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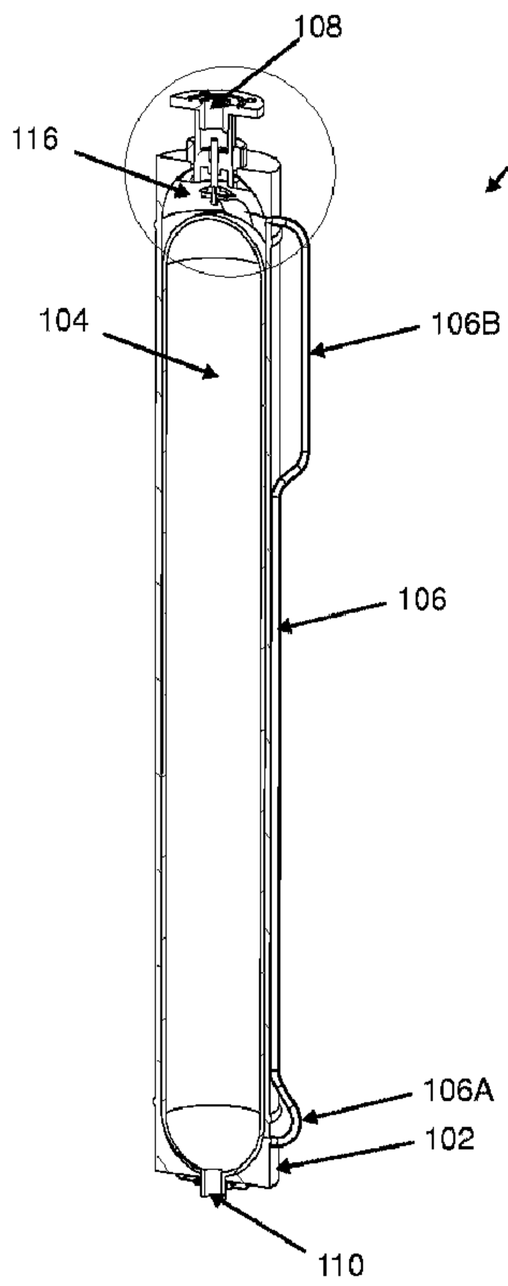

(57) Abrégé/Abstract:
A pressure compensator for a subsea electric installation, which comprises a rigid bottle (102) and a flexible bag (104) placed in the rigid bottle (102), the pressure compensator comprising a first opening (108) at a first end of the pressure compensator (100)

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(57) Abrégé(suite)/Abstract(continued):
allowing fluid communication of an insulating medium arranged to intermediate space (116) between the rigid bottle (102) and the flexible bag (104), the pressure compensator (100) further comprising a second opening (110) at a second end of the pressure compensator (100) allowing fluid communication of seawater arranged within the flexible bag (104), characterized in that the pressure compensator comprises a bypass channel (106) providing fluid communication between two points in the intermediate space (116) of the pressure compensator (100).

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(54) Title: PRESSURE COMPENSATOR

(57) Abstract: A pressure compensator for a subsea electric installation, which comprises a rigid bottle (102) and a flexible bag (104) placed in the rigid bottle (102), the pressure compensator comprising a first opening (108) at a first end of the pressure compensator (100) allowing fluid communication of an insulating medium arranged to intermediate space (116) between the rigid bottle (102) and the flexible bag (104), the pressure compensator (100) further comprising a second opening (110) at a second end of the pressure compensator (100) allowing fluid communication of seawater arranged within the flexible bag (104), characterized in that the pressure compensator comprises a bypass channel (106) providing fluid communication between two points in the intermediate space (116) of the pressure compensator (100).

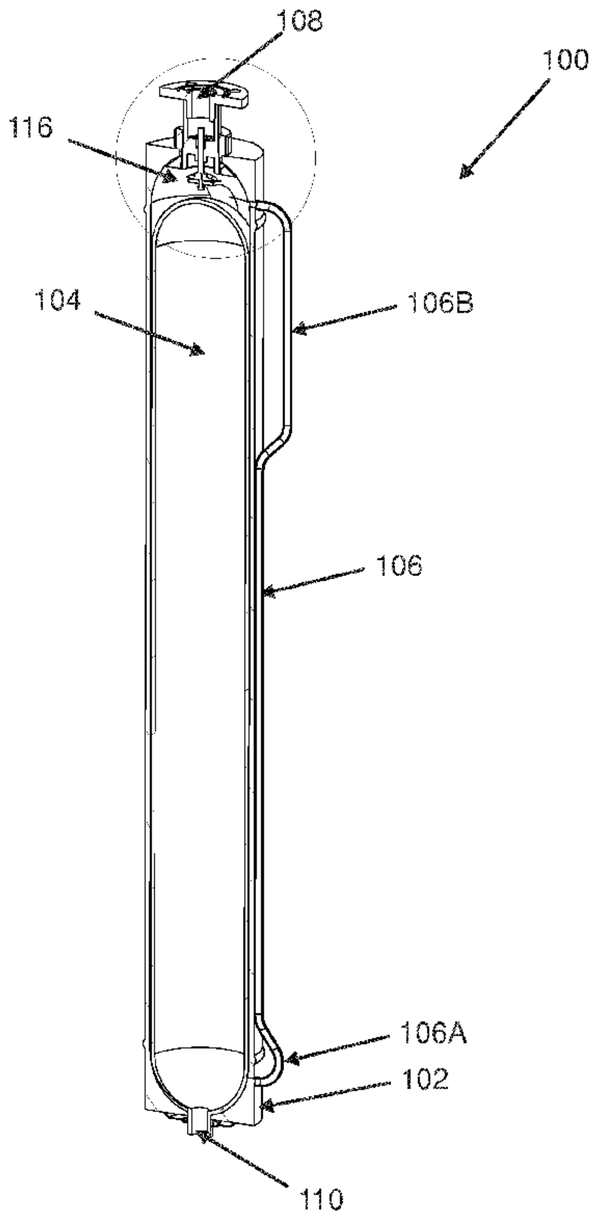

Fig. 1

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PRESSURE COMPENSATOR

FIELD

The present invention relates to a transformer for use in a subsea environment, especially to a bottle pressure compensator used in a subsea electric installation.

BACKGROUND

Subsea electric installations, such as transformers or frequency converters, are assemblies used under water. Typically these installations are filled with insulation fluid. During operation of the installation, temperature of the insulation fluid varies, whereby pressure compensation of the medium is needed. This involves use of a pressure compensator, which is in fluid communication with the interior of the installation. The pressure compensator is provided for receiving excess fluid when its temperature and volume increase, and return the fluid back to the installation when its temperature gets lower.

One type of pressure compensators is a bottle compensator. The bottle compensator has a rigid bottle, and a flexible bag residing within the rigid bottle. The flexible bag may be connected to seawater outside the housing. The intermediate state between the flexible bag and the rigid bottle may act as a reservoir for receiving the excess fluid, such as oil, from the installation.

Existing solutions for bottle compensators have a serious drawback in that they are poorly suited for arctic conditions where the temperature goes below zero. In such environments, if the installation needs to be raised to the surface of water for maintenance, the existing bottle compensators are prone to freezing damages.

SUMMARY

An object of the present invention is to provide a pressure compensator so as to alleviate the above disadvantages.

The present invention provides the important advantage in that dam-

ages due to freezing can be avoided, or at least alleviated.

DRAWINGS

In the following, the invention will be described in greater detail by means of some embodiments with reference to the accompanying drawings, in which

Figure 1 shows one embodiment of a bottle compensator in one possible mounting position; and

Figure 2 shows a more specified view of the area marked in Figure 1.

DETAILED DESCRIPTION

Figure 1 shows a vertically cut cross-section of one embodiment of a bottle-type pressure compensator 100. The compensator may have an elongate bottle-like structure, which may have a round, or at least substantially round cross-section when cut in horizontal direction.

The compensator 100 may have a rigid outer shell 102, which may be made of metal, for instance. Inside the rigid outer shell is placed a flexible bag or bladder 104. The flexible bag can be made of elastic material, such as rubber.

The compensator has two openings 108, 110, one at substantially each end of the rigid bottle 102. The first opening 108 connects the pressure compensator 100 for fluid communication to the subsea installation, such as a transformer or a frequency converter. The subsea installation may comprise rigid piping, to which the pressure compensator 100 is connected. To attach and connect the pressure compensator to the installation, fastening and sealing equipment may be provided.

The second opening 110 is provided for seawater communication. Through the second opening, the water can enter to and exit from the flexible bag 104. At the second opening 110, the bag is arranged to the rigid bottle 102 watertight. In this way, the water can only enter to the interior of the bag 104 and not to the intermediate space 116 between the bag 104 and the bottle 106. In an embodiment, the bag comprises a protruding outlet, which is dimensioned slightly smaller than the second opening 110. There may be attached a sleeve to the outlet portion of the bag 104, which may project slightly out from the opening 110 of the bottle. The sleeve may comprise threads, which are attachable to counter-

threads of a fastening element that fastens the outlet of the bag 104 to the second opening 110 of the bottle.

Figure 1 shows the bottle compensator in the principal mounting position, that is, in vertical position in which the seawater connector 110 points downwards. Even though the bottle has been shown in vertical position, other mounting positions are possible. However, the embodiments relate to mounting positions, where the water connector 110 resides at the same, or lower level than the insulating medium connector 108. The mounting position may thus vary between the shown vertical position and horizontal position of the compensator.

Between the flexible bag 104 and the rigid bottle 106, there is an intermediate space 116. During use, the intermediate space 106 contains insulating medium, such as transformer oil, that has entered the space 116 via the first opening 108. Initially, before lowering the installation to water, the compensator may be initialized such that half of the total volume is filled with oil, and half of the volume interior of the bag 104, is filled with air. When the transformer is lowered to water, seawater at least partly replaces the air.

The bottle compensator further includes a bypass channel, which alleviates fluid communication between two points in the intermediate space 116. In an embodiment, the two points are substantially at the ends of the bottle. This kind of example is shown in Figure 1, which shows a bypass pipe 106 that connects the ends of the bottle via two bypass openings. Close to the bypass openings, the bypass pipe may have curved sections 106A, 106B to approach the bottle substantially perpendicularly such as to alleviate fluid flow therein.

As Figure 1 shows, the bypass channel may be provided as a bypass pipe 106 arranged exterior to the bottle.

In another embodiment, the bypass channel may be arranged as a pipe that is provided within the rigid bottle 102 in the intermediate space 116.

In another embodiment, the channel is provided by arranging one or more grooves, to the interior wall of the bottle thus allowing the fluid, such as transformer fluid to flow in the intermediate space.

In a further embodiment, the bypass channel is formed by means of a separating member, which keeps the interior of the bottle and the flexible bag separated from each other such that a bypass channel is formed within the bottle.

In an embodiment, the separating member is one or more protrusion(s)/bar(s) arranged on one of the bag or the bottle. The protrusion may be longitudinal. In another embodiment, the separating member comprises a set of protrusions, which together form a channel for the intermediate fluid. The protrusions may take various forms, and may be point-like, for instance.

In the embodiments mentioned above, and in further embodiments, there is provided a bypass channel for allowing the flow of insulating medium between two points in the intermediate space. In some embodiments, the channel is arranged in the form of a pipe. In other embodiments, the channel is formed by keeping the bottle and the flexible bag at least partly separated from each other, by means of a projection and/or a groove in one or both of the bottle and the bag.

Although in the above, reference has been made to only one bypass channel, the pressure compensator may comprise multiple such channels. And although reference has been mainly made to that the bypass channel connects the two ends of the pressure compensator, the bypass channel may alternatively, or in addition to, connect two points that are closer to each other than at the ends of the bottle. Also in such a case, the bypass channel alleviates fluid communication between two points that are separated from each other in the longitudinal direction of the bottle.

In an embodiment, the bypass channel is substantially parallel to the longitudinal direction of the bottle. Such as in Figure 1, even though there are small sections of the channel 106A, 106B that are not parallel to the longitudinal direction of the bottle, the substantial direction of the channel is. In another embodiment, the bypass channel(s) may be inclined to the longitudinal direction of the bottle.

Figure 2 shows a more specific view of the first end 108 of the pressure compensator 100. There is provided a bypass channel in the form of a pipe 106B arranged exterior of the bottle, which pipe enters the intermediate space 116 substantially perpendicularly.

When the bypass channel is a pipe or a groove in the rigid bottle, the channel may extend closer to the end of bottle than the end of the flexible bag. In this way it may be ensured that the bag in no circumstances is able to block the

fluid communication in the channel. This applies to one or both of the first and second ends of the bottle.

There may be provided a separating member 112, which keeps the bag separated from the first opening 108. The separating member may thereby prevent the bag to block the fluid flow and to slip into the opening 108.

The separating member may comprise a planar surface arranged at a distance from the opening 110 such the insulating medium may flow between the planar surface and the inner wall of the bottle.

There may additionally be provided a support member 114 for supporting the bag in the bottle. In an embodiment, the support member comprises a fastening member, which fixes or fastens one portion of the bag with respect to the bottle. In an embodiment, the fastening member fastens the bag to the bottle. In another embodiment, shown in Figure 2, the fastening member fastens the bag to the separating member 112.

In an embodiment, the fastening member comprises a strap, which is attached to the bag and one of the bottle or the separating member. The strap may be flexible.

In another embodiment, the support member may comprise one or more rods, which is/are arranged to maintain substantially the length of the bag. In an embodiment, the rod is arranged inside the bag. In another embodiment, the rod is arranged to a receptacle provided on the outer surface of the bag. The rod is preferably substantially rigid and its length is at least half of the length of the bag. It may be made of metal or plastic, for instance. The rod has no sharp portions, whereby puncturing of the bag is prevented.

The pressure compensator according to previous embodiments is suitable for use in a position, where the water connector 110 is at same or lower level than the connector 108 for the insulating medium.

It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A pressure compensator for a subsea electric installation, which comprises a rigid bottle and a flexible bag placed in the rigid bottle, the pressure compensator comprising a first opening at a first end of the pressure compensator allowing fluid communication of an insulating medium arranged to intermediate space between the rigid bottle and the flexible bag, the pressure compensator further comprising a second opening at a second end of the pressure compensator allowing fluid communication of seawater arranged within the flexible bag, wherein the pressure compensator comprises a bypass channel providing fluid communication between two points in the intermediate space of the pressure compensator, wherein the two points are separated from each other in the longitudinal direction of the bottle.

2. A pressure compensator according to claim 1, wherein the rigid bottle has an elongate form, and the bypass channel is arranged substantially parallel to the longitudinal direction of the rigid bottle.

3. A pressure compensator according to claim 1 or 2, wherein the bypass channel is arranged to connect substantially the first end and substantially the second end of the pressure compensator.

4. A pressure compensator according to any one of claims 1 to 3, wherein the pressure compensator has a separation member for keeping the flexible bag and the rigid bottle at least partly at a distance from each other such that the bypass channel is formed to the intermediate space.

5. A pressure compensator according to claim 4, wherein the separation member comprises a groove or a protrusion on the inner surface of the rigid bottle and/or a groove or a protrusion on the outer surface of the flexible bag such as to separate the rigid bottle and the flexible bag at least partly from each

other such that a bypass channel is formed between the inner surface of the rigid bottle and the outer surface of the flexible bag.

6. A pressure compensator according to any one of claims 1 to 5, wherein the bypass channel comprises a bypass pipe.

7. A pressure compensator according to claim 6, wherein the bypass pipe is arranged exterior to the rigid bottle.

8. A pressure compensator according to any one of claims 1 to 7, wherein the pressure compensator is arranged for mounting in a substantially vertical position where the first opening resides higher than the second opening.

9. A pressure compensator according to any one of claims 1 to 8, wherein the pressure compensator comprises a support member for supporting the flexible bag such that it substantially maintains its length in all usage situations.

10. A pressure compensator according to claim 9, wherein the support member comprises a stiff rod arranged in contact with the flexible bag such as to substantially maintain its length.

11. A pressure compensator according to claim 9, wherein the support member comprises a fastening member for fastening an end of the flexible bag to the first end of the pressure compensator.

12. A pressure compensator according to any one of claims 1 to 11, wherein the pressure compensator comprises a separation member for keeping the flexible bag separated from the first opening such as to ensure fluid communication in the first opening.

13. A pressure compensator according to claim 12 when dependent on claim 11, wherein the fastening member is attached to the separation member.

14. A subsea electric installation, comprising a pressure compensator as defined in any one of claims 1 to 13, wherein the pressure compensator is mounted to the subsea electric installation such that the first opening is arranged vertically at the same level or higher than the second opening.

15. A subsea electric installation according to claim 14, wherein the subsea electric installation is a transformer.

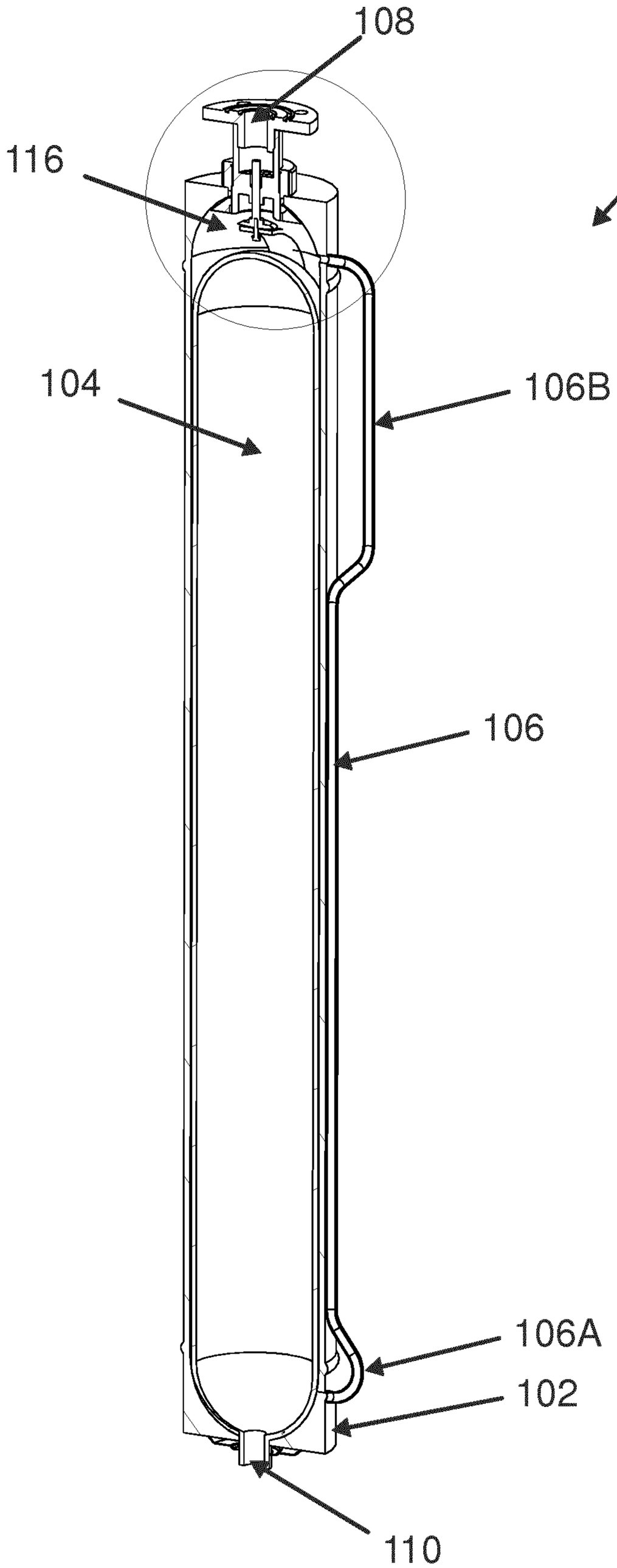


Fig. 1

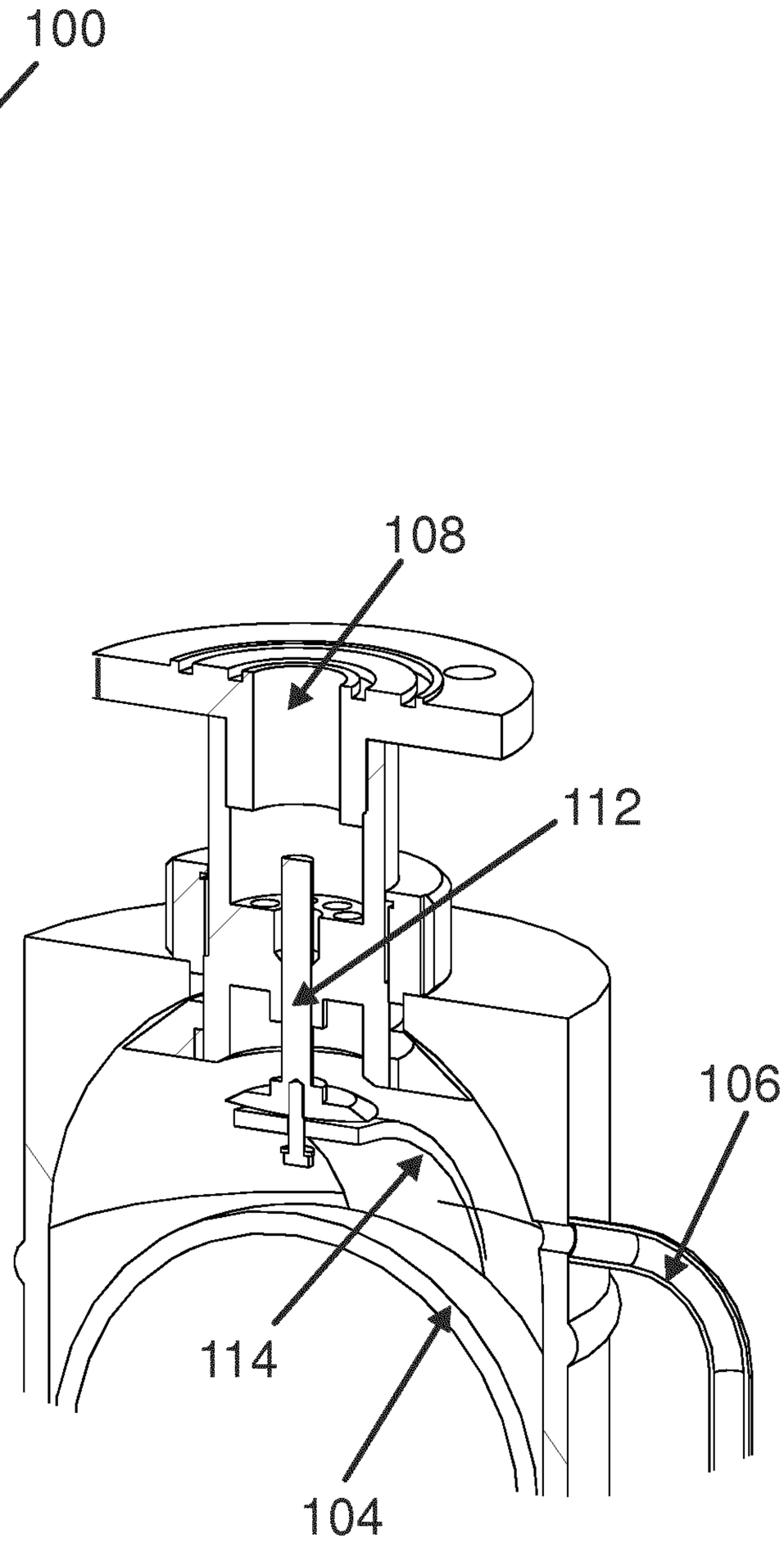
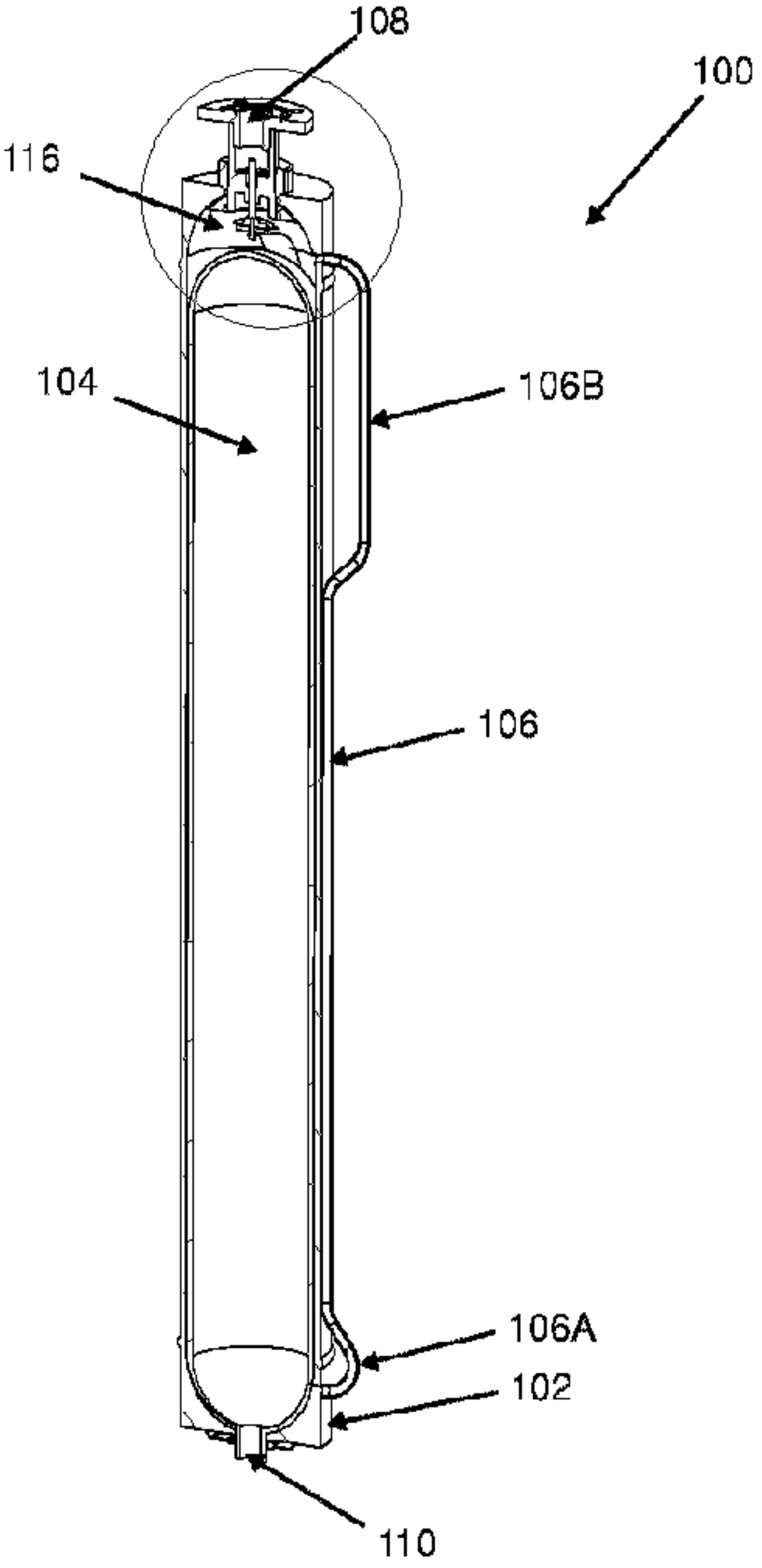


Fig. 2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