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(54) **METHOD OF INSTALLING HYBRID RISER TOWER**

INSTALLATIONSVERFAHREN FÜR HYBRIDSTEIGROHRTURM

PROCÉDÉ D'INSTALLATION POUR TOUR DE COLONNE MONTANTE HYBRIDE

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Description

[0001] The present invention relates to a method of installing hybrid riser towers, according to the characteristics of the preamble of independent claim 1. Hybrid Riser Towers are known and form part of the so-called hybrid riser, having an upper and/or lower portions ("jumpers") made of flexible conduit and suitable for deep and ultra-deep water field development. US-A-6082391 (Stolt/Doris) proposes a particular Hybrid Riser Tower (HRT) consisting of an empty central core, supporting a bundle of riser pipes, some used for oil production some used for water and gas injection. This type of tower has been developed and deployed for example in the Girassol field off Angola. Insulating material in the form of syntactic foam blocks surrounds the core and the pipes and separates the hot and cold fluid conduits. Further background has been published in paper "Hybrid Riser Tower: from Functional Specification to Cost per Unit Length" by J-F Saint-Marcoux and M Rochereau, DOT XIII Rio de Janeiro, 18 October 2001. Updated versions of such risers have been proposed in WO 02/053869 A1. These multibore HRTs are very large and unwieldy, cannot be fabricated everywhere, and reach the limit of the component capabilities.

[0002] One known solution is to use a number of Single Line Offset Risers (SLORs) which are essentially monobore HRTs. A problem with these structures is that for a drill centre (a cluster of wells), a large number of these structures are required, one for each production line, each injection line and each gas line. This means that each structure needs to be placed too close to adjacent structures resulting in the increased risk of each structure getting in the way of or interfering with others, due to wake shielding and wake instability.

[0003] Another problem with all HRTs is vortex induced vibration (alternating shedding of trailing vortices), which can lead to fatigue damage to drilling and production risers.

[0004] Closest prior art WO 01/14687 discloses a method for installing a riser configuration having a submerged tower comprising a plurality of riser pipes substantially inserted in guide conduits and also having a buoyancy tank and gravity base connected by said riser pipes and guide conduits, comprising the steps of: -fabricating a bundle of guide conduits and riser pipes on a roller bed or rail bed from which it can be launched, -connecting the buoyancy tank and gravity base to opposite ends of said bundle, -sealing at least a plurality of the guide conduits and riser pipes of the bundle, -launching the resultant structure and connecting the buoyancy tank and gravity base ends of the structure to respective towing vessels via towing wires, -flooding the buoyancy tank to provide it with substantial negative buoyancy so that both the tank and the base will act as clump weights, -towing the structure to the offshore location for its installation as a sub-surface tow while maintaining sufficient angle and tension in the towing wires to maintain sub-

stantial tension in the pipe bundle, -lowering the base end of the structure by paying out the towing wire connected to the base, -permitting water to enter the spaces formed between the riser pipes and their respective guide conduit when the base has reached a predetermined depth in order to limit the differential pressure across the wall of the guide conduits, -continuing lowering the base end of the structure until the structure is perpendicular and suspended from the towing wire connected to the buoyancy tank, and -lowering the structure to allow the base to penetrate the bottom mud-line and anchoring the base to the ocean floor, and removing the water ballast and towing wire from the buoyancy tank, thus providing tension in the guide conduits.

[0005] The invention aims to address one or more of the drawbacks inherent in the above prior art.

[0006] Described herein is a method of installing a riser comprising a plurality of conduits extending from the seabed toward the surface and having an upper end supported at a depth below the sea surface, wherein a first of said conduits acts as a central structural core, said other conduits being arranged around said first conduit.

[0007] Said other conduits are preferably arranged substantially symmetrically around said first conduit.

[0008] In one example said first conduit is a fluid injection line and said other conduits consist of production lines, Said riser preferably comprising two such production lines. At least one of said production lines may be thermally insulated. In one embodiment both production lines are thermally insulated. Alternatively, only one of said production lines is thermally insulated, the uninsulated line being used as a service line. Said thermal insulation may be in the form of a pipe in pipe structure with the annular space used as a gas lift line. Said fluid injection line may be a water or gas injection line.

[0009] Said riser may further comprise buoyancy. Said buoyancy may be in the form of blocks located at intervals along the length of the riser. Said blocks may be arranged symmetrically around said first conduit to form a substantially circular cross-section. Said foam blocks are preferably arranged non-contiguously around said first conduit.

[0010] Said production lines may provide a pigging loop.

[0011] Also described herein is a riser comprising three conduits arranged substantially symmetrically around a central core, said conduits extending from the seabed toward the surface and having an upper end supported at a depth below the sea surface, wherein a first of said conduits is a fluid injection line, said other conduits being production lines.

[0012] Said production lines may provide a pigging loop.

[0013] In one example said first conduit is a water injection line and said other conduits consist of production lines. Two such production lines may be provided. At least one of said production lines may be thermally insulated. In one embodiment both production lines are thermally insulated. Alternatively, only one of said production

lines is thermally insulated, the uninsulated line being used as a service line. Said thermal insulation may be in the form of a pipe in pipe structure with the annular space used as a gas lift line. Said riser may further comprise buoyancy. Said buoyancy may be in the form of blocks located at intervals along the length of the riser. Said blocks may be arranged symmetrically around said first conduit to form a substantially circular cross-section. Said foam blocks are preferably arranged non-contiguously around said first conduit.

[0014] Said riser may further comprise a plurality of guide frame elements arranged at intervals along the length of said riser, said frame elements guiding said conduits in place. Sliding devices between the risers and the guide frames may be included to allow sliding and dampen Vortex Induced Motion.

[0015] Said structural core may also be used as a conduit, either as a production line, injection line or gas lift line.

[0016] Also described is a riser comprising a plurality of conduits extending from the seabed toward the surface and having an upper end supported at a depth below the sea surface wherein said riser is provided with buoyancy along at least a part of its length, said buoyancy resulting in said riser having a generally circular cross-section, the circumference of which being non-contiguous.

[0017] Generally circular in this case means that the general outline of the riser in cross section is circular (or slightly oval/ovoid) even though the outline is non-contiguous and may have considerable gaps in the circular shape.

[0018] Said buoyancy may be in the form of blocks located at intervals along the length of the riser. Said blocks may be arranged symmetrically around said first conduit to form said largely circular cross-section. Said foam blocks are preferably arranged such that there are gaps between adjacent blocks to obtain said non-contiguous profile.

[0019] A first of said conduits may act as a central structural core, said other conduits being arranged around said first conduit. Said other conduits are preferably arranged substantially symmetrically around said first conduit. In a main embodiment said first conduit is a fluid injection line and said other conduits consist of production lines. Said fluid injection line may be a water or gas injection line. Alternatively said riser may comprise three conduits arranged substantially symmetrically around a central core, wherein a first of said conduits is a fluid injection line, said other conduits being production lines.

[0020] Two such production lines may be provided. At least one of said production lines may be thermally insulated. In one example both production lines are thermally insulated. Alternatively, only one of said production lines is thermally insulated, the uninsulated line being used as a service line. Said thermal insulation may be in the form of a pipe in pipe structure with the annular space used as a gas lift line.

[0021] The invention provides for a method of installing a riser, said riser comprising a plurality of conduits extending from the seabed toward the surface and having an upper end supported at a depth below the sea surface by a buoyancy module, said riser being assembled at a place other than the installation site and transported thereto in a substantially horizontal configuration wherein said buoyancy module is attached to said riser by a non-rigid connection prior to said riser being upended to a substantially vertical working orientation, the riser and buoyancy module being transported together by a first, leading, vessel and second, trailing, vessel, the method characterised in that it comprises the following steps:

- 5 • the second vessel, connected by a first line to the top end of the riser during transportation, pays in said line and moves toward the riser,
- 10 • the Buoyancy module is rotated approximately 90 degrees,
- 15 • the permanent connection between riser and buoyancy module is made on a service vessel;
- 20 • a second line, which connected the top of the buoyancy module to the top of the riser during transportation, is disconnected from said riser and passed to said second vessel;
- 25 • Said first line is disconnected,
- 30 • The riser upending process is begun.

[0022] Said connection between the buoyancy module and the riser may be made at the installation site. Said non-rigid connection may be made using a chain. Said chain may be provided in two parts during transportation, with a first part connected to the riser (either directly or indirectly) and a second part connected to the buoyancy module (either directly or indirectly) while being transported. Said parts may be of approximately equal length. Said parts may each be in the region of 10m to 30m long. The two parts may be connected together on a service vessel. In order to provide room to make the connection, the buoyancy tank may first be rotated. Said rotation may be through approximately 90 degrees.

[0023] Said buoyancy module may be towed to the installation site with the riser. Said buoyancy module may be towed behind said riser by connecting a towing line between the riser and the buoyancy module, independent of any other towing lines.

[0024] Reference to "top" and "bottom" above is to be understood to mean the top and bottom of the item referred to when it is installed.

[0025] Also described herein is a method of accessing a coil tubing unit located substantially at the top of a riser structure, said riser structure comprising a plurality of conduits extending from the seabed toward the surface

and having an upper end supported at a depth below the sea surface by a buoyancy module, wherein said method comprises attaching a line to a point substantially near the top of said riser, and exerting a force on said line to pull said riser, or a top portion thereof, from its normal substantially vertical configuration to a configuration off vertical.

[0026] The riser's normal substantially vertical configuration should be understood to cover orientations off true vertical, yet vertical in comparison to other riser systems.

[0027] Said buoyancy module may be attached to said riser (directly or indirectly) by means of a non-rigid connection such as a chain. Said line is preferably attached to a lower portion of said buoyancy module. The tension on said line may therefore also cause said buoyancy module to be moved a distance laterally away from the vertical axis of said riser, thereby allowing access to the coil tubing unit from directly above.

[0028] Said tension may be exerted on said line by means of a winch or similar device. Said winch may be located on a Floating Production, Storage and Offloading (FPSO) Vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] Embodiments of the invention will now be described, by way of example only, by reference to the accompanying drawings, in which:

Fig. 1 shows a known type of riser structure in an offshore oil production system;

Fig. 2 shows a multibore hybrid riser tower designed for a drill centre;

Figs. 3a and 3b show, respectively, the riser structure of Fig. 2 in cross section and a section of the riser tower in perspective;

Figs. 4a and 4b show, respectively, an alternative riser structure in cross section and a section of the alternative riser tower in perspective;

Fig 5 shows an alternative riser structure in cross-section;

Fig. 6 shows a riser structure with buoyancy tank being towed to an installation site,

Fig. 7 shows in detail the towing connection assembly used in Fig. 6

Figs. 8a and 8b depict two steps in the installation method according to an embodiment of the invention; and

Figs. 9a and 9b depict a method for accessing coil

tubing.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0030] Figure 1 illustrates a floating offshore structure 100 fed by riser bundles 110, which are supported by subsea buoys 115. Spurs 120 extend from the bottom of the riser bundle to the various well heads 130. The floating structure is kept in place by mooring lines (not shown), attached to anchors (not shown) on the seabed. The example shown is of a type known generally from the Girassol development, mentioned in the introduction above.

[0031] Each riser bundle is supported by the upward force provided by its associated buoy 115. Flexible jumpers 135 are then used between the buoys and the floating structure 100. The tension in the riser bundles is a result of the net effect of the buoyancy combined with the ultimate weight of the structure and risers in the seawater. The skilled person will appreciate that the bundle may be a few metres in diameter, but is a very slender structure in view of its length (height) of for example 500m, or even 1 km or more. The structure must be protected from excessive bending and the tension in the bundle is of assistance in this regard.

[0032] Hybrid Riser Towers (HRTs), such as those described above, have been developed as monobore structures or as structures comprising a number, in the region of six to twelve, of risers arranged around a central structural core.

[0033] It is normal for deepwater developments to be phased and are often built around a drill centre. A drill centre is usually of two piggable production lines (at least one being thermally insulated) and an injection line.

[0034] Figure 2 shows a simplified multibore hybrid riser tower designed for a drill centre. It comprises two (in this example) production lines 200, a water injection line 210, buoyancy blocks 220, an Upper Riser Termination Assembly (URTA) 230 with its own self buoyancy 240, a buoyancy tank 250 connected to the URTA by a chain 260, jumpers 270 connecting the URTA 230 to a Floating Production Unit (FPU) 280. At the lower end there is a Lower Riser Termination Assembly (LRTA) 290, a suction or gravity or other type of anchor 300, and a rigid spool connection 310. This spool connection 310 can be made with a connector or an automatic tie-in system (such as the system known as MATIS (RTM) and described in WO03/040602). It should be noted that instead of the water injection line 210, the riser tower may comprise a gas injection line.

[0035] As mentioned previously, conventional HRTs usually comprise a central structural core with a number of production and injection lines arranged therearound. In this structure. however, the water injection line 210 doubles as a central core for the HRT structure, with the two production lines arranged either side, on the same plane, to give a flat cross-section.

[0036] The inventors have identified that for a small

isolated reservoir the minimum number of lines required are three, two production lines to allow pigging and one injection line to maintain pressure.

[0037] The risers themselves may be fabricated onshore as horizontally sliding pipe-in-pipe incorporating annular gaslift lines, although separate gaslift lines can also be envisaged. The top connection of an annulus pipe-in-pipe can be performed by welding a bulkhead or by a mechanical connection.

[0038] Figures 3a and 3b show, respectively, the riser tower in cross section and a section of the riser tower in perspective. This shows the two production lines 200, the water injection line/ central core 210, guide frame 320 and buoyancy foam blocks 220a, 220b. The guide frame 320 holds the three lines 200, 210 in place, in a line. A plurality of these guide frames 320 are comprised in the HRT, arranged at regular intervals along its length.

[0039] It can also be seen that the buoyancy blocks 220a, 220b are arranged non-contiguously around the water injection line/ riser core. For an onshore-assembled HRT, the riser assembly must be buoyant so that, in the event of loss of the HRT by the tugs towing it, it will not sink. Buoyancy of the HRT once installed is provided by the addition of the buoyancy 230 along the riser assemble and the buoyancy provided by the buoyancy element 250 at the top. Attaching buoyancy foam blocks to the risers themselves would reduce the compression in the core pipe but the hydrodynamic section would become very asymmetrical. Therefore, it is preferred for the foam blocks to be attached to the core pipe/ guide frame as shown.

[0040] The fact that the foam blocks are arranged non-contiguously around the HRT (as well as being applied non-contiguously along its length) minimises the occurrence of Vortex Induced Vibration (VIV) in the riser tower. A conventional completely circular cross-section causes a wake, while the breaking up of this circular outline breaks the wake, resulting in a number of smaller eddy currents instead of one large one, and consequently reduced drag. The riser cross-section should still maintain a largely circular (or slight ovoid) profile, as there is no way of knowing the water current direction, so it is preferable that the structure should be as insensitive to direction as possible

[0041] The distance between guide frames is governed by the amount of compression in the core pipe. Guiding devices are required between the guide frame and the riser.

[0042] Figures 4a and 4b show an alternative example to that described above wherein the two production lines 200 and the single water injection line/ gas injection line 210 is arranged symmetrically around a structural core 410. As before there are guide frames 400 and buoyancy foam blocks 220a, 220b, 220c arranged non-contiguously around the core 410. It is possible in this embodiment for the structural core to be used as a line, should a further line be desired.

[0043] Figure 5 shows a variation of the example de-

picted in figures 3a and 3b. In this variation instead of two identical insulated production lines there is provided only one insulated production line 200 and one non-insulated service line 500. As before, the water/gas injection line 210 acts as the structural core for the riser tower, and there are provided guide frames 510 at intervals along the length with buoyancy blocks 220a, 220b attached thereto. Under normal conditions the production comes through the insulated line. The service line is always filled with dead oil (not likely to form hydrates). Upon shutdown dead oil from the service line is pushed back into the production line.

[0044] It should be noted that the hybrid riser is constructed onshore and then towed to its installation site where it is upended and installed. In order to be towed the riser is made neutrally buoyant (or within certain tolerances). Towing is done by at least two tugs, one leading and one at the rear.

[0045] Figure 6 shows (in part) a hybrid riser being towed to an installation site prior to being upended and installed. It shows the riser 600, and at what will be its top when installed, an upper riser installation assembly (URTA) 610. Attached to this via buoyancy tank tow line 620 is the main top buoyancy tank 630 floating on the sea surface. The URTA 610 is also attached to a trail tug 650 (the lead tug is not shown) about 650 metres behind the URTA via riser tow line 640. A section of the main permanent chain link 660a, attached to the buoyancy tank 630 and for making the permanent connection between this and the URTA 610, can also be seen, as yet unconnected. It should be noted that the buoyancy tank tow line 620 is actually attached to the top of the buoyancy tank 630, that is the buoyancy tank 630 is inverted compared to the riser 600 itself.

[0046] Figure 7 shows in detail the rigging of the URTA 610. This shows a triplate with swivel 700 which connects the URTA 610 (and therefore the riser 600) to the buoyancy tank 630 and trail tug 650 by buoyancy tank tow line 620 and riser tow line 640 respectively. Also shown is the other section of the permanent chain link 660b attached to the top of the URTA 610.

[0047] By using a chain to connect the buoyancy tank to the riser (instead of, for example a flexjoint) and by making the chain link long enough (say each section 630a, 630b being about 20 metres in length) it becomes possible to attach the buoyancy tank 230 to the riser 600 by joining these two sections 630a, 630b together at the installation site prior to upending. This dispenses with the need to have a heavy installation vessel with crane to hold and install the buoyancy tank when upended. Only service vessels are required. It also allows the possibility of towing the buoyancy tank with the riser to the installation site thus reducing cost. Furthermore, the use of a chain instead of a rigid connection dispenses with the need for a taper joint.

[0048] Figures 8a and 8b show the trail tug and apparatus of Figure 6 during two steps of the installation method. This installation method is as follows: The buoyancy

tank is moved back (possibly by a service vessel) and the trail tug 650 pays in the Riser tow line 640 and moves back 150 m towards the riser 600. The paying in of the tow rope causes the URTA 610 to rise towards the water surface. The buoyancy tank 630 is then rotated 90 degrees (again the service vessel will probably do this) to allow room for the permanent chain connection to be made.

[0049] With the buoyancy tank 630 rotated, the service vessels pays in the 60m permanent chain section 660a from the buoyancy tank 630, and the 60m permanent chain section 660b on the URTA 610. The permanent chain link between the buoyancy tank 630 and the URTA 610 (and therefore the riser 600) is made on the shark jaws of the service vessel. The resulting situation is shown in Figure 4a. This shows the buoyancy tank 630 at 90 degrees with the permanent chain connection 660 in place. The trail tug 650 (now about 100m from the URTA 610) is still connected to the URTA 610 by riser tow line 640. The buoyancy tank tow line 620 is still connected between the buoyancy tank 630 and the URTA 610 and is now slack.

[0050] The slack buoyancy tank tow line 620 is now disconnected from the triplate swivel 700 and is then passed on to the trail tug 650. Therefore this line 620 is now connected between the trail tug 650 and the top of the buoyancy tank 630. This line 620 is then winched taut. The riser towing line 640 is then released. This situation is shown in Figure 4b. It can be seen that the tension now goes through the buoyancy tank towing line 620, buoyancy tank 620 and permanent chain 660. The triplate swivel 700 is then removed to give room to the permanent buoyancy tank shackle, and the permanent buoyancy tank shackle is secured. The upending process can now begin with the lead tug paying out the dead man anchor. The upending process is described in US06082391 and is incorporated herein by reference.

[0051] One issue with the Hybrid Riser Tower as described (with chain connection to the buoyancy tank) is the coil tubing access. This was previously done by having access to the coil tubing unit to be from directly vertically above the URTA. In this case the buoyancy tank was rigidly connected with a taper joint. However access from vertically above is not possible with the buoyancy tank attached to a chain also directly vertically above the URTA.

[0052] Figures 9a and 9b depicts a method for accessing the coil tubing unit for a Hybrid Riser Tower which has its buoyancy tank attached non-rigidly, for instance with a chain, as in this example. This shows the top part of the installed riser tower (which may have been installed by the method described above), and in particular the riser 600, URTA 610, buoyancy tank 630, permanent chain link 660, the coil tubing access 700, and a temporary line 710 from a winch 730 on the Floating Production, Storage and Offloading (FPSO) Vessel 720 to the bottom of the buoyancy tank 630.

[0053] The method comprises attaching the temporary

line 710 from the winch 730 on the FPSO 720 to the bottom of the buoyancy tank 630 and using the winch 730 to pull this line 710 causing the riser assembly to move off vertical. This provides the necessary clearance 740 for the coil tubing access.

[0054] The inventors have recognised that, with the buoyancy tank 630 connected by a chain 660, the temporary line 710 should be attached to the bottom of the buoyancy tank 630. Should it be connected to the top of the buoyancy tank 630, the tank tends only to rotate, while connection to the URTA 610 means that the buoyancy tank 630 tends to remain directly above and still preventing the coil tubing access.

[0055] The above embodiments are for illustration only and other embodiments and variations are possible and envisaged without departing from the scope of the invention, as defined by the appended claims.

Claims

1. A method of installing a riser (600), said riser comprising a plurality of conduits extending from the seabed toward the surface and having an upper end (610) supported at a depth below the sea surface by a buoyancy module (630), said riser being assembled at a place other than the installation site and transported thereto in a substantially horizontal configuration wherein said buoyancy module is attached to said riser by a non-rigid connection (660) prior to said riser being upended to a substantially vertical working orientation, the riser and buoyancy module being transported together by a first, leading, vessel and second, trailing, vessel (650), the method **characterised in that** it comprises the following steps:

- the second vessel, connected by a first line (640) to the top end of the riser during transportation, pays in said line and moves toward the riser,
- the Buoyancy module is rotated approximately 90 degrees,
- the permanent connection between riser and buoyancy module is made on a service vessel;
- a second line (620), which connected the top of the buoyancy module to the top of the riser during transportation, is disconnected from said riser and passed to said second vessel;
- Said first line is disconnected,
- The riser upending process is begun.

2. A method of installing a riser as claimed in claim 1 **characterised in that** said connection between the buoyancy module and the riser is made at the installation site.

3. A method of installing a riser as claimed in claim 1 or 2 **characterised in that** said non-rigid connection

is made using a chain.

4. A method of installing a riser as claimed in claim 3 **characterised in that** said chain is provided in two parts during transportation, with a first part connected, directly or indirectly, to the riser (660b) and a second part connected, directly or indirectly, to the buoyancy module while being transported. 5
5. A method of installing a riser as claimed in claim 4 **characterised in that** said parts are of approximately equal length. 10
6. A method of installing a riser as claimed in claim 4 or 5 **characterised in that** said parts are each in the region of 10m to 30m long. 15
7. A method of installing a riser as claimed in claim 4, 5 or 6 **characterised in that** the two parts are connected together on a service vessel. 20
8. A method of installing a riser as claimed in any of claims 4 to 7 **characterised in that**, in order to provide room to make the connection, the buoyancy tank is rotated prior to connection. 25
9. A method of installing a riser as claimed in claim 8 **characterised in that** said rotation is through approximately 90 degrees. 30
10. A method of installing a riser as claimed in any of claims 1 to 9 **characterised in that** said buoyancy module is towed to the installation site with the riser. 35
11. A method of installing a riser as claimed in claim 10 **characterised in that** said buoyancy module is towed behind said riser by connecting a towing line between the riser and the buoyancy module, independent of any other towing lines. 40

Patentansprüche

1. Verfahren zum Installieren eines Steigrohrs (600), wobei das Steigrohr mehrere Kanäle umfaßt, die vom Meeresboden zu der Oberfläche verlaufen und ein oberes Ende (610) aufweisen, das in einer Tiefe unter der Meeresoberfläche von einem Auftriebsmodul (630) getragen wird, wobei das Steigrohr an einem anderen Platz als dem Installationsort zusammengebaut und in einer im Wesentlichen horizontalen Konfiguration dorthin transportiert wird, wobei das Auftriebsmodul durch eine nicht starre Verbindung (660) an dem Steigrohr angebracht ist, bevor das Steigrohr in eine im Wesentlichen vertikale Arbeitsorientierung hochkant gestellt wird, wobei das Steigrohr und das Auftriebsmodul zusammen von einem ersten, führenden Fahrzeug und einem zwei-

ten, nachfolgenden Fahrzeug (650) transportiert werden, wobei das Verfahren **dadurch gekennzeichnet ist, dass** es die folgenden Schritte umfasst:

- das zweite Fahrzeug, während des Transports über ein erstes Seil (640) mit dem oberen Ende des Steigrohrs verbunden, rollt das Seil auf und bewegt sich auf das Steigrohr zu,
 - das Auftriebsmodul wird um etwa 90 Grad gedreht,
 - die permanente Verbindung zwischen Steigrohr und Auftriebsmodul erfolgt auf einem Service-Fahrzeug;
 - ein zweites Seil (620), das während des Transports die Oberseite des Auftriebsmoduls mit der Oberseite des Steigrohrs verband, wird von dem Steigrohr getrennt und an das zweite Fahrzeug übergeben;
 - das erste Seil wird getrennt,
 - der Prozess des Hochkantstellens des Steigrohrs wird begonnen.
2. Verfahren zum Installieren eines Steigrohrs nach Anspruch 1, **dadurch gekennzeichnet, dass** die Verbindung zwischen dem Auftriebsmodul und dem Steigrohr am Installationsort hergestellt wird.
 3. Verfahren zum Installieren eines Steigrohrs nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die nicht starre Verbindung mit einer Kette hergestellt wird. 30
 4. Verfahren zum Installieren eines Steigrohrs nach Anspruch 3, **dadurch gekennzeichnet, dass** die Kette während des Transports in zwei Teilen vorgesehen ist, wobei ein erster Teil direkt oder indirekt mit dem Steigrohr (660b) verbunden ist und ein zweiter Teil direkt oder indirekt mit dem Auftriebsmodul verbunden ist, während es transportiert wird. 40
 5. Verfahren zum Installieren eines Steigrohrs nach Anspruch 4, **dadurch gekennzeichnet, dass** die Teile ungefähr gleiche Länge aufweisen.
 6. Verfahren zum Installieren eines Steigrohrs nach Anspruch 4 oder 5, **dadurch gekennzeichnet, dass** die Teile jeweils im Bereich 10 m bis 30 m lang sind.
 7. Verfahren zum Installieren eines Steigrohrs nach Anspruch 4, 5 oder 6, **dadurch gekennzeichnet, dass** die beiden Teile auf einem Service-Fahrzeug miteinander verbunden werden.
 8. Verfahren zum Installieren eines Steigrohrs nach einem der Ansprüche 4 bis 7, **dadurch gekennzeichnet, dass** der Auftriebstank vor der Verbindung ge-

dreht wird, um Platz für die Verbindung zu machen.

9. Verfahren zum Installieren eines Steigrohrs nach Anspruch 8, **dadurch gekennzeichnet, dass** die Drehung durch etwa 90 Grad erfolgt.
10. Verfahren zum Installieren eines Steigrohrs nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** das Auftriebsmodul zu dem Installationsort mit dem Steigrohr gezogen wird.
11. Verfahren zum Installieren eines Steigrohrs nach Anspruch 10, **dadurch gekennzeichnet, dass** das Auftriebsmodul hinter dem Steigrohr gezogen wird, indem ein Zugseil zwischen dem Steigrohr und dem Auftriebsmodul unabhängig von etwaigen anderen Zugseilen gezogen wird.

Revendications

1. Procédé d'installation d'une colonne montante (600), ladite colonne montante comprenant une pluralité de canalisations s'étendant du plancher océanique à la surface et étant dotée d'une extrémité supérieure (610) soutenue à une profondeur située en dessous de la surface de la mer par un module de flottabilité (630), ladite colonne montante étant assemblée dans un lieu autre que le site d'installation et transportée sur ce dernier sous une configuration sensiblement horizontale dans laquelle ledit module de flottabilité est attaché à ladite colonne montante par une liaison souple (660) avant de redresser ladite colonne montante dans une attitude de travail sensiblement verticale, la colonne montante et le module de flottabilité étant transportés ensemble par un premier navire de tête et un deuxième navire de queue (650), le procédé étant **caractérisé en ce qu'il** comprend les étapes suivantes :

- Le deuxième navire, relié par une première ligne (640) à l'extrémité supérieure de la colonne montante pendant le transport, enroule ladite ligne et se déplace en direction de la colonne montante,
- Le module de flottabilité est tourné à environ 90 degrés ;
- La liaison permanente entre la colonne montante et le module de flottabilité est réalisée sur un navire de service ;
- Une deuxième ligne (620), qui relie la partie supérieure du module de flottabilité à la partie supérieure de la colonne montante pendant le transport, est déconnectée de ladite colonne montante et passée sur ledit deuxième navire ;
- Ladite première ligne est déconnectée,
- Le processus de redressement de la colonne montante commence.

2. Procédé d'installation d'une colonne montante selon la revendication 1, **caractérisé en ce que** ladite liaison entre le module de flottabilité et la colonne montante est réalisée sur le site d'installation.
3. Procédé d'installation d'une colonne montante selon la revendication 1 ou 2, **caractérisé en ce que** ladite liaison souple est réalisée par le biais d'une chaîne.
4. Procédé d'installation d'une colonne montante selon la revendication 3, **caractérisé en ce que** ladite chaîne est fournie en deux parties pendant le transport, une première partie étant reliée, directement ou indirectement, à la colonne montante (660b) et une deuxième partie étant reliée, directement ou indirectement, au module de flottabilité pendant le transport.
5. Procédé d'installation d'une colonne montante selon la revendication 4, **caractérisé en ce que** lesdites parties sont de longueur approximativement égale.
6. Procédé d'installation d'une colonne montante selon la revendication 4 ou 5, **caractérisé en ce que** la longueur de chacune desdites parties se situe entre 10 m et 30 m.
7. Procédé d'installation d'une colonne montante selon la revendication 4, 5 ou 6, **caractérisé en ce que** les deux parties sont reliées entre elles sur un navire de service.
8. Procédé d'installation d'une colonne montante selon l'une quelconque des revendications 4 à 7, **caractérisé en ce qu'on** fait d'abord tourner le caisson de flottabilité afin de ménager de la place pour réaliser la liaison.
9. Procédé d'installation d'une colonne montante selon la revendication 8, **caractérisé en ce que** ladite rotation est effectuée à environ 90 degrés.
10. Procédé d'installation d'une colonne montante selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** ledit module de flottabilité est remorqué sur le site d'installation avec la colonne montante.
11. Procédé d'installation d'une colonne montante selon la revendication 10, **caractérisé en ce que** ledit module de flottabilité est remorqué derrière ladite colonne montante en fixant une ligne de remorquage entre la colonne montante et le module de flottabilité, indépendante de toutes les autres lignes de remorquage.

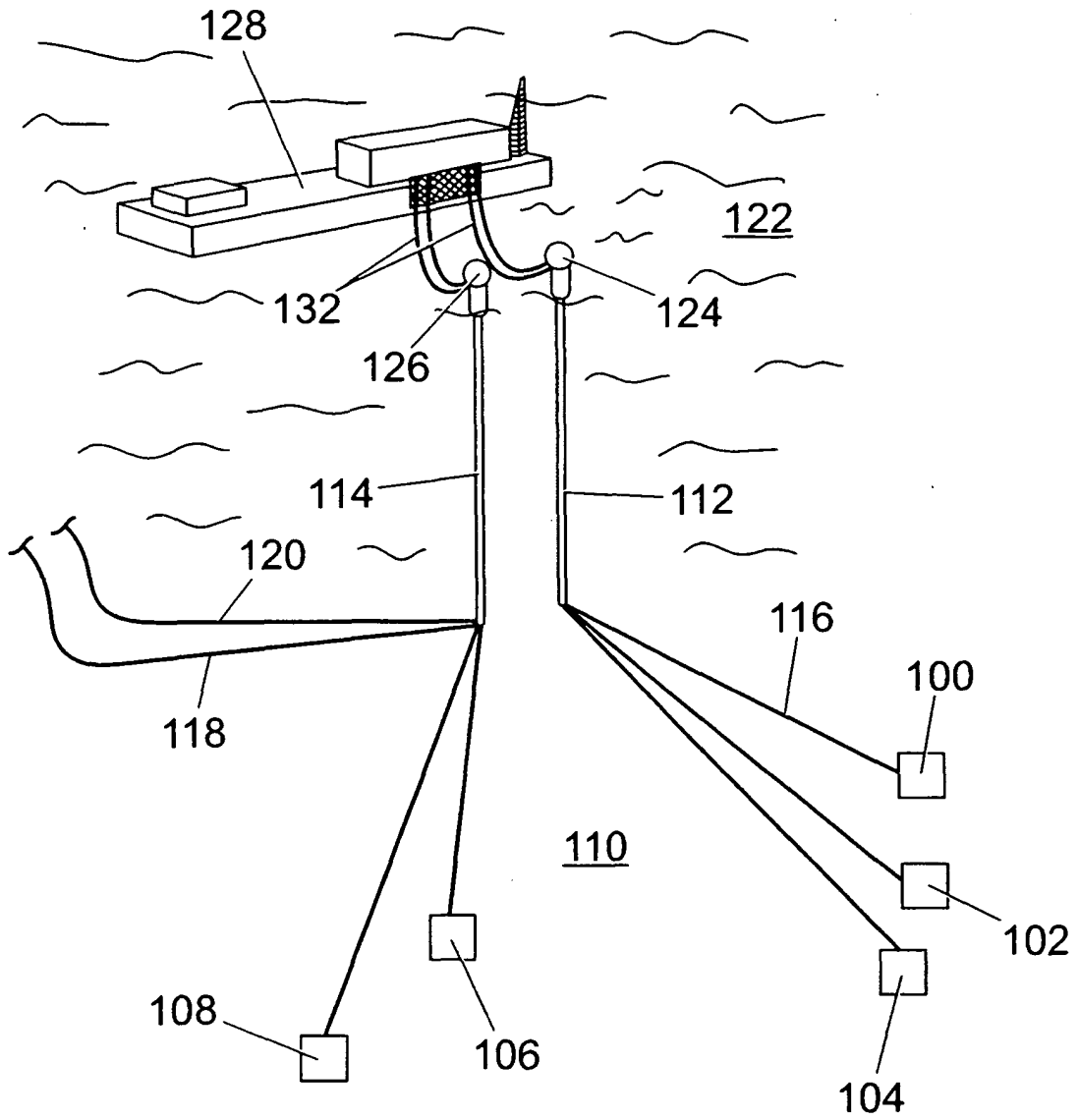


Fig. 1

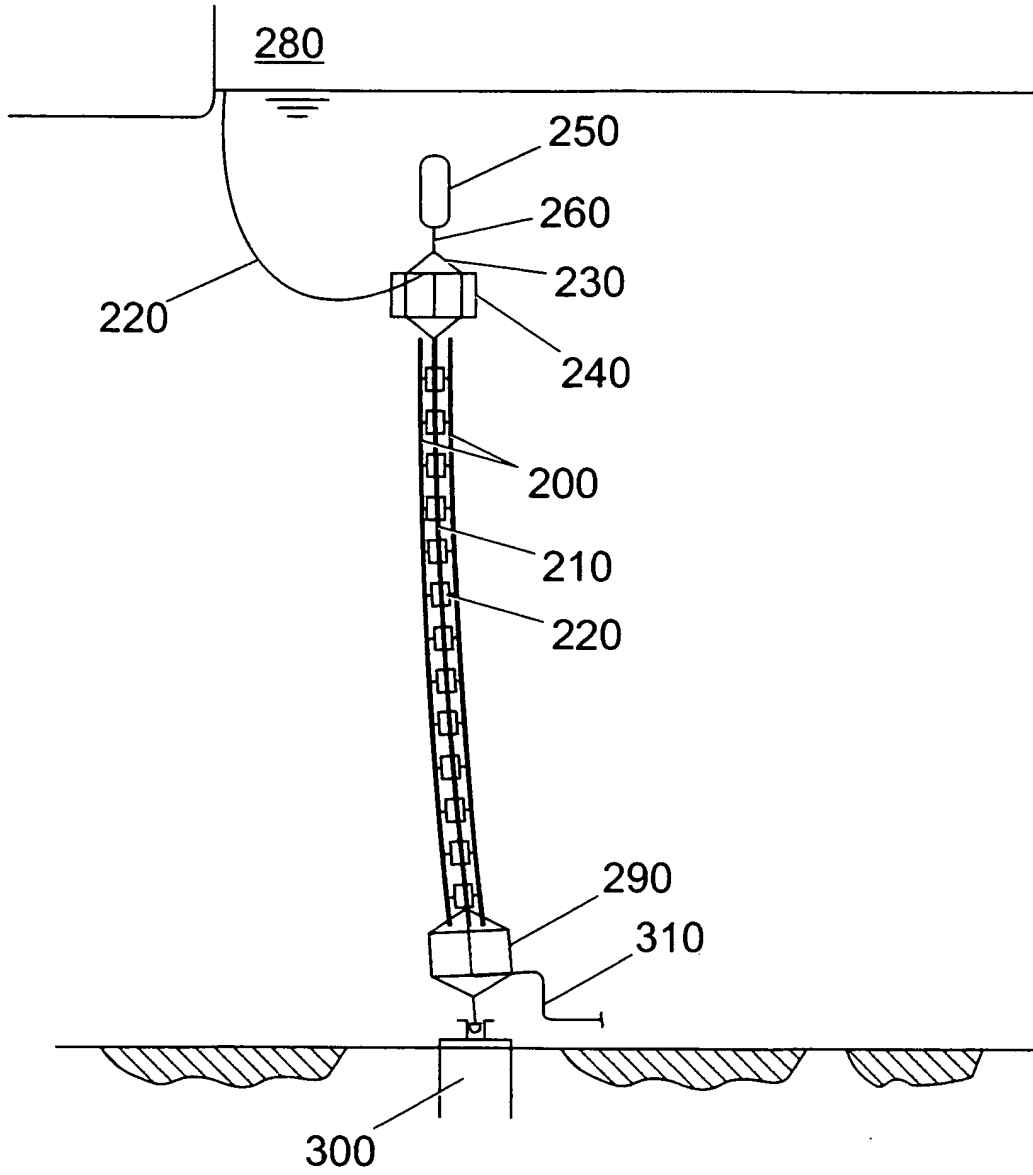


Fig. 2

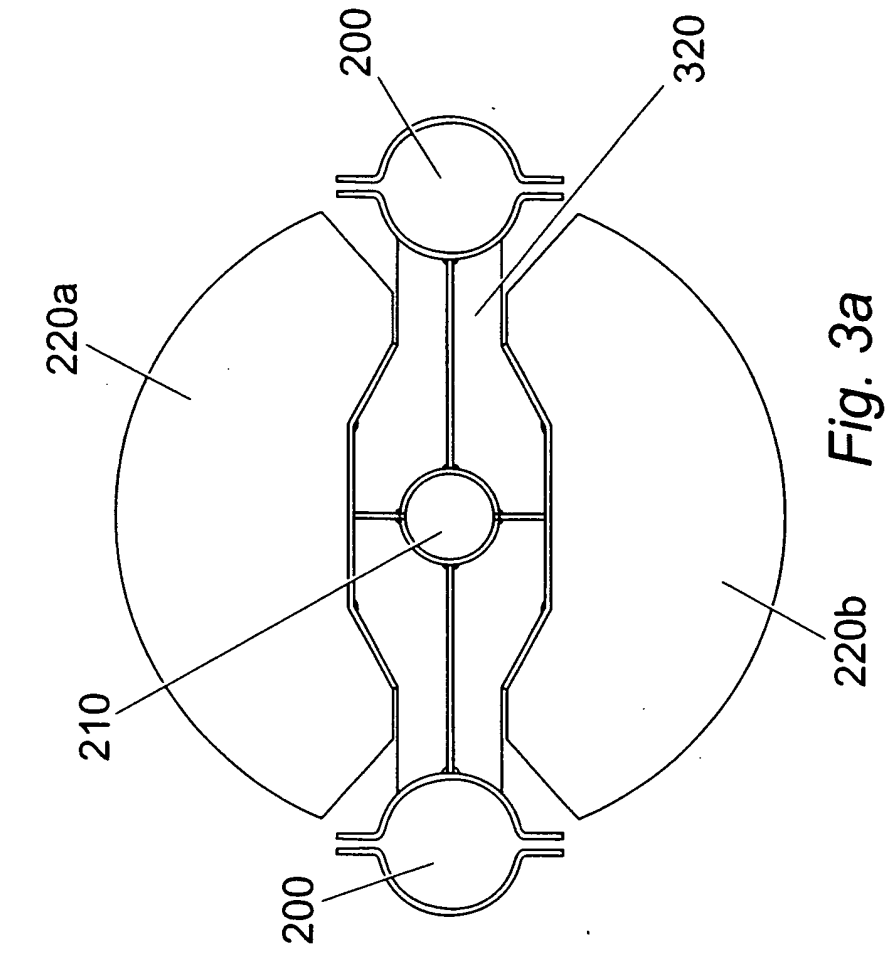


Fig. 3a

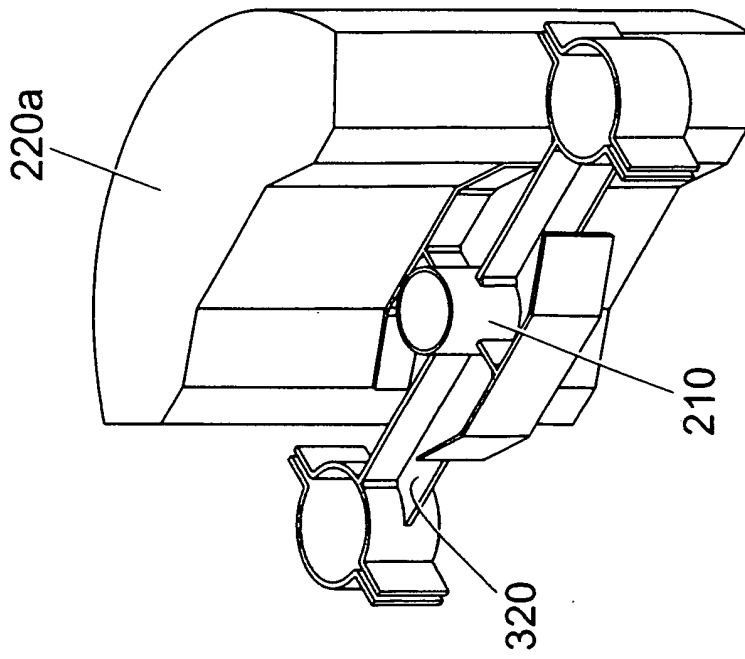


Fig. 3b

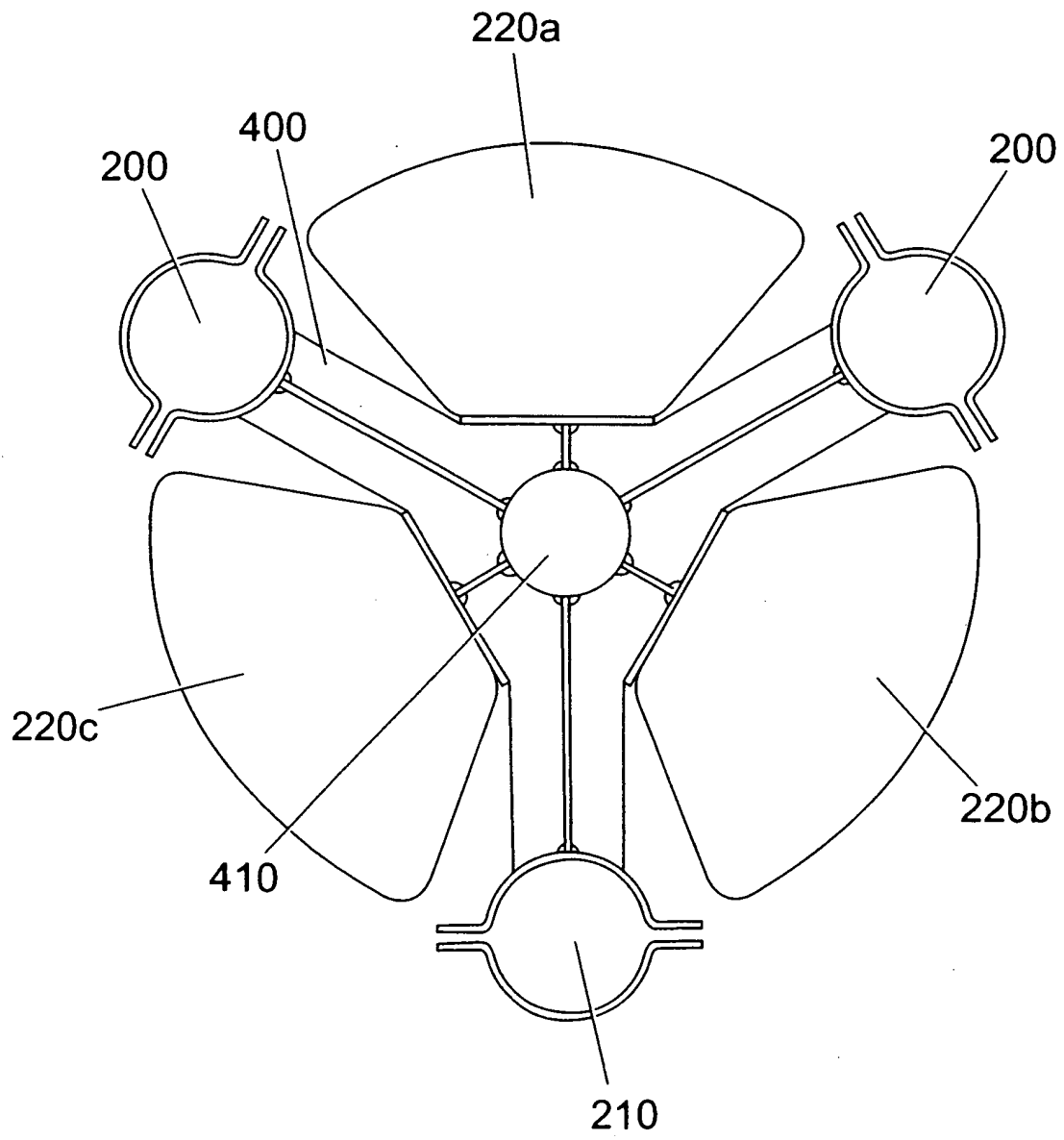


Fig. 4a

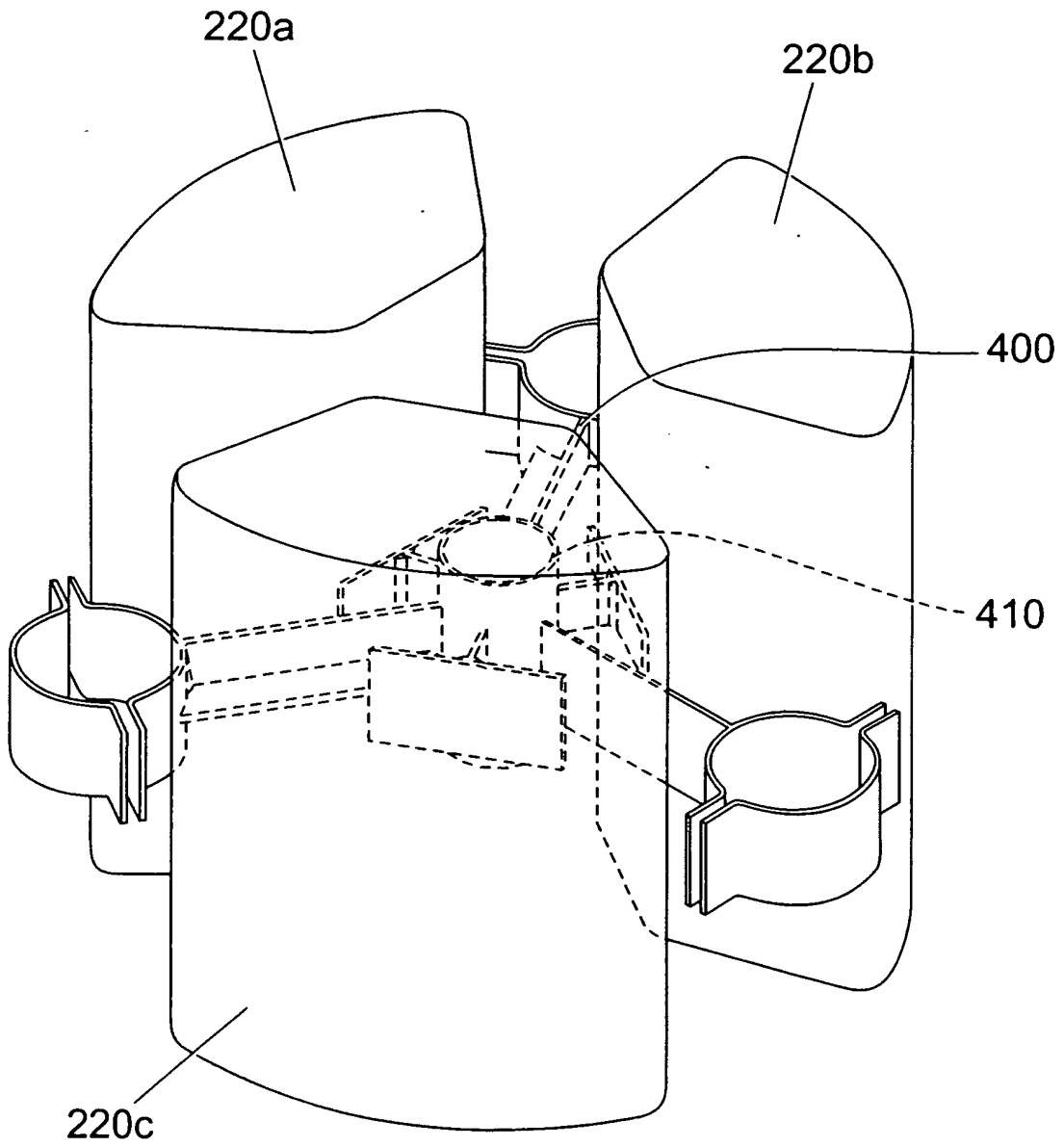


Fig. 4b

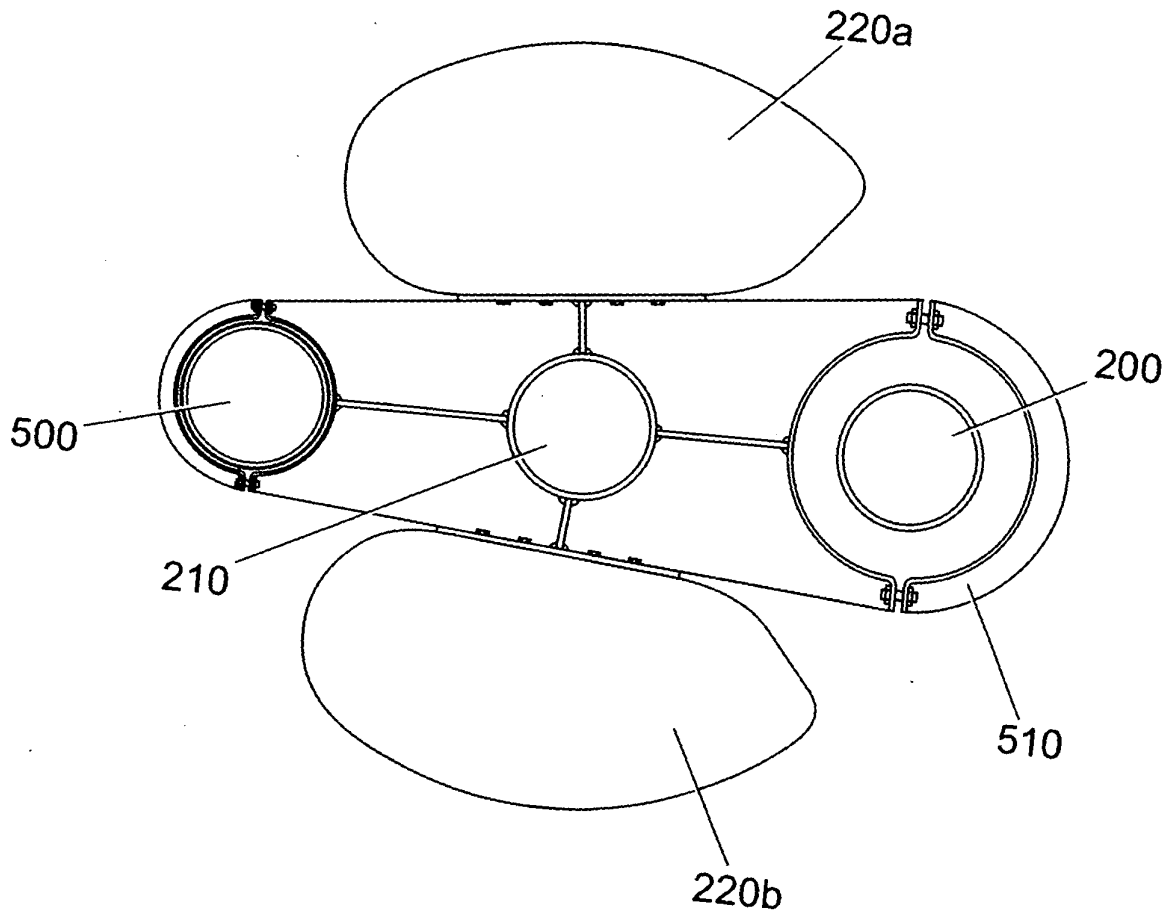


Fig. 5

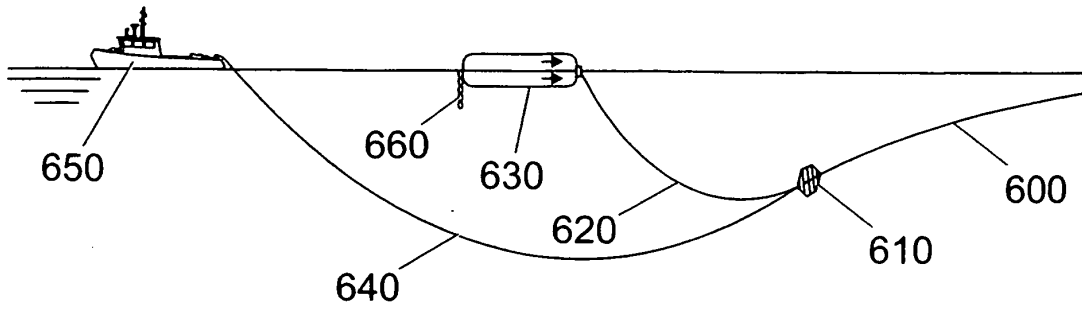


Fig. 6

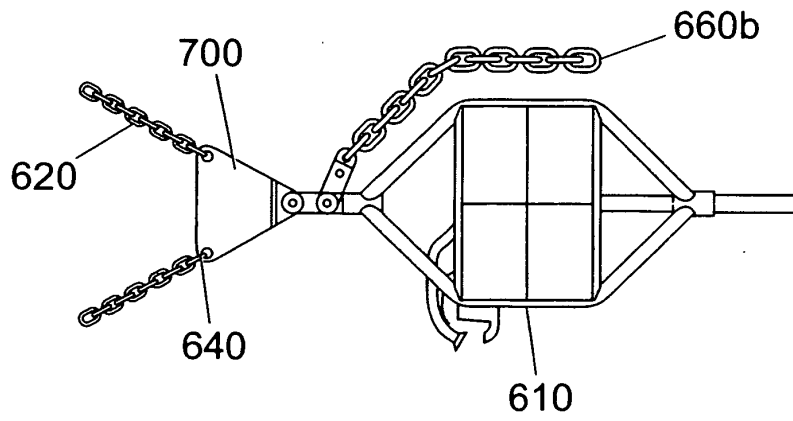


Fig. 7

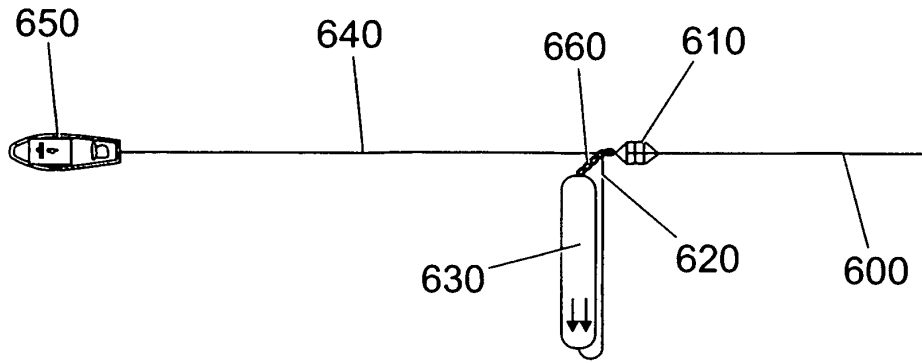


Fig. 8a

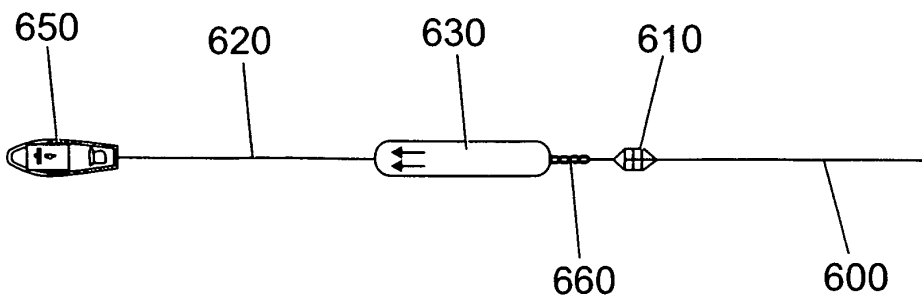
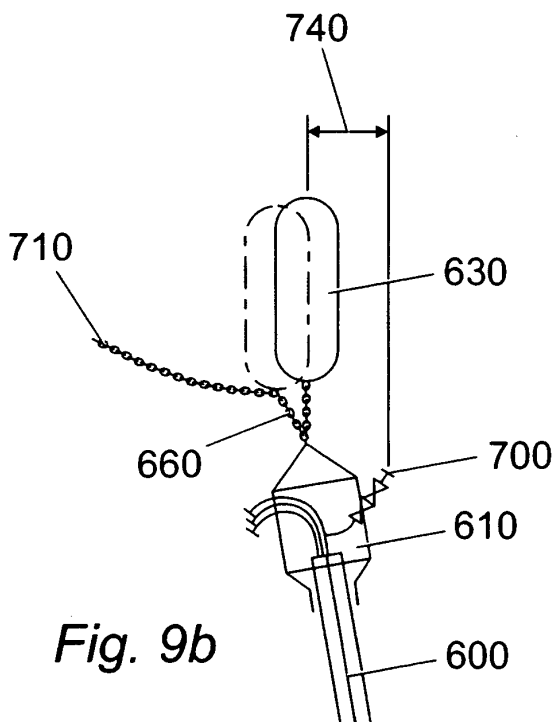
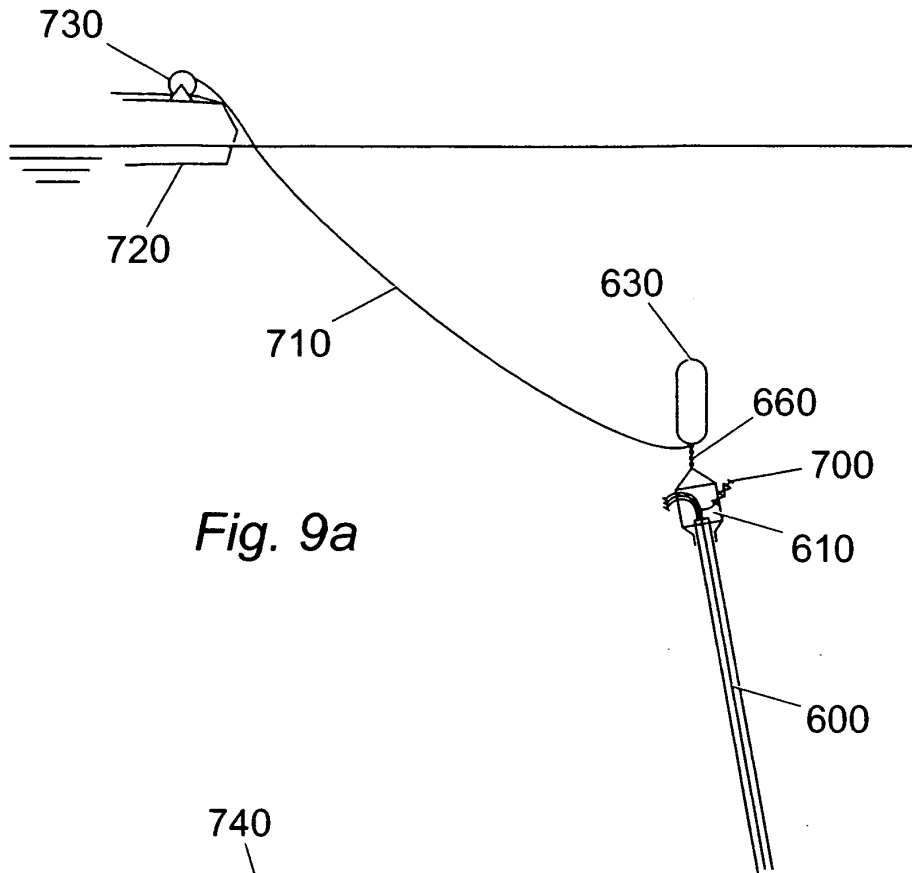


Fig. 8b



REFERENCES CITED IN THE DESCRIPTION

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