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(54) **AN ON-LOAD TAP CHANGER COMPRISING A FASTENER**

(57) An on-load tap changer (OLTC) (1) comprising a housing, said housing comprising a housing body (2) and a metal body (3) attached to the housing body (2) using a plurality of fasteners (4),
each respective one of said fasteners (4) comprising:
a bolt (5) configured to extend from an outside of the housing body (2), through a respective hole of the housing body (2), and to engage with a threaded hole of the metal body (3) on an inside of the housing body (2), said fastener (4) further comprising a bushing (6) inserted in the respective hole of the housing body (2), said bushing (6) comprising a central opening through which the bolt (5) extends.

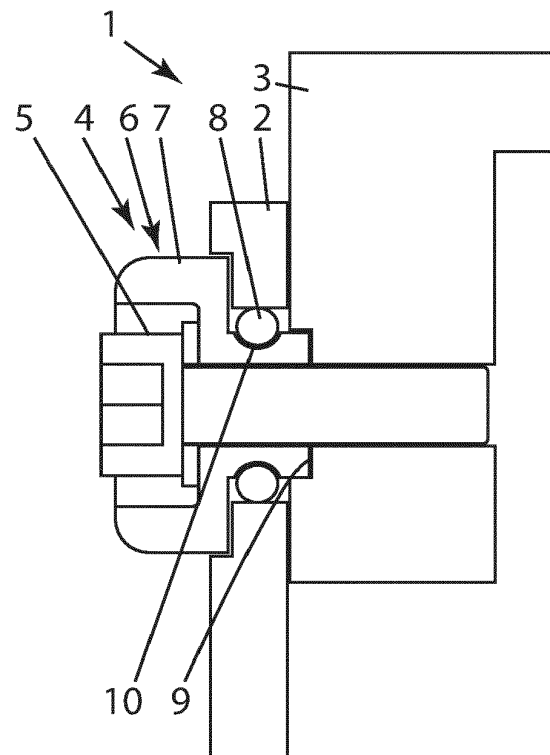


Fig. 11

Description

TECHNICAL FIELD

[0001] The present invention relates to improvements to fasteners between members of an OLTC. Specifically, the invention relates to fasteners for OLTCs designed for use in moving working conditions, such as at sea.

BACKGROUND OF THE INVENTION

[0002] On-load tap changers (OLTCs) typically comprise a housing formed by a housing body having opposite open ends, each end being closed by a respective lid attached to the housing body using fasteners. The housing body may be made from a rigid material, such as a fiber-reinforced plastic material. When the OLTC is exerted to accelerations, the fittings tend to wear at the respective junction between fitting and housing body, such that the risk of failure increases. For static installations this is not a problem, but when using the OLTC in moving applications, for example on floating platforms at sea, the problem increases.

[0003] Accordingly, it is an object of the invention to make the OLTC more robust.

SUMMARY OF THE INVENTION

[0004] According to a first aspect, the object is achieved by an OLTC according to claim 1, with alternative embodiment defined in the dependent claims. The OLTC comprises a housing, said housing comprising a housing body and a metal body attached to the housing body using a plurality of fasteners. Each respective one of said fasteners comprises:

a bolt configured to extend from an outside of the housing body, through a respective hole of the housing body, and to engage with a threaded hole of the metal body on an inside of the housing body. The fastener further comprises a bushing inserted in the respective hole of the housing body, said bushing comprising a central opening through which the bolt extends.

[0005] The bushing provides a smooth interface towards the bolt which mitigates abrasion on the bolt whilst the larger outer diameter of the bushing provides an enlarged wear surface facing the housing body.

[0006] The bushing may extend into a respective recess of the metal body, said recess extending around each respective threaded hole in the metal body and said recess being configured to provide a tight fit with the bushing.

[0007] Since the bushing extends into the recess of the metal body, and since the bushing has a tight fit with the recess, relative movements between the bushing and the metal body are prevented, which in turn reduces relative movement between the bolt and the bushing, thus reducing wear on the bolt.

[0008] The metal body may be a lid configured to cover

an open end of the housing body. For cylindrical housing bodies with two open ends, one lid is typically provided at each open end of the housing body. However, the fasteners are able to attach any metal member component to the housing body.

[0009] A resilient member, such as rubber or an elastomer, may be provided between the bushing and the housing body and configured to align the bushing with the respective hole of the housing body.

[0010] The resilient member enables proper alignment of the bushing with respect to the housing body whilst enabling relative movement between the bushing and the housing body. By allowing relative movement between the bushing and the housing body, dynamic loading conditions on the OLTC, typically occurring when used at sea, may be absorbed without excessive internal stress on or around fasteners. Also, larger tolerances may be used at production of the OLTC without affecting assembly of the OLTC negatively.

[0011] The resilient member may be attached to the bushing using moulding or vulcanization. The resilient member may alternatively be attached to the housing body on a radial circumference of the respective hole of the housing body.

[0012] Affixing the resilient member to either the bushing or the housing body enables more exact positioning of the resilient member and reduces the risk of misplacing the resilient member at manufacturing or maintenance of the OLTC.

[0013] The bushing may be provided with a circumferential recess, wherein the resilient member extends into said recess and protrudes radially outside of the recess with respect to a central axis of the bolt.

[0014] The radially protruding portion of the resilient member will deform elastically upon relative movements between the bushing and the metal member. Since the resilient member extends into the circumferential recess, a portion of the resilient member within the circumferential recess will also deform, allowing greater movement of the protruding portion of the resilient member, which in turn enables use of a tougher material of the resilient member, thus increasing resistance to wear of the resilient member.

[0015] The resilient member may be formed by a gasket, such as an O-ring or cylindrical member.

[0016] The bushing may be made of an electrically conductive material.

[0017] The electrical conductivity of the bushing enables the bushing to improve distribution of an electric field extending by the bolt/bushing.

[0018] The bushing may comprise a collar extending around a head of the bolt.

[0019] The collar protects a head of the bolt from wear and tear and if the collar is made from an electrically conductive material, the electrically conductive properties of the bushing 6 enables the collar to improve distribution of an electric field extending by the bolt/bushing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] All figures show schematic views not drawn to measure. Figs. 2 and 4-12 are cross-sectional views.

Fig. 1 shows an embodiment of an on-load tap changer (OLTC).

Fig. 2 shows an embodiment of a prior art fastener for attaching a metal body to a housing body of an OLTC.

Fig. 3 shows an exploded view of a fastener according to the invention along with a housing body of the OLTC also shown in fig. 1.

Fig. 4 shows a cross-sectional view of the fastener also shown in fig. 3 when used on the OLTC for mounting a metal body in the form of a lid of the OLTC to a housing body of the OLTC.

Figs. 5-12 show various alternative embodiments of the fastener of the invention.

Specifically,

Fig. 5 shows an embodiment without resilient member between the bushing and the housing body;

Fig. 6 shows an embodiment where the bushing extends into a corresponding recess of the metal body (lid) of the OLTC;

Fig. 7 shows an embodiment with a resilient member in the form of an O-ring fitted between the bushing and the housing body;

Fig. 8 shows an embodiment with a resilient member in the form of a cylindrical member fitted between the bushing and the housing body;

Fig. 9 shows an embodiment in which the resilient member is attached to the bushing using moulding or vulcanization;

Fig. 10 shows an embodiment in which the resilient member is attached to the housing body on a radial circumference of the respective hole of the housing body;

Fig. 11 shows an embodiment in which the bushing is provided with a circumferential recess aligning the gash et with the bolt; and

Fig. 12 shows a fastener comprising an alternative embodiment of the bushing without collar.

DETAILED DESCRIPTION

[0021] Embodiments of the invention will hereinafter be described with reference to the appended drawings.

[0022] A basic embodiment of a fastener used in an OLTC 1 according to the invention is shown in fig. 5. The OLTC comprises a housing, said housing comprising a housing body 2 and a metal body 3 attached to the housing body 2 using a plurality of fasteners 4. Each respective one of said fasteners 4 comprises:

a bolt 5 configured to extend from an outside of the housing body 2, through a respective hole of the housing body 2, and to engage with a threaded hole of the metal body 3 on an inside of the housing body 2. The fastener 4 further comprises a bushing 6 inserted in the respective

hole of the housing body 2, said bushing 6 comprising a central opening through which the bolt 5 extends. Also, the bushing 6 comprises a collar 7 extending around a head of the bolt 5. The collar 7 protects the head of the bolt 5, thereby making subsequent service of the OLTC 1 easier by ensuring the bolt head is not damaged and can thus be easily rotated. In other embodiments, the collar 7 may optionally be omitted. The bushing 6 provides a smooth interface towards the bolt 5 which mitigates abrasion on the bolt 5 whilst the larger outer diameter of the bushing 6 provides an enlarged wear surface facing the housing body 2.

[0023] The bushing 6 is made of an electrically conductive material. The electrically conductive properties of the bushing 6 enables the collar 7 to improve distribution of an electric field extending by the bolt 5/bushing 6.

[0024] In other embodiments, other materials, including electrically isolating materials, may alternatively be used for the bushing 6.

[0025] If the screw is made from an isolation material, such as a ceramic material or a fibre-composite material, a collar is typically not needed on the bushing.

[0026] As shown in fig. 6, the bushing 6 may extend into a respective recess 9 of the metal body 3, said recess 9 extending around each respective threaded hole in the metal body 3 and said recess 9 being configured to provide a tight fit with the bushing 6.

[0027] Since the bushing 6 extends into the recess 9 of the metal body 3, and since the bushing 6 has a tight fit with the recess 9, relative movements between the bushing 6 and the metal body 3 are prevented, which in turn reduces relative movement between the bolt 5 and the bushing 6, thus reducing wear on the bolt 5.

[0028] In other embodiments, the bushing 6 may optionally instead not engage with a recess of the metal member 3.

[0029] In the embodiments of the appended figures, the metal body 3 is a lid of the OLTC 1 configured to cover an open end of the housing body 2. In other embodiments of the OLTC 1, the metal body 3 may be any member of the OLTC 1 attached to the housing body 2, such as a bracket or frame.

[0030] As shown in figs. 4, and 7-12, a resilient member 8, such as rubber or an elastomer, may, in any embodiment, be provided between the bushing 6 and the housing body 2. The resilient member 8 is configured to align the bushing 6 with the respective hole of the housing body 2.

[0031] The resilient member 8 enables proper alignment of the bushing with respect to the housing body 2 whilst enabling relative movement between the bushing and the housing body 2. By allowing relative movement between the bushing 6 and the housing body 2, dynamic loading conditions on the OLTC 1, typically occurring when used at sea, may be absorbed without excessive internal stress on or around fasteners. Also, higher tolerances may be used at production of the OLTC 1 without affecting assembly of the OLTC 1 negatively.

[0032] As shown in fig. 9, the resilient member 8 may be attached to the bushing 6 using moulding or vulcanization. As shown in fig. 10, the resilient member 8 may alternatively be attached to the housing body 2 on a radial circumference of the respective hole of the housing body 2.

[0033] Affixing the resilient member to either the bushing 6 or the housing body 2 enables more exact positioning of the resilient member 8 and reduces the risk of misplacing the resilient member 8 at manufacturing or maintenance of the OLTC 1.

[0034] As shown in figs. 4, 11 and 12, the bushing 6 may be provided with a circumferential recess 10, wherein the resilient member 8 extends into said recess 10 and protrudes radially outside of the recess 10 with respect to a central axis of the bolt 5. The radially protruding portion of the resilient member 8 will deform elastically upon relative movements between the bushing 6 and the metal member 3. Since the resilient member 8 extends into the circumferential recess 10, a portion of the resilient member 8 within the circumferential recess 10 will also deform, allowing greater movement of the protruding portion of the resilient member 8, which in turn enables use of a tougher material of the resilient member 8, thus increasing resistance to wear of the resilient member 8.

[0035] As shown in figs. 4, and 7-12, the resilient member 8 may be formed by any suitable gash et, such as an O-ring or cylindrical member. The resilient member 8 may be provided with geometries for engaging with corresponding geometries formed on the bushing 6 and/or on the housing body 2, thus improving alignment of the resilient member 8 with the bushing 6 and/or with the housing body 2.

[0036] It should be understood that the invention is not limited to the specific combination of features illustrated in the examples of the appended figures. For example, the recess of the metal body 3 receiving an end of the bushing 6 (examples in figs. 4 and 6-12) may be omitted from any of the embodiments in figs. 4 and 6-12. Similarly, the collar 7 omitted in fig. 12, may be omitted in any embodiment of the bushing 6. Also note that a washer is typically used between the head of the bolt 5 and the bushing, although that washer may be omitted.

Claims

1. An on-load tap changer (OLTC) (1) comprising a housing, said housing comprising a housing body (2) and a metal body (3) attached to the housing body (2) using a plurality of fasteners (4), each respective one of said fasteners (4) comprising: a bolt (5) configured to extend from an outside of the housing body (2), through a respective hole of the housing body (2), and to engage with a threaded hole of the metal body (3) on an inside of the housing body (2), said fastener (4) further comprising a bushing (6) inserted in the respective hole of the housing body

(2), said bushing (6) comprising a central opening through which the bolt (5) extends.

2. An OLTC (1) according to claim 1, wherein the bushing (6) extends into a respective recess (9) of the metal body (3), said recess (9) extending around each respective threaded hole in the metal body (3) and said recess (9) being configured to provide a tight fit with the bushing (6).
3. An OLTC (1) according to any one of claims 1-2, wherein the metal body (3) is a lid configured to cover an open end of the housing body (2).
4. An OLTC (1) according to any one of claims 1-3, wherein a resilient member (8), such as rubber or an elastomer, is provided between the bushing (6) and the housing body (2) and configured to align the bushing (6) with the respective hole of the housing body (2).
5. An OLTC (1) according to claim 4, wherein the resilient member (8) is attached to the bushing (6) using moulding or vulcanization.
6. An OLTC (1) according to claim 4, wherein the resilient member (8) is attached to the housing body (2) on a radial circumference of the respective hole of the housing body (2).
7. An OLTC (1) according to claim 6, wherein the bushing (6) is provided with a circumferential recess (10), and wherein the resilient member (8) extends into said recess (10) and protrudes radially outside of the recess (10) with respect to a central axis of the bolt (5).
8. An OLTC (1) according to claim 4, wherein the resilient member (8) is formed by a gash et, such as an O-ring or cylindrical member.
9. An OLTC (1) according to any one of claims 1-8, wherein the bushing (6) is made of an electrically conductive material.
10. An OLTC (1) according to any one of claims 1-9, wherein the bushing (6) comprises a collar (7) extending around a head of the bolt (5).

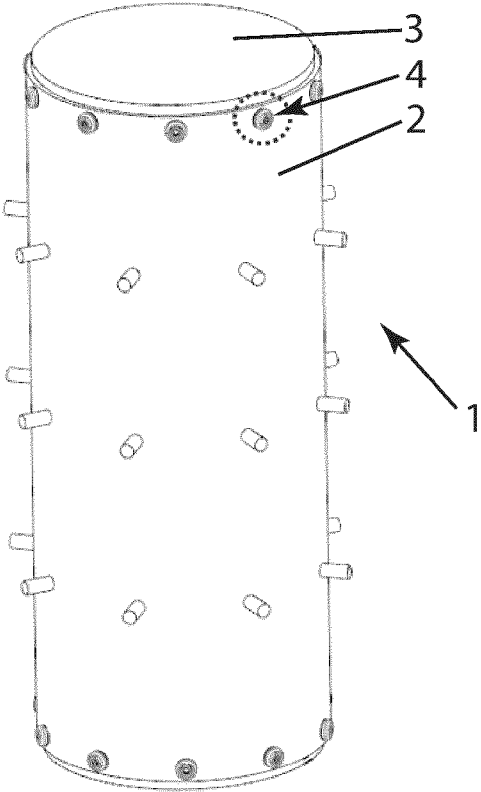


Fig. 1

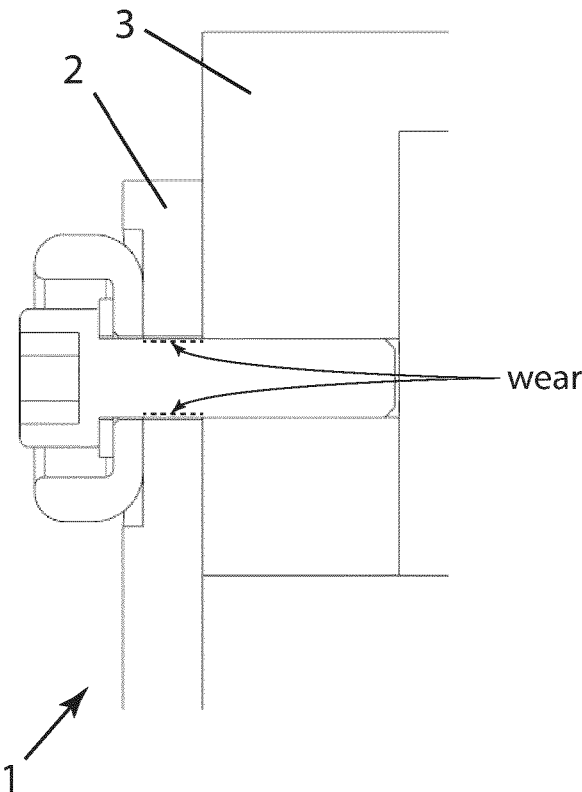


Fig. 2 - prior art

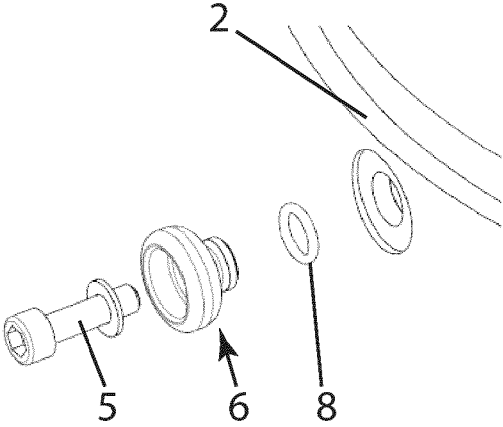


Fig. 3

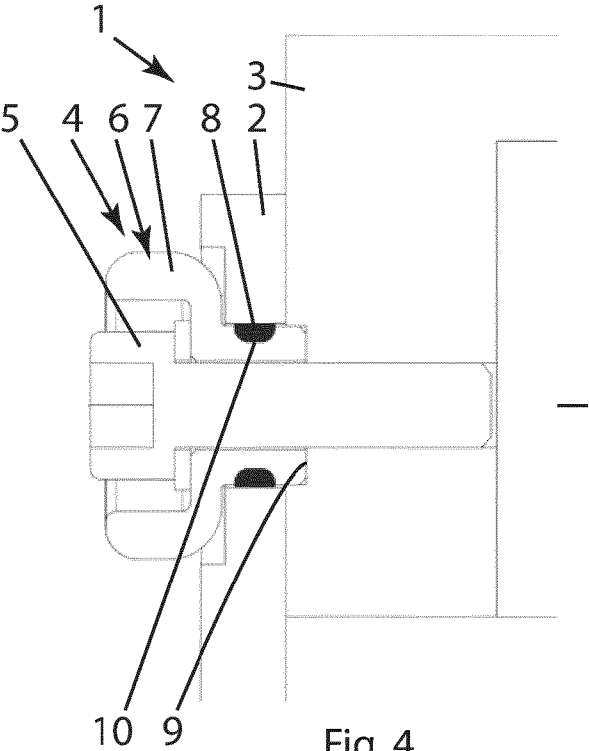


Fig. 4

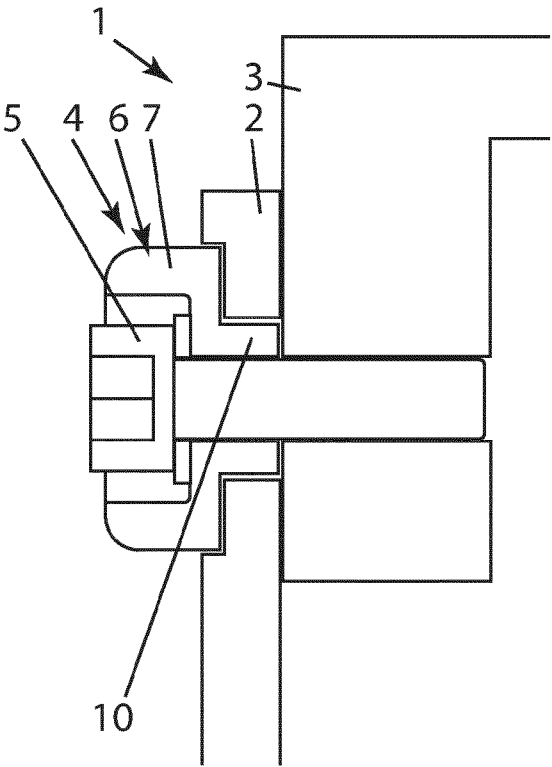


Fig. 5

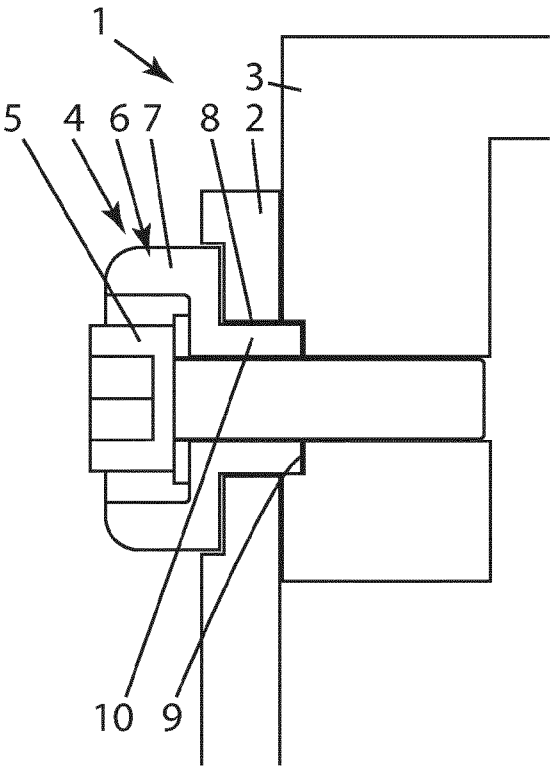


Fig. 6

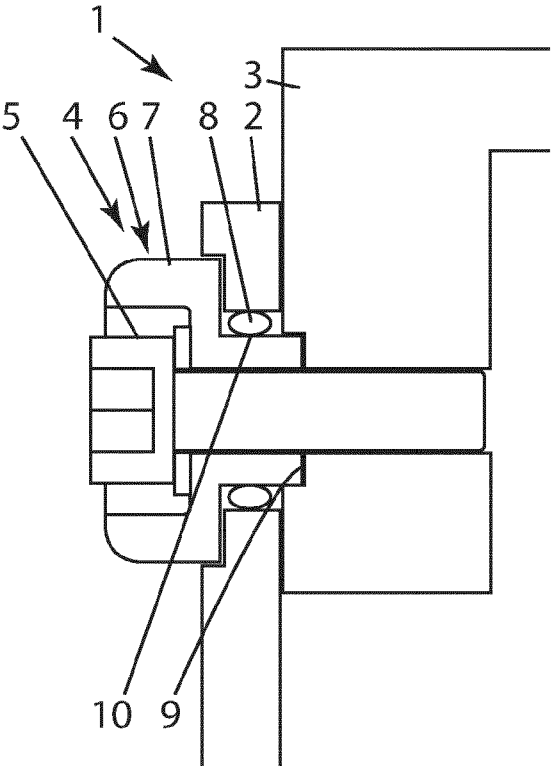


Fig. 7

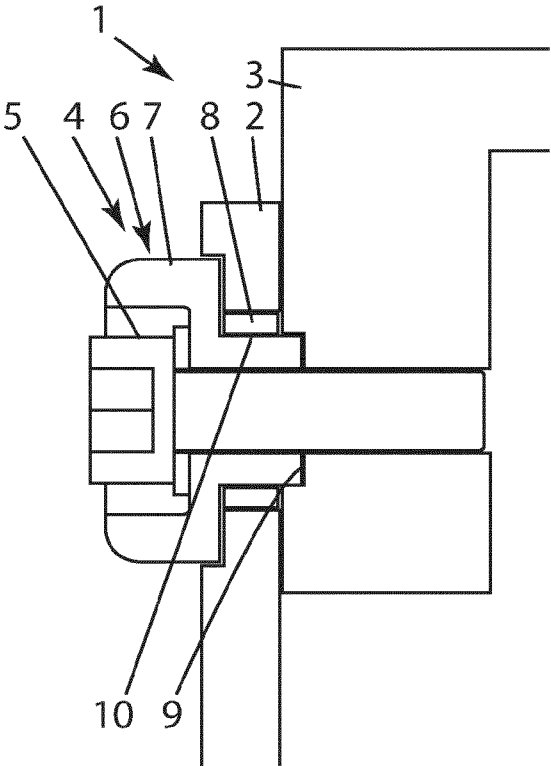


Fig. 8

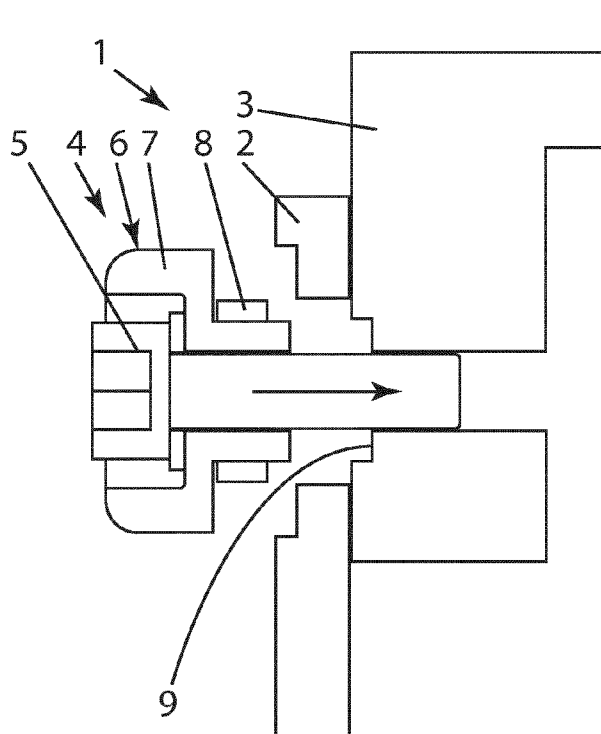


Fig. 9

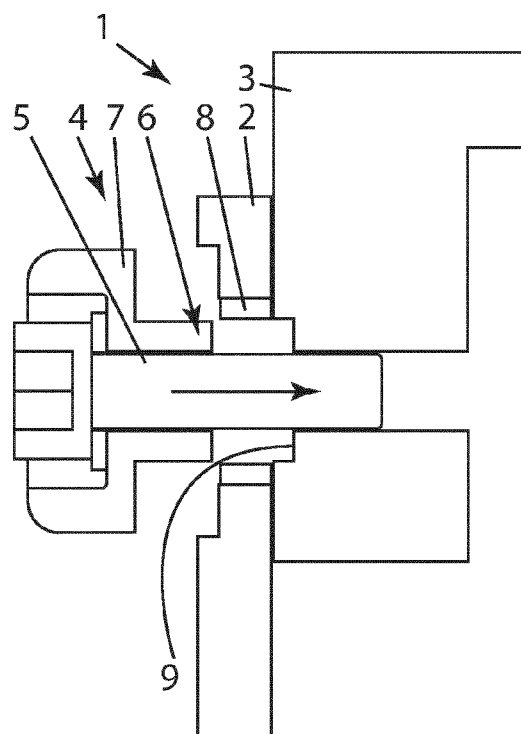


Fig. 10

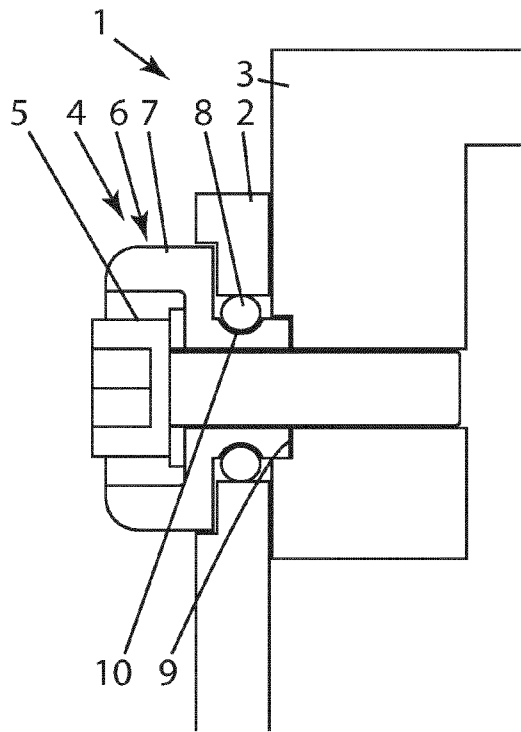


Fig. 11

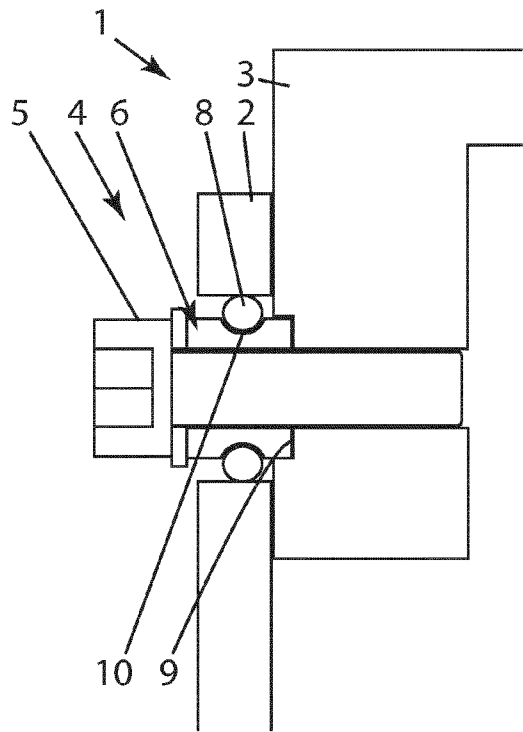


Fig. 12



EUROPEAN SEARCH REPORT

Application Number

EP 23 22 0104

DOCUMENTS CONSIDERED TO BE RELEVANT

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			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		21 June 2024	Findeli, Luc
CATEGORY OF CITED DOCUMENTS		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	
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EP 23 22 0104

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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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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82