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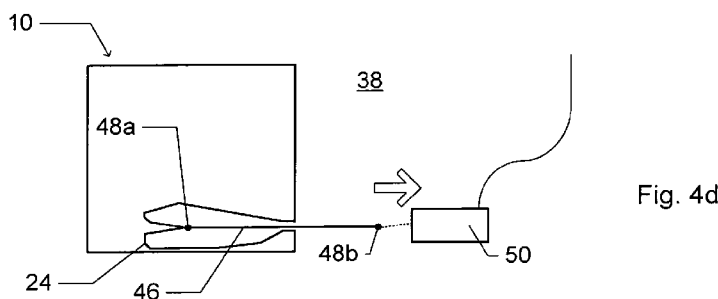
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(57) Abstract: The present invention relates to a method of replacing a flexible container (24) provided inside a subsea storage tank, wherein the flexible container defines a space (30) separated from a remaining storage space (32) of the subsea storage tank, and wherein the flexible container is connected via one opening (26) thereof to a first inlet/outlet (16) of the subsea storage tank, for allowing seawater exclusively into and out from the flexible container. The method comprises: filling seawater into the remaining storage space of the subsea storage tank from a second inlet/outlet (20) of the subsea storage tank; disconnecting and/or removing the old flexible container; and inserting a new flexible container (24') through the first inlet/outlet. The present invention also relates to a replaceable, flexible container for a subsea storage tank. The present invention also relates to a method of installing a storage tank on the seabed.

**METHOD OF REPLACING A FLEXIBLE CONTAINER PROVIDED INSIDE A SUBSEA STORAGE TANK, REPLACEABLE FLEXIBLE CONTAINER AND METHOD OF INSTALLING A STORAGE CONTAINER ON THE SEABED**

The present invention relates to a method of replacing a flexible container  
5 provided inside a subsea storage tank. The present invention also relates to a replaceable, flexible container for a subsea storage tank. The present invention also relates to a method of installing a storage tank on the seabed.

Subsea storage tanks may be used for storing oil or other hydrocarbons from oil  
10 production offshore. The oil is stored in the tanks until it can be exported using e.g. shuttle tankers. There are typically two ways of storing this oil production:

1. In subsea storage cells, which depend on the difference in density between seawater and the produced oil. Here the oil is pumped into the top of the cell and likewise drained from the same spot.

15 2. In a floating storage. The floating storage can be incorporated in the production unit (FPSO – floating production, storage and offloading), or it can be a dedicated storage vessel (FSU – floating storage unit).

However, the use of FSUs may be very costly. Furthermore, FSUs, although reinforced, have a tendency to suffer fatigue cracking in its internal structure arising  
20 from wave action on the hull over long periods. In order to repair such damage, a conventional storage vessel will normally have to be brought ashore for repair at a suitable facility. With the usual storage vessel away, a temporary replacement vessel must be sought in order to avoid shut down in the production rate.

Further, WO2004037681 A1 discloses a seabed located storage for crude oil or  
25 other fluid, which storage comprises a storage section in form of an oil and waterproof cloth formed as a flexible balloon that can be filled with, store and emptied for a storage fluid, a structure section formed as an external casing over the storage section. All equipment that can have demand for maintenance or replacement, such as valves, instruments, pumps and the storage section, can be disconnected from the storage and  
30 brought to the surface, either together or as modules of equipment. However, WO2004037681 A1 is rather silent about how such replacements are carried out in practice.

WO2004037681 A1 also discloses that deployment of the storage preferably takes place by use of a crane vessel or at least a crane means. An appropriate volume of  
35 air is discharged through hatches, pipes or other outlets such that a weak positive buoyancy is achieved, while the storage or an assembly of several storages are handled stably of the crane. By beginning deployment air is discharged in a controlled way until

a weak negative buoyancy is achieved. As the storage is deployed into the sea the air will be compressed and the buoyancy will become more and more negative, which has to be handled entirely by the crane vessel or similar. This may limit the actual water depths for which such a storage may be placed.

5

It is an object of the present invention to provide an improved method of replacing a flexible container provided inside a subsea storage tank. It is another object to provide an improved method of installing a storage tank on the seabed.

These objects, and other objects that will be apparent from the following description, are achieved by the present invention as defined in the appended independent claims. Embodiments are set forth in the appended dependent claims.

According to an aspect of the present invention, there is provided a method of replacing a flexible container provided inside a subsea storage tank, wherein the flexible container defines a space separated from a remaining storage space of the subsea storage tank, and wherein the flexible container is connected via one opening thereof to a first inlet/outlet of the subsea storage tank, for allowing seawater exclusively into and out from the flexible container, which method comprises:

- filling seawater into the remaining storage space of the subsea storage tank from a second inlet/outlet of the subsea storage tank, such that any seawater in the flexible container is (mostly or completely) discharged through the first inlet/outlet;
- disconnecting and/or removing the flexible container; and
- inserting a new flexible container through the first inlet/outlet.

Disconnecting and/or removing the flexible container may include one of the alternatives a)-c):

a) introducing a cutting means through the first inlet/outlet, cutting loose the flexible container from the first inlet/outlet by means of the cutting means, and leaving the cut away flexible container in the subsea storage tank,

b) while the flexible container is inside the subsea storage tank, disconnecting a mounting flange via which the flexible container is connected to the first inlet/outlet, and then removing the mounting flange from the first inlet/outlet such that the flexible container still affixed to its mounting flange is pulled out from the storage tank through the first inlet/outlet, or

c) turning the flexible container at least partly inside out through the first inlet/outlet by means of a pulling member having one part or end attached to the inside of the flexible container remote from the first inlet/outlet and another part or end accessible via the first inlet/outlet.

It is appreciated that the alternatives a)-c) are of a similar nature.

The replacement of the flexible container according to the present method is relatively simple. Also, the flexible container can be replaced while the (remaining) storage tank is maintained on the seabed. Hence, costly and time-consuming surfacing of the storage tank is avoided. Also, the risk for oil contamination may be removed or at least reduced. Also, with alternative c), “snagging” at the first inlet/outlet is avoided, i.e. that the flexible container unintentionally attaches itself to other parts of the structure along the path it is being removed.

In one embodiment, inserting the new flexible container through the first inlet/outlet includes: providing the new flexible container pre-packed in an elongated shape; inserting the pre-packed new flexible container into the subsea storage tank through the first inlet/outlet; and allowing the inserted, pre-packed new flexible container to unfold or develop inside the subsea storage tank. The new flexible container may be pre-packed using a fluid-soluble packing means adapted to dissolve after a specific time (e.g. 24 hours) of exposure to fluid. The packaging means may for instance be water-soluble, and the fluid may be seawater. Further, allowing the inserted, pre-packed new flexible container to unfold or develop inside the subsea storage tank may include: extracting seawater from the remaining storage space of the subsea storage tank, and allowing seawater into the new flexible container.

In another embodiment, inserting the new flexible container through the first inlet/outlet includes: if still in place, removing a mounting flange from the first inlet/outlet; inserting a new mounting flange including a rolled-up new flexible container into the first inlet/outlet; and extracting seawater from the remaining storage space of the subsea storage tank, and allowing seawater into the new flexible container, causing the new flexible container to unroll in the storage tank.

The present method may further comprise: storing hydrocarbons (e.g. oil) in the remaining storage space of the subsea storage tank.

Further, the flexible container may be provided below the remaining storage space of the subsea storage tank, the first inlet/outlet may be provided in a side wall at the bottom of the storage tank, and the second inlet/outlet may be provided in the top of the storage tank.

According to another aspect of the invention, there is provided a replaceable, flexible container for a subsea storage tank, which container is made of a water- and oil-proof material and has one opening for connection to an inlet/outlet of the subsea storage tank, wherein the container is pre-packed in an elongated shape and provided with a water-soluble packing means keeping the container in the elongated shape. The packing means may be adapted to dissolve after a specific time of exposure to water. Further, the container can be made of a polymeric material, such as – but not limited to

– polyethylene. This aspect may exhibit the same or similar technical effects and features as the previously described aspect of the invention, and vice versa.

According to yet another aspect of the invention, there is provided a method of installing a storage tank on the seabed, wherein a flexible container is provided inside  
5 the storage tank, the flexible container defining a lower space separated from a remaining upper storage space of the subsea storage tank, wherein the method comprises: filling an incompressible hydrocarbon liquid which is lighter than surrounding seawater into the remaining upper storage space, such that the storage tank gets a positive net buoyancy; positioning the storage tank in the sea above or nearby an  
10 installation location; removing at least a fraction of the hydrocarbon liquid from the remaining storage space, and allowing seawater into the flexible container, such that the storage tank gets a negative net buoyancy; and allowing the storage tank to immerse down to the installation location. This aspect may exhibit the same or similar technical effects and features as the previously described aspects of the invention. This method  
15 may further comprise: adjusting the amount of hydrocarbon liquid in the remaining storage space container for controlling the net buoyancy of the storage tank. The hydrocarbon liquid may for example be pentane.

These and other aspects of the present invention will now be described in more  
20 detail, with reference to the appended drawings showing currently preferred embodiments of the invention.

Fig. 1 is a perspective view partly in cross section of a subsea storage tank for use in aspects of the present invention.

Fig. 2 is schematic view of a tank farm comprising a plurality of subsea storage  
25 tanks of the type shown in fig. 1.

Figs. 3a-3d schematically illustrate a method of installing a storage tank on the seabed.

Figs. 4a-4h schematically show a sequence of operations for replacing a flexible container according one or more embodiments of the present invention.

30

Fig. 1 shows a subsea storage tank 10. The tank 10 has the general shape of a hemisphere or torispherically domed cylindrical shape 12 mounted on a rigid base 14. The whole construction, which constitutes the tank 10, is arranged such that it may be placed on the sea floor or seabed in way of, or in connection with, offshore oil  
35 production facilities.

The tank 10 is provided with a first inlet/outlet 16 in or near the base 14, and a first filling and emptying line 18 for seawater is connected to the first inlet/outlet 16.

The tank 10 is also provided with a second inlet/outlet 20 at the top of the tank, and a second filling and emptying line 22 primarily for oil is connected to the second inlet/outlet 20.

Attached to the first inlet/outlet 16, there is a flexible container or bellows 24. Namely, the flexible container 24 is provided inside the tank 10, and the flexible container has one opening 26 which is connected to the first inlet/outlet 16, preferably via a mounting flange 28 of the flexible container 24, which mounting flange 28 is attached to a mating flange of the first inlet/outlet 16. The flexible container 24 defines a lower space 30 which is separated from the (remaining) upper storage space 32 of the tank 10. The lower space 30 may for instance be a seawater zone, and the upper space 32 may be an oil zone. The flexible container 24 is preferably made of a water- and oil-proof material, for instance a polymeric material, such as reinforced polyethylene.

By this arrangement, seawater coming into and out of the container 24 is prevented from direct contact with the oil contained in the space 32 of the tank 10, such that no release of oil or oil emulsion is ensured as oil is filled into or emptied from the tank 10. Further advantages of the tank 10 include inexpensive storage capacity, scalable capacity over time, no fatigue cracking, and no manning costs.

During regular or normal storage operations, a product like oil may be filled into the storage space 32 of the tank 10 via the second inlet/outlet 20. As oil is filled into the space 32, seawater is displaced out from flexible container 24 to make space for the oil. Likewise, when oil is pumped out from the storage space 32, seawater flows into the flexible container 24 to replace the oil thus pumped out from space 32.

Fig. 2 shows a tank farm comprising a plurality of tanks 10 of the type described above in relation to fig. 1. In the exemplary tank farm in fig. 2, three tanks 10a-10c are provided. The top inlets/outlets 20 allow import of oil (or other hydrocarbons) from an oil production facility 34. They also allow export of oil, for instance to a tanker or a pipeline as indicated by reference sign 36. The top inlets/outlets 20 may also allow import/export of seawater from/to the sea 38 in connection with replacement of the flexible containers. Hence, also seawater could be provided into the upper space 32 of each tank 10, as will be explained further below. Seawater that has been in the spaces 32 is preferably passed through an Oily (water) Discharge Monitor (ODM) before being discharged back to the sea 38. The ODM monitors the oil content in the water and directs the flow towards a holding tank 40 if the oil level is above acceptable limits.

A method of installing the storage tank 10 on the seabed will now be explained in the following with reference to figs. 3a-3d. First, pentane *P* is filled into the remaining space 32, such that the storage tank 10 gets a positive net buoyancy (fig. 3a). Here, the entire tank 10/upper space 32 may be filled with pentane. Then, the tank 10 is

positioned is the sea 38 above or near an installation location 42 on the seabed 44 (fig. 3b). The tank 10 may for instance be towed to this position. As the tank 10 is positioned in the sea 38 above or near the installation location 42, pentane *P* is pumped out from the upper space 32, allowing seawater *W* to flow into the flexible container 24 (fig. 3b).

5 The relative amounts of seawater and pentane are selected such that the storage tank 10 gets a desired slightly negative net buoyancy or flotation, whereby the tank 10 may start to immerse towards the seabed 44 (fig. 3c). During the immersion towards the seabed, the tank 10 may for instance be guided laterally by means of a surface based crane. Also during the immersion, the relative amounts of pentane and seawater in the tank 10 may

10 be adjusted, by pumping pentane *P* into or out of the upper space 32. This allows the submerged weight of the tank 10 to be carefully controlled at any water depth for safe installation. When the tank 10 has reached its installation location 42 on the seabed 44 (fig. 3d), all the pentane may be pumped out from the storage space 32, thereby allowing seawater to be filled into the flexible container 24, so that the storage tank 10

15 gets its final submerged weight after which the storage tank 10 can be safely secured to the seabed. The stiff base 14 of the tank 10 allows the tank 10 to be either piled to the seabed where it is positioned, or to be suctioned in place by a number of suction skirts underneath the base 14 of the tank 10, for example. Instead of pentane, other light hydrocarbon liquids could be used, for instance hexanes. The hydrocarbon liquid used

20 here should be incompressible, and be lighter than the surrounding water in the sea 38. For instance, the hydrocarbon liquid used may have a relative density (with respect to water) of less than 0.75.

Methods for replacing the flexible container 24 provided inside the subsea storage tank 10 will now be described in the following. The container 24 used for

25 containing seawater is likely to be made of a polymeric material, which has a tendency to lose its mechanical characteristics with age in combination with a number of bending cycles (fatigue). The container 24 may therefore have to be replaced with regular intervals, such as 3 to 5 years typically.

A sequence of operations for replacing the flexible container 24 is shown in figs. 4a-4h. The methods for replacing the flexible container 24 according to the present

30 invention may be performed subsea, without having to bring the tank 10 to the surface.

First, any oil *O* and/or other hydrocarbon(s) contained in the upper space 32 of the tank 10 is pumped out or otherwise discharged from the space 32 (see fig. 4a) via the second inlet/outlet 20. Then, seawater *W1* or another suitable fluid is filled into this

35 space 32 via the second inlet/outlet 20 or via another inlet/outlet in fluid communication with the space 32, such that any seawater *W2* in the flexible container is mostly or completely discharged through the first inlet/outlet 16 and the flexible container 24 is

fully deflated/flattened (see fig. 4b). About 80-90 % of the tank's storage space 32 may be filled with seawater in this state, for instance. After that, there are several ways of disconnecting and/or removing the old flexible container 24. It should be noted that 'old' not necessarily means that the flexible container 24 is very aged, but rather that it for some reason(s) is time to replace it.

In one embodiment (a) (not shown), a cutting means or tool is introduced through the first inlet/outlet 16 wherein the flexible container 24 is connected. The cutting tool may for instance be controlled by means of an ROV. Then, the flexible container 24 is cut loose from the first inlet/outlet 16 by using the cutting tool. The thus cut away container 24 may be left at the bottom of the storage tank 10.

In another embodiment (b) (not shown), the mounting flange 28 is disconnected from the first inlet/outlet 16 while the old flexible container 24 is still inside the storage tank 10. Then the mounting flange 28 is removed from the first inlet/outlet 16, whereby the old flexible container 24 still affixed to the mounting flange 28 is pulled out from the storage tank 10 through the first inlet/outlet 16.

In yet another embodiment (c) illustrated in figs. 4c-4e, the flexible container 24 is turned inside out through the first inlet/outlet 16 and its own mounting flange 28 by means of a pulling member 46. The pulling member 46 may for instance be a rope or a wire or the like. One end 48a of the pulling member 46 is attached to the inside of the flexible container 24 remote from the first inlet/outlet 16. Preferably, said end 48a is attached opposite the first inlet/outlet 16, as illustrated. The other end 48b of the pulling member 46 is accessible or protrudes through the first inlet/outlet 16. The pulling member 46 was preferably pre-installed in the flexible container 24 during its assembly/manufacture. In fig. 4c, an ROV 50 connects to the end 48b of the pulling member 46 at the first inlet/outlet 16. Then, when the ROV 50 pulls the member 46 out from the tank 10, the flexible container 24 is turned inside out (fig. 4d). Finally, the complete flexible container 24 has been pulled out through the first inlet/outlet 16 (fig. 4e) by means of the ROV 50. Once the container 24 has been extracted through the first inlet/outlet 16 in this manner, the flange 28 is disconnected from the inlet/outlet 16, and the entire container 24-flange 28 assembly is removed from the tank 10. This method has the advantage of avoiding contact with the oil infested outside of the old container 24 with that of the surrounding seawater in the tank's environment. This is so because the outside of the container 24 becomes the inside of same once it has been removed from the tank 10 in this manner. Also in embodiment c), the mounting flange 28 and the flexible container 24 can be removed when the flexible container is (only) partially pulled out.

Once the old flexible container 24 has been disconnected and/or removed, there are several ways of inserting a new flexible container 24'. It should be noted that 'new' not necessarily means that the flexible container 24' is brand new or previously unused, but rather that it is another container compared to the original or previous "old"

5 container 24, or that it is the previous container that has been mended.

In one embodiment illustrated in figs. 4f-4h, the new flexible container 24' is pre-packed in an elongated shape, like a solid bar-shaped body 52. It is hence suitable for insertion through the first inlet/outlet 16. The pre-packed new container 24' may for instance be packaged in a water-soluble packaging means 54. The packaging means 54  
10 may for instance be a foil or tapes or a cover or the like wrapped around the new container 24'. The packaging means 54 is adapted to dissolve in water, preferably after a pre-defined time. The pre-defined time may for instance be approximately 24 hours. In fig. 4f, the new packed bar-shaped container 24' is provided on guide bars 56 outside the first inlet/outlet 16. Then, an ROV 50 pushes the packed container 24' into the tank  
15 10 through in inlet/outlet 16 (fig. 4g). When the complete container 24' has been inserted, its opening 26 is connected to the first inlet/outlet 16. In this embodiment, any old mounting flange may be removed before the new container is inserted, and the new container may have a new mounting flange with becomes attached to a corresponding flange of the inlet/outlet 16.

20 The operation of inserting the pre-packed new container 24' shall take less time than it takes for the water-soluble foil or tape or cover 54 to dissolve. Hence, once the new flexible container 24' has been inserted into the tank 10, the foil or tape or cover 54 will dissolve in the seawater in the tank 10, "releasing" the new flexible container 24' and allowing it to unfold or develop inside the tank 10 (fig. 4h). The unfolding of the  
25 new flexible container 24' is effected by pumping seawater *W1* from the storage space 32 until the new flexible container 24' is fully developed. As a consequence of extracting seawater *W1* from the storage space 32, seawater *W2* enters the new container 24' via the reconnected first filling and emptying line 18. Once the new flexible container 24' is fully developed, the tank 10 is yet again ready to operate as an oil  
30 storage facility. The seawater pumped out from the storage space 32 is preferably passed through an OMD before being discharged to the sea.

In another embodiment (not shown), the old mounting flange 28 is removed from the first inlet/outlet 16 (if it has not already been removed, cf. embodiments (b) and (c) described above wherein the flexible container is removed together with the  
35 mounting flange). Then, a new mounting flange including a rolled-up new flexible container is inserted into the first inlet/outlet 16, and the new mounting flange may be secured to a mating or corresponding flange of the inlet/outlet 16. Then, to assist the

new flexible container to unroll, seawater is pumped out from the storage space 32, and seawater is allowed into the new container via the first inlet/outlet 16 and the reconnected first filling and emptying line 18. Thereafter, the tank 10 is yet again ready to operate as an oil storage facility. The seawater pumped out from the storage space 32  
5 is preferably passed through an OMD before being discharged to the sea.

As mentioned above, the tank 10 may be used to store hydrocarbons, such as oil. However, it can also be used for storing other (imported) fluids, such as fresh water for increased oil recovery (IOR) purposes or other hydrocarbons for diluent purposes.

The person skilled in the art will realize that the present invention by no means  
10 is limited to the embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims.

C l a i m s

1. A method of replacing a flexible container (24) provided inside a subsea storage tank (10), wherein the flexible container defines a space (30) separated from a remaining storage space (32) of the subsea storage tank, and wherein the flexible container is connected via one opening (26) thereof to a first inlet/outlet (16) of the subsea storage tank, for allowing seawater exclusively into and out from the flexible container, which method comprises:
- filling seawater into the remaining storage space of the subsea storage tank from a second inlet/outlet (20) of the subsea storage tank, such that any seawater in the flexible container is discharged through the first inlet/outlet;
- one of
- a) introducing a cutting means through the first inlet/outlet, cutting loose the flexible container from the first inlet/outlet by means of the cutting means, and leaving the cut away flexible container in the subsea storage tank,
- b) while the flexible container is inside the subsea storage tank, disconnecting a mounting flange (28) via which the flexible container is connected to the first inlet/outlet, and then removing the mounting flange from the first inlet/outlet such that the flexible container still affixed to the mounting flange is pulled out from the storage tank through the first inlet/outlet, and
- c) turning the flexible container at least partly inside out through the first inlet/outlet by means of a pulling member (46) having one part or end (48a) attached to the inside of the flexible container remote from the first inlet/outlet and another part or end (48b) accessible via the first inlet/outlet; and
- inserting a new flexible container (24') through the first inlet/outlet.
2. A method according to claim 1, wherein inserting the new flexible container through the first inlet/outlet includes:
- providing the new flexible container (24') pre-packed in an elongated shape (52);
- inserting the pre-packed new flexible container into the subsea storage tank through the first inlet/outlet; and
- allowing the inserted, pre-packed new flexible container to unfold or develop inside the subsea storage tank.

3. A method according to claim 2, wherein the new flexible container is pre-packed using a fluid-soluble packing means (54) adapted to dissolve after a specific time of exposure to fluid.
- 5 4. A method according to claim 2 or 3, wherein allowing the inserted, pre-packed new flexible container to unfold or develop inside the subsea storage tank includes: extracting seawater from the remaining storage space of the subsea storage tank, and allowing seawater into the new flexible container.
- 10 5. A method according to claim 1, wherein inserting the new flexible container through the first inlet/outlet includes:  
if still in place, removing a mounting flange (28) from the first inlet/outlet;  
inserting a new mounting flange including a rolled-up new flexible container into the first inlet/outlet; and  
15 extracting seawater from the remaining storage space of the subsea storage tank, and allowing seawater into the new flexible container, causing the new flexible container to unroll in the storage tank.
6. A method according to any preceding claim, which method further comprises:  
20 storing hydrocarbons in the remaining storage space of the subsea storage tank.
7. A method according to any preceding claim, wherein the flexible container is provided below the remaining storage space of the subsea storage tank, the first inlet/outlet is provided in a side wall at the bottom of the storage tank, and the second  
25 inlet/outlet is provided in the top of the storage tank.
8. A replaceable, flexible container (24') for a subsea storage tank (10), which container is made of a water- and oil-proof material and has one opening (26) for connection to an inlet/outlet (16) of the subsea storage tank, wherein the container is  
30 pre-packed in an elongated shape (52) and provided with a water-soluble packing means (54) keeping the container in the elongated shape.
9. A container according to claim 8, wherein the packing means is adapted to dissolve after a specific time of exposure to water.

10. A container according to claim 8 or 9, wherein the container is made of a polymeric material.

11. A method of installing a storage tank (10) on the seabed (44), wherein a flexible  
5 container (24) is provided inside the storage tank, the flexible container defining a lower space separated (30) from a remaining upper storage space (32) of the subsea storage tank, wherein the method comprises:

filling an incompressible hydrocarbon liquid which is lighter than surrounding  
seawater (38) into the remaining upper storage space (32), such that the storage tank  
10 gets a positive net buoyancy;

positioning the storage tank in the sea (38) above or nearby an installation  
location (42);

removing at least a fraction of the light hydrocarbon liquid from the remaining  
storage space, and allowing seawater into the flexible container, such that the storage  
15 tank gets a net negative buoyancy; and

allowing the storage tank to immerse down to the installation location.

12. A method according to claim 11, which method further comprises: adjusting the  
amount of hydrocarbon liquid in the remaining storage space for controlling the net  
20 buoyancy of the storage tank.

13. A method according to claim 11 or 12, wherein said hydrocarbon liquid is pentane.

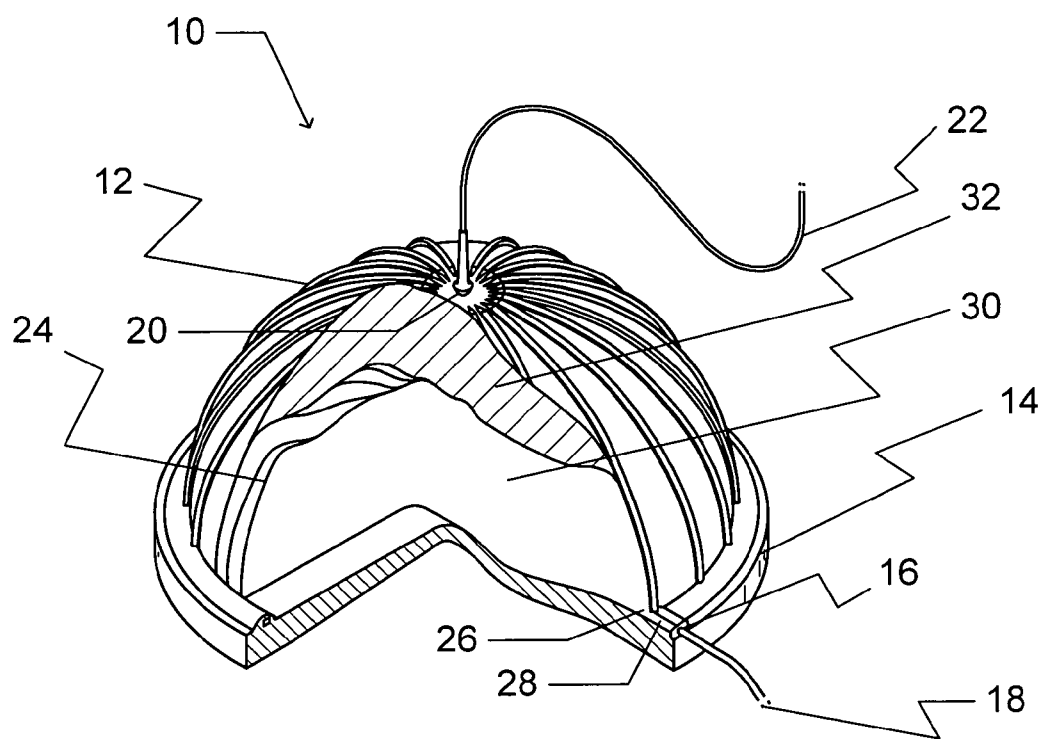


Fig. 1

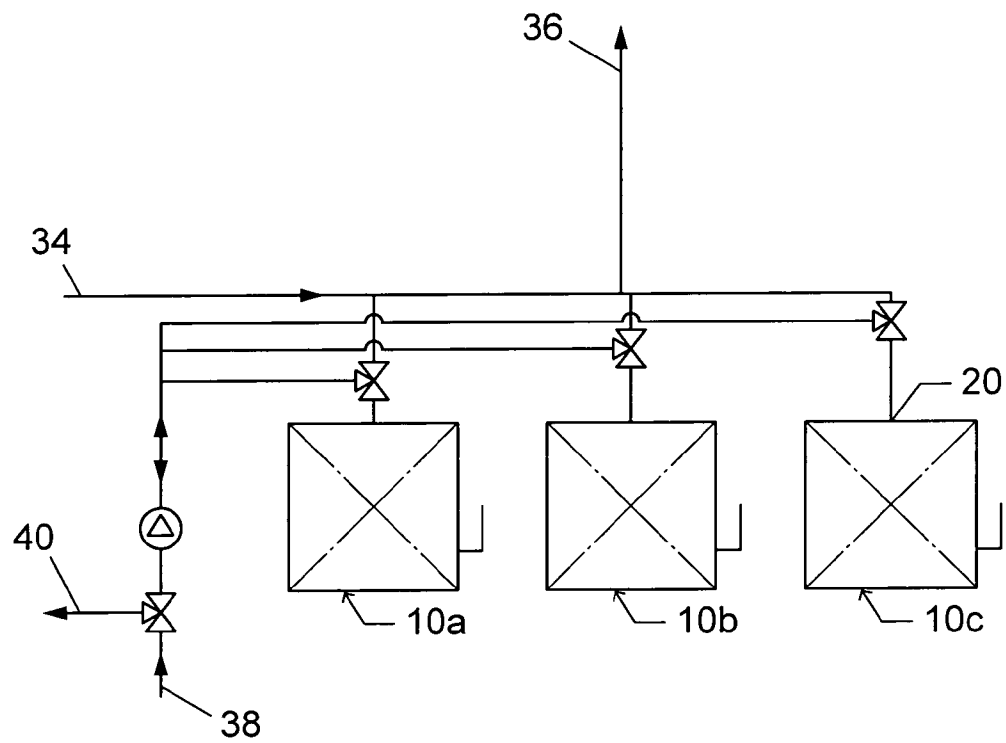


Fig. 2

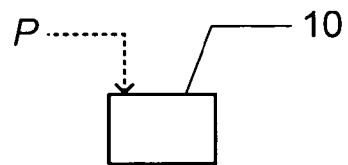


Fig. 3a

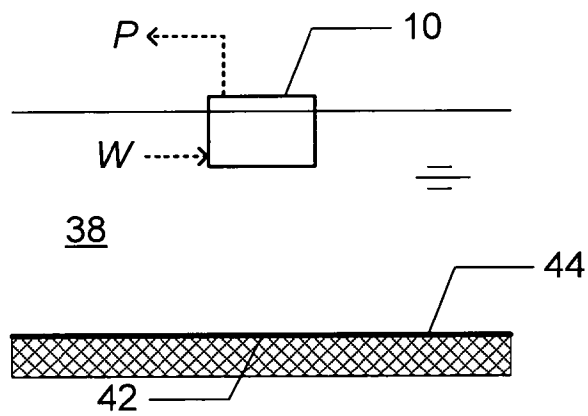


Fig. 3b

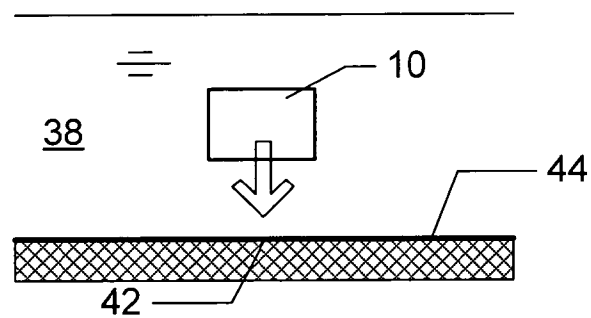


Fig. 3c

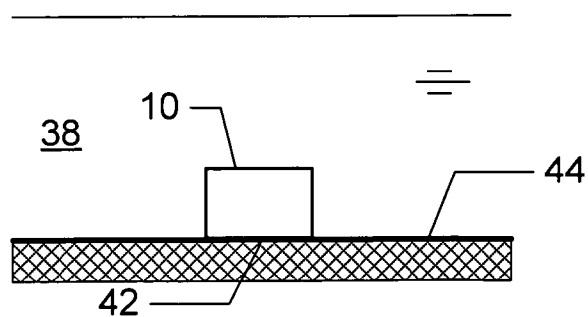
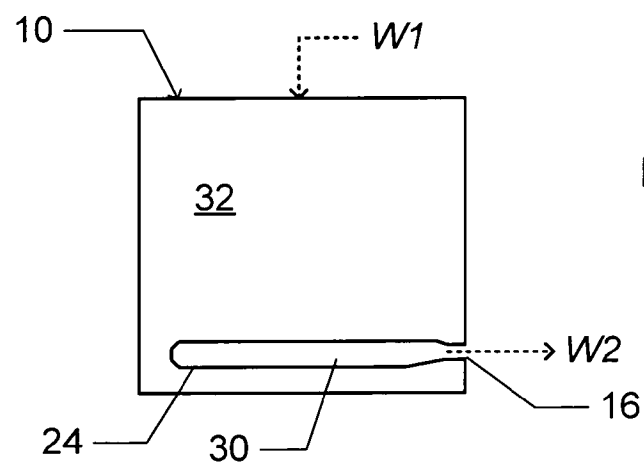
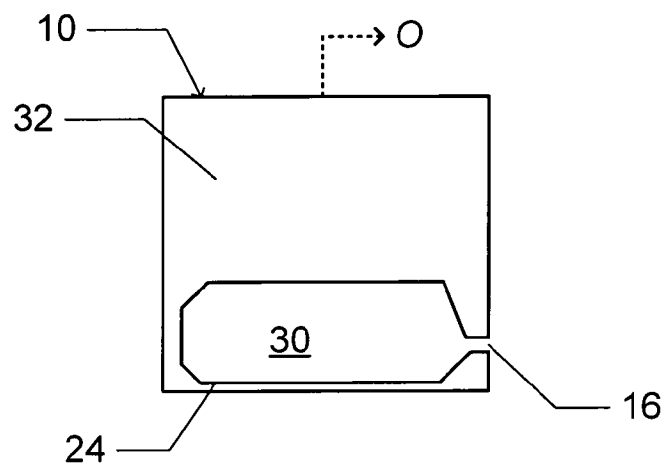
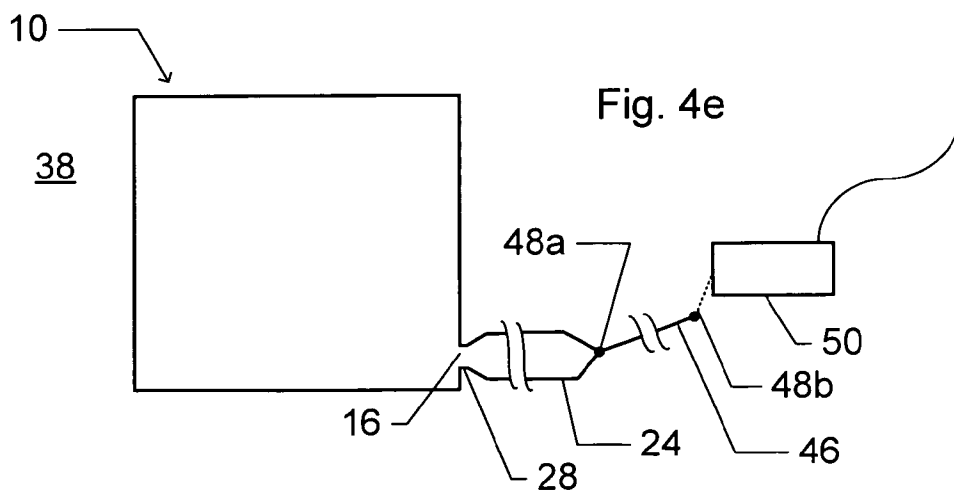
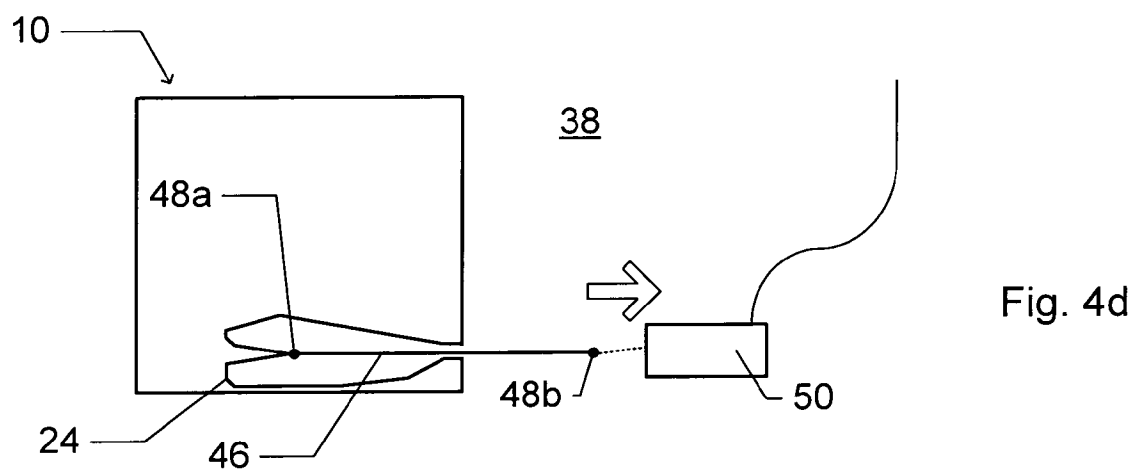
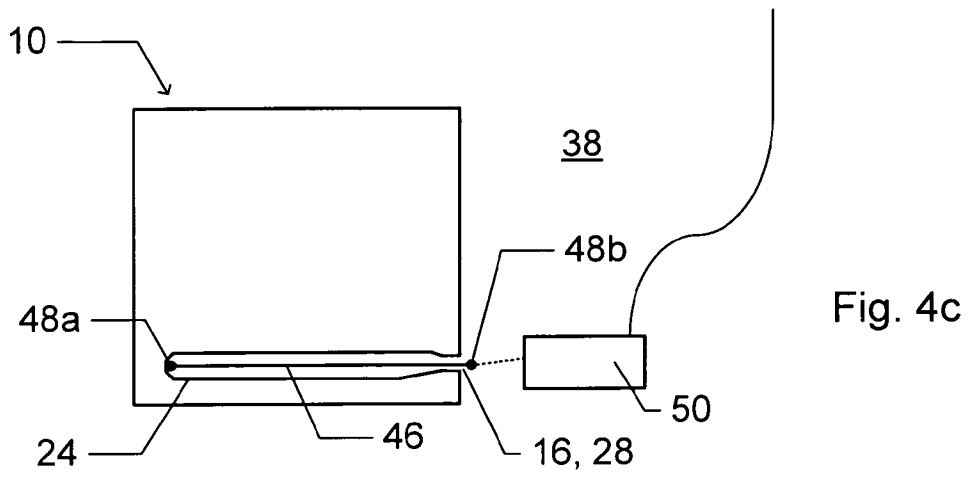
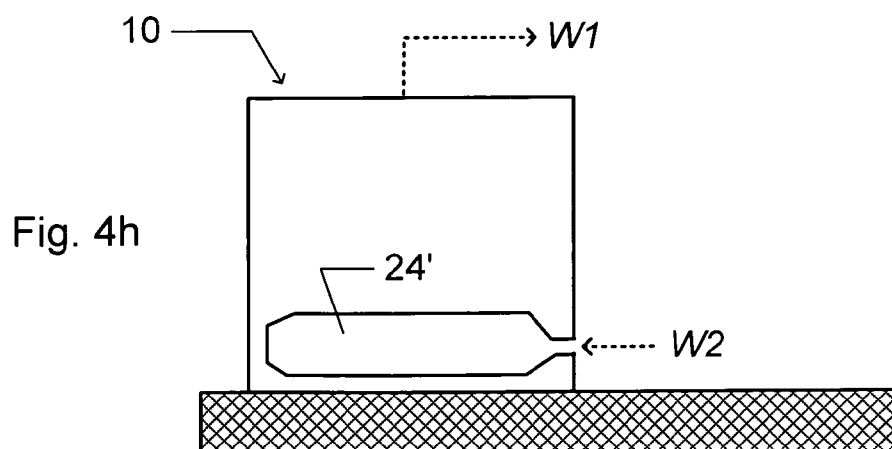
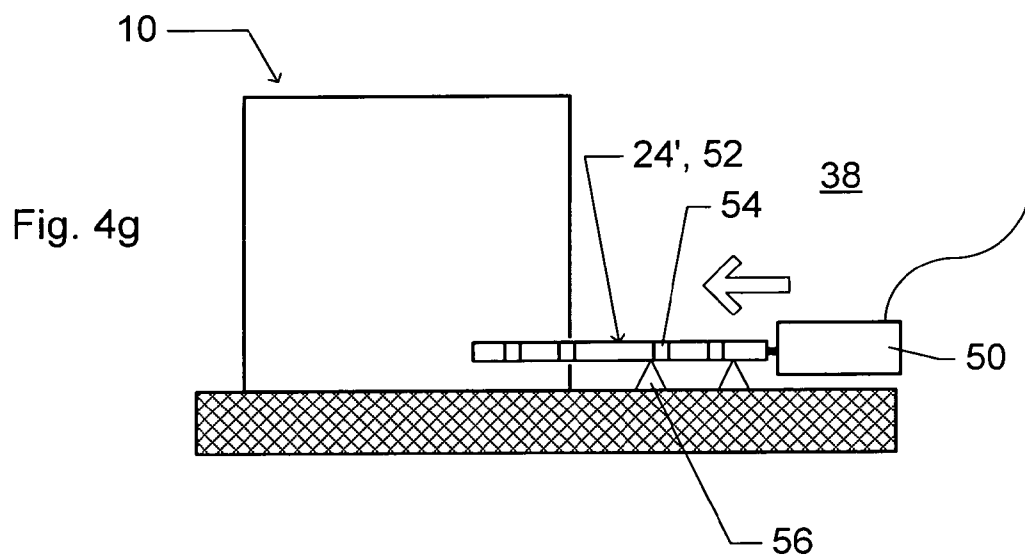
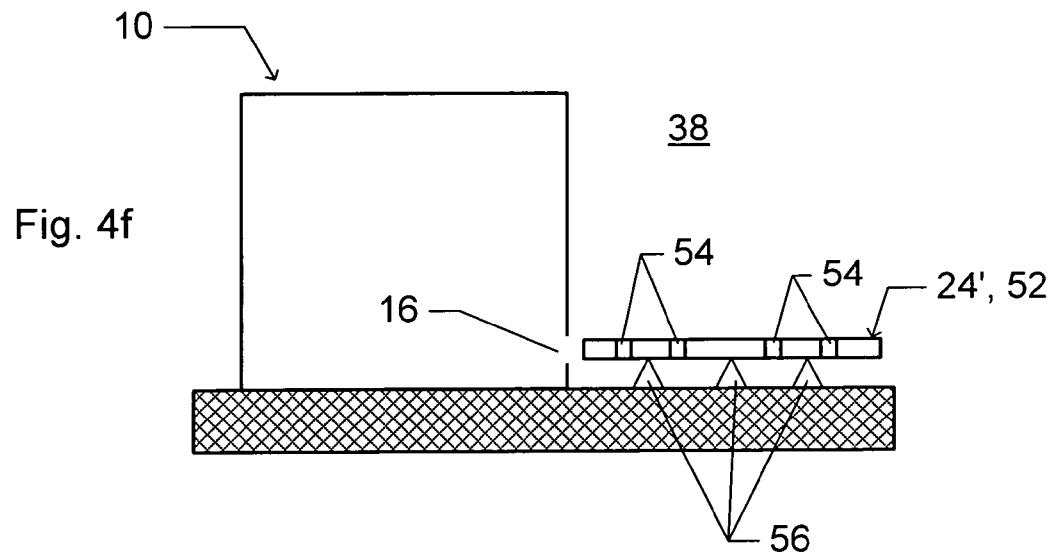


Fig. 3d







## INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2011/057865

A. CLASSIFICATION OF SUBJECT MATTER  
INV. B65D88/78  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
B65D B63B F17C E02D E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                             | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | WO 2004/037681 A1 (NAVION ASA [NO]; SAMUELSEN ARILD [NO]; BREIVIK KAARE [NO]; RAVNDAL OLA) 6 May 2004 (2004-05-06) cited in the application<br>page 4, lines 28-32<br>figure 2 | 1                     |
| A         | US 4 190 072 A (FERNANDEZ RAMON J [US] ET AL) 26 February 1980 (1980-02-26) column 3, line 43 - column 4, line 52<br>figures 3-6                                               | 1                     |
| X         | WO 2007/004216 A2 (TERRASAFE ENVIRONMENTAL PROT L [IL]; WEBER ZVIKA [IL]; SHEFFER URI [IL]) 11 January 2007 (2007-01-11) page 7, line 9 - page 8, line 24<br>figures 2C-3      | 8-10                  |
|           | -----<br>-/-                                                                                                                                                                   |                       |



Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

12 April 2012

Date of mailing of the international search report

20/04/2012

Name and mailing address of the ISA/

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Authorized officer

Piolat, Olivier

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2011/057865

| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                            |                       |
|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category*                                            | Citation of document, with indication, where appropriate, of the relevant passages                                                         | Relevant to claim No. |
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| X                                                    | WO 02/076816 A2 (CONOCO INC [US])<br>3 October 2002 (2002-10-03)<br>page 13, paragraph 43 - page 16, paragraph 49<br>figures 3-6<br>-----  | 11-13                 |
| A                                                    | FR 2 200 862 A5 (C G DORIS CIE G E [FR])<br>19 April 1974 (1974-04-19)<br>page 2, line 28 - page 5, line 13<br>figure 1<br>-----           | 11                    |
| A                                                    | US 5 899 637 A (BLANCHARD CONRAD J [US] ET AL)<br>4 May 1999 (1999-05-04)<br>column 5, line 11 - column 6, line 23<br>figures 6-8<br>----- | 11                    |
| A                                                    | US 4 660 606 A (CHEUNG MAXWELL C [US])<br>28 April 1987 (1987-04-28)<br>column 9, lines 62-68<br>figures 2, 4, 6A-6C<br>-----              | 11                    |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/057865

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)  | Publication<br>date         |
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| US 5899637                                | A                   | 04-05-1999                  | NONE                        |
| US 4660606                                | A                   | 28-04-1987                  | NONE                        |

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/EP2011/057865

### Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

#### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-7

Method of replacing a flexible container provided inside a subsea storage tank

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2. claims: 8-10

Flexible container

---

3. claims: 11-13

Method of installing a storage tank on the seabed

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