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(54) **Blowout preventer and launcher system**

(57) The present invention relates to a blowout preventer for being mounted on a well head, comprising a plurality of valves arranged in fluid communication with

each other, connected and forming a tubular pipe. Furthermore, the invention relates to a subsea launcher system, a subsea well intervention module and a subsea well intervention system.

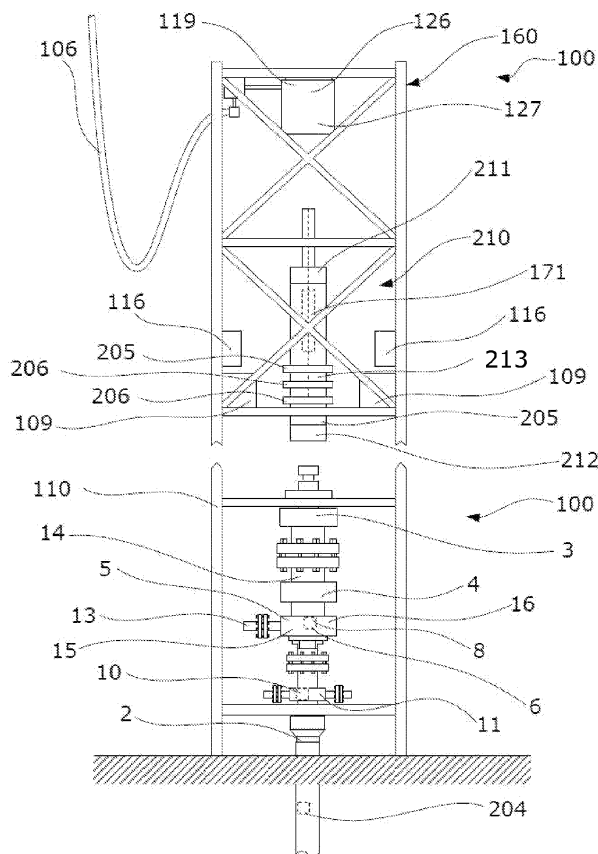


Fig. 2

Description

Field of the Invention

[0001] The present invention relates to a blowout preventer for being mounted on a well head, comprising a plurality of valves arranged in fluid communication with each other, connected and forming a tubular pipe. Furthermore, the invention relates to a subsea launcher system, a subsea well intervention module and a subsea well intervention system.

Background Art

[0002] During production of oil, it may become necessary to perform maintenance work in a well or to open a production well. Such well work is known as well intervention. Inside the well, a production casing is placed which in its upper end is closed by a well head. The well head can be situated on land, on an oil rig or on the seabed below water.

[0003] When a well head is situated on the seabed on deep water, well intervention is more complicated since visibility below water can be poor. Furthermore, the weather conditions at sea can interfere with the accomplishment of an intervention and, in case of a rough sea, interrupt the intervention.

[0004] In regard to such subsea intervention operations, it is a known practice to perform these by lowering an intervention module from a surface vessel onto the well head structure by means of a plurality of remotely operated vehicles (ROVs). Before mounting the operational intervention module comprising the operational tool or the like in a lubricator, a blowout preventer is mounted on the wellhead in order to prevent blowouts.

[0005] A blowout preventer (BOP) is a large device with a series of valves (also referred to as "rams") placed at the top of a well which can be closed for safety reasons during drilling or other operations. The rams are designed to close if pressure from an underground formation causes fluid, such as oil or natural gas, to enter the wellbore and threaten the rig.

[0006] By closing the rams, undesired fluid flow can be prevented, thus making it possible to regain control of the wellbore. Once the well is closed, the situation is evaluated to determine the procedure required to return the well to safe operating status.

[0007] A BOP can be installed above ground or under water. BOPs for deepwater wells are powered and controlled remotely by means of hydraulic actuators. There are three basic types of valves used in deepwater BOPs: One type of valve is a "ram" which serves to seal off a pipe of a specific diameter by making a sharp horizontal motion. Another type seals off pipes of various diameters. A third type of BOP valve seals off the well bore itself.

[0008] The largest oil spill in recent time, the Horizon Deepwater, occurred despite the fact that the BOP used employed valves all the three above-mentioned types.

Summary of the Invention

[0009] It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved blowout preventer providing higher safety during deep sea interventions.

[0010] The above objects, together with numerous other objects, advantages, and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a blowout preventer for being mounted on a well head, comprising:

- a plurality of valves arranged in fluid communication with each other, connected and forming a tubular pipe,

wherein the blowout preventer further comprises a display visible from outside the blowout preventer.

[0011] The blowout preventer may further comprise a storing device for storing measurements, signals or recorded data.

[0012] The invention furthermore relates to a blowout preventer for being mounted on a well head, comprising:

- a frame structure, and
- a plurality of valves arranged in fluid communication with each other, forming a tubular pipe which is fastened to the frame structure,

wherein the blowout preventer further comprises a storing device for storing measurements, signals or recorded data.

[0013] The blowout preventer as described above may further comprise a display.

[0014] This display may be a flat display panel, a Nixie tubes display, a light-emitting diode display, a vacuum fluorescent display, a refreshable Braille display, a cathode ray tube display, a liquid crystal display, an electroluminescent display, a thin-film transistor display, a laser video display, a surface-conduction electron-emitter display, a nanocrystal display, a carbon nanotubes display, a split-flap display, a flip-disc display, a roll sign display or a segmented display, such as a seven-segment display.

[0015] Moreover, the blowout preventer may comprise a transparent cover covering the display or monitor to fluidly seal off the display or monitor.

[0016] The cover may be made of glass or plastic.

[0017] Furthermore, the blowout preventer may comprise a control unit comprising the storage device, and a communication unit for communicating with the display or monitor.

[0018] Additionally, the blowout preventer may comprise a sensor for sensing the temperature and/or well fluid pressure inside the well.

[0019] Moreover, the blowout preventer may further

comprise a docking station enabling an operational tool in the well to connect to the blowout preventer and be charged or recharged, or to upload or download information or signals to and from the communication unit.

[0020] The present invention furthermore relates to a subsea launcher system for launching a downhole tool through a well head subsea, comprising a lubricator closed off at its first end by a blind cap, a downhole tool arranged in the lubricator, a lubricator valve arranged to close off the lubricator at its second end, a shear ram valve connected with the lubricator valve, and a connector for connecting the subsea launcher system to a blowout preventer or a well head.

[0021] The subsea launcher system may further comprise a second lubricator valve arranged between the shear ram valve and the connector.

[0022] Furthermore, the subsea launcher system may comprise a disconnection unit arranged between the lubricator valve and the connector for disconnecting a part of the launcher system.

[0023] Moreover, the subsea launcher system may comprise a docking station arranged at the first end of the lubricator to enable the tool to connect with the docking station and be charged, recharged, and/or communicate data to and/or from the tool.

[0024] This docking station may comprise a Universal Series Bus (USB) to enable communication with the tool.

[0025] In addition, the blowout preventer may comprise a power unit, such as a battery.

[0026] Furthermore, the blowout preventer may comprise a supporting structure. Additionally, the downhole tool may be wireless and driven only by an internal power source.

[0027] The present invention also relates to a subsea well intervention module for performing well intervention operations in a well, comprising a blowout preventer as described above, comprising a supporting structure.

[0028] Furthermore, the invention relates to a subsea well intervention module for performing well intervention operations in a well, comprising a subsea launcher system as described above, comprising a supporting structure.

[0029] The subsea well intervention module may further comprise an attachment means for removably attaching the supporting structure to a structure of a well head or an additional structure, a navigation means, and a well manipulation assembly.

[0030] In an embodiment, the navigation means may comprise a buoyancy system adapted for regulating a buoyancy of the submerged well intervention module.

[0031] Furthermore, the subsea well intervention module may have a top part and a bottom part, the bottom part having a higher weight than the top part.

[0032] In another embodiment, the supporting structure may be a frame structure.

[0033] Furthermore, the frame structure may have an outer form and defines an internal space containing the well manipulation assembly and the navigation means,

the well manipulation assembly and the navigation means both extending within the outer form of the frame structure.

[0034] In addition, the navigation means may have at least one propulsion unit for manoeuvring the module in the water.

[0035] Furthermore, the supporting structure may be a frame structure having a height, a length and a width corresponding to the dimensions of a standard shipping container.

[0036] The subsea well intervention module as described above may further comprise a control system for controlling the well manipulation assembly, the navigation means, the buoyancy system and the intervention operations.

[0037] Furthermore, the supporting structure may be a frame structure having an outer form and defines an internal space containing a control system, the control system extending within the outer form of the frame structure.

[0038] Additionally, the navigation means may comprise at least one guiding arm for gripping around another structure in order to guide the module into place.

[0039] Moreover, the navigation means may comprise a detection means for detecting a position of the intervention module.

[0040] In an embodiment, the buoyancy system may comprise a displacement tank, a control means for controlling the filling of the tank, and an expansion means for expelling sea water from the displacement tank when providing buoyancy to the module to compensate for the weight of the intervention module itself in the water.

[0041] Moreover, the detection means may comprise at least one image recording means.

[0042] Additionally, the well manipulation assembly may comprise a tool delivery system comprising at least one tool for being submerged into the well, and a tool submersion means for submerging the tool into the well through the well head, and it may furthermore comprise at least one well head connection means for being connected to the well head, and a well head valve control means for operating at least a first well head valve for providing access of the tool into the well through the well head connection means.

[0043] Furthermore, the tool delivery system may comprise at least one driving unit for driving the tool forward in the well.

[0044] Additionally, the well manipulation assembly may comprise a cap removal means for removing a protective cap from the well head.

[0045] The subsea well intervention module may further comprise a power system for supplying power to an intervention operation, such as a cable from the surface vessel, a battery, a fuel cell, a diesel current generator, an alternator, a producer or the like power supplying means.

[0046] In an embodiment, the power system may comprise a power storage system for storing energy gener-

ated from an intervention operation, such as submersion of an operational tool into the well.

[0047] In another embodiment, the power system may have enough reserve power for the control system to disconnect the well head connection means from the well head, the cable for providing power from the power system, the wireline from the intervention module, or the attachment means from the well head structure.

[0048] Furthermore, the supporting structure may, at least partly, be made of hollow profiles.

[0049] Moreover, the hollow profiles may enclose a closure comprising a gas.

[0050] The present invention furthermore relates to a subsea well intervention system comprising a subsea intervention module as described above, and a remotely operational vehicle for navigating the intervention module onto the well head or another module subsea.

[0051] In an embodiment, the remotely operational vehicle may comprise a camera and/or a communication device for communicating with a control unit of the blowout preventer.

[0052] Furthermore, the subsea well intervention system may comprise a plurality of sensors arranged in the well for sensing the temperature and/or well fluid pressure inside the well.

[0053] Moreover, the subsea well intervention system may comprise a downhole tool having a sensing device for sensing the temperature and/or well fluid pressure inside the well.

[0054] In addition, the system may further comprise at least one remote control means for remotely controlling some or all functionalities of the intervention module, the remote control means being positioned above water.

[0055] Additionally, the subsea well intervention system may comprise at least one autonomous communication relay device for receiving signals from the intervention module, converting the signals into airborne signals, and transmitting the airborne signals to the remote control means, and vice versa, to receive and convert signals from the remote control means and transmit the converted signals to the intervention module.

[0056] In an embodiment, the intervention module or parts of the intervention module may be made of a metal, such as steel or aluminium, or a light weight material weighing less than steel, such as polymers or a composite material, e.g. glass or carbon fibre reinforced polymers.

[0057] Finally, the present invention relates to the use of the blowout preventer as described above for performing a well intervention.

Brief Description of the Drawings

[0058] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a blowout preventer mounted on a well head,

Fig. 2 shows an intervention module comprising a subsea launcher system ready to be mounted on the blowout preventer,

Fig. 3 shows the intervention module of Fig. 2 mounted on the blowout preventer,

Fig. 4 is a schematic view of an intervention operation,

Fig. 5 is a schematic view of an intervention module according to the invention docked on a well head,

Fig. 6 is a schematic view of an intervention module according to the invention,

Figs. 7 and 8 are schematic views of two embodiments of buoyancy systems according to the invention,

Fig. 9 is a schematic view of one embodiment of an intervention module,

Fig. 10 is a schematic view of another embodiment of an intervention module,

Fig. 11 shows one embodiment of a subsea well intervention system,

Fig. 12 shows another embodiment of the intervention system, and

Fig. 13 shows yet another embodiment of the intervention system.

[0059] All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

Detailed description of the invention

[0060] Fig. 1 shows a blowout preventer 1 mounted to a well head 2 arranged on the seabed on deep water. The blowout preventer 1 comprises a plurality of valves 3, 4 arranged on top of each other, and thus in fluid communication with each other. The first valve is an annular valve 3 and the rest of the valves are rams 4. The valves 3, 4 are connected and form part of a tubular pipe 14. In the end closest to the rams, the tubular pipe is connected with the well head 2, and in the other end, the tubular pipe may be connected with a subsea intervention module 100.

[0061] The blowout preventer 1 is arranged in a supporting structure 110 in the form of a frame structure, and

together with the frame structure it forms a subsea intervention module 100. Furthermore, the blowout preventer 1 comprises a display 5 on its outside to enable a diver or a Remote Operational Vehicle (also called an ROV) to read the display.

[0062] The display 5 is arranged in connection with the tubular pipe 14 next to the valve, also called a ram 4. The display 5 is positioned inside a display housing 15, and the front of the display is covered by a transparent front plate 16 to fluidly seal off the display 5. The display housing 15 has been mounted on the tubular pipe 14 and forms part of the pipe. The display 5 is connected to sensors 10 inside the pipe 14 and displays the measured data of the sensor on the display 5 which is visible from outside the blowout preventer through the transparent front plate. The sensors measure the condition inside the tubular pipe 14 below the valve and thus also the conditions of the well fluid inside the well. The sensors 10 sense the temperature and/or the pressure of the well fluid inside the well.

[0063] The display 5 is a flat display panel, but may also be another kind of display, such as a Nixie tubes display, a light-emitting diode display, a vacuum fluorescent display, a refreshable Braille display, a cathode ray tube display, a liquid crystal display, an electroluminescent display, a thin-film transistor display, a laser video display, a surface-conduction electron-emitter display, a nanocrystal display, a carbon nanotubes display, a split-flap display, a flip-disc display, a roll sign display or a segmented display, such as a seven-segment display.

[0064] In Fig. 2, the blowout preventer 1 comprises a control unit 8 further comprising a storage device 6 and a communication unit 9 for communicating with the display 5. The storing device 6 is used for storing measurements, signals or recorded data and is arranged in the display housing 15 behind the display 5. The storing device 6 stores the data from the sensor measurements and thus functions as a "black box" so that when an ROV connects to the display housing 15, the data can be read by the ROV or be read into a communication box of the ROV. When the ROV emerges to the vessel or the rig, the data can be read into a computer and analysed. In this way, an approaching failure can be predicted as the signs of such a failure can be read from the well fluid conditions before it accelerates and causes damage in the well and a leak of oil mud into the sea.

[0065] Some of the main objectives of subsea intervention are to gather information about the downhole production and the well condition by using data acquisition equipment. Accurate diagnosis of the well may be necessary in order to determine unexpected performance as well as to verify the composition and rates from the different zones open to production. This approach is essential in order to select the best possible reservoir and the best production management techniques. The diagnosis is also used as valuable input for future heavier well intervention operations.

[0066] In Fig. 3, the blowout preventer 1 further com-

prises a power unit 13, such as a battery, for powering the display 5, the sensors 10 and the control unit 8. In another embodiment, the display 5, the sensors 10 and the control unit 8 each comprise a power unit 13. As can be seen in Fig. 3, the power unit 13 is positioned in a way that enables an ROV to recharge it by connecting to it from outside the blowout preventer 1.

[0067] The transparent front plate in the form of a cover is made of glass or plastic or the like transparent material.

[0068] In one embodiment, the control unit 8 comprises an analysing unit used to compare a measurement of a sensor to the previous measurement of that sensor. If the measurement is the same as the previous measurement, the new measurement replaces the old, and thus the storing device does not store any useless measurements.

[0069] The blowout preventer 1 forms part of a subsea intervention module 100 for performing well intervention operations in a well. As can be seen in Figs. 1-3, the subsea intervention module 100 comprising the blowout preventer 1 is connected as the first intervention module to the well head 2. Subsequently, another intervention module comprising a subsea launcher system comprising the downhole tool in a lubricator is connected to the first intervention module comprising the blowout preventer.

[0070] Figs. 2 and 3 show a subsea launcher system 210 for launching a downhole tool 171 through a well head 2 subsea. The subsea launcher system 210 comprises a lubricator (178) which is closed off by a blind cap 211 at its first end. The downhole tool 171 is arranged in the lubricator, and at its other and second end, the lubricator is closable by a lubricator valve 205. The lubricator valve 205 is connected with a shear ram valve 206, and a connector 212 for connecting the subsea launcher system to a blowout preventer 1 or a well head 2 is arranged at the bottom of the subsea launcher system 210. For security reasons, the subsea launcher system 210 also comprises a second lubricator valve below the shear ram valve 206. The first lubricator valve is also called a swap valve, and the second lubricator valve is also called a hydraulic master valve.

[0071] Furthermore, the subsea launcher system 210 comprises a disconnection unit 213 arranged between the first lubricator valve and the first shear ram valve for disconnecting a part of the launcher system in case of an uncontrollable well situation. In this way, the subsea launcher system 210 can also be disconnected and re-used for other well intervention operations. Furthermore, a riser-based system for a light semisubmersible intervention rig can be used for heavy fluid circulation in the well.

[0072] The shear ram valve is part of a control system which can be operated by an ROV or a diver or from a vessel or rig through an umbilical or by means of WIFI, 3G, acoustics or wireless communication. The shear ram valve is designed so that it is able to cut through a tool and close it off completely to make a fluid tight seal.

[0073] As can be seen in Figs. 2 and 3, the subsea launcher system 210 further comprises a docking station 211 arranged at the first end of the lubricator so that the tool can connect with the docking station and be charged, recharged, and/or communicate data to and/or from the tool. The tool then passes the blowout preventer 1 and subsequently enters into the lubricator for docking into the docking station. The docking station 211 comprises a Universal Series Bus (USB) to enable communication with the tool when it is docked in the docking station.

[0074] The downhole tool is wireless and driven only by an internal power source. The tool has a driving unit for driving the tool forward in the casing and an operational unit, such as a logging unit, a diagnostic unit, a stroker or the like operational units.

[0075] The docking station 211 may be electronically connected to a second display or to the display of the blowout preventer so that a diver can send operation instructions to the tool without having to bring the tool out of the well. The tool can upload or download information or signals to and from the communication unit 9 of the control unit 8.

[0076] The invention also relates to a subsea well intervention system 200 comprising the subsea intervention module 100 and the remotely operational vehicle 201 for navigating the intervention module 100 onto the well head 2 or another module subsea.

[0077] As shown in Fig. 1, the remotely operational vehicle comprises a camera 202 and a communication device 203 for communicating with a control unit 8 of the blowout preventer 1.

[0078] The subsea well intervention system 200 further comprises a plurality of sensors 204 arranged in the well for sensing the temperature and/or well fluid pressure inside the well.

[0079] As shown in Fig. 3, the subsea well intervention system 200 comprises a downhole tool 171 having a sensing device 205 for sensing the temperature and/or well fluid pressure inside the well. When the tool has been down in the well, it connects to the docking station, and the data measured by the sensing device is uploaded to the control unit 8 of the blowout preventer 1 so that the data can be transferred through the display 5 to the ROV of the diver. The diver and/or the ROV comprise a communication unit which is able to communicate optically with the display and obtain information about the condition of the well. The display 5 may also comprise a bar code which is readable by the ROV. The bar code can be an identification tag of the individual well, and/or it can show the status of the well. The display 5 can have several bar codes, and the control unit determines from the measurements of the sensors which bar codes to display on the display.

[0080] Fig. 4 shows a subsea well intervention module 100 for performing intervention operations on subsea oil wells 101. The subsea intervention module 100 is launched from a surface vessel 102, e.g. by simply pushing the module 100 out into the sea from a deck in the

back of the vessel 102 or over a side 103 of the vessel 102. Due to the fact that launching of the intervention module can be done just by dumping the module 100 into the water, launching is feasible by a greater variety of vessels, including vessels which are more commonly available. Thus, the intervention module 100 may also be launched into the water 104 by e.g. a crane (not shown).

[0081] After launch, the intervention module 100 navigates to the well 101 by means of a navigation means 105 to perform the intervention as shown in Fig. 4 or by means of a Remote Operational Vehicle (also called an ROV).

[0082] In another embodiment, the navigation means 105 comprises a communication means allowing an operator, e.g. located on the surface vessel 102, to remotely control the intervention module 100 via a control system 126. The remote control signals for the navigation means 105 and the power to the intervention module 100 are provided through a cable 106, such as an umbilical or a tether, which is spooled out from a cable winch 107.

[0083] A well head 120 located on the sea floor, as shown in Figs. 5 10, is the upper termination of the well 101 and comprises two well head valves 121 and terminals for connection of a production pipe line (not shown) and for various permanent and temporary connections. The valves 121 may typically be operated mechanically, hydraulically or both. At its top, the well head 120 has a protective cap 123 which must be removed before proceeding with the other intervention tasks. Typically, subsea well heads 120 are surrounded by carrying structures 112 to provide load relief for the well head 120 itself when external units are connected. The carrying structure 112 may be equipped with two, three or four attachment posts 113. The attachment means 111 of the intervention module 100 must be adapted to the specific type of carrying structure 112 on the well head 120 which the intervention module is to be docked onto. The attachment means 111 may simply support the intervention module on the carrying structure 112 by gravity, or it may comprise one or more locking devices to keep the module 100 in place on the well head 120 after docking has taken place.

[0084] Docking of the intervention module 100 is performed by remote control. The intervention module 100 is navigated to the well head 120, rotated to be aligned with the well head structure, and steered to dock on the structure. This may be done by an ROV or a navigation means 105 having propulsion means and being provided in the subsea intervention module 100.

[0085] In order to gain good vertical manoeuvrability, the navigation means 105 is provided with a buoyancy system 117 adapted for regulating a buoyancy of the submerged well intervention module 100. By controlling the buoyancy of the intervention module 100 while submerged, the module may be made to sink (negative buoyancy), maintain a given depth (neutral buoyancy) or rise (positive buoyancy) in the water 104. By using this principle to provide better vertical manoeuvrability, even

heavy objects may be controlled efficiently as exemplified by submarines utilising such arrangements. In one embodiment, minor vertical position adjustments may be performed with a vertical propulsion unit 116 suitably oriented.

[0086] Providing the well intervention module 100 with substantially increased buoyancy has the additional effect that it lowers the resulting force exerted on the well head by the weight of the module 100. Preferably, the intervention module 100 should be maintained at near neutral buoyancy, i.e. be "weightless". This lowers the risk of rupture of the well head 120, which would otherwise result in a massive environmental disaster.

[0087] To aid this docking procedure, the navigation means 105 comprises a detection means 109 for detection of the position of the intervention module 100 in the water 104.

[0088] Having an intervention module 100 which is able to manoeuvre independently in the water 104 reduces the requirements for the surface vessel 102 since the vessel 102 merely needs to launch the intervention module in the water 104, after which the module 100 is able to descend into the water under its own command, thus alleviating the need for expensive specially equipped surface vessels, e.g. with large heave-compensated crane systems (not shown).

[0089] Furthermore, the lower part of the subsea intervention module 100 weighs more than the upper part of the subsea intervention module. This is done to ensure that the module does not turn upside down when submerging so that the bottom and not the top of the module 100 is facing the well head structure or another module onto which it is to be mounted.

[0090] The intervention module 100 may be remotely controlled by a combined power/control cable 106, by separate cables or even wirelessly. Since the intervention module 100 comprises navigation means 105 enabling the module to move freely in the water, no guide wires or other external guiding mechanisms are needed to dock the module onto the well head 120. In some events, the wireline connection 108, 118 between the surface vessel 102 and the module 100 needs to be disconnected, and in these events, the module of the present invention is still able to proceed with the operation. Furthermore, there is no need for launching additional vehicles, such as ROVs, to control the intervention module. This leads to a simpler operation where the surface vessel 102 has a larger degree of flexibility, e.g. to move away from approaching objects, etc.

[0091] The navigation means may have a propulsion unit 115, 116, a detection means 109 and/or a buoyancy system 117. If the navigation means 105 of the module 100 has both a propulsion unit 115, 116 and a detection means 109, the propulsion unit is able to move the module into place onto another module or a well head structure on the seabed. If the module 100 only has a buoyancy system 117, a remotely operational vehicle is still needed to move the module into position, however the

buoyancy system makes the navigation much easier.

[0092] Furthermore, when the bottom part of the module 100 weighs more than the top part, it is ensured that the module always has the right orientation.

[0093] The subsea well intervention module 100, 150, 160 according to the invention is formed by a supporting structure 110 onto which the various subsystems of the intervention module may be mounted. The supporting structure 110 comprises attachment means 111 for removably attaching the supporting structure 110 to a structure 112 of a well head 120 or an additional structure of the well head. Thus, the attachment means 111 allows the intervention module 100 to be docked on top of the well head 120. In another embodiment, the attachment means 111 of a second intervention module 160 can be docked on top of the first intervention module 150 already docked on the well head 120. The first module is used for removing the cap of the well head 120, and the second module is used in the intervention operation for launching a tool into the well 101.

[0094] When one intervention module operates in the well 101, another intervention module is mounted with another tool for performing a second operation in the well, also called a second run. When the module for the second run is ready to use, the module is dumped into the water 104 and waits in the vicinity of the well head 120 ready to be mounted when the "first run" is finished. In this way, mounting of the tool for the next run can be performed while the previous run is performed.

[0095] As a result, each module can be mounted with one specific tool decreasing the weight of the module on the well head 120 since a module does not have a big tool delivery system 170 with a lot of tools and means for handling the tools. Furthermore, there is no risk of a tool getting stuck in the tool delivery system 170. In addition, they may be more particularly designed for a certain purpose since other helping means can be built in relation to the tool, which is not possible in a tool delivery system 170.

[0096] As shown in Fig. 5, the intervention module 100 comprises a well manipulation assembly 125 enabling the intervention module to perform various well intervention operations needed to complete an intervention job. Furthermore, the intervention module 100 has a navigation means 105 with a propulsion unit 115, 116 for manoeuvring the module sideways in the water 104. However, the propulsion unit 115, 116 may also be designed to move the module 100 up and down. Additionally, the intervention module 100 has a control system 126 for controlling the well manipulation assembly 125, the navigation means 105 and the intervention operations, such as a tool 171 operating in the well 101.

[0097] The supporting structure 110 is made to allow water to pass through the structure, thus minimising the cross-sectional area on which any water flow may act. Thus, the module 100 can navigate faster through the water by reducing the drag of the module. Furthermore, an open structure enables easy access to the compo-

nents of the intervention module 100.

[0098] In another embodiment, the supporting structure 110 is constructed, at least partly, as a tube frame structure since such a construction minimises the weight. Thus, the supporting structure 110 may be designed from hollow profiles, such as tubes, to make the structure more lightweight. Such a lightweight intervention module results in reduced weight on the well head 120 when the module is docked onto the same, reducing the risk of damage to the well head. Furthermore, a lightweight intervention module enables easier handling of the module 100, e.g. while aboard the surface vessel 102.

[0099] The supporting structure 110 could be made from metal, such as steel or aluminium, or a light weight material weighing less than steel, such as a composite material, e.g. glass or carbon fibre reinforced polymers. Some parts of the supporting structure 110 could also be made from polymeric materials.

[0100] Other parts of the intervention module 100 could also be made from metals, such as steel or aluminium, or a light weight material weighing less than steel, such as polymers or a composite material, e.g. glass or carbon fibre reinforced polymers. Such other parts of the intervention module 100 could be at least part of the attachment means 111, the well manipulation assembly 125, the navigation means 105, the propulsion unit 115, 116, the control system 126, the detection means 109, the winch 127 un-coiling an intervention medium, e.g. a local wireline, the tool exchanging assembly, the tool delivery system 170, the power storage system 119 or the like means of the intervention module 100.

[0101] The supporting structure 110 may also be made of hollow profiles enclosing gas, providing further buoyancy to the module 100 when submerged into the sea.

[0102] Fig. 6 shows how the supporting structure 110 of an embodiment of the intervention module fully contains the navigation means 105, the control system 126 and the well manipulation assembly 125 within the outer form of the frame. Thus, the supporting structure 110 protects the navigation means 105, the control system 126 and the well manipulation assembly 125 from impact with e.g. the sea floor or objects on the surface vessel 102. Therefore, the intervention module 100 is able to withstand being bumped against the sea floor when it descends, and to lay directly on the sea floor, e.g. when waiting to be docked on the well head 120.

[0103] In order to perform a well intervention, a cap of the well head 120 has to be removed, and subsequently, a tool is launched into the well 101 as shown in Fig. 9. Therefore, the first intervention module 150 to dock onto the well head 120 is a module where the well manipulation assembly 125 comprises means for removing a protective cap 123. In a next intervention step, a second intervention 160 module comprising means for deploying a tool 171 into the well 101 is docked onto the first intervention module 150. The first 150 and the second 160 module may, in another embodiment, be comprised in one module as shown in Figs. 5 and 10.

[0104] The detection means 109 uses ultrasound, acoustic means, electromagnetic means, optics or a combination thereof for detecting the position of the module 100 and for navigating the module onto the well head 120 or another module. When using a combination of navigation techniques, the detection means 109 can detect the depth, the position and the orientation of the module 100. Ultrasound may be used to gauge the water depth beneath the intervention module 100 and to determine the vertical position, and at the same time, a gyroscope may be used to determine the orientation of the intervention module. One or more accelerometers may be used to determine movement in a horizontal plane with respect to a known initial position. Such a system may provide full position information about the intervention module 100.

[0105] In another embodiment, the detection means 109 comprises at least one image recording means, such as a video camera. Furthermore, the image recording means comprises means for relaying the image signals to the surface vessel 102 via the control system 126. The video camera is preferably oriented to show the attachment means 111 of the intervention module 100 as well as the well head 120 during the docking procedure. This enables an operator to guide the intervention module 100 by vision, e.g. while the module is being docked on the well head 120. As shown in Fig. 5, the image recording means may be mounted on the supporting structure 110 of the intervention module 100 in a fixed position, or be mounted on a directional mount which may be remotely controlled by an operator. Evident to the person skilled in the art, the vision system may comprise any number of suitable light sources to illuminate objects within the optical path of the vision system.

[0106] In another embodiment, the image recording means further comprises means for analysing the recorded image signal, e.g. to enable an autonomous navigational system to manoeuvre the intervention module 100 by vision.

[0107] To achieve better manoeuvrability of the intervention module 100 while submerged, it must be able to maintain its vertical position within the water 104, simultaneously be able to move in the horizontal plane, and be able to rotate around a vertical axis 114, allowing the attachment means 111 to be aligned with the attachment posts 113 of the carrying structure 112 of the well head 120 for docking.

[0108] Horizontal manoeuvrability as well as rotation may be provided by one or more propulsion units 115, 116, such as thrusters, water jets or any other suitable means of underwater propulsion. In one embodiment, the propulsion units 115, 116 are mounted onto the intervention module 100 in a fixed position, i.e. each propulsion unit 115, 116 has a fixed thrust direction in relation to the intervention module 100. In this embodiment, at least three propulsion units 115, 116 are used to provide movability of the module 100. In another embodiment, the thrust direction from one or more of the propulsion

units 115, 116 may be controlled, either by rotating the propulsion unit itself or by directing the water flow, e.g. by use of a rudder arrangement or the like. Such a setup makes it possible to achieve full ma-noeuvrability with a fewer number of propulsion units 115, 116 than necessary if the units are fixed to the intervention module 100.

[0109] The intervention module 100 may be remotely operated, be operated by an autonomous system or a combination of the two. For example, in one embodiment, docking of the module is performed by a remote operator, but an autonomous system maintains e.g. neutral buoyancy while the module 100 is attached to the well head 120. The buoyancy system 117 may furthermore provide means for adjusting the buoyancy to account for changes in density of the surrounding sea water, arising from e.g. changes in temperature or salinity.

[0110] Figs. 7 and 8 show two different embodiments of buoyancy systems 117. Generally, the buoyancy system 117 must be able to displace a mass of water corresponding to the total weight of the intervention module 100 itself. For example, if the module weighs 30 tonnes, the mass of the water displaced must be 30 tonnes, roughly corresponding to a volume of 30 cubic metres, to establish neutral buoyancy. However, not the full volume will need to be filled with water for the module 100 to descend since this would make the module sink very quickly. Therefore, a part of the buoyancy system 117 may be arranged to permanently provide buoyancy to the module while another part of the buoyancy system 117 may displace a volume to adjust the buoyancy from negative to positive. The permanent buoyancy of the buoyancy system 117 can be provided by a sealed off compartment of a displacement tank 130 filled with gas or a suitable low-density material, such as syntactic foam. The minimum buoyancy will depend on the drag of the module 100 as it descends. Similarly, the maximum buoyancy obtainable should be selected to enable the module 100 to ascent with a reasonably high speed to allow expedient operations, but not faster than safe navigation of the module 100 mandates.

[0111] Fig. 7 shows a buoyancy system 117 comprising a displacement tank 130 which may be filled with seawater or with a gas, such as air. To increase the buoyancy of the module 100, gas is introduced into the tank 130, displacing seawater. To lower the buoyancy, gas is let out of the tank 130 by a control means 131, thus letting seawater in. The control means 131 for controlling the filling of the tank with sea-water may simply be one or more remotely operated valves letting gas in the tank 130 escape. The tank may have an open bottom, or it may completely encapsulate the contents. In case of an open tank, water will automatically fill up the tank 130 when the gas escapes, and in case of a closed tank, an inlet valve is needed to allow water to enter the tank 130.

[0112] Fig. 8 shows a buoyancy system 117 comprising a number of inflatable means 140 which may be inflated by expansion means 132. Any number of inflatable means 140 may be envisioned, e.g. one, two, three, four,

five or more. The inflatable means 140 may be formed as balloons, airtight bags or the like, and may be inflated to increase buoyancy, e.g. when the intervention module 100 is to ascend to the sea surface after the intervention procedure. The expansion means 132 may comprise compressed gas, such as air, helium, nitrogen, argon, etc. Alternatively, the gas needed for inflation of the inflatable means 140 is generated by a chemical reaction, similar to the systems used for inflation of airbags in cars. The inflatable means 140 must be fabricated from materials sufficiently strong to withstand the water pressure found at the desired operational depth. Such materials could be a polymer material reinforced with aramid or carbon fibres, metal or any other suitable reinforcement material. A buoyancy system 117 as shown in Fig. 8 may optionally comprise means for partly or fully releasing gas from an inflatable means 440 or even for releasing the whole inflatable means 140 itself.

[0113] In one embodiment, the intervention module 100, 150, 160 has a longitudinal axis parallel to a longitudinal extension of the well 101, and the module is weight sym-metric around its longitudinal axis. Such symmetric weight distribution ensures that the intervention module 100 does not wrench the well head 120 and the related well head structure when docked onto the well head.

[0114] In another embodiment, the buoyancy system 117 is adapted to ensure that the centre of buoyancy onto which the buoyant force acts is located on the same longitudinal axis as the centre of mass of the intervention module 100, and that the centre of buoyancy is located above the centre of mass. This embodiment ensures a di-rectional stability of the intervention module 100.

[0115] As shown in Fig. 5, the intervention module 100, 150, 160 comprises a power system 119 which is positioned on the module. The power system 119 can be in the form of a cable 106 connected to the surface vessel 102 or in the form of a battery, a fuel cell, a diesel current generator, an alternator, a producer or the like local power supplying means. In one embodiment, the power system 119 powers the well manipulation assembly 125 and/or other means of the module using hydraulic, pressurised gas, electricity or the like energy. By providing a local power supplying means or a reserve power to the intervention module 100, the intervention module is able to release itself from the well head 120 or another module and, if needed, bring up a tool in the well 101. This, at least, enables the intervention module 100 to self-surface, should such damage or other emergencies occur. In another embodiment, the local power supplying means allows the intervention module 100 to independently perform parts of the intervention procedure without an external power supply.

[0116] In some embodiments, the power system 119 comprises a power storage system 133 for storage of energy generated from intervention operations, such as submersion of an operational tool 171 into the well 101. In one such embodiment, the power storage system 133

comprises a mechanical storage of the energy released as the tool 171 is lowered within the well 101, which stored energy can be used for a later hoisting of the tool. The power storage system 133 may comprise a mechanical storage means being any kind of a tension system, pneumatic storage means, hydraulic storage means or any other suitable mechanical storage means. By providing the intervention module 100 with a power storage system 133, the required capacity of e.g. electrical power needed for operations is lowered due to the reuse of stored energy. Of course, the intervention module 100 may comprise any combination of two or more power supplying means.

[0117] Furthermore, the power system 119 of the intervention module 100 may be powered by at least one cable 106 for supplying power from above surface to the intervention module. The cable 106 is detachably connected to the intervention module 100 in a connection 108 enabling easy separation of the cable from the intervention module in the event that the surface vessel 102 needs to move. This is shown in Fig. 9 where the cable 106 has just been detached. The cable 106 may be adapted to supply the intervention module 100 with electrical power from the surface vessel 102 and may e.g. be provided as an umbilical or a tether.

[0118] Communication with the surface vessel 102 enables the intervention module 100 to be remotely operated and to transmit various measurement and status data back to the vessel. The intervention module 100 may communicate by wire or wirelessly with the surface vessel 102 or with other units, submerged or on the surface. The communication wire may be a dedicated communication line provided as a separate cable or as a separate line within a power cable, or a power delivery wire connection, such as a power cable. In another embodiment, as shown in Figs. 11 and 12, the intervention module 100 comprises wireless communicational means, such as radio frequency communication, acoustic data transmission, an optical link or any other suitable means of wireless underwater communication. Communication may take place directly with the intended recipient or by proxy, i.e. intermediate sender and receiver units, such as relay devices 190. The communication means may enable bi or unidirectional communication communicating such data from the intervention module 100 as a video feed during the docking procedure, position, current depth reading, status of subsystems or other measurement data, e.g. from within the well 101. Communication to the intervention module 100 could e.g. be requests for return data, manoeuvring operations, control data for the well manipulation assembly, i.e. controlling the actual intervention process itself, etc.

[0119] In one embodiment, the control system 126 comprises both wired and wireless communicational means, e.g. so that a high-bandwidth demanding video feed may be transmitted by wire until the intervention module 100 is docked on the well head 120. When the module has been docked, less bandwidth-demanding

communications, such as communication needed during the intervention itself, may be performed wirelessly by means of relay devices 190.

[0120] If the communication wire, e.g. combined with a power cable, is released from the intervention module 100, no physical connection is required between any surface or submerged vessel and the intervention module due to the fact that the intervention module may still be controlled by the wireless connection 180, 191. Thus, in one embodiment, the control system 126 comprises disconnection means 108, for disconnection of the cable for providing power to the system, a wireline for connection of the intervention module 100 to a vessel 102, or the attachment means 111. Subsequent to the disconnection, the intervention module 100 continues to function from its own power supply. When the cable has been released from the intervention module 100 and recovered on the surface vessel 102, the vessel is free to navigate out of position, e.g. to avoid danger from floating obstacles, such as icebergs, ships, etc.

[0121] As mentioned, in order to perform the actual intervention tasks, the module 100 comprises a well manipulation assembly 125 which may be a cap removal means 134 or a tool delivery system 170. The tool delivery system 170 comprises at least one tool 171 for submersion into the well 101 and a tool submersion means 172 for submerging the tool into the well 101 through the well head 120. Having a tool submersion means 172 of the tool delivery system 170 mounted on the module 100 makes handling of the tool independent of the surface vessel 102. This ensures that the well head 120 is not subject to any undue strain or torque from e.g. a long wire line or guide wires extending from the well head 120 to the surface vessel 102. Such strain or torque is highly unwanted since it may ultimately lead to rupture of the well head 120, which could potentially lead to a massive environmental disaster.

[0122] To connect the well manipulation assembly 125 to the well head 120, the assembly further comprises at least one well head connection means 173 and a well head valve control means 174 for operating at least a first well head valve 121 for providing access of the tool into the well 101 through the well head connection means 173. Well heads typically have either mechanically or hydraulically operated valves. Thus, the well head valve control means 174, controlled by the intervention module control system 126, comprises means for operating the valve controls, such as a mechanical arm or a hydraulic connection, and a system for delivering the required mechanical or hydraulic force to the valve controls.

[0123] The tool submersion means 172 may be a winch 127 un-coiling an intervention medium, such as a local wireline, a braided line or a lightweight composite cable, connected to the tool for submerging the tool into the well 101 and coiling the intervention medium when pulling the tool up from the well.

[0124] Well interventions commonly require tools to be submerged into the well 101 by wireline, coiled tubing,

etc. In the event that part of the well 101 is not substantially vertical, a downhole tractor can be used as a driving unit to drive the tool all the way into position in the well. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

[0125] The supporting structure 110 is a frame structure having a height, a length and a width corresponding to the dimensions of a standard shipping container. A shipping container may have different dimensions, such as 8-foot (2.438 m) cube (2.44 m x 2.44 m x 2.44 m) units used by the United States' military, or later standardised containers having a longer length, e.g. 10-foot (3.05 m), 20-foot (6.10 m), 40-foot (12.19 m), 48 foot (14.63 m) and 53 foot (16.15 m) lengths. European and Australian containers may be slightly wider, such as 2 inches (50.8 mm).

[0126] The connection means 173 typically comprises a lubricator 178 for connecting to the well head 120 and for taking up the tool when it is not deployed. Furthermore, the connection means 173 typically comprises a grease injection head for establishing a tight seal around the tool submersion means 172 while still allowing the tool submersion means to pass through the sealing for moving the tool in and out of the well 101. In one embodiment, the control system 126 comprises disconnection means 108 for disconnection of the well head connection means 173 enabling the lubricator 178 to be disconnected from the well head 120. In case of an emergency, the tool comprises a release device for releasing the cable from the tool in the event that the tool gets stuck downhole.

[0127] In a further embodiment, the power system 119 has an amount of reserve power large enough for the control system 126 to disconnect the well head connection means 173 from the well head 120, the cable for providing power from the power system 119, the wireline from the module, and/or the attachment means 111 from the well head structure. In this way, the intervention module 100 can resurface even if a cable needs to be disconnected, e.g. due to an oncoming risk to the surface vessel 102. In one embodiment, the required reserve power may be provided by equipping the intervention module 100 with a suitable number of batteries enabling the required operations.

[0128] The well intervention module 100, 150 may also comprise two or more tools which are stored in a tool exchanging assembly while the tools are not deployed. The tool exchanging assembly, controlled by the control system 126, enables tool exchange between two or more tools, allowing multiple intervention operations requiring different tools to be performed by the same module without the need for the module to resurface, or other outside influence.

[0129] A typical intervention operation requires at least one additional configuration of the well manipulation assembly 125, besides the configuration with a tool. As mentioned, the additional configuration can be a cap re-

moval assembly 151 comprising a cap removal means 134, as shown in Fig. 9. Such cap removal means 134 may be adapted to pull or unscrew the protective cap 123 of the well 101, depending on the design of the well head 120 and/or the protective cap 123. Furthermore, the cap removal means 134 may be adapted to vibrate the cap 123 to loosen debris and sediments which may have been deposited on the cap.

[0130] As mentioned, the cap removal assembly 151 may be mounted on a special inter-vention module dedicated to being a cap removal module 150. This cap removal module 150 may be adapted to allow subsequent intervention modules 100, 160 to be docked in extension to itself when attached to the well head 120. The module shown in Fig. 9 comprises a receiving means 155 towards the top of the supporting structure 110 where the receiving means 155 is adapted to receive the attachment means 111 of a subsequent intervention module 100, 160. In the embodiment shown in Fig. 9, the cable has now been detached from the module 100 so as to be recovered by the surface vessel 102. The control system of the cap removal module 150 is now communicatively connected to the surface vessel 102 by a wireless link.

[0131] As shown in Fig. 12, some embodiments of the subsea well intervention system 100 comprise at least one autonomous communication relay device 190 for wirelessly receiving waterborne signals 180 from the intervention module 100, 150, 160, converting the signals from the module 100 into airborne signals 191 and transmitting the airborne signals to the remote control means 192, and vice versa to receive and convert signals from the remote control means and transmit the converted signals to the intervention module 100.

[0132] In an embodiment, the autonomous communication relay device 190 is designed as a buoy and has a resilient communication cable 194, 199 hanging underneath. The communication relay device 190 may be a small vessel, a dinghy, a buoy or any other suitable floating structure. Preferably, the relay device 190 comprises navigation means 105 enabling it to be remotely controlled from the surface vessel 102, e.g. to maintain a specific position. Also, in some embodiments, the relay device 190 comprises means for detecting its current position, such as a receiver 193 for the Global Positioning System (GPS).

[0133] In Fig. 11, the resilient communication cable 194, 199 hangs underneath the vessel 102 where the end of the cable has means for communicating with a first 100, 150 and a second 100, 160 module.

[0134] Airborne communication to and from the intervention module 100 is relayed between underwater communicational means and above-surface communicational means, such as antennas 192, as seen in Fig. 12. Underwater communication means may be a wire which is connected to the intervention module 100 (see Fig. 13), or it may be a means for wireless underwater communication, e.g. by use of radio frequency signals or optical or acoustic signals. If wireless communication is

used, the communicational relay device 190 may be adapted for lowering the underwater communicational means far down into the water, e.g. to reach depths of 10-100%, alternatively 25-75%, or even 40-60% of the water depth. This limits the required underwater wireless transmission distance as it may be required to circumvent the excessively large transmission losses of electromagnetic radiation in sea water. Airborne communication may take place with the surface vessel 102 or with e.g. a remote operations centre.

[0135] Fig. 13 shows an embodiment where the underwater communication means of the relay device 190 is a communication wire 199 which is connected to the intervention module 100, and which may be pulled out from the relay device 190 as the intervention module descends. The relay device 190 may be provided with means for spooling out the wire 199, or the wire may simply be pulled from a spool by the weight of the intervention module 100 as the module descends. The wire 199 may be hoisted either by electromechanical means, such as a winch, or by purely mechanical means, such as a tension system.

[0136] A subsea well intervention utilising intervention modules according to the present intervention thus comprises the steps of positioning a surface vessel 102 in vicinity of the subsea well head 120, connecting a subsea well intervention module 100 to a wireline on the vessel, dumping the subsea well intervention module 100 into the sea from the surface vessel 102 by pushing the module over an edge of the vessel, controlling the navigation means 105 on the intervention module 100, manoeuvring the module 100 onto the well head 120, connecting the module 100 onto the well head 120, controlling the control system 126 to perform one or more intervention operations, detaching the module 100 from the well head 120 after performing the operations, and recovering the module 100 onto the surface vessel 102 by pulling the wireline. The surface vessel 102 does not need to be accurately positioned over the well head 120 since the module 100 navigates independently and is not suspended from the vessel. Furthermore, the often critical prior art procedure of deploying the intervention module into the water is significantly simplified since the module 100 may merely be pushed over the side 103 of the surface vessel 102. This enables deployment of an intervention module 100 in rough conditions which would otherwise be prohibitive for intervention operations. Also, since the module 100 is remotely operated, there is no need for deploying additional vehicles, such as ROVs, thus further simplifying the intervention operation.

[0137] In some embodiments of the intervention method according to the invention, one or more additional subsea well intervention modules are dumped sequentially after or simultaneously with the first module. As the first intervention module performs its designated operations, the next intervention module may be prepared on the surface vessel 102 and launched into the sea to descend towards the well head 120. When the first intervention

module has performed its operations, it may return to the surface by its own means while the second intervention module waits in the proximity of the well head 120 to be docked on the well head. By having an awaiting second intervention module, a quick change from one intervention module to the next is possible, compared to a situation where multiple intervention modules need to be lowered by crane onto the well head, e.g. via a set of guide wires. In that case, more time is needed to perform the intervention.

[0138] By Nixie tubes display is meant a display comprising Nixie tubes. By a light-emitting diode display is meant a display using light-emitting diode for making readable letters or other information. By a vacuum fluorescent display is meant a display comprising vacuum fluorescent for displaying information, by a refreshable Braille display is meant a display comprising refreshable Braille for displaying information, by a cathode ray tube display is meant a display comprising cathode ray tube for displaying information, by a liquid crystal display is meant a display comprising liquid crystal for displaying information, by an electroluminescent display is meant a display comprising electroluminescent for displaying information, by a thin-film transistor display is meant a display comprising a thin-film transistor for displaying information, by a laser video display is meant a display comprising laser video for displaying information, by a surface-conduction electron-emitter display is meant a display comprising surface-conduction electron-emitter for displaying information, by a nanocrystal display is meant a display comprising nanocrystal for displaying information, by a carbon nanotubes display is meant a display comprising carbon nanotubes for displaying information, by a split-flap display is meant a display comprising split-flap for displaying information, by a flip-disc display is meant a display flipping discs for displaying information, by a roll sign display is meant a display rolling different signs for displaying information and by a segmented display, such as a seven-segment display, is meant a display comprising rolling different segments for displaying information.

[0139] By fluid or well fluid is meant any kind of fluid that may be present in oil or gas wells downhole, such as natural gas, oil, oil mud, crude oil, water, etc. By gas is meant any kind of gas composition present in a well, completion, or open hole, and by oil is meant any kind of oil composition, such as crude oil, an oil-containing fluid, etc. Gas, oil, and water fluids may thus all comprise other elements or substances than gas, oil, and/or water, respectively.

[0140] By a casing is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0141] In the event that the tool is not submergible all the way into the casing, a downhole tractor can be used to push the tool all the way into position in the well. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a

Well Tractor®.

[0142] Although the invention has been described in the above in connection with preferred embodiments of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. Blowout preventer (1) for being mounted on a well head (2), comprising:

- a plurality of valves (3, 4) arranged in fluid communication with each other, connected and forming a tubular pipe,

wherein the blowout preventer further comprises a display (5) visible from outside the blowout preventer.

2. Blowout preventer according to claim 1, further comprising a storing device (6) for storing measurements, signals or recorded data.

3. Blowout preventer (1) for being mounted on a well head, comprising:

- a frame structure (7), and
- a plurality of valves arranged in fluid communication with each other, forming a tubular pipe which is fastened to the frame structure,

wherein the blowout preventer further comprises a storing device (6) for storing measurements, signals or recorded data.

4. Blowout preventer according to claim 3, further comprising a display (5).

5. Blowout preventer according to claim 1, 2 or 4, wherein the display is a flat display panel, a Nixie tubes display, a light-emitting diode display, a vacuum fluorescent display, a refreshable Braille display, a cathode ray tube display, a liquid crystal display, an electroluminescent display, a thin-film transistor display, a laser video display, a surface-conduction electron-emitter display, a nanocrystal display, a carbon nanotubes display, a split-flap display, a flip-disc display, a roll sign display or a segmented display, such as a seven-segment display.

6. Blowout preventer according to any of the preceding claims, further comprising a control unit (8) comprising the storage device, and a communication unit (9) for communicating with the display or monitor.

7. Blowout preventer according to any of the preceding claims, further comprising a sensor (10) for sensing the temperature and/or well fluid pressure inside the well.

8. Blowout preventer according to claim 6, further comprising a docking station (11) enabling an operational tool (12) in the well to connect to the blowout preventer and be charged or recharged, or to upload or download information or signals to and from the communication unit.

9. Subsea launcher system (210) for launching a downhole tool through a well head subsea, comprising:

- a lubricator (178) closed off at its first end by a blind cap,
- a downhole tool (171) arranged in the lubricator,
- a lubricator valve (205) arranged to close off the lubricator at its second end,
- a shear ram valve (206) connected with the lubricator valve, and
- a connector (212) for connecting the subsea launcher system to a blowout preventer or a well head.

10. Subsea launcher system according to claim 8, further comprising a second lubricator valve arranged between the shear ram valve and the connector.

11. Subsea launcher system according to claim 8 or 9, further comprising a disconnection unit (213) arranged between the lubricator valve and the connector for disconnecting a part of the launcher system.

12. Subsea launcher system according to any of claims 8-10, further comprising a docking station (211) arranged at the first end of the lubricator to enable the tool to connect with the docking station and be charged, recharged, and/or communicate data to and/or from the tool.

13. Subsea launcher system according to any of claims 8-11, wherein the downhole tool is wireless and driven only by an internal power source.

14. Subsea well intervention module (100) for performing well intervention operations in a well, comprising a blowout preventer according to any of claims 1-7, comprising a supporting structure (110).

15. Subsea well intervention module (100) for performing well intervention operations in a well, comprising a subsea launcher system according to any of claims 8-12, and further comprising a supporting structure (110).

16. Subsea well intervention module according to claim 10, further comprising:
- an attachment means (111) for removably attaching the supporting structure to a structure of a well head or an additional structure,
 - a navigation means (105), and
 - a well manipulation assembly (105).
17. Subsea well intervention system (200) comprising
- a subsea intervention module (100) according to any of claims 13-15, and
 - a remotely operational vehicle (201) for navigating the intervention module onto the well head or another module subsea.
18. Subsea well intervention system according to claim 16, wherein the remotely operational vehicle comprises a camera (202) and/or a communication device (203) for communicating with a control unit of the blowout preventer.
19. Subsea well intervention system according to claim 17 or 18, further comprising a plurality of sensors arranged in the well for sensing the temperature and/or well fluid pressure inside the well.
20. Subsea well intervention system according to claim 17 or 18, further comprising a downhole tool having a sensing device (205) for sensing the temperature and/or well fluid pressure inside the well.
21. Use of the blowout preventer according to any of claims 1-7 or a subsea launcher system according to any of claims 8-12 for performing a well intervention.

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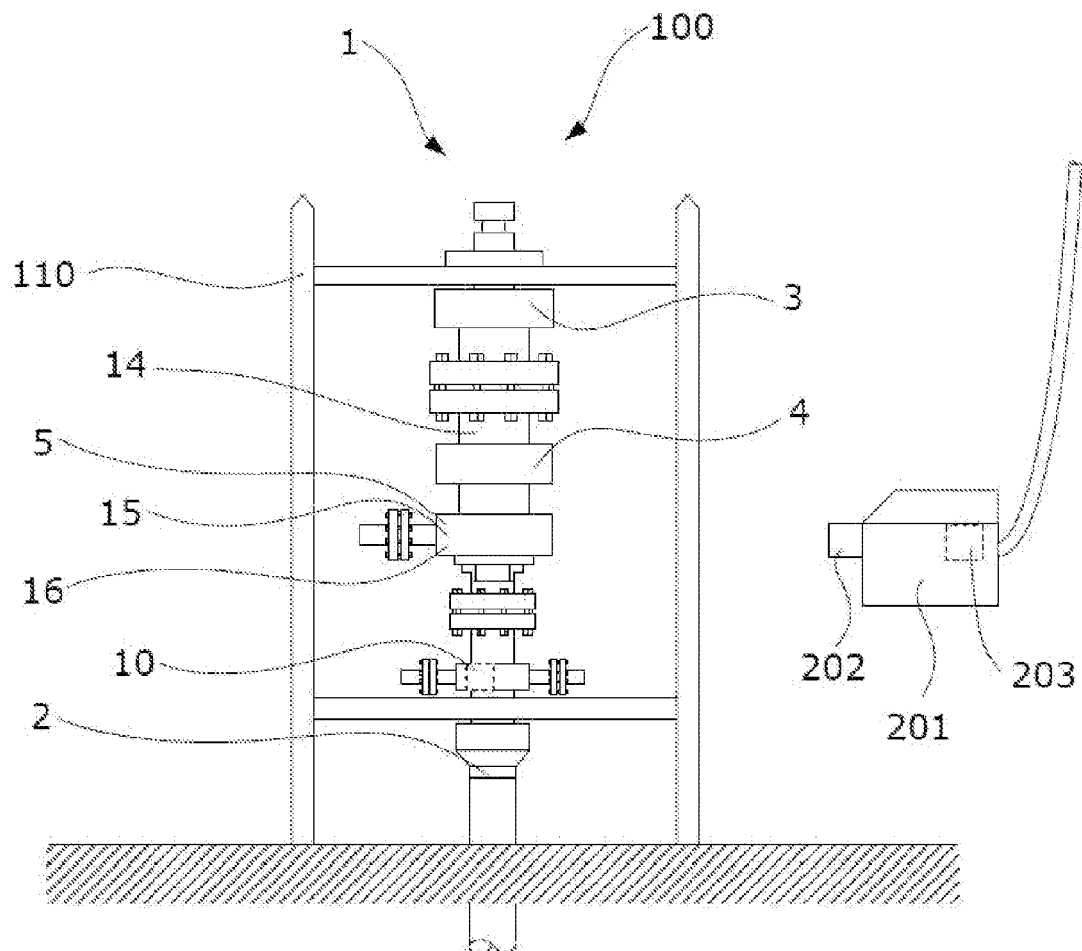


Fig. 1

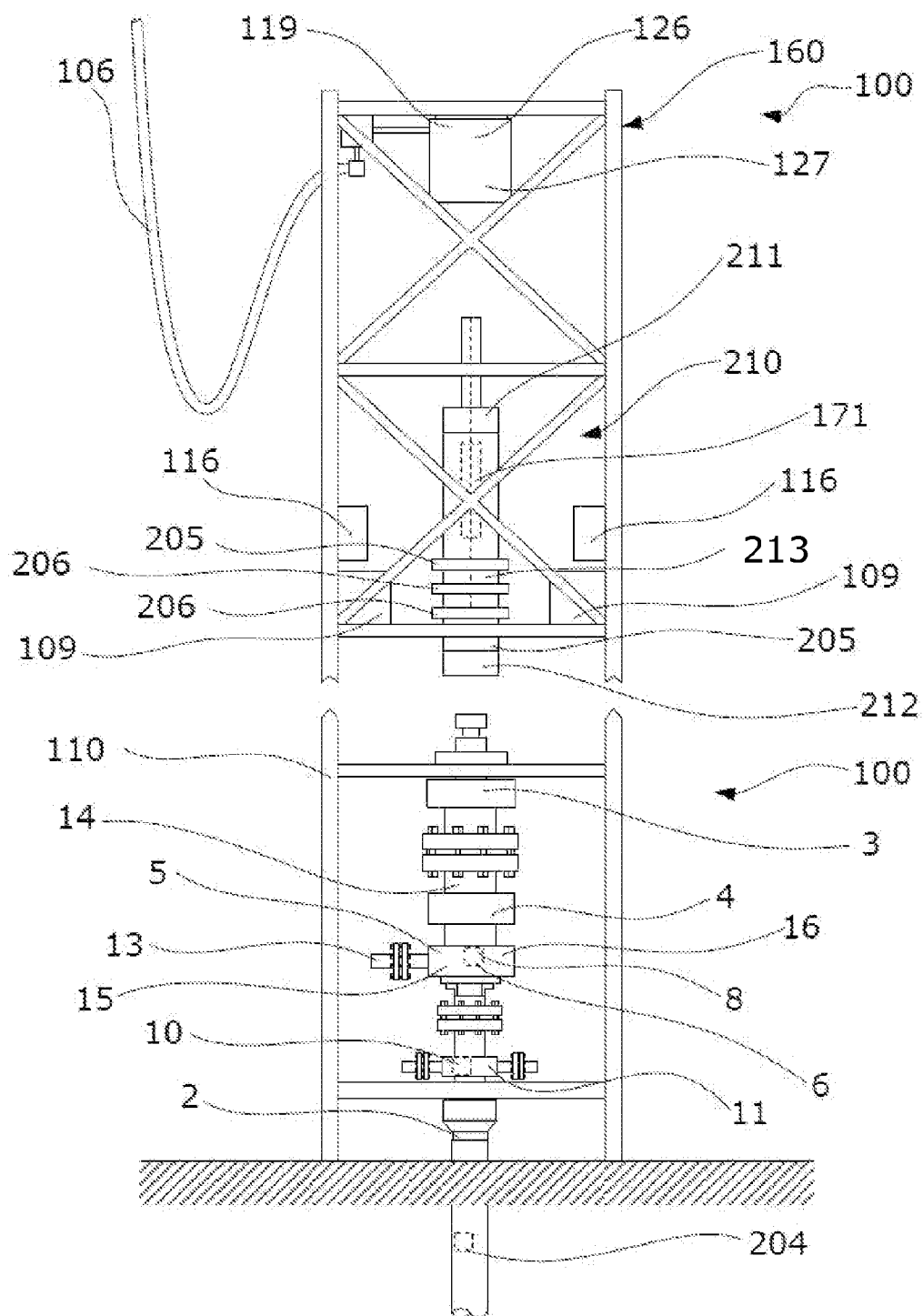


Fig. 2

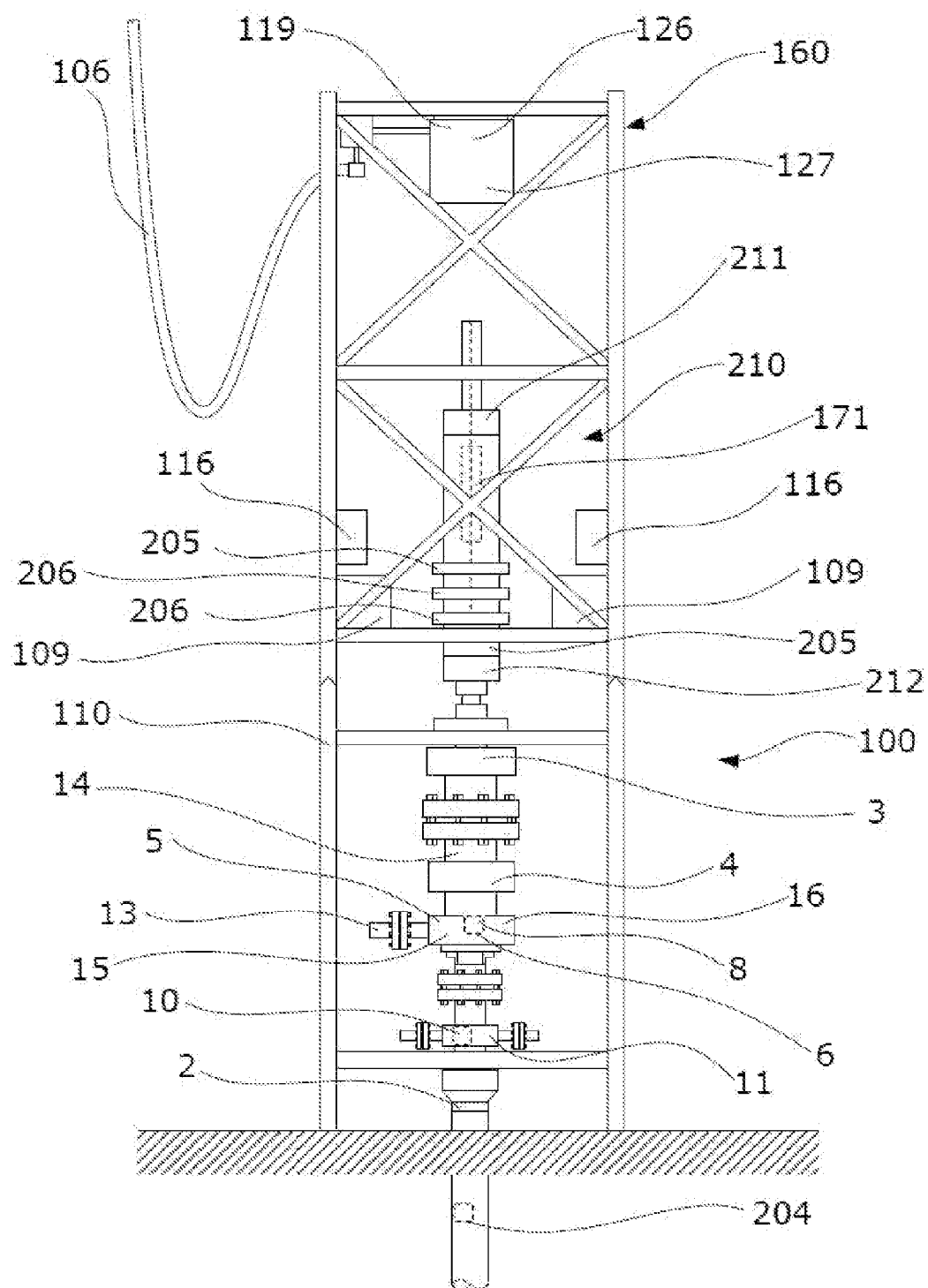


Fig. 3

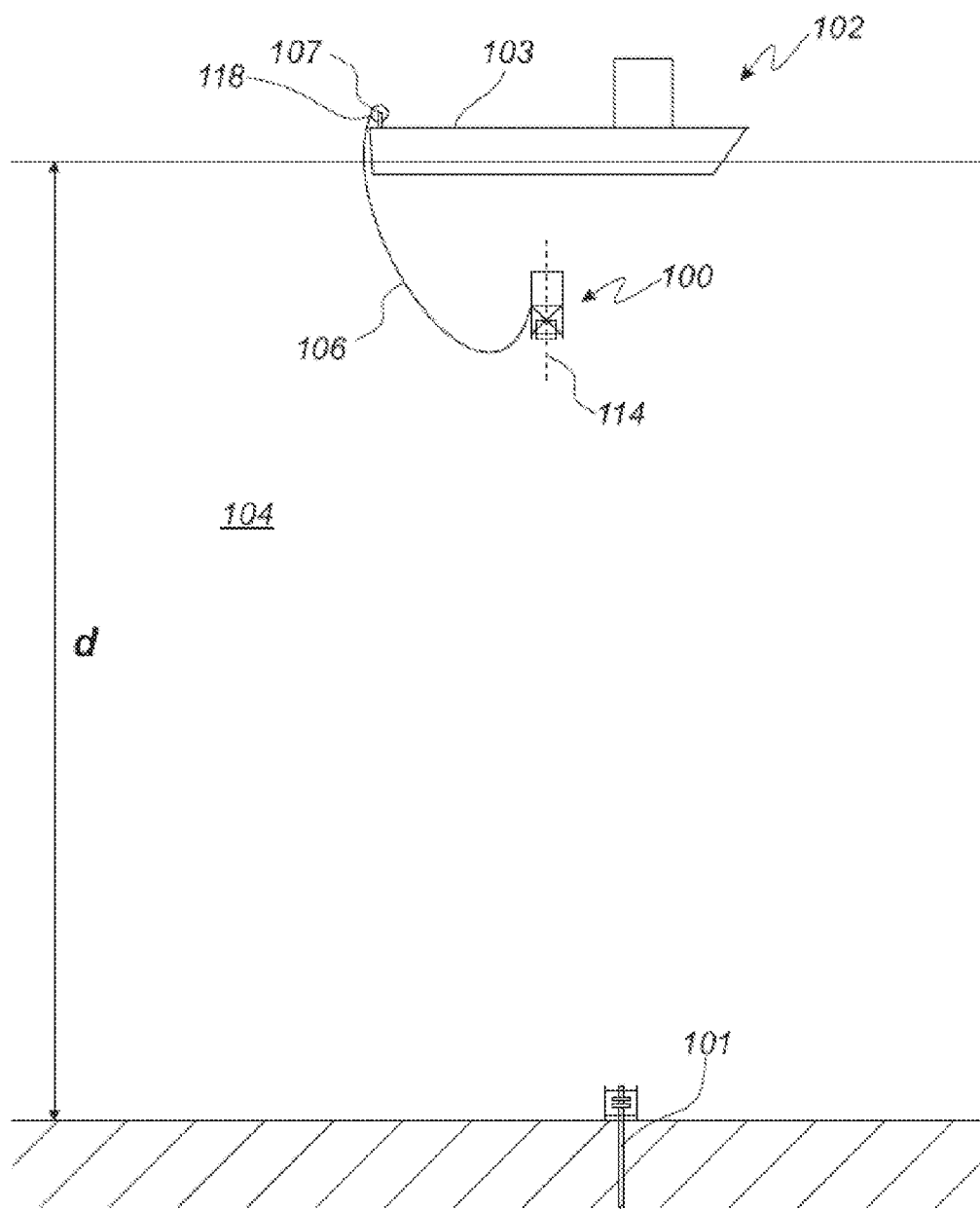


Fig. 4

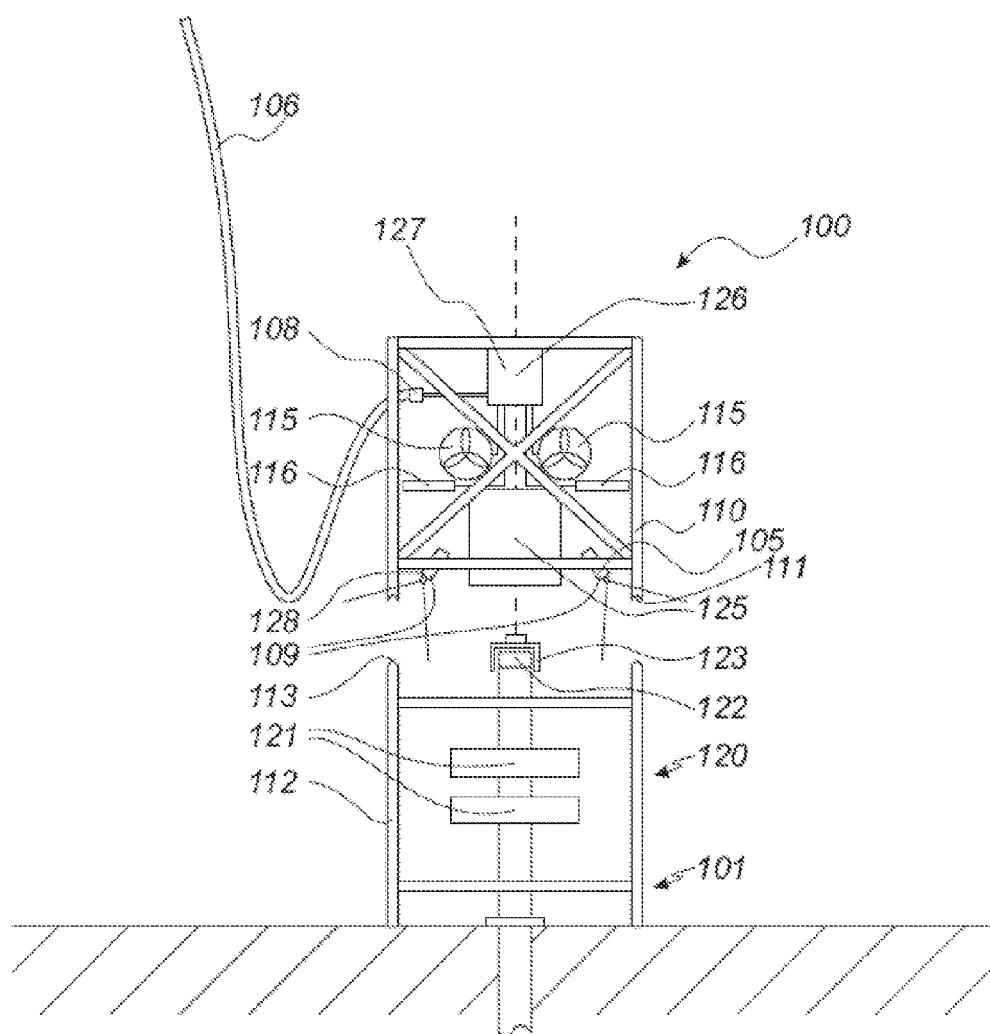


Fig. 5

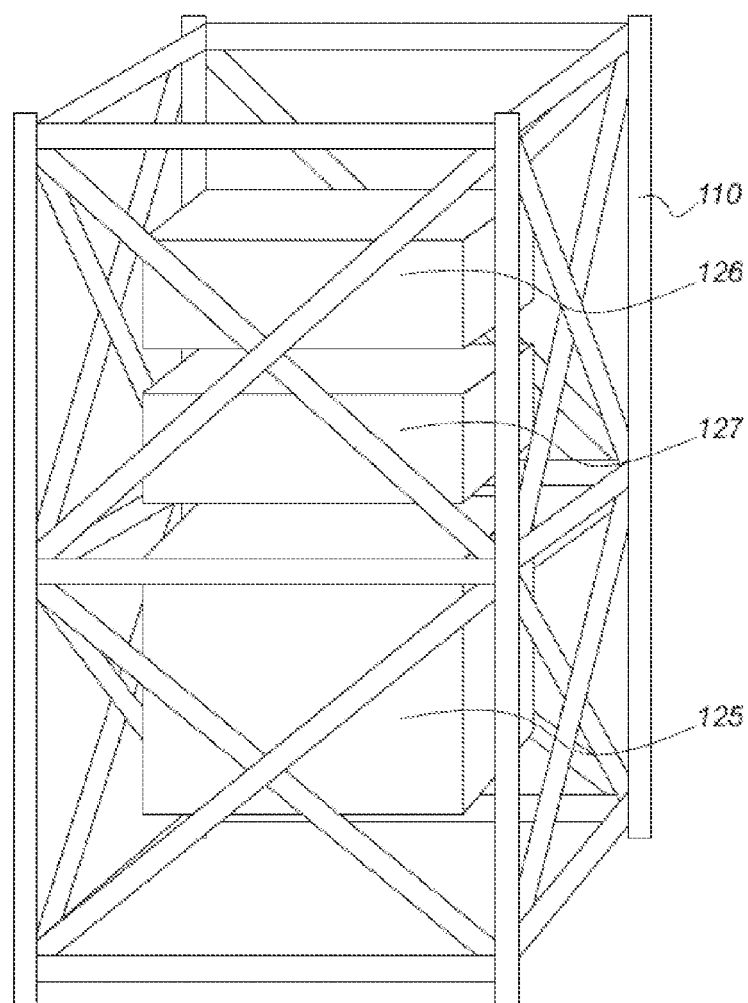


Fig. 6

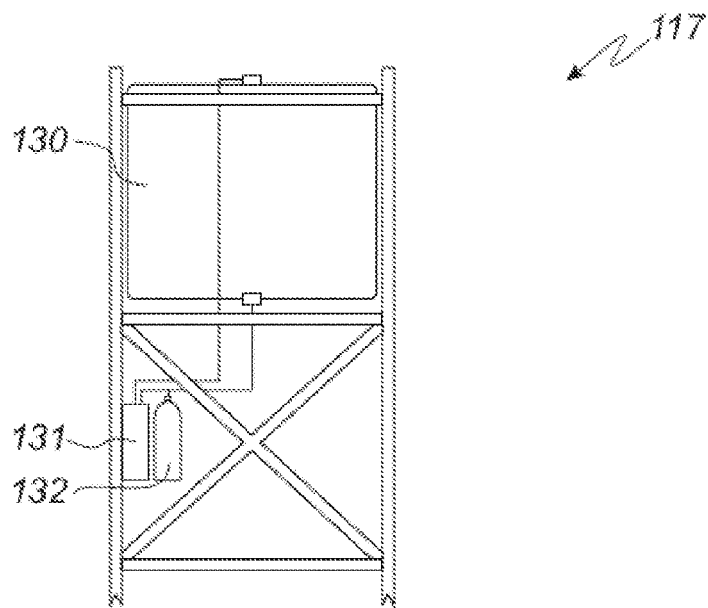


Fig. 7

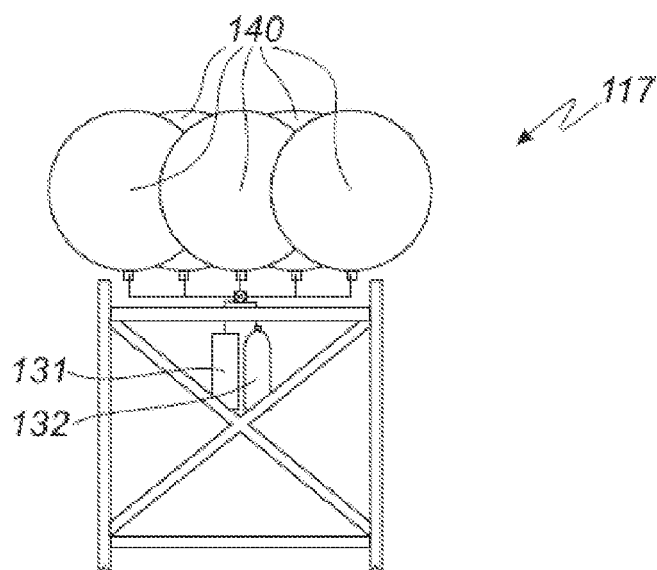


Fig. 8

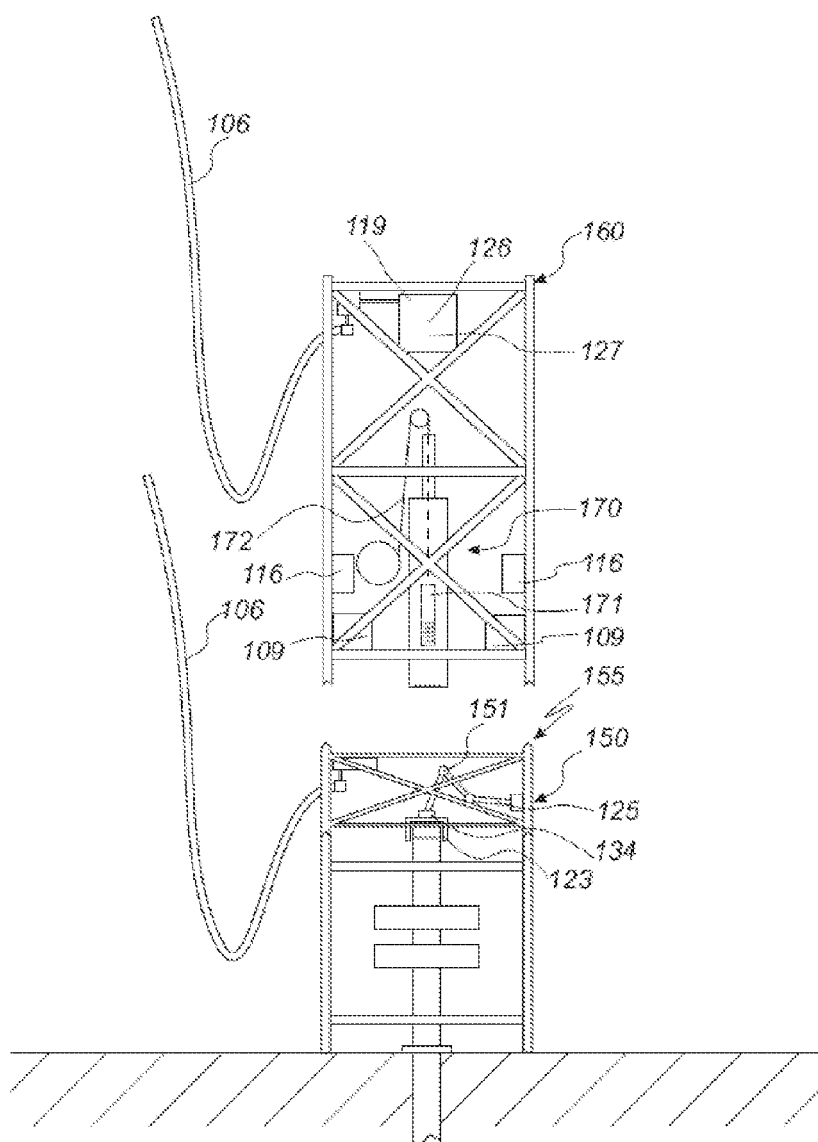


Fig. 9

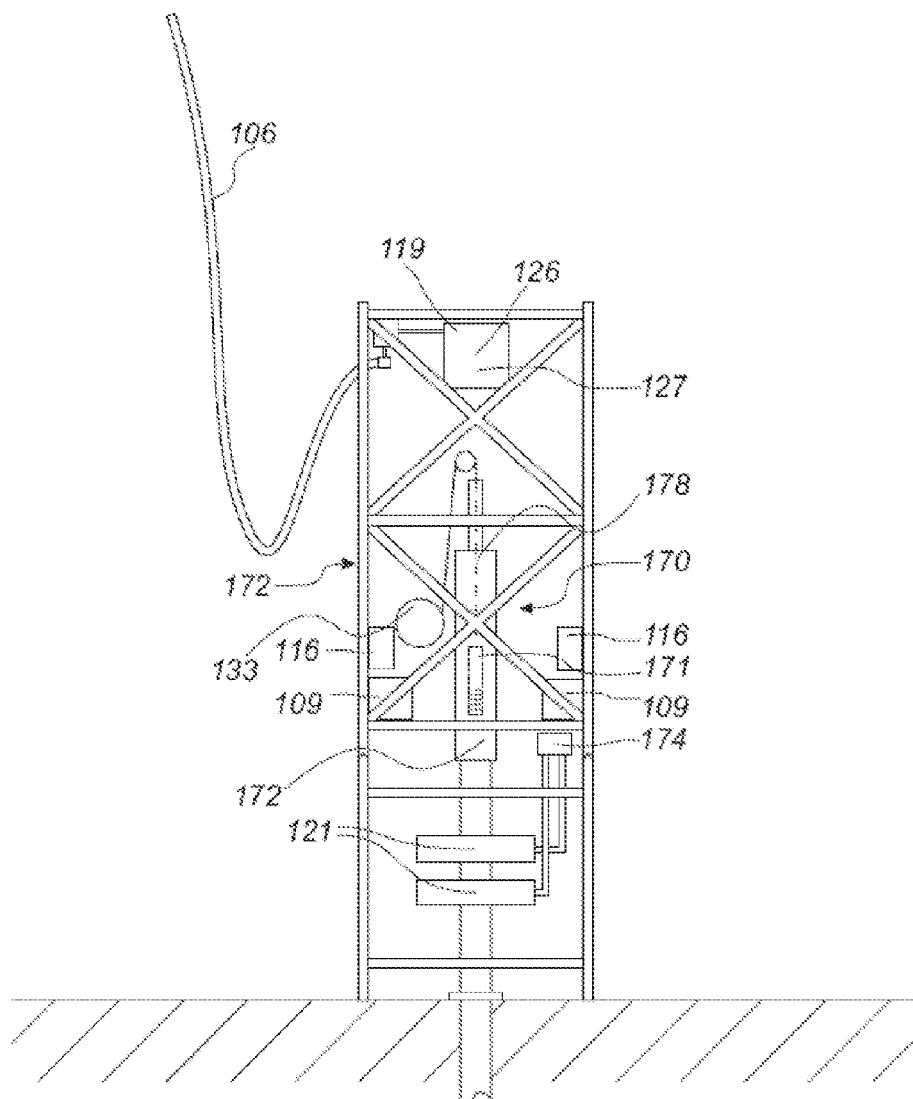


Fig. 10

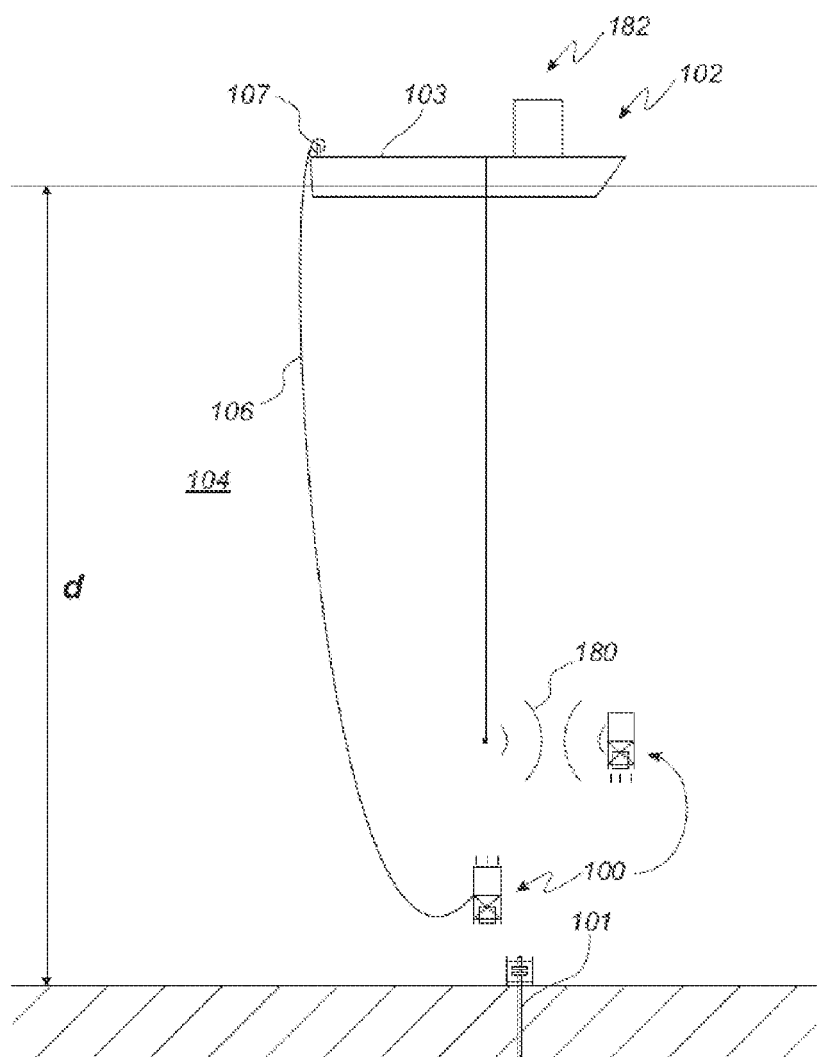


Fig. 11

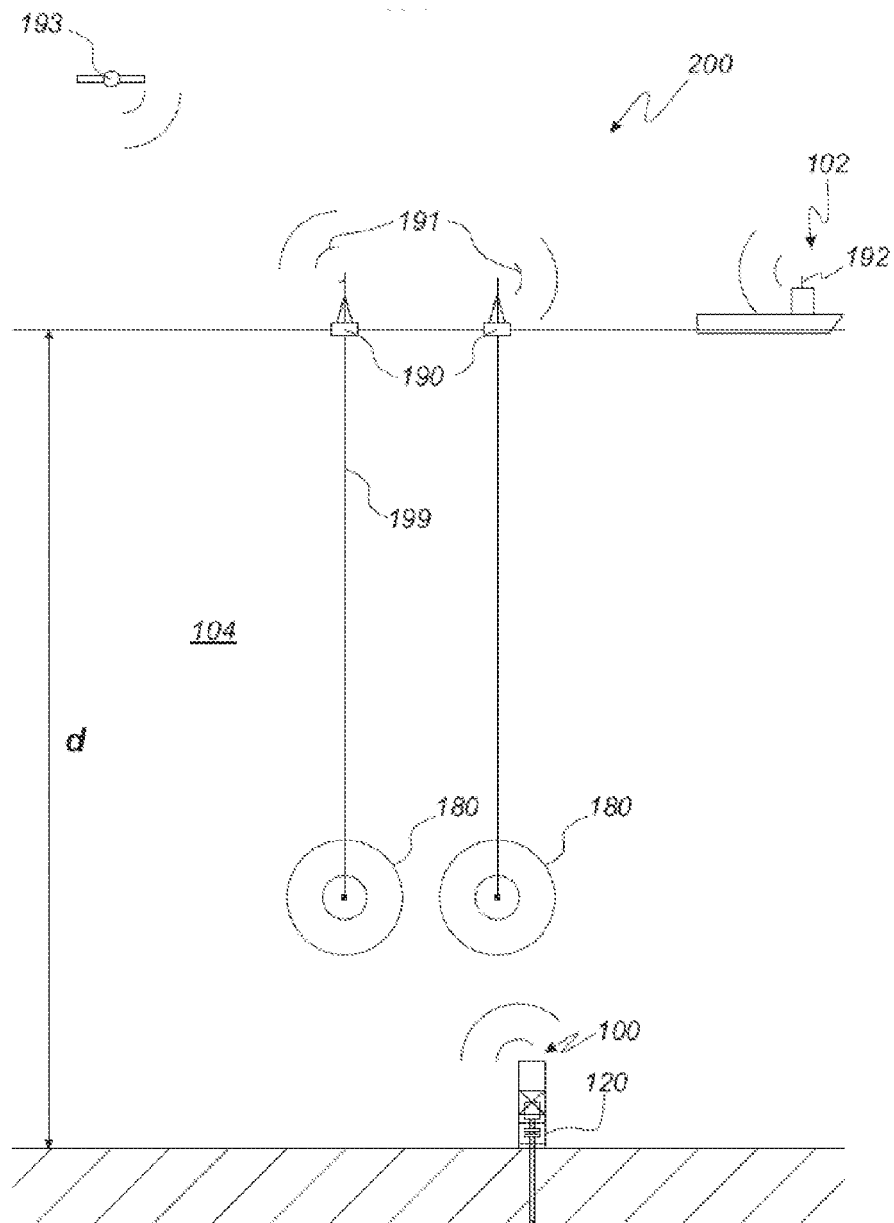


Fig. 12

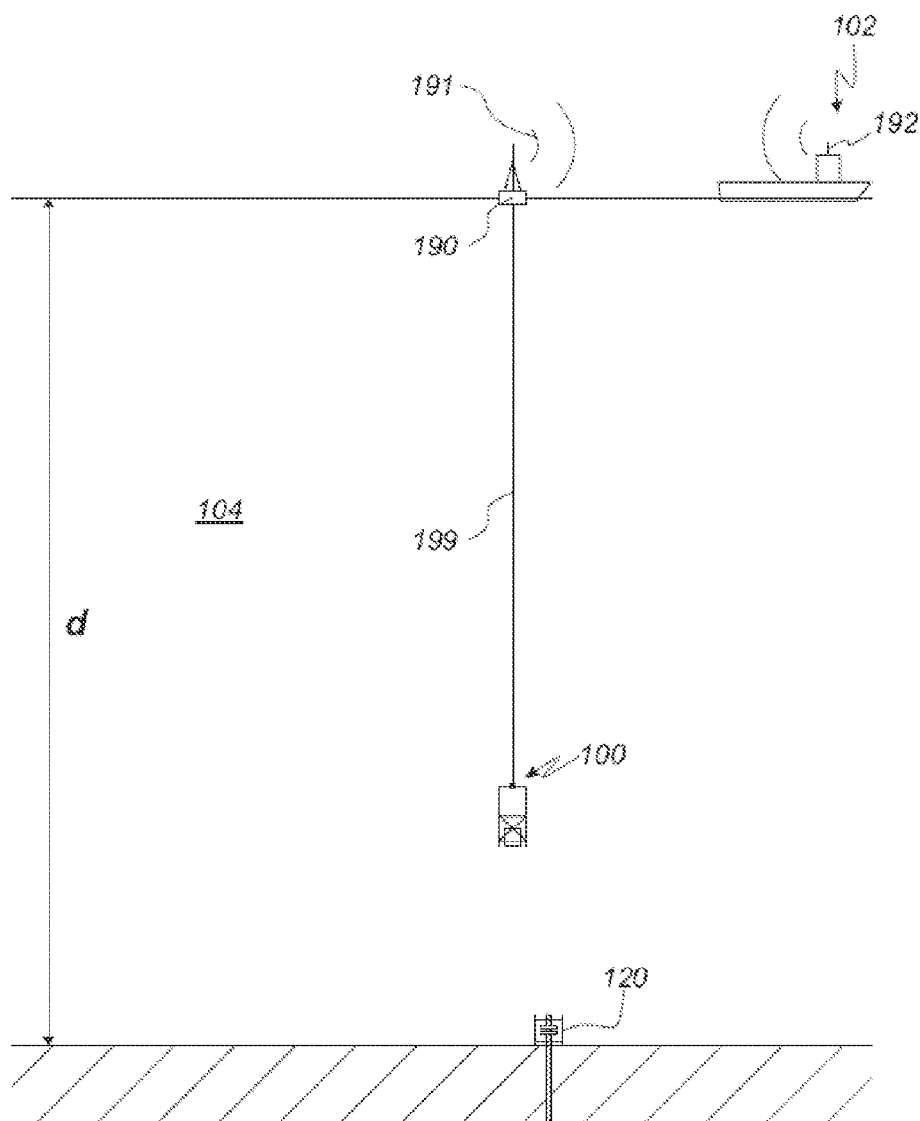


Fig. 13



EUROPEAN SEARCH REPORT

Application Number
EP 10 16 9262

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 490 525 A (NETTLES HENRY D) 20 January 1970 (1970-01-20)	1-8	INV. E21B33/06
Y	* column 6, line 27 - line 55 * * figure 4 *	14,16-21	E21B33/076
Y	----- US 6 808 021 B2 (ZIMMERMAN THOMAS H [US] ET AL) 26 October 2004 (2004-10-26) * column 6, line 46 - line 65 * * figure 5 *	14,16-21	
X	----- US 4 162 704 A (GUNTHER ALBERT W [US]) 31 July 1979 (1979-07-31) * column 5, line 31 - line 51 * * pressure gauge (24) * * figure 3 *	1,7	
A	----- US 2003/106692 A1 (REAUX JAMES R [US] ET AL) 12 June 2003 (2003-06-12) * figure 1 *	9-13,15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E21B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 8 April 2011	Examiner Schouten, Adri
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

4
EPO FORM 1503 03/02 (P04C01)



Application Number

EP 10 16 9262

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION
SHEET B**

Application Number
EP 10 16 9262

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-8, 14, 16-21

A blowout preventer

2. claims: 9-13, 15

A subsea launcher system

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 16 9262

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-04-2011

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