



## (51) International Patent Classification:

B65D 88/78 (2006.01) B65D 88/16 (2006.01)

B63B 11/04 (2006.01) B65D 88/20 (2006.01)

B63B 25/12 (2006.01) B65D 88/62 (2006.01)

## (21) International Application Number:

PCT/NO2020/050115

## (22) International Filing Date:

06 May 2020 (06.05.2020)

## (25) Filing Language:

English

## (26) Publication Language:

English

## (30) Priority Data:

1906414.6 07 May 2019 (07.05.2019) GB

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

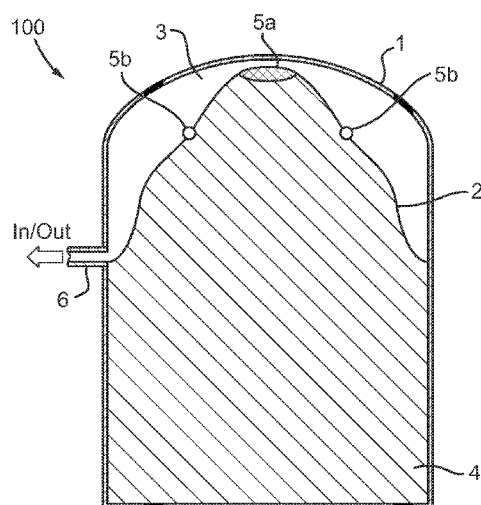
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

## Published:

— with international search report (Art. 21(3))

## (54) Title: SUBMERGED STORAGE OF HYDROCARBON FLUIDS

Fig. 1



(57) Abstract: A device (100) for submerged storage of hydrocarbon fluids (3) is disclosed. The device (100) comprises a tank (1) for holding fluids (3), (4), the tank being separated into two volumes by a flexible sheet (2) forming a bag or membrane. Hydrocarbon (fluids) (3) can be stored in the tank (1) in a volume enclosed by the flexible sheet (2). The device further comprises one or more buoyancy modifying elements (5) in the form of weights 5b and/or floats (5a), with the buoyancy modifying elements (5) attached to the flexible sheet (2) in order to provide local changes to the buoyancy of the flexible sheet (2).

## SUBMERGED STORAGE OF HYDROCARBON FLUIDS

The present invention relates to a device for submerged storage of hydrocarbon fluids and to the storage of hydrocarbon fluids using the device. In example  
5       embodiments, the invention relates to subsea storage of oil.

It is known to store hydrocarbons such as crude oil in submerged storage devices, such as devices located on the seabed. This can provide advantages by avoiding the need to transport hydrocarbons from submerged production facilities to the water surface, either for convenience or for use in systems where there is also submerged processing of  
10       the hydrocarbons. For example, it has been proposed to process crude oil at subsea facilities to remove water and perform some hydrocarbon separation steps before the resulting hydrocarbons are transported to the surface. There is a clear benefit to limiting transport of hydrocarbons only to the more valuable fractions, with water and potentially also unwanted hydrocarbons being re-injected without ever having been transported to  
15       the surface. Moreover, there are also benefits to submerged storage facilities when used with surface vessels. Storing hydrocarbons subsea avoids the need for the permanent presence of a surface vessel to store hydrocarbons on, which would otherwise be producing carbon dioxide emissions and require additional cost to run. Instead hydrocarbons can be transported from the submerged storage device to the surface  
20       vessel when it is present. The reduced need for the presence of a surface vessel is thus of environmental and economic benefit.

It will be appreciated that in order to allow for a submerged storage system it is generally necessary to provide some ballast when the buoyancy forces from the hydrocarbons are larger than the weight of the structure. In most cases the surrounding  
25       water is used to fill the space not occupied. However, it is undesirable to allow the hydrocarbons to be in direct contact with the water, as this introduces a risk of an undesirable increase in the water content of the hydrocarbons, as well as a risk of pollution of the water with hydrocarbons. In the case of sea water there are also particular disadvantages from introduction of salt into the hydrocarbons, which can further reduce  
30       their value.

Chemicals and carefully designed systems can keep separation between water and the hydrocarbon fluids, but this approach brings further issues as an emulsion layer typically forms at the barrier, with this emulsion layer containing water, oils and chemicals, and needing separate treatment and handling. Such an emulsion layer generally grows  
35       over time and needs periodic removal and treatment or disposal. Undesired bacterial growth can also occur, with a side effect of that being generation of sulphuric acid. Such

bacterial growth can create further problems for tank and pipe systems within the storage device as well as during onward transport, such as in pumping systems and on the transport vessels.

In order to address these issues systems have been developed using a "bag" or "balloon" to contain the hydrocarbons within a submerged storage tank. Such a bag storage system can maintain a physical separation between the water and the hydrocarbons using a cloth or similar that is impermeable with respect to both water and hydrocarbons (typically oil). An example of this type of system is described in the published prior art in US 7448404. As the submerged storage device is filled then the bag is filled and allowed to spread and expand to fill the tank, with the surrounding water being expelled. When the hydrocarbons are retrieved from the tank then the bag collapses and folds, with water filling the tank around the outside of the bag. In the design proposed in US 7448404 the bag is emptied and filled via pipework at the top of the tank, since the hydrocarbons are less dense than the surrounding water and thus float to the top. Sea water is allowed to enter and leave the tank via openings low down at the sides, so that the tank always remains full of water, outside the bag, and/or hydrocarbon fluids, within the bag.

In alternative proposals to address similar problems, there is disclosure of the use of a membrane arrangement for physical separation between the water and the hydrocarbons, where the membrane is not a bag that fully encloses the hydrocarbons, but instead is used to divide a tank into two portions. An example of such an arrangement can be found in US 4228754, which describes a tank for use in a shipping vessel or for subsea storage. With those types of arrangements, the membrane may fold or stretch to change shape and allow one side of the tank to be filled with hydrocarbon fluids, expelling fluid such as sea water from the other side of the tank.

It will be appreciated that the use of such bag and membrane systems addresses the issues that arise from contact between the hydrocarbons and the water. However, it would of course be desirable to provide an improved system if possible.

Viewed from a first aspect the invention provides a device for submerged storage of hydrocarbon fluids, the device comprising: a tank for holding fluids, the tank being separated into two volumes by a flexible sheet forming a bag or membrane, wherein hydrocarbon fluids can be stored in the tank in a volume enclosed by the flexible sheet; the device further comprising one or more buoyancy modifying elements in the form of weights and/or floats, with the buoyancy modifying elements attached to the flexible sheet in order to provide local changes to the buoyancy of the flexible sheet.

With the device of this aspect the flexible sheet is modified by the buoyancy modifying elements, which can include the addition of weights and/or floats. There may be multiple weights and/or multiple floats forming the buoyancy modifying elements. By the use of buoyancy modifying elements it is possible to change the behaviour of the flexible sheet as the tank is filled or emptied. This can be used to ensure that the flexible sheet adopts a preferred position or form during filling and emptying. In cases where the flexible sheet may form into folds, the use of buoyancy modifying elements can ensure that there is minimal risk of unexpected or uncontrolled folding causing damage to the flexible sheet. The buoyancy modifying elements may be placed at multiple locations across the extent of the flexible sheet, including at positions spaced apart in two directions across the sheet. The buoyancy modifying elements may be of spherical or ovoid shape placed at multiple locations across the extent of the flexible sheet and/or may be of toroidal shape located concentric to one another extending across the flexible sheet, i.e. they may be provided as a ring or a set of rings. Thus, when the flexible sheet is extending between walls of the tank in a non-flat configuration then the buoyancy modifying elements may be at various locations in three dimensions along the extent of the flexible sheet in its non-flat configuration.

The flexible sheet could be a bag as referenced above in relation to the prior art of US 7448404. In some example embodiments the flexible sheet is a membrane that separates the tank into two volumes of adjustable size, wherein the membrane changes shape and position and thereby changes the size of the two volumes as one of the volumes is filled with or emptied of hydrocarbon fluids. The other of the volumes may advantageously be filled with water, such as water from the surrounding environment, for example sea water. A membrane arrangement of this type may have advantages over a bag type arrangement since forces arising from the buoyancy of the hydrocarbon fluid will act on the wall of the tank above the membrane, whereas in a bag type arrangement the forces arising from the buoyancy of the hydrocarbon fluid will act on the bag, typically by pressing it against a wall of the tank. This can cause stresses on folds of the flexible sheet, as well as increase cyclic stresses on the bag material. The stresses and possible forces against the top structure of the tank may be avoided if the membrane is located below the hydrocarbons. By using buoyancy modifying elements a controlled behaviour of the membrane may be achieved.

The membrane may be considered as a surface with buoyancy modifying elements spaced apart across that surface, such as spaced apart across both a width and length direction of a tank, where the width and length are the horizontal dimensions of the tank when in use. In some examples, the buoyancy modifying elements include a float at

a centre of the membrane and multiple weights (or one or more weight rings) spaced apart around the centre of the membrane. This may advantageously prevent water or other fluids and/or objects denser than the desired hydrocarbons in the hydrocarbon storage side from collecting in a depression in the centre of the membrane. This assists with their extraction from the hydrocarbon storage tank by encouraging the flow of denser substances to the edge of the flexible sheet where port(s) may be located for extraction.

The tank may have one or more ports for entry and exit of fluids. There may be a hydrocarbon port for flow of hydrocarbon fluids into or out the tank, with the filling and emptying of the tank typically being done by an external pump or other apparatus, such as submerged pump linked with the device, or alternatively a shipboard pump or a pump on a platform attached to the device via a suitable riser. There may be one or more water port(s) for egress and ingress of water during filling and emptying of the hydrocarbon fluids. In some examples the water port(s) are simple openings into the surrounding water, with the water from the surrounding environment (for example, sea water) being allowed to flow freely into and out of the tank to fill the space available outside of the flexible sheet as the volume of hydrocarbons enclosed by the flexible sheet changes. The water port(s) may be at the base of the tank.

In the case of a membrane as the flexible sheet the tank may have a hydrocarbon port at an upper part thereof or at a side part thereof. The hydrocarbon port should allow for hydrocarbon fluid to enter the volume enclosed by the membrane, and therefore typically the membrane may be joined to the wall of the tank at a location beneath the location of the hydrocarbon port.

The membrane may be joined to a wall of the tank with a seal extending around the full extent of the tank, such as around the circumference of a cylindrical or spherical tank. The membrane may be attached to the wall of the tank via clamping, such as via releasable clamps. This can allow for enhanced ease of replacement of the membrane if needed.

The flexible sheet may be provided with fold lines to aid movement of the flexible sheet as the tank is filled with hydrocarbon fluids, or emptied. Thus, there may be pre-formed folds or other formations on the flexible sheet, such as reinforcements, to promote or deter folding as required.

The buoyancy modifying elements may be provided with sensors to indicate their position within the hydrocarbon storage tank. The sensors may relay to a controller and/or processor how full or empty the tank is, to assist in preventing the flexible sheet rupturing from internal stresses due to the tank being under or overfilled. In various embodiments magnetic pickups may be implemented to determine the heights of the buoyancy

modifying elements and hence their locations. The measurement may be relayed via standard communications equipment already well-known to the skilled person. Similarly, sensors to indicate pressure within the hydrocarbon storage tank may also be provided to monitor an internal pressure and assist in preventing the flexible sheet from rupturing.

5 Viewed from a second aspect the invention provides a method of storing hydrocarbon fluids at a submerged location, the method comprising using a device as described in connection with the first aspect, with examples of the method also including using a device with optional features as set out above. Thus, the method may comprise submerged storage of hydrocarbon fluids in a submerged tank, the tank being separated  
10 into two volumes by a flexible sheet forming a bag or membrane, wherein hydrocarbon fluids are stored in the tank in a volume enclosed by the flexible sheet; the device further comprising one or more buoyancy modifying elements attached to the flexible sheet and in the form of weights and/or floats, and the method including use of the buoyancy modifying elements to provide local changes to the buoyancy of the flexible sheet.

15 Thus, the method includes use of a flexible sheet that is modified by the buoyancy modifying elements to change the behaviour of the flexible sheet as the tank is filled or emptied. The buoyancy modifying elements can be as discussed above, for example with such elements at various locations in three dimensions along the extent of the flexible sheet in a non-flat configuration.

20 In some example embodiments the flexible sheet is a membrane that separates the tank into two volumes of adjustable size, as discussed above. In that case, the membrane may be joined to a wall of the tank with a seal extending around the full extent of the tank, such as around the circumference of a cylindrical or spherical tank. The membrane may be attached to the wall of the tank via clamping, such as via releasable  
25 clamps. The method may comprise periodic replacement of the membrane by separating it from the walls of the tank. The method may alternatively or additionally include removal of the membrane for inspection.

The tank may have one or more ports for entry and exit of fluids and the method may include using a hydrocarbon port for flow of hydrocarbon fluids into or out the tank,  
30 with the filling and emptying of the tank typically being done by an external pump or other apparatus, such as submerged pump linked with the device, or a pump at, or above, the water surface that is attached to the device via a suitable riser. The pump at the water surface may be a shipboard pump or a pump on a platform. One or more water port(s) may be used for ingress and egress of water during filling and emptying of the  
35 hydrocarbon fluids. In some examples the water port(s) are simple openings into the surrounding water, with the water hence being allowed to flow freely into and out of the

tank to fill the space available outside of the flexible sheet as the volume of hydrocarbons enclosed by the flexible sheet changes.

An example embodiment will now be described with reference to the accompanying drawings in which:

5           Figure 1 shows a submerged hydrocarbon storage tank with the majority of the volume of the tank filled with water; and

          Figure 2 shows a submerged hydrocarbon storage tank with the majority of the volume of the tank filled with hydrocarbon fluid.

          With reference to the Figures, a device 100 for the submerged storage of  
10   hydrocarbon fluids 3 is depicted. The device 100 includes a hydrocarbon storage tank 1 where a volume of the tank filled with a fluid such as water 4 and the remaining volume of the tank is filled with a hydrocarbon fluid 3 such as oil, such that the hydrocarbon storage tank 1 is completely occupied. The body of water 4 and the body of hydrocarbon fluid 3 is prevented from mixing and/or interacting by a flexible sheet, such as a membrane 2. The  
15   membrane 2 is attached to an internal wall of the hydrocarbon storage tank 1 approximately halfway down the height of the hydrocarbon storage tank 1 and is attached to the internal wall of the hydrocarbon storage tank 1 by a seal running circumferentially around the internal wall. The location of the seal between the membrane 2 and the internal wall is below a hydrocarbon port 6 which allows for the ingress or egress of  
20   hydrocarbon fluids 3 from the hydrocarbon storage tank 1.

          The membrane 2 is an impermeable, flexible sheet or member defining two separate volumes, with suitable elasticity such that it may be deformed by the relative pressures exerted at the interface between water 4 and hydrocarbon fluid 3 within the hydrocarbon storage tank 1. The membrane 2 is of suitable strength to resist puncture or  
25   injury due to forces present at its surface with either fluid present within the hydrocarbon storage tank 1. The membrane 2 is of a suitable surface area to cover the horizontal planar extent of the hydrocarbon storage tank 1, as well as being able to substantially conform to the shape of either the top half or bottom half of the internal wall of the hydrocarbon storage tank 1, such that two completely separate volumes are defined  
30   which may occupy majorly the full volume or a fraction of the volume of the hydrocarbon storage tank 1 each.

          To aid the membrane 2 in its ascent and/or descent within the hydrostatic carbon storage tank 1 as the respective volumes of the water 4 and the hydrocarbon fluid 3 vary, buoyancy modifying elements 5 are attached to the membrane 2. The buoyancy modifying  
35   elements include floats 5a and weights 5b. Although two weights 5b and a single float 5a are present in the Figures, any number of buoyancy modifying elements 5 comprising

varying populations of floats 5a and weights 5b may be implemented into the membrane 2 to achieve desired movement of the membrane 2. The buoyancy modifying elements 5 prevent the membrane 2 from coming into contact with itself during filling and emptying of a volume, hence reducing frictional forces experienced which may cause injury to the membrane 2. The membrane 2 may also feature a number of fold lines or pre-defined folds to encourage or deter folding of the membrane 2 as desired. The buoyancy modifying elements 5 may be of a spherical or ovoid shape located at multiple locations across the extent of the membrane 2, and/or may be of a toroidal shape located concentric to one another across the extent of the membrane 2. For example, the Figures shown may represent a single float 5a of ovoid shape located at the centre of the membrane, surrounded by either two weights 5b or a single toroidal weight 5b with the cross section displayed.

As shown in the Figures, a float 5a may be located at the centre of the membrane 2. During drilling the hydrocarbon fluids 3 extracted may comprise about 0.5% water 4. The presence of a float 5a in the centre of the membrane 2 prevents the denser water 4 from pooling in a depression in the centre of the membrane 2, as the float 5a causes the water 4 to flow to the outer edges of the membrane 2, where a port 6 may be located. Hence the float 5a in the centre assists in the efficient extraction from contaminant water 4 or other undesired denser products from the hydrocarbon fluid 3 portion of the hydrocarbon tank 1.

The hydrocarbon storage tank 1 is a rigid container made of suitable material to withstand hydrostatic and/or dynamic forces which may act upon it internally and/or externally. The material chosen for the hydrocarbon storage tank 1 is also desirably of a suitable density to ballast against the buoyant forces experienced when a majority of or all of the volume of the hydrocarbon storage tank 1 comprises hydrocarbon fluids 3. For example, when mostly full of hydrocarbon fluids 3, a buoyancy force of about 2000 tonnes may act on the top surface of the hydrocarbon storage tank 1. As such, the tank 1 may be made of a suitable steel alloy. The tank 1 may be anchored to the sea bed such as via mounting on a suitable foundation, in order to assist in counteracting buoyant forces experienced.

The hydrocarbon storage tank 1 depicted in Figure 1 is of cylindrical profile with a domed ceiling enclosing its volume. The height of an exemplary cylindrical profile hydrocarbon storage tank 1 may be in the region of 10m to 40m, having a volume anywhere in the region of 1000m<sup>3</sup> to 50000m<sup>3</sup>. While the tank 1 in the Figures has a cylindrical shape, other shapes may also be chosen as desired such as, but not limited to, a spherical or cuboidal shape.

The hydrocarbon storage tank 1 features a number of ports, such as hydrocarbon port(s) 6 which allow for the ingress and/or egress of hydrocarbon fluid 3 from the hydrocarbon fluid volume defined by the membrane 2. Water port(s) (not pictured) are also present within the hydrocarbon storage tank 1 which allows the ingress and/or egress of water 4 as the hydrocarbon fluid 3 is inserted or extracted from the hydrocarbon storage tank 1. Water ports are ideally present at the base of the hydrocarbon storage tank 1. To releasably attach the membrane 2 to the internal wall of the hydrocarbon storage tank 1 with the required seal between the two volumes, clamping plates may be disposed within the hydrocarbon storage tank 1 to clamp the membrane 2 in place using any suitable mechanism, allowing for easy removal and insertion of the membrane 2 during maintenance.

As shown in Figure 1, in an empty or mostly empty configuration a minority of the volume of the hydrocarbon storage tank 1 is occupied by the hydrocarbon fluid 3. A majority of the volume is occupied by water 4, and this fills the remainder of the tank 1 such that the tank 1 is completely occupied by fluid. The denser fluid, in this embodiment water 4, occupies a volume residing below the volume occupied by less dense fluid. As a result of hydrostatic forces resulting from differing densities between the hydrocarbon fluid 3 and the water 4, the membrane 2 conforms to a shape such as that shown in Figure 1. The membrane 2 is well-distributed without coming into contact with itself due to the presence of the buoyancy modifying elements 5, which aid the membrane 2 in adopting a required shape.

The hydrocarbon fluid 3 may be injected into the hydrocarbon storage tank 1 through the hydrocarbon port 6. The hydrocarbon fluid 3 may be delivered to the hydrocarbon port 6 by any suitable means such as, but not limited to, pumping through a pipe or riser. The ingress of hydrocarbon fluid 3 causes the egress of water 4 from the hydrocarbon storage tank 1 through a water port. In doing so, the device 100 moves from the configuration shown in Figure 1 to the configuration shown in Figure 2.

Figure 2 depicts the hydrocarbon storage tank 1 when the hydrocarbon fluid 3 is the majority fluid within the hydrocarbon storage tank 1 and the original volume of water 4 has mostly been expelled. The buoyancy modifying elements 5 assist the membrane 2 in unfolding such that abrasive forces may be reduced to prevent puncture and/or injury of the membrane 2.

The buoyancy modifying elements 5 can include sensors to indicate their position within the hydrocarbon storage tank. These sensors can be used to relay information to a controller and/or processor in order to relay how full or empty the tank is. In one example, magnetic pickups may be implemented to determine the heights of the buoyancy

modifying elements relative to metal elements of the tank and hence to determine their locations. Alternatively or additionally there may be sensors to indicate the pressure within the hydrocarbon storage tank.

5 It will be understood that the skilled person could make modifications to the arrangement of Figures 1 and 2 whilst achieving many of the same advantages. For example, a bag could be disposed within the hydrocarbon storage tank 1 instead of a membrane 2, with buoyancy modifying elements 5 suitably attached to the bag and hydrocarbon ports 6 and the like suitably positioned within the hydrocarbon storage tank 1 to fulfil its function as described above.

CLAIMS:

1. A device for submerged storage of hydrocarbon fluids, the device comprising: a tank for holding fluids, the tank being separated into two volumes by a flexible sheet forming a bag or membrane, wherein hydrocarbon fluids can be stored in the tank in a volume enclosed by the flexible sheet; the device further comprising one or more buoyancy modifying elements in the form of weights and/or floats, with the buoyancy modifying elements attached to the flexible sheet in order to provide local changes to the buoyancy of the flexible sheet.

2. A device as claimed in claim 1, comprising multiple weights and/or multiple floats forming the buoyancy modifying elements.

3. A device as claimed in claim 1 or 2, wherein the buoyancy modifying elements are configured to change the behaviour of the flexible sheet as the tank is filled or emptied to ensure that the flexible sheet adopts a preferred position or form during filling and emptying.

4. A device as claimed in claim 1, 2 or 3, wherein the flexible sheet and the buoyancy modifying elements are arranged such that when the flexible sheet extends between walls of the tank in a non-flat configuration then the buoyancy modifying elements are at various locations in three dimensions along the extent of the flexible sheet.

5. A device as claimed in any preceding claim, wherein the flexible sheet is a membrane that separates the tank into two volumes of adjustable size, and wherein the membrane is arranged to change shape and position to thereby change the size of the two volumes as one of the volumes is filled with or emptied of hydrocarbon fluids.

6. A device as claimed in claim 5, wherein the buoyancy modifying elements include a float at a centre of the membrane and multiple weights spaced apart around the centre of the membrane.

7. A device as claimed in claim 5 or 6, wherein the membrane may be joined to a wall of the tank with a seal extending around the full extent of the tank.

8. A device as claimed in claim 5, 6 or 7, wherein the membrane is attached to the wall of the tank via releasable clamps.

5 9. A device as claimed in any preceding claim, comprising at least one hydrocarbon port for flow of hydrocarbon fluids into and/or out of the tank

10 10. A device as claimed in any preceding claim, comprising one or more water port(s) for ingress and/or egress of water during filling and emptying of the hydrocarbon fluids.

11. A device as claimed in claim 10, wherein the water port(s) are openings into the surrounding water, such that when the tank is in use the water is allowed to flow freely into and out of the tank to fill the space available outside of the flexible sheet as the volume of hydrocarbons enclosed by the flexible sheet changes.

12. A device as claimed in any preceding claim, wherein the flexible sheet is provided with fold lines to aid movement of the flexible sheet as the tank is filled with hydrocarbon fluids, or emptied.

13. A device as claimed in any preceding claim, comprising one or more sensors to measure the position of the buoyancy modifying elements within the tank.

14. A device as claimed in claim 13, wherein communications equipment relays the position measurement to a processor.

15. A device as claimed in any preceding claim, wherein the tank is of a suitable material to ballast the tank against buoyancy forces resulting from the presence of hydrocarbon fluids within the tank.

16. A method of storing hydrocarbon fluids at a submerged location, the method comprising using a device as described in any preceding claim.

17. A method as claimed in claim 16, comprising submerged storage of hydrocarbon fluids in the tank at the submerged location, the tank being separated into two volumes by the flexible sheet, wherein the hydrocarbon fluids are stored in the tank in

the volume enclosed by the flexible sheet; the method including use of the buoyancy modifying elements to provide local changes to the buoyancy of the flexible sheet.

18. A method as claimed in claim 16 or 17, wherein the flexible sheet is a membrane that separates the tank into two volumes of adjustable size, the membrane is joined to a wall of the tank with a seal extending around the full extent of the tank and attached to the wall of the tank via releasable clamps; and the method comprises periodic replacement of the membrane by separating it from the walls of the tank and/or removal of the membrane for inspection.

19. A method as claimed in claim 16, 17 or 18, wherein the tank has one or more ports for entry and/or exit of fluids and the method includes using a hydrocarbon port for flow of hydrocarbon fluids into and/or out the tank, with the filling and emptying of the tank being done by an external pump or other apparatus including one or more of a submerged pump linked with the device or a pump at, or above, the water surface that is attached to the device via a suitable riser.

Fig. 2

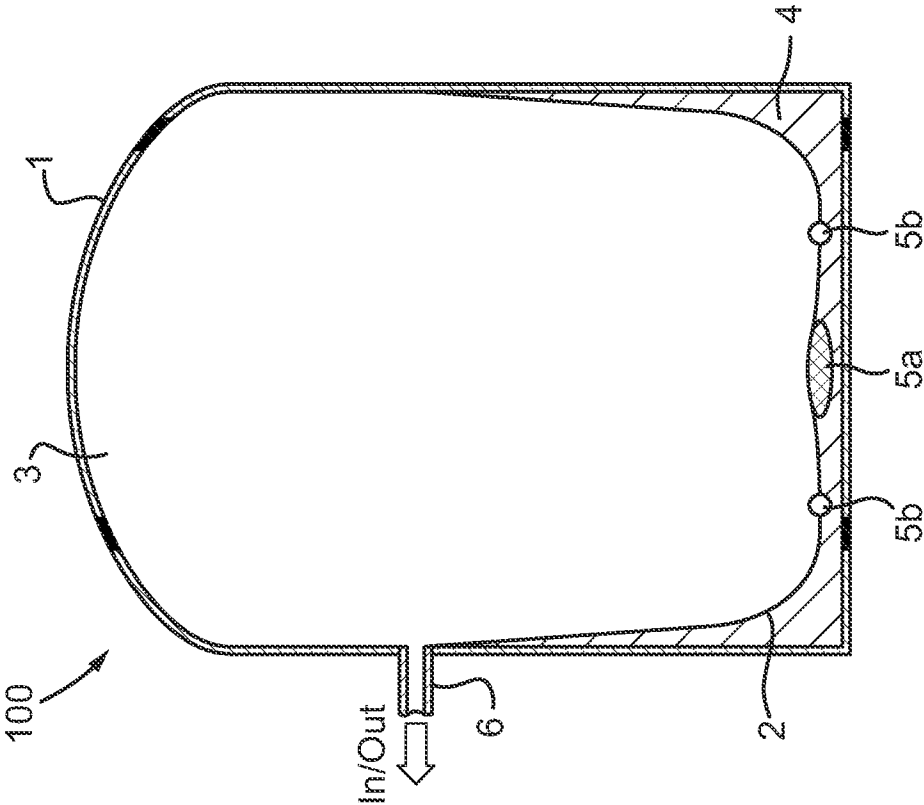
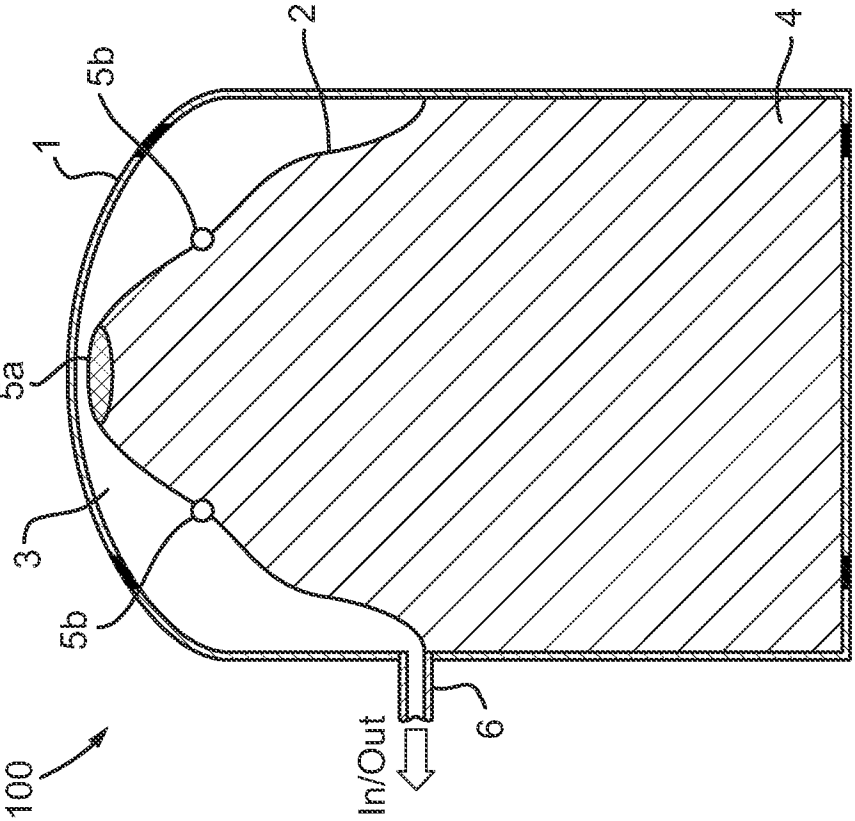


Fig. 1



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2020/050115

| <b>A. CLASSIFICATION OF SUBJECT MATTER</b>                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| B65D 88/78 (2006.01), B63B 11/04 (2006.01), B63B 25/12 (2006.01), B65D 88/16 (2006.01), B65D 88/20 (2006.01), B65D 88/62 (2006.01), B65G 5/00 (2006.01)                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| According to International Patent Classification (IPC) or to both national classification and IPC                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| <b>B. FIELDS SEARCHED</b>                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Minimum documentation searched (classification system followed by classification symbols)<br>B65D, B63B, B65G                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched<br><br>DK, NO, SE, FI: Classes as above.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)<br>EPODOC, WPI, FULL TEXT: ENGLISH         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Category*                                                                                                                                                               | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Relevant to claim No. |
| Y                                                                                                                                                                       | US 2018/0148137 A1 (CASTELLO, X. et al.) 2018.05.31<br>Paragraphs [0027], [0045]-[0049], figs. 4-7.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1-19                  |
| Y                                                                                                                                                                       | WO 2016/207359 A2 (KONGSBERG OIL & GAS TECH AS) 2016.12.29<br>Figs. 1b, 3, page 20 line 27-page 21 line 26.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1, 16                 |
| Y                                                                                                                                                                       | US 4059065 A (CLARK, R. L. et al.) 1977.11.22<br>Figs. 2-6, column 4 line 18-column 5 line 13, column 6 lines 42-68 and claims 1-3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1, 16                 |
| Y                                                                                                                                                                       | WO 2011/084164 A1 (HORTON WISON DEEPWATER INC) 2011.07.14<br>Paragraphs [0064], [0072], figs. 2-6, 11, 14.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1, 16                 |
| A                                                                                                                                                                       | WO 2016/099287 A1 (SUBHYDRO AS) 2016.06.23<br>Figs. 5-8C, paragraphs [0077], [0082], [0089].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1- 19                 |
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| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
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PCT/NO2020/050115

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