnet 59 to the innermost wall (floor) using an adhesive (e.g. an epoxy), affixing the sprung arms 56 of the coil/diaphragm/arms structure to the ledge defined between the first and second sections of cavity 12, affixing the connecting rod 28 to the diaphragm 58, and affixing the sealing plate 24 to the main body 10 such that the connecting rod 28 protrudes through the sealing plate aperture 26.

[0050] Thus assembled, the transducer assembly 100 can be affixed by way of the protruding member 22 / second member of the connecting rod 28 to a suitably prepared substrate.

[0051] In particular, it is contemplated that the protruding member 22 of the transducer assembly 100 could be configured for attachment to a threaded hole in a helmet. Still further, it is contemplated for attachment to the visor mount of a helmet

[0052] In operation a driving electrical signal, representative of an audio signal, would be applied to the transducer cable 52 which would cause the diaphragm 58 and the connecting rod 28 attached thereto to oscillate and thereby produce the audio signal.

[0053] Further, where the connecting rod 28 is connected to a substrate, that substrate will also tend to oscillate according to the audio signal.

[0054] Where the substrate is a helmet, the wearer of the helmet will thereby be able to perceive and understand that audio signal by for instance two mechanisms. Firstly the helmet would tend to oscillate and thereby transmit air pressure waves through the wearer's ear into the auditory canal. Secondly the helmet, where it presses firmly against the wearer's skull, would tend to transmit sound directly to the inner ear through more direct oscillation of the skull (a phenomenon often referred to as bone conduction).

[0055] The main body 10, sealing plate 24 and back plate 60 housing are made of a polyoxymethylene such as Delrin® acetal resin (as supplied by Dupont, see further details at www.dupont.com). However other materials which provide comparable or adequate hardness could be used. For instance, the main body 10, sealing plate 24 and back plate 60 could be formed from Aluminium or an alloy thereof.

[0056] As shown in figure 3, an alternative connecting rod 32 may be used in a housing or transducer assembly 100, replacing the connecting rod 22.

[0057] The alternative, frangible connecting rod 32 is adapted to be frangible and as such has a frangible section 34 which has the form of a narrowed neck section 36.

[0058] A transducer assembly 100 comprising a frangible connecting rod 32 is suited for application to a substrate where sudden forces may be applied to the assembly 100 which would be undesirable to transfer to the substrate (for example where the substrate is a protective helmet).

[0059] Accordingly the frangible rod 32 can be configured to break under a predetermined load such that the frangible connecting rod 32 mitigates the risk of such loads being transferred from the transducer assembly 100 to the substrate.

[0060] Referring to Figure 4, the transducer assembly 100 is shown in one particularly contemplated context where it is affixed to a helmet 300. The helmet 300 also has mounted on it a radio transmitter receiver 200, which is electrically connected to the feed wire 52 of the transducer 50. However in alternative scenarios, the transducer assembly 100 could be affixed to the helmet 300 whist the radio transmitter receiver 200 could be affixed elsewhere on the operator, for instance at the waist on a belt.

[0061] The transducer assembly 100 is attached by screwing the protruding member 22 into the visor mount of the helmet 300 until the gasket 30 abuts the surface of the helmet 300 and thereby creates a seal around the aperture 26 and protruding member 22. The protruding member 22 may be sized with length such that it extends, even at its deepest penetration, only partially into the visor mount hole, an arrangement known as 'underflush'. In particular a space of 2 to 3 mm can be provided between the member 22 at its deepest penetration and the floor of the visor mount hole. Thus the protruding member 22 tends to be prevented from breaching into the helmet 300 in the event of a force applied through the transducer assembly 100, down the protruding member 22 and towards the helmet 300.

[0062] In use the radio unit 200 may receive an electromagnetic signal (which is representative of an audio signal) at an antenna, convert this to an electrical signal (again representative of the audio signal) and feed this to the transducer assembly over feed wire 42. The provision of a feed wire 42 between the transducer assembly 100 and the radio unit 200 enables not only an electrical/audio signal but also power to be conveyed to the transducer assembly 100.

[0063] In alternative embodiments, there may be a wireless communication link between the radio transmitter receiver 200 and the transducer assembly 100. In such cases a local power supply can be integrated into the transducer assembly 100. In particular, the transducer assembly 100 may therefore comprise a battery and

a charging circuit (which may be a port for a charging cable, or may be an inductive coil for interfacing with an inductive charging device).

[0064] The radio unit 200 may apply certain transfer functions to the electrical signal so as to configure the signal for use with the transducer assembly 100.

[0065] For instance the radio unit 200 may limit the amplitude of the signal so as to protect the user against high power sound waves that could damage the user's hearing. Further, the radio unit 200 may apply frequency-dependent amplitude reduction or enhancement, so that the natural resonances of the helmet 300 are counter-balanced.

[0066] Additionally or alternatively, the transducer assembly 100 may be provided with electronic components to perform form certain transfer functions or signal processing, and in particular may comprise a signal amplifier, a voltage regulator, and/or a low pass filter (to reduce the bass in the signal).

[0067] In an alternative arrangement the radio unit 200 and transducer assembly 100 may be integrated into the same unit.

Claims

1. A housing for connecting a transducer to a substrate, the housing comprising:

   A main body defining a cavity for accommodating the transducer; and
   A connecting body for connecting to the transducer and the substrate, and for covering the cavity,

   the connecting body comprising a protruding member for fastening to a reciprocal form in the substrate.

2. A housing according to claim 1 wherein the connecting body comprises:

   A connecting rod having a first and second member, the first member being for fastening to the transducer, the second member being the protruding member for fastening to a reciprocal form in the substrate, the connecting rod being arranged such that the first member extends towards the cavity and the second member extends away from the cavity,
   A sealing plate for covering the cavity, the sealing plate comprising an aperture for allowing the second member of the connecting rod to protrude therethrough.

3. A housing according to claim 2 wherein the connecting rod comprises a collar interposed between the first and second member, the collar being adapted to promote the correct positioning of the connecting rod between the main body and the sealing plate.

4. A housing according to any one of the preceding claims wherein the connecting body defines an outer surface for presenting to the substrate and wherein there is provided a gasket at the outer surface, which surrounds the protruding member.

5. A housing according to any one of the preceding claims wherein the main body is provided with a channel for securely accommodating transducer cabling at an outer surface of the housing.

6. A housing according to claim 5 further comprising a back plate provided with a channel for accommodating transducer cabling, the back plate being attachable to the main body such that transducer cabling may be contained between the main body channel and the back plate channel.

7. A housing according to any one of the preceding claims wherein the protruding member for fastening to the substrate is a threaded bolt for fastening to a threaded hole within a substrate.

8. A housing according to claim 7 wherein the threaded bolt is adapted for fastening to a predetermined hole in a helmet.

9. A housing according to claim 8 wherein the threaded bolt is adapted for fastening to a visor mount hole in a helmet.

10. A housing according to any one of the preceding claims wherein the main body comprises a hole for allowing ingress of glue so as to secure the transducer during assembly.

11. A housing according to any one of the preceding claims wherein the cavity of the main body defines a ledge on which sprung arms of the transducer can attach.

12. A housing according to any one of the preceding claims wherein the protruding member comprises a frangible section such that under a predetermined load, the protruding member can detach from the housing.

13. A housing according to any one of the preceding claims wherein the protruding member is shorter than the depth of the reciprocal form of the substrate such that the housing abuts the substrate to provide an axial separation between the protruding member and the substrate.

14. A transducer assembly comprising:

A housing according to any one of the preceding claims, and
A transducer.

15. A communication helmet comprising:

A helmet for an operator;

A transducer assembly according to claim 14, and being mounted on the helmet; and
A radio transceiver unit mounted to an operator-wearable item and configured to feed a signal to the transducer assembly.

Fig. 1

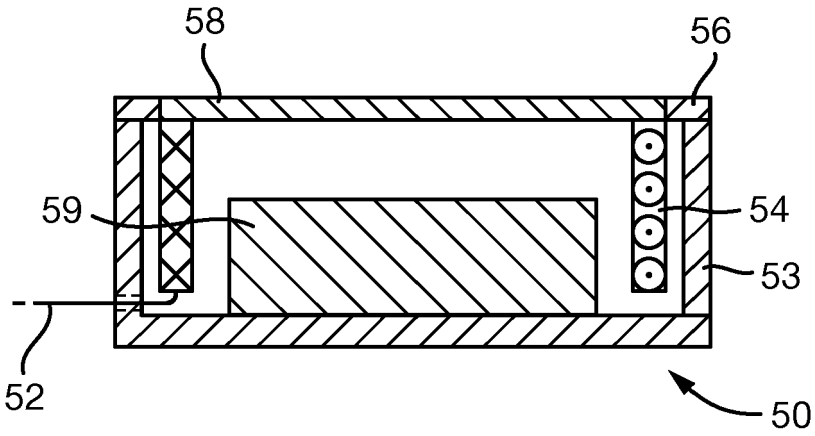

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Fig. 2

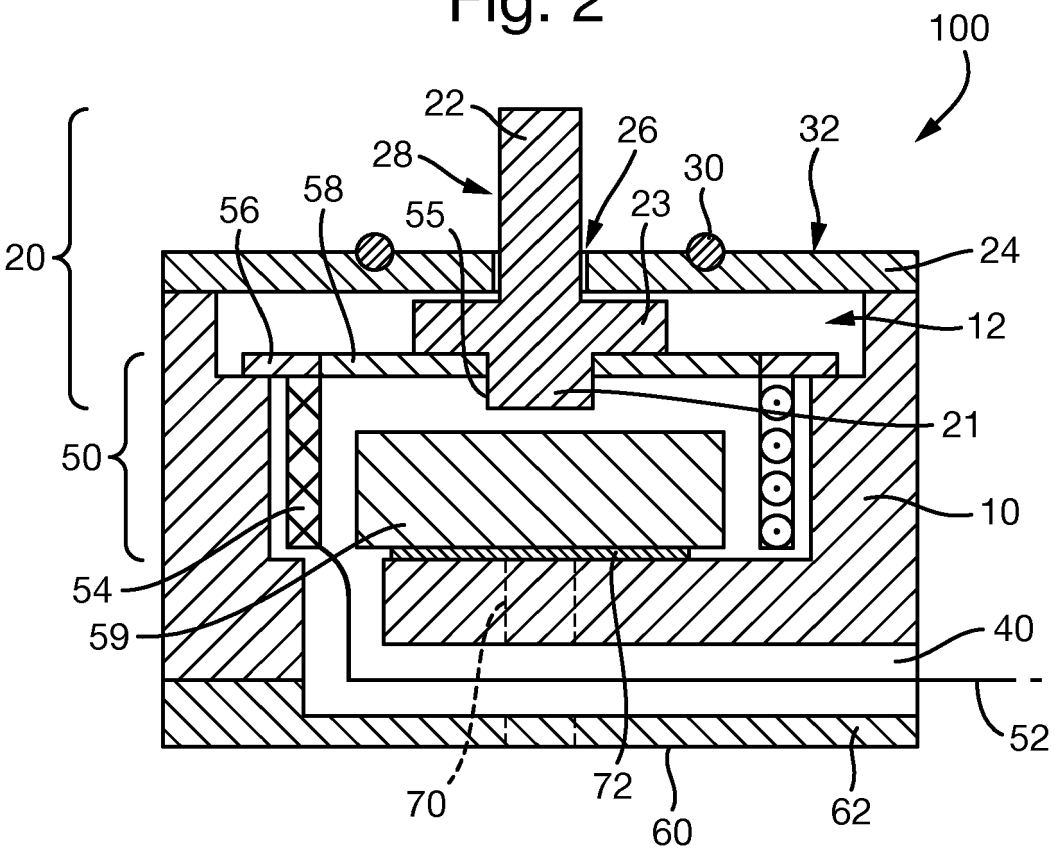
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Fig. 3

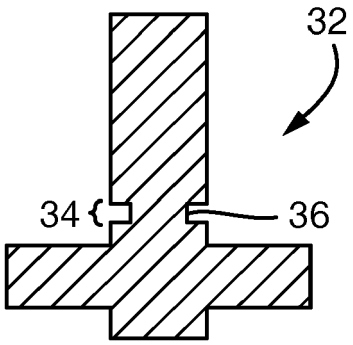
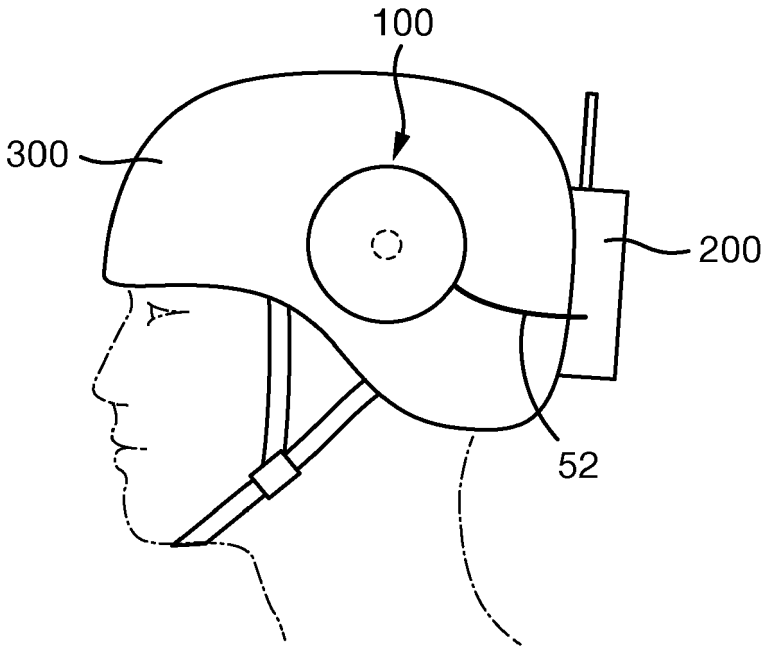


Fig. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 16 18 0301

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 January 2017	Navarri, Massimo

CATEGORY OF CITED DOCUMENTS

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