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(54) **Title**: WELL CLEAN-UP WITH SUBSEA SEPARATOR

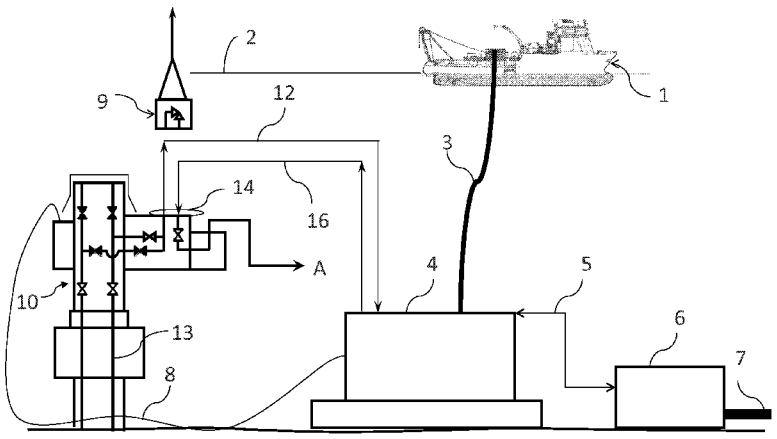

Fig. 1

(57) **Abstract**: System and method for performing a well operation such as well clean-up, flow testing, well stimulation or similar, wherein the system comprises; a subsea unit comprising storing means for solid substances and fluids, - a fluid flow connection between a main flow path and the subsea unit, which main flow path extends from a well through a subsea tree to a production facility, - means for allowing the well to produce through the fluid flow connection to the subsea unit for a desired period of time, - connection means for connecting and disconnecting the fluid flow connection from the main flow path.

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WELL CLEAN-UP WITH SUBSEA SEPARATOR

Field of the invention

The invention regards systems and associated methods of performing a temporary well operation such as well clean-up, flow testing, well stimulation or similar.

Background of the invention

Today subsea wells are normally flowed back to a production facility on a Mobile Offshore Drilling Unit (MODU), or another rig or vessel floating on the surface of water, upon finishing the completion operations to perform well unload or well clean-up. The well unload operation or well clean-up operation refers to any operation that makes the well ready for production. This operation may be performed either prior to starting production from a well for the first time or after work-over or intervention has been performed on the well for the first, second or multiple time. The operation includes flushing sand, debris, or other solid particles or fluids from the well prior to production startup. Performing the operation, i.e. flowing the wells back to the MODU or vessel, requires installation and mobilization of various pieces of test- and safety equipment. In addition, additional vessels may also be required to provide fluid storage capacity for the fluids that are flowed back to the surface as opposed to flaring the hydrocarbons through the flare tower on the rig or vessel.

The clean-up and unloading operations are very time consuming and costly, and ties up an expensive MODU or other vessel or rig for this work. The surface equipment requires special handling, testing, safety equipment and measures to ensure proper and safe handling of the hydrocarbons. In addition, it is inherently safety critical to ensure that these operations are neither unsafe nor that problems arise in relation to hydrocarbon handling during emergency shutdown and emergency disconnect of the system in the case of station keeping problems with surface vessels, e.g. vessel drive-off or drift-off.

US 2012/0037376 A1 describes a solution including a light intervention vessel configured to deploy and connect a subsea well intervention package on a subsea well or installation and an auxiliary vessel directly coupled to the same subsea well or installation, and configured to receive and treat returns from the same well.

However, some operators have tried to avoid the time and expense of flowing the wells back to the MODU, vessel or rig and have opted to flow them back to the production facility and have the production facility deal with the fluids and well debris. Doing so puts a risk on the production facility and the subsea production tree. The choke can be damaged or plugged by debris in the well flow or due to failure in the bottom hole assembly equipment, which then delays production startup until corrective measures/ repairs are completed. The production facility also has to deal with fluids and debris that are not generally present in the fluids they handle, and could potentially damage or negatively affect production equipment. Such fluids include completions fluids, acids, debris or similar typically found in a subsea well post completion/ intervention activities.

US 2011/0139460 A1 describes a solution for subsea clean-up without using the choke valve on the production tree, such as to make sure that the choke valve is not damaged by sand, debris or solid particles in the clean-up flow. Instead the clean-up flow is lead through a bypass connection bypassing the production tree choke valve.

There is then three different alternatives for performing such operation, a) flow the well fluid to surface, with equipment to handle this fluid at surface, b) use production facilities with the added risk of damaging these facilities, and or possibly have to design these facilities to be able to cope with this, which possibly makes them less efficient during normal production, and c) bypassing critical elements in the subsea production facility, as for instance bypassing the choke.

It is an object of the present invention to provide a system and method that is safe with regards to handling of hydrocarbons.

It is another object of the invention to provide a system that is less expensive and easier to operate than known solutions and a system which only needs one vessel.

It is another object to provide a solution that minimizes the amount of solid particles flowing through the choke valve.

Yet another object of the invention is to provide a system that requires less processing equipment on the surface.

Summary of the invention

The invention provides systems and methods by which well fluids, injection fluids, debris or solid particles used in or being produced as a result of a well

operation, such as a well clean-up, and well unload or flowback is handled subsea without the need to flow to the MODU, rig, vessel or production facility. These fluids, which may include debris and solid particles, can undergo subsea separation and depressurization to a safe condition for lifting to surface or analysis and re-injection, if required. In addition the system provides a solution where clean-up and flowback is performed without sending the solid particles through the subsea infrastructure, i.e. the production tree choke valve, as well as where the need for a subsea test tree during clean-up or flowback is eliminated. By not flowing the well fluids or solid particles, such as hydrocarbon fluids and cuttings, to the surface, e.g. to a MODU, rig, vessel or production facility, the safety of the operations is significantly improved and the risk of personnel exposure to high pressure and/ or high temperature hydrocarbon fluids is eliminated. Drive-off concerns in relation to vessel station keeping are eliminated as are concerns with fatigue associated with the operation of a possible riser system. Additionally, the system provides a cost effective means of performing a well operation, e.g. well clean-up or unloading operations, using a subsea installed system for handling various completion fluids, intervention fluids, acids, debris etc. normally found in a subsea well post completion activities. The system also has the capability of performing extended well testing activities, either with or without the developments production facilities, by separating out the well fluids or particles that are unwanted in the production equipment and producing the hydrocarbons present in the well fluids.

The system may comprise a subsea tree system, e.g. a vertical tree or a horizontal tree, e.g. FMC Enhanced Vertical Deepwater Tree (FMC EVDT) or a FMC Enhanced Horizontal Tree (FMC EHXT), that allows fluids to be flowed into a mudline, tree mounted, or well control package mounted processing unit or any combination thereof that is capable of performing the well operation, e.g. well clean-up, well testing or similar. Removing the flow module from the tree provides access to both the production bore of the subsea well as well as the well jumper and flowline that tie the well to the production facilities. Removing the flow module also removes the production choke from the tree, eliminating potential for damage during well operations.

The term well operation shall be understood as any well operation, exemplified as well clean-up, flow testing or well stimulation, where work is done

on a well prior to first startup of production or as maintenance work on a producing well, such as work-over or well intervention work. Similarly, the term well fluids is to be understood as any fluid or solid present in the well during or subsequent a well operation.

The term subsea unit shall be understood as any system capable of performing separation of one or more phases of well fluid as previously described. The unit may be made up of various pieces of equipment that not only perform separation operations, but are capable of fluid measurement, i.e. flow meters, de-sanders, boosting pumps for various liquid phases, compressors, fluid storage vessels, along with necessary valves, and control and instrumentation devices to support remote operation.

The invention concerns a method of performing a temporary well operation such as well clean-up, flow testing, well stimulation or similar, the method comprising the steps of;

- providing a subsea unit comprising storing means for well fluids,
- providing a fluid flow connection between a main flow path and the subsea unit, which main flow path extends from a well through the subsea tree to a production facility,
- allowing the well to flow for a desired period of time through the fluid flow connection and to the subsea unit,
- disconnecting the fluid flow connection from the main flow path. The subsea unit may preferably be arranged at a location close to the well or subsea tree in question.

The invention also concerns a method of performing a well operation, such as well clean-up, flow testing, well stimulation or similar, the method comprising the steps of;

- either before starting up production from a new well or temporary shutting-off production from a producing well, providing a subsea unit comprising storing means for well fluids on a seabed close to the well and wellhead in question,
- performing a well operation such as well completion work or intervention,
- connecting a fluid flow connection between the subsea unit and a main flow path of the well,

- allowing the well to flow for a desired period of time through the fluid flow connection and to the subsea unit,

- disconnecting the fluid flow connection from the main flow path, and

- starting-up or resuming production from the well.

The method according to the invention may further comprise the step of running the subsea unit on a line from a vessel.

The method according to the invention may further comprise the step of providing the subsea unit at a subsea location either before starting up production from a new well or temporary shutting-off production from a producing well.

The method according to the invention may further comprise the step of connecting the fluid flow connection by the use of a remotely operated vehicle (ROV). The interfaces in the connections of the fluid flow connections may be provided with a ROV-friendly interface which is known to the person skilled in the art.

The method may further comprise the step of depressurizing the storing means and/ or separation means. During normal production, i.e. by flowing the well flow through the standard processing equipment, the well flow is normally flowed through a choke for depressurization. In the subsea unit water is separated from the gas in the well flow and the formation of hydrates is prevented. Depressurization of the storing means according to the present invention solves the same need of preventing hydrates to form in occasions where gas and or oil are produced from the storing means.

The method may further comprise the step of lifting the storing means to a vessel. After the desired period of time has lapsed, the subsea unit may be lifted to the surface by means known to the person skilled in the art, with or without the use of a remotely operated vehicle (ROV), such as by cable, coiled tubing, crane, wireline etc. The subsea unit can be lifted with or without hydrocarbons. A suitable vessel could empty the storage vessel to reduce weight of the lift for the recovery operation or to simply ready the storage vessel for the next operation. Alternatively, the subsea unit may be arranged permanently subsea or kept subsea for several operations before it is lifted.

The method according to the invention may comprise the step of depressurizing the storing means before lifting the storing means to a vessel.

In an embodiment the desired period of time for the well fluids to be produced through the fluid flow connection to the subsea unit corresponds to the time necessary for performing the temporary operation.

In an embodiment of the method according to the invention, the well fluids comprises a multiphase flow and at least one of the phases of said multiphase flow is separated out and stored in the separator, while at least one of the other of said phases is produced.

In another embodiment of the method according to the invention, the well fluids comprise a multiphase flow and all of the phases of said multiphase flow are separated in the subsea unit and produced.

In yet another embodiment of the method the well fluids comprises a multiphase flow and all of the phases of said multiphase flow are separated out and stored in the subsea unit.

The method according to the invention may further comprise the steps of;

- arranging an umbilical line for injection fluids, the umbilical line extending from a vessel on the surface to at least one of subsea unit, subsea tree or well control unit, and

- cleaning the well by injecting fluids to the well through at least one of said subsea unit, subsea tree or well control unit, and

- starting up or resuming production when the cleaning is completed.

The invention also concerns a system adapted for performing a temporary well operation such as well clean-up, flow testing, well stimulation or similar, wherein the system comprises;

- a subsea unit comprising storing means for well fluids,

- a fluid flow connection between a main flow path and the subsea unit, which main flow path extends from a well through a subsea tree to a production facility,

- means for allowing the well to flow, through the fluid flow connection and to the subsea unit for a desired period of time,

- connection means for connecting and disconnecting the fluid flow connection from the main flow path.

The storing means in the system according to the invention may comprise at least one separator and/ or tank.

The invention also relates to a system adapted for performing a well operation such as well clean-up, flow testing, well stimulation or similar, wherein the system comprises;

- a subsea unit comprising a separator for well fluids,
- a fluid flow connection between a main flow path and the subsea unit, which main flow path extends from a well through a subsea tree to a production facility,
- means for allowing the well to flow, through the fluid flow connection and to the subsea unit for a desired period of time,
- connection means for connecting and disconnecting the fluid flow connection from the main flow path.

The subsea unit in the system according to the invention may comprise a separator and storing means. Alternatively, the separator according to the invention may comprise storing means.

The connection means in the system according to the invention may be any known connections known to the person skilled in the art, such as threads, flange, connector finger in connection with a hub or locking groove etc.

The system may comprise at least one choke valve arranged in the main flow path. The fluid flow connection may be connected to the main flow path eliminating flow through the production tree choke valve such as to prevent the fluids and particle damage the choke valve. When the fluid flow connection is connected to the main flow path, the well fluids and solids particles or debris will flow through the fluid flow connection and to the subsea unit. The subsea unit may comprise, among other equipment, a storing means. Processed fluids from the subsea unit may be lead through a fluid exit line leading to a production facility, subsea storage vessel or storage vessel. A single two-way or bi-directional jumper, or two independently installable jumpers make the connection between the subsea unit and a flow module.

The separator in the system according to the invention may comprise a gravity separator or an inline separator, or other fluid separation mechanisms or devices. The storing means may be any closed container or similar that is applicable for storing of solid substances and fluids. As the water depth, water temperature, water pressure, water salinity etc. differ from location to location the storing means can be made applicable for the desired conditions on the specific

locations. Similarly, the pressure, temperature and composition of the fluid and solid particles entering the storing means may differ, and the storing means may be adapted to comply with such differences.

There may in the system according to the invention be arranged an umbilical line for injection fluids extending from a vessel on the surface to at least one of said subsea unit, subsea tree or a well control unit. The line may be connected to the subsea tree to provide injection fluids, communication, power and control of the subsea tree during operations from a surface vessel or a topside facility. The power and control of the subsea unit and the subsea tree can be established from for instance an umbilical line run down from a vessel and connected to the subsea unit, or the power and/ or control can be provided from the vessel or topside facility via connections made to a subsea umbilical termination assembly (SUTA), or a combination of the two. The umbilical line may provide the subsea unit with power, chemicals, hydraulics, barrier fluids and or electrical power. Alternatively, or in addition, a well control unit may be provided subsea to control the system. The well control unit may be driven hydraulically, electrically, acoustically or by any other means known to the skilled person in the art.

The subsea unit in the system according to the invention may comprise subsea equipment in addition to storing means, such as separation means, pump, multi-phase flow meter, choke, chemical injection means, instrumentation and sand/ debris management.

The subsea unit can be arranged for temporary use subsea, while in another embodiment the subsea unit can be arranged for permanent use.

The system may be adapted to be used on a single or multiple subsea wells, and is applicable to be installed both permanently and temporary subsea.

The means for allowing the well to produce for a desired period of time comprises valve means in connection with the fluid flow connection. Alternatively it may comprise timer, different sensors opening or closing valves etc.

The fluid flow connection in the system according to the invention may comprise a jumper, pipe or tube. The flow connection may be any tubular element capable of transporting a fluid.

The system according to the invention may comprise depressurization means for depressurizing the storing means or separator. The depressurizing means may comprise a choke.

The subsea unit can be configured to provide appropriate equipment for specific operations. In an embodiment the subsea unit may comprise equipment including pumps, flow meters, valves and/ or sand and debris management devices. The subsea unit may be rated for the full shut-in pressure (SIP) of the well. The SIP can be defined as the surface force per unit area exerted at the top of the wellbore, e.g. wellhead, when it is closed at either the trees or the BOP stack. Alternatively, the subsea unit may be equipped with appropriate pressure sensing safety equipment devices to allow the pressure rating of the processing unit to be substantially less than the shut-in wellhead pressure of the wells. This may be accomplished in a similar manner used in high integrity pipeline protection systems (HIPPS).

In the absence of having a retrievable flow module on the subsea tree for access to the main flow path, the well control package could be utilized to provide access to the main flow path. The subsea unit, or individual components thereof according to the invention could be mounted in whole or in part on the well control package, a horizontal or vertical tree, or on the mudline or any combination thereof. The well control package may include a riser or lubricator system to permit vertical access to the subsea tree and well by coiled tubing, wireline, electric line, fibre optic or other from a surface vessel. The well control package may comprise well control features such as pipe rams, coil tubing rams, blind shear rams to both annulus and production bores with multiple crossover facilities between the two and/ or emergency disconnect features. Thus, if vertical access is required, i.e. installation and removal of wireline plugs, then no subsea processing features will prevent vertical well access. Hydrocarbons and well fluids will flow vertical up through the subsea tree and into the subsea well control package, which will then direct the fluids out to the subsea unit for processing. Therefore, the hydrocarbons and well fluids may undergo processing subsea prior to either be lifted up to the surface for analysis and possibly, if required, being re-injected into the subsea well control package and subsea tree and then onto a production system or storage system as required. The arrangement of the system as described will provide the benefit of permitting

access to the well from above and will ensure that the existing production infrastructure such as flowlines and flow modules will not require to be removed or to be disturbed during the well operations according to this invention. The jumpers may be installed between the subsea unit, e.g. a subsea processing unit, and the subsea well control package or alternatively, the system could be configured as an integrated solution with the subsea well control package and the subsea unit installed and operated as one integrated system.

The system may further comprise at least one choke valve in the subsea unit. The fluid flow connection can be connected to the main flow path with production choke removed in the case of the flow module or routed through well control package to avoid flow of debris through the tree choke valve.

The invention will now be described in non-limiting embodiments and with reference to the attached drawings, wherein;

Brief description of the drawing

Fig. 1 shows an embodiment of a subsea system according to the invention.

Fig. 1A shows an embodiment of a subsea system according to the invention with the well control option.

Fig. 2 shows a simplified subsea tree with a retrievable flow module.

Fig. 3 shows a simplified subsea tree connected to a subsea unit via flow module connection points.

Fig. 4 shows an embodiment of a subsea tree without a retrievable choke or flow module.

Fig. 5 shows a simplified well control package connected to a subsea tree and connected to a subsea unit and where the flow is re-injected to the well from the subsea unit.

Fig. 6 shows a well control package connected to a subsea tree and connected to a subsea unit and where the flow is flowed to subsea storage units or tanks.

Fig. 7 shows a well control package connected to a subsea tree and connected to a subsea unit and where the flow is flowed to a surface vessel from the subsea unit.

Fig. 8 shows an embodiment without a well control package connected to a subsea tree where the subsea unit is connected to a subsea tree.

Detailed description of a preferential embodiment

An embodiment of the invention is shown in fig. 1. A subsea tree 10 is arranged on a sea bottom. The subsea tree 10 is connected to a wellhead, and can be connected to a blow out preventer or a subsea well control package. A main flow path 13 extends axially along the subsea tree 10. A choke valve for the tree is contained in the remotely retrievable flow module 9. With the flow module 9 removed from the tree 10 at reference connection point 14, a fluid flow connection 12 is connected to the main flow path 13. When the fluid flow at connection point 14 is connected (i.e. in fluid communication with the main flow path 13), the well fluids and solid particles or debris from a well operation is flowed through the fluid flow connection 14 via jumper 12 to a subsea unit 4. The subsea unit 4 may comprise, among other equipment, a storing means. Processed fluids from the subsea unit 4 may be flowed through a fluid exit line 16 leading to a production facility, subsea storage vessel/tank or a surface vessel with storage tanks (all denoted by collective term A in the figure). If the vertical or horizontal subsea tree is not equipped with a retrievable production choke herein referred to as a flow module 9, a well control package 11 can be installed on the tree 10 to establish connection with main flow path 13, refer to fig 1A.

In fig. 1A the fluid flow from flow path 13 exits the well control package 11 via a jumper 12 installed to allow flow to the subsea unit 4. Clean fluid would then return via fluid exit line 16 from subsea unit 4 to well control package 11, then through subsea tree 10 via the annulus side of the tree 10, through crossover 40 to flow path 13 and through the production tree choke and finally into production facility (collective term A).

In fig 1, the case where the production umbilical(s), and subsea production facilities are in place and operational, subsea unit 4 is connected to a subsea umbilical termination assembly (SUTA) 6 via a connection line 5. The connection line 5 may be provided with ROV-friendly connections (not shown) in each end for easy connection and disconnection to the subsea unit 4 and the SUTA 6, respectively. The SUTA 6 is connected to an electro hydraulic production umbilical 7 at another end thereof. The production umbilical provides supply of power, chemicals and/or hydraulic fluid for valve actuation. A MODU or vessel 1 is floating on the surface 2 of a body of water. An umbilical line 3 extends from the vessel 1 to the subsea unit 4. The umbilical line 3 can provide the subsea

unit 4 with power, chemicals, hydraulics, barrier fluids and/ or electrical power or these can be supplied by the umbilical 7 or combination thereof. Electrical and/or hydraulic lines 8 are installed by ROV from subsea unit 4 to tree 10 to provide vessel 1 with operational control of tree 10 and subsea unit 4.

In Fig 1A, where well control package 11 is utilized and subsea production facilities are in place and operational, umbilical 3 is connected to well control package 11 directly. Electric and hydraulic controls lines from well control package 11 to subsea tree 10 and well control package 11 to the subsea unit 4 are installed by ROV, and collectively shown as 15 and 21 respectively. The umbilical and control lines can be installed in any number of configurations known to the person skilled in the art.

In the absence of the SUTA 6, the umbilical line 3 provides all necessary power, chemicals and hydraulic fluid to subsea unit 4, subsea tree 10 and/or well control package 11, subsea storage vessel or storage vessel (all denoted by collective term A in the figure).

Fig. 2 shows a subsea tree 10 with a retrievable flow module 9 connected. A number of valves are arranged in the subsea tree 10. A black-filled symbol indicates that the valve is closed, while a white-filled symbol indicates that the valve is open. The main flow path 13 is directed upwards and the flow is first flowing through an open valve 30. An upper tree valve 31 in the main flow path is closed. The flow is flowing through the open wing valve 32 and to the flow module 9 which contains production choke for the subsea tree 10. From the flow module 9 the flow eventually flows out trough a fluid flow connection or well jumper 12 leading to a production facility, subsea storage vessel or storage vessel (all denoted by collective term A in the figure).

Fig. 3 shows an embodiment of figure 2, but the subsea retrievable flow module has been removed, and subsea tree 10 is shown without the flow module. In the embodiment in figure 3 the fluid flow connection 12 is connected to the subsea tree 10 via the flow module connection point 14. The fluid flow connection 12 is in the other end connected to a subsea unit 4. The subsea unit 4 has a return flow connection (line 16) leading the flow, or parts of the flow, back to the flow module connection point 14. From the flow module connection the fluid flow is lead to either a production facility, subsea storage vessel or storage vessel (all denoted by collective term A in the figure). The umbilical line 3

extends from a vessel to the subsea unit 4 (as discussed above). Electrical and hydraulic control lines 21 provide the electrical and hydraulic power from the surface vessel to the subsea tree 10 via the subsea unit 4.

Fig. 4 shows an embodiment of the subsea tree 10 according to figure 2, but the production choke assembly is integral to the tree and non-retrieval and not contained within a retrievable flow module. This configuration of subsea tree does not therefore have the flow module connection provisions.

Fig. 5 shows a well control package 22 connected on the top of the subsea tree 10 with integral production choke as described above, and connected to a subsea unit 4. Connections and fluid flow are made between the well control package 11 and subsea unit 4. The flow is returned via line 16 to the annulus side of the well control package 11 and through the annulus of the tree 10, through cross over valve 40 to the production bore downstream of closed production wing valve 32. The processed fluid then presents no potential to damage the subsea tree production choke, and is flowed through the production choke and through fluid flow connection or well jumper 12 leading to a production facility, subsea storage vessel or storage vessel (all denoted by collective term A in the figure).

Fig. 6 shows a well control package 22 connected to a subsea tree 10 and connected to the subsea unit 4. The flow is directed to subsea storage units or tanks 24 through line 16. Electrical and hydraulic control lines 21 provide the electrical and hydraulic power, as well as chemicals from the well control package 22 to the subsea tree 10. Pressure caps 23 provide pressure barriers as required on the subsea tree 10 and well control package 23. Umbilical lines 3, 7 provide the subsea unit 4 with power, chemicals, hydraulics, barrier fluids and/ or electrical power.

Fig. 7 shows an alternative embodiment of figure 6 in that the well flow is directed to a surface vessel through processing line 25 instead of being directed to subsea storage units.

Fig. 8 is an alternative embodiment of figures 5, 6 and 7. In figure 8 the subsea tree shown does not require a well control package for the well operations. The subsea tree 10 is shown with flow module removed, similar to that of Fig 3, however the production facilities, and subsea storage is not available. The processed fluid is sent to the surface vessel through processing

line 25 as in figure 7. This example demonstrates that the same process flow options are available to the subsea tree 10 with flow module provision with or without the well control package.

The invention is herein described in a non-limiting embodiment. A skilled person in the art will understand that there may be made alterations and modifications to the embodiments that are within the scope of the invention as defined in the attached claims, and elements or features of the different embodiments may be combined in any configuration.

CLAIMS

1. Method of performing a temporary well operation such as well clean-up, flow testing, well stimulation or similar, the method comprising the steps of;

- providing a subsea unit comprising storing means for well fluids,

- providing a fluid flow connection between a main flow path and the subsea unit, which main flow path extends from a well through the subsea tree to a production facility,

- allowing the well to flow for a desired period of time through the fluid flow connection and to the subsea unit,

- disconnecting the fluid flow connection from the main flow path.

2. Method according to claim 1, wherein the method further comprises the step of;

- running the subsea unit on a line from a vessel.

3. Method according to claim 1 or 2, wherein the method comprises the step of;

- providing the subsea unit at a subsea location either before starting up production from a new well or temporary shutting-off production from a producing well.

4. Method according to claims 1, 2 or 3, wherein the method comprises the step of;

- connecting the fluid flow connection by the use of a remotely operated vehicle.

5. Method according to any of the preceding claims, wherein the method comprises the step of depressurizing the storing means.

6. Method according to any of the preceding claims, wherein the method comprises the step of lifting the storing means to a vessel.

7. Method according to claim 6, wherein the method comprises the step of depressurizing the storing means before lifting the storing means to a vessel.

8. Method according to any of the preceding claims, wherein the desired period of time for the well fluids to be produced through the fluid flow connection to the subsea unit corresponds to the time necessary for performing the temporary operation.

9. Method according to any of the preceding claims, wherein the well fluids comprises a multiphase flow and that at least one of the phases of said multiphase flow is separated out and stored in the separator, while at least one of the other of said phases is produced.

10. Method according to any of claims 1 to 8, wherein the well fluids comprises a multiphase flow and that all of the phases of said multiphase flow are separated in the subsea unit and produced.

11. Method according to any of claims 1-8, wherein the well fluids comprises a multiphase flow and that all of the phases of said multiphase flow are separated out and stored in the subsea unit.

12. Method according to any of the preceding claims 1-11, wherein the method comprises the step of;

- arranging an umbilical line for injection fluids, the umbilical line extending from a vessel on the surface to at least one of subsea unit, subsea tree or well control unit, and

- cleaning the well by injecting fluids to the well through at least one of said subsea unit, subsea tree or well control unit, and

- starting up or resuming production when the cleaning is completed.

13. Method of performing a well operation, such as well clean-up, flow testing, well stimulation or similar, the method comprising the steps of;

- either before starting up production from a new well or temporary shutting-off production from a producing well, providing a subsea unit comprising storing means for well fluids on a seabed,

- performing a well operation such as well completion work or intervention,

- connecting a fluid flow connection between the subsea unit and a main flow path of the well,

- allowing the well to flow for a desired period of time through the fluid flow connection and to the subsea unit,

- disconnecting the fluid flow connection from the main flow path, and

- starting-up or resuming production from the well.

14. Method according to claim 13, wherein the method comprises the step of;

- arranging an umbilical line for injection fluids, the umbilical line extending from a vessel on the surface to at least one of the subsea unit, subsea tree or control unit, and

- cleaning the well by injecting fluids to the well through at least one of said subsea unit, subsea tree or a well control unit, and

- starting up or resuming production when the cleaning is completed.

15. Method according to claims 13 or 14, wherein the well fluids comprises a multiphase flow and that one of the phases of said multiphase flow is separated out and stored in the subsea unit, while at least one of the other of said phases is produced.

16. Method according to claims 13 or 14, wherein the well fluids comprises a multiphase flow and that all of the phases of said multiphase flow are separated in the subsea unit and produced.

17. Method according to claims 13 or 14, wherein the well fluids comprises a multiphase flow and that all of the phases of said multiphase flow is separated out and stored in the subsea unit.

18. Method according to any of claims 13-17, wherein the method further comprises the step of;

- running the subsea unit on a line from a vessel.

19. Method according to any of the preceding claims 13-18, wherein the method comprises the step of;

- providing the subsea unit at a subsea location either before starting up production from a new well or temporary shutting-off production from a producing well.

20. Method according to any of the preceding claims 13-19, wherein the method comprises the step of;

- connecting the fluid flow connection by the use of a remotely operated vehicle.

21. Method according to any of the preceding claims 13-20, wherein the method comprises the step of depressurizing the storing means.

22. Method according to any of the preceding claims 13-20, wherein the method comprises the step of lifting the storing means to a vessel.

23. Method according to claim 22, wherein the method comprises the step of depressurizing the storing means before lifting the storing means to a vessel.

24. Method according to any of the preceding claims 13-23, wherein the desired period of time for the well fluids to be flowed through the fluid flow connection to the subsea unit corresponds to the time necessary for performing the temporary operation.

25. System adapted for performing a temporary well operation such as well clean-up, flow testing, well stimulation or similar, wherein the system comprises;

- a subsea unit comprising storing means for well fluids,
- a fluid flow connection between a main flow path and the subsea unit, which main flow path extends from a well through a subsea tree to a production facility,
- means for allowing the well to flow, through the fluid flow connection and to the subsea unit for a desired period of time,
- connection means for connecting and disconnecting the fluid flow connection from the main flow path.

26. System according to claim 25, wherein the system comprises at least one choke valve arranged in the main flow path, and wherein the fluid flow connection is connected to the main flow path upstream the choke valve.

27. System according to claims 25 or 26, wherein the storing means comprises at least one separator and/ or tank.

28. System according to claim 27, wherein the separator comprises a gravity separator and/or an inline separator.

29. System according to any of the preceding claims 25-28, wherein the means for allowing the well to produce for a desired period of time comprises valve means in connection with the fluid flow connection.

30. System according to any of the preceding claims 25-28, wherein the fluid flow connection comprises a jumper, pipe or tube.

31. System according to any of the preceding claims 25-30, wherein the subsea unit further comprises separating means, pumps, flow meters, valves and/ or sand and debris management devices.

32. System according to any of the preceding claims 25-31, wherein the system further comprises a subsea well control package, which well control package comprises pipe rams, coil tubing rams, blind shear rams and/ or emergency disconnect features.

33. System according to any of the preceding claims 25-32, wherein the system comprises depressurization means for depressurizing the storing means.

34. System according to any of the preceding claims 25-33, wherein an umbilical line for injection fluids is arranged extending from a vessel on the surface to at least one of said subsea unit, subsea tree or a well control unit.

35. System adapted for performing a well operation such as well clean-up, flow testing, well stimulation or similar, wherein the system comprises;

- a subsea unit comprising a separator for well fluids,
- a fluid flow connection between a main flow path and the subsea unit, which main flow path extends from a well through a subsea tree to a production facility,
- means for allowing the well to flow, through the fluid flow connection and to the subsea unit for a desired period of time,
- connection means for connecting and disconnecting the fluid flow connection from the main flow path.

36. System according to claim 35, wherein the subsea unit comprises a separator and a storing means.

37. System according to claim 36, wherein the separator comprises storing means.

38. System according to any of the preceding claims 35-37, wherein the system comprises at least one choke valve arranged in the main flow path, and wherein the fluid flow connection is connected to the main flow path upstream the choke valve.

39. System according to claims 36 or 37, wherein the separator comprises a gravity separator and/or an inline separator.

40. System according to any of the preceding claims 35-39, wherein the means for allowing the well to produce for a desired period of time comprises valve means in connection with the fluid flow connection.

41. System according to any of the preceding claims 35-40, wherein the fluid flow connection comprises a jumper, pipe or tube.

42. System according to any of the preceding claims 35-41, wherein the subsea unit further comprises at least one of the following equipments; separating means, pumps, flow meters, valves or sand and debris management devices.

43. System according to any of the preceding claims 35-42, wherein the system further comprises a subsea well control package, which well control package comprises pipe rams, coil tubing rams, blind shear rams and/ or emergency disconnect features.

44. System according to any of the preceding claims 35-43, wherein the system comprises depressurization means for depressurizing the separator.

45. System according to any of the preceding claims 35-44, wherein an umbilical line for injection fluids is arranged extending from a vessel on the surface to at least one of said subsea unit, subsea tree or a well control unit.

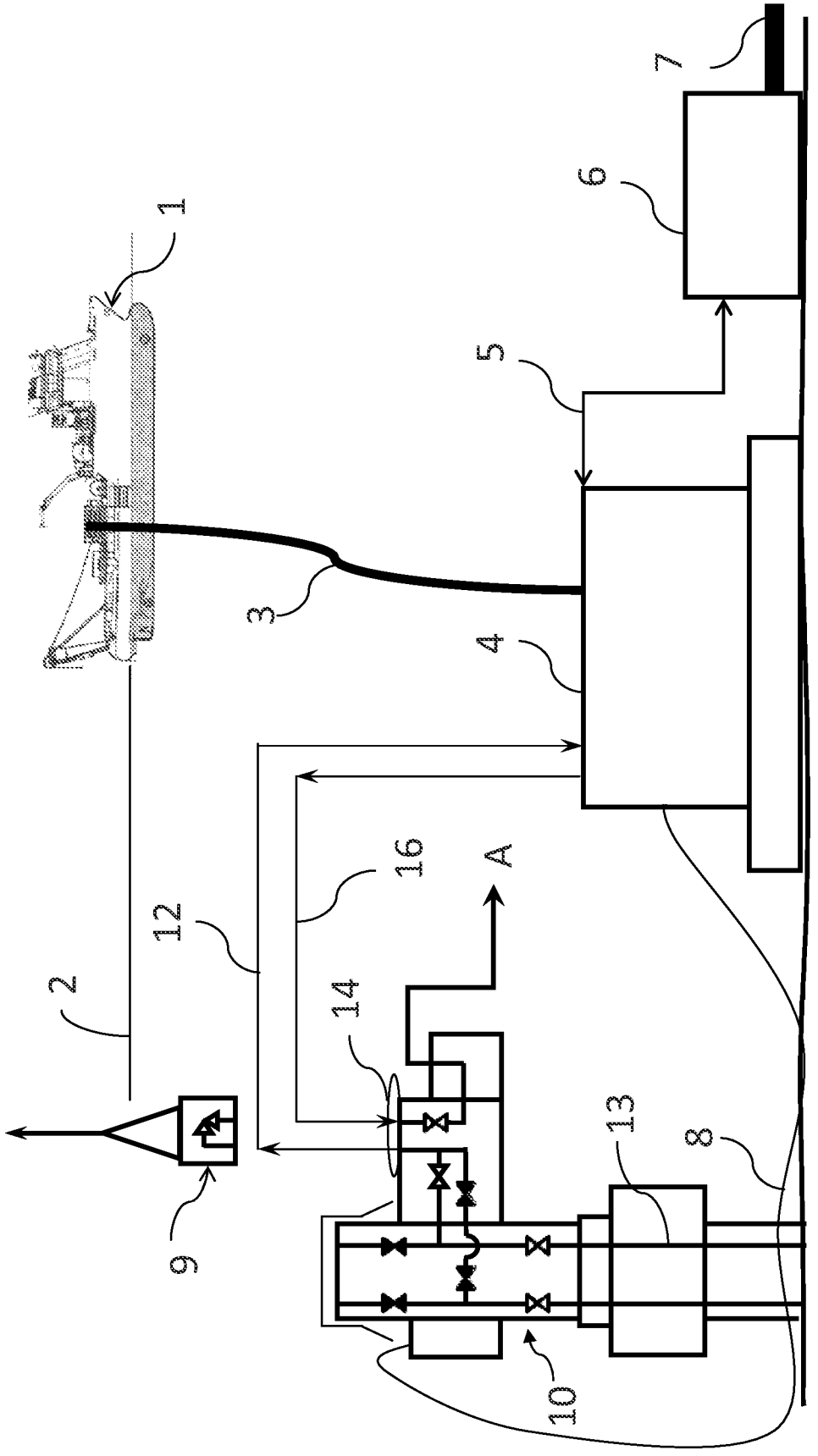

Fig. 1

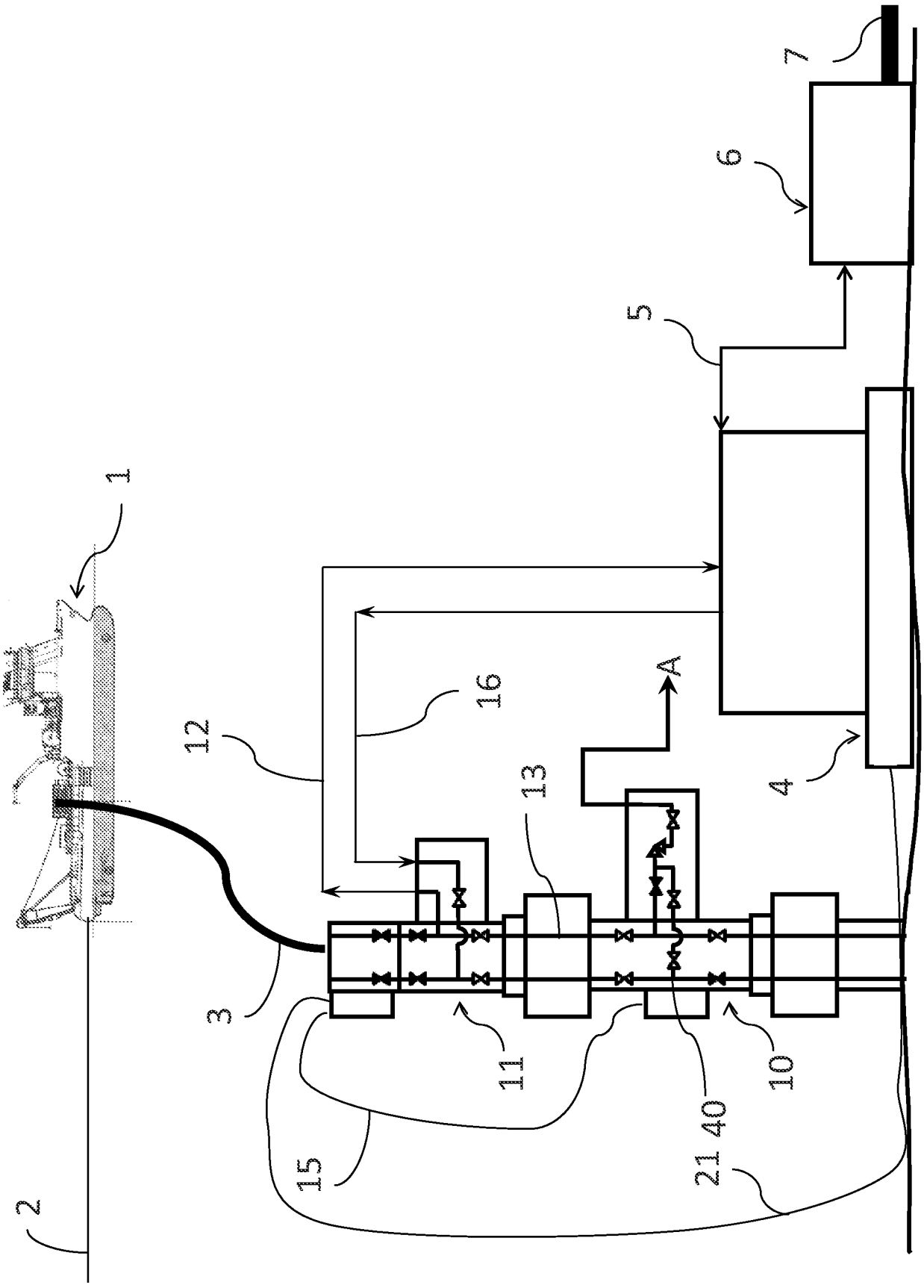

Fig. 1A

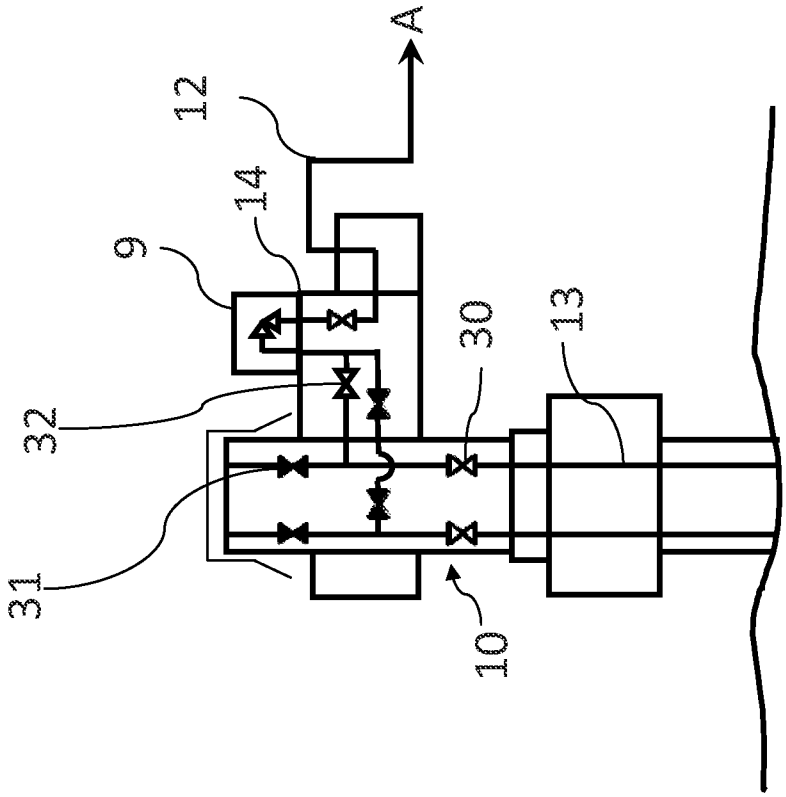

Fig. 2

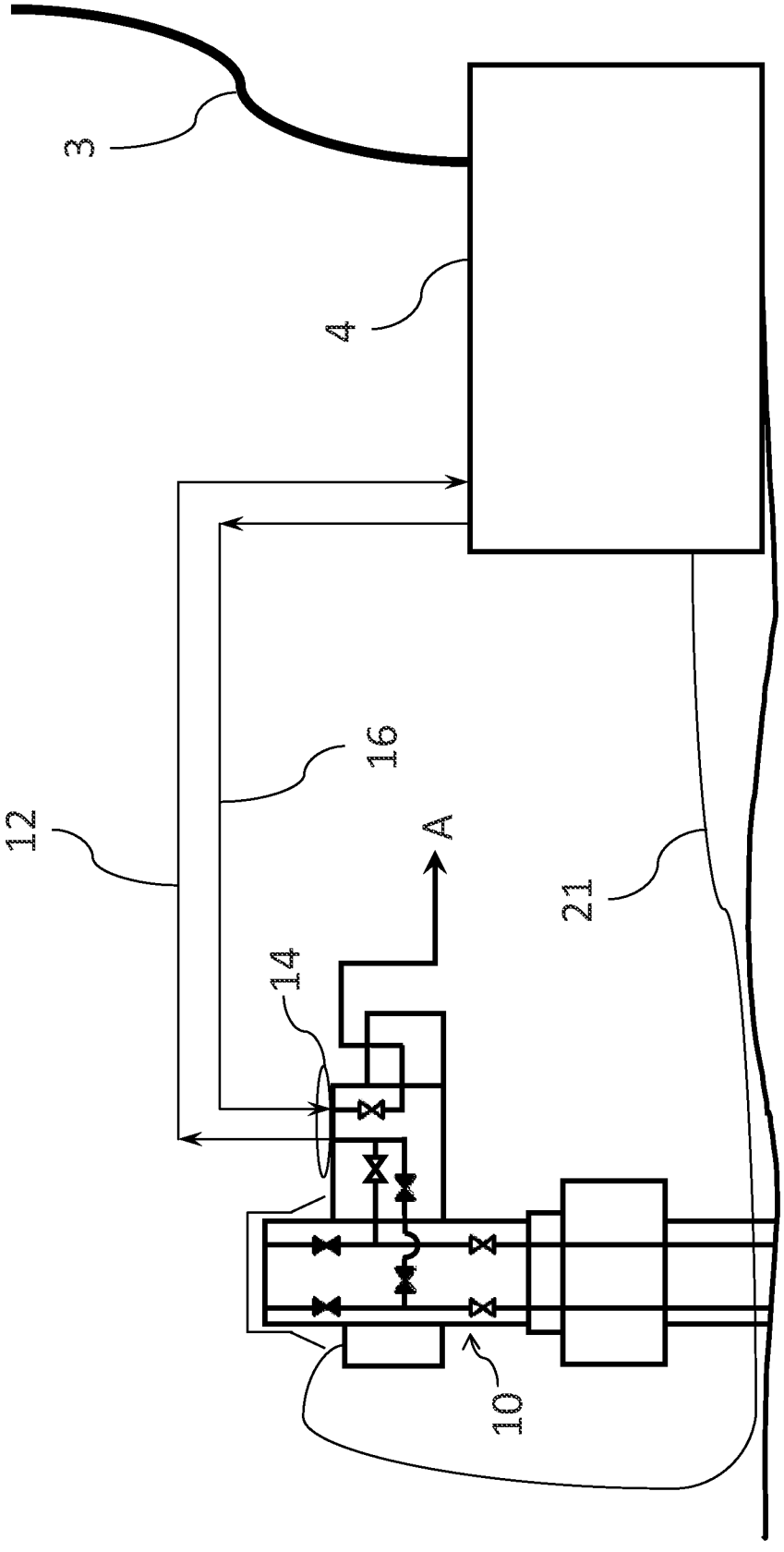

Fig. 3

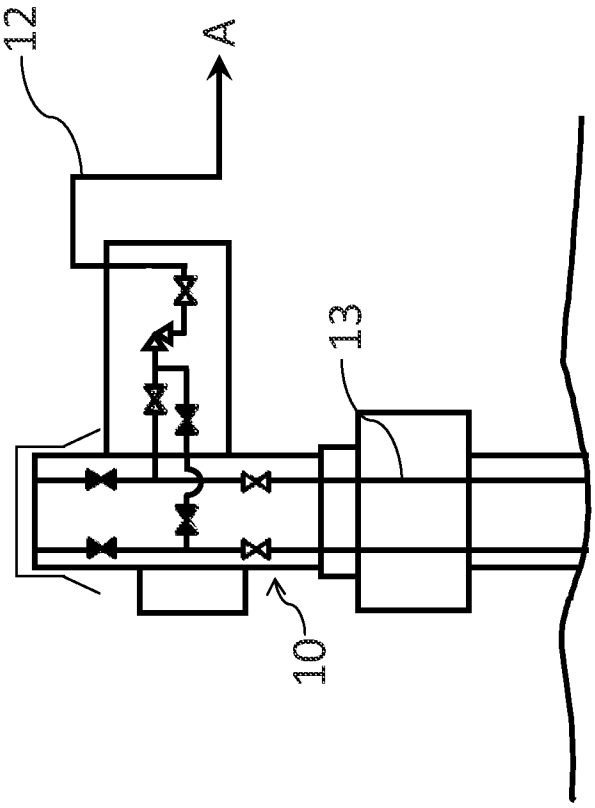

Fig. 4

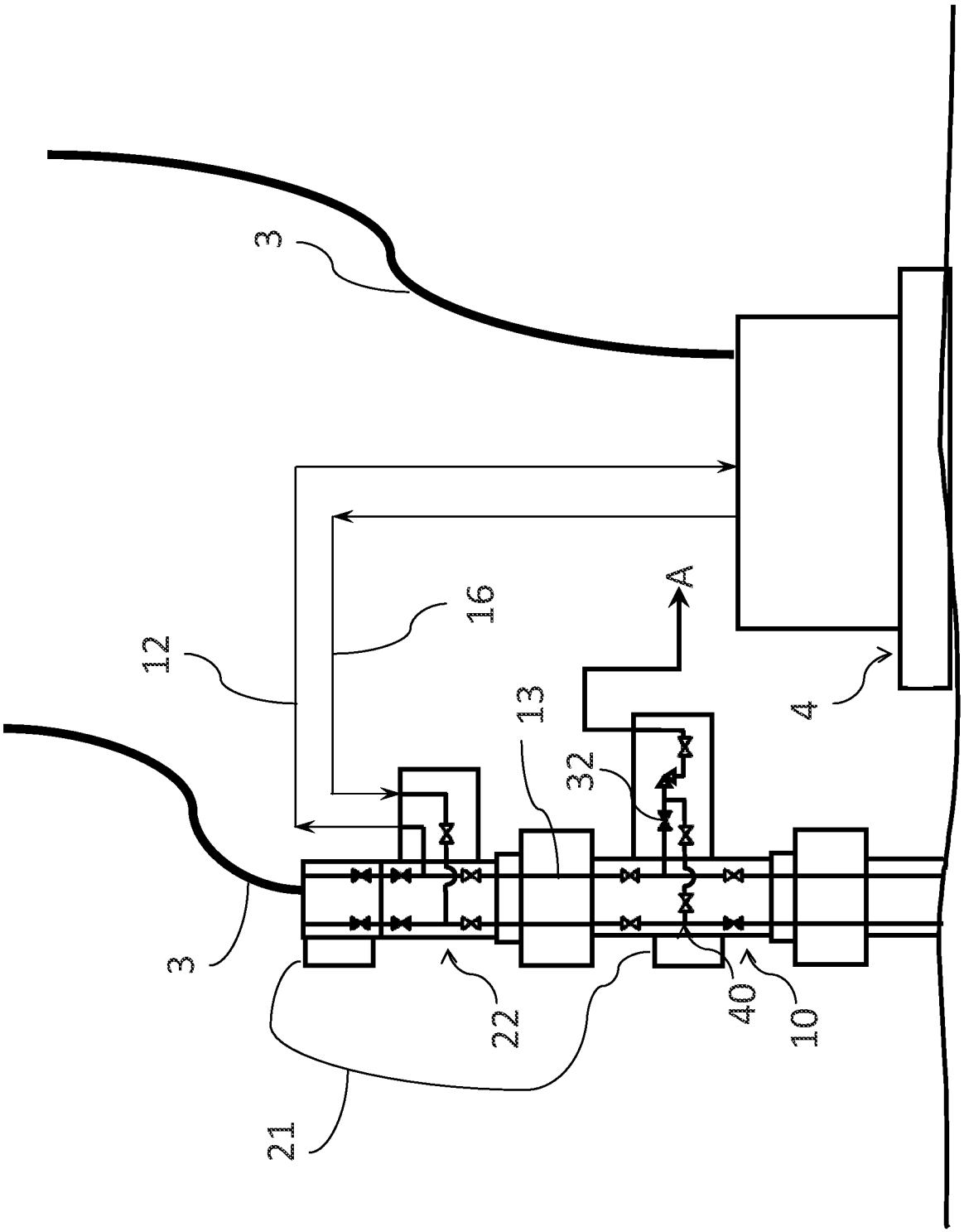

Fig. 5

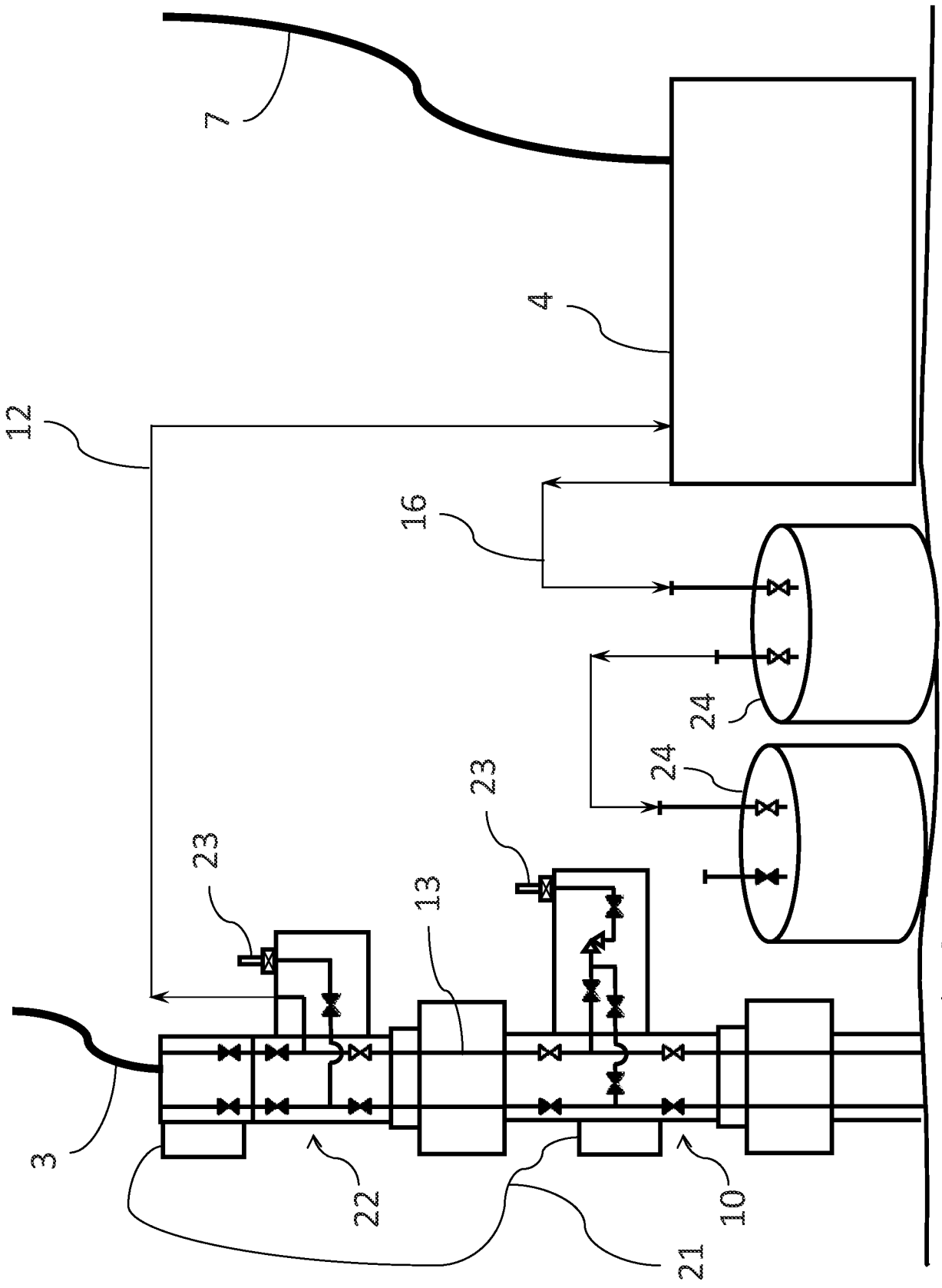

Fig. 6

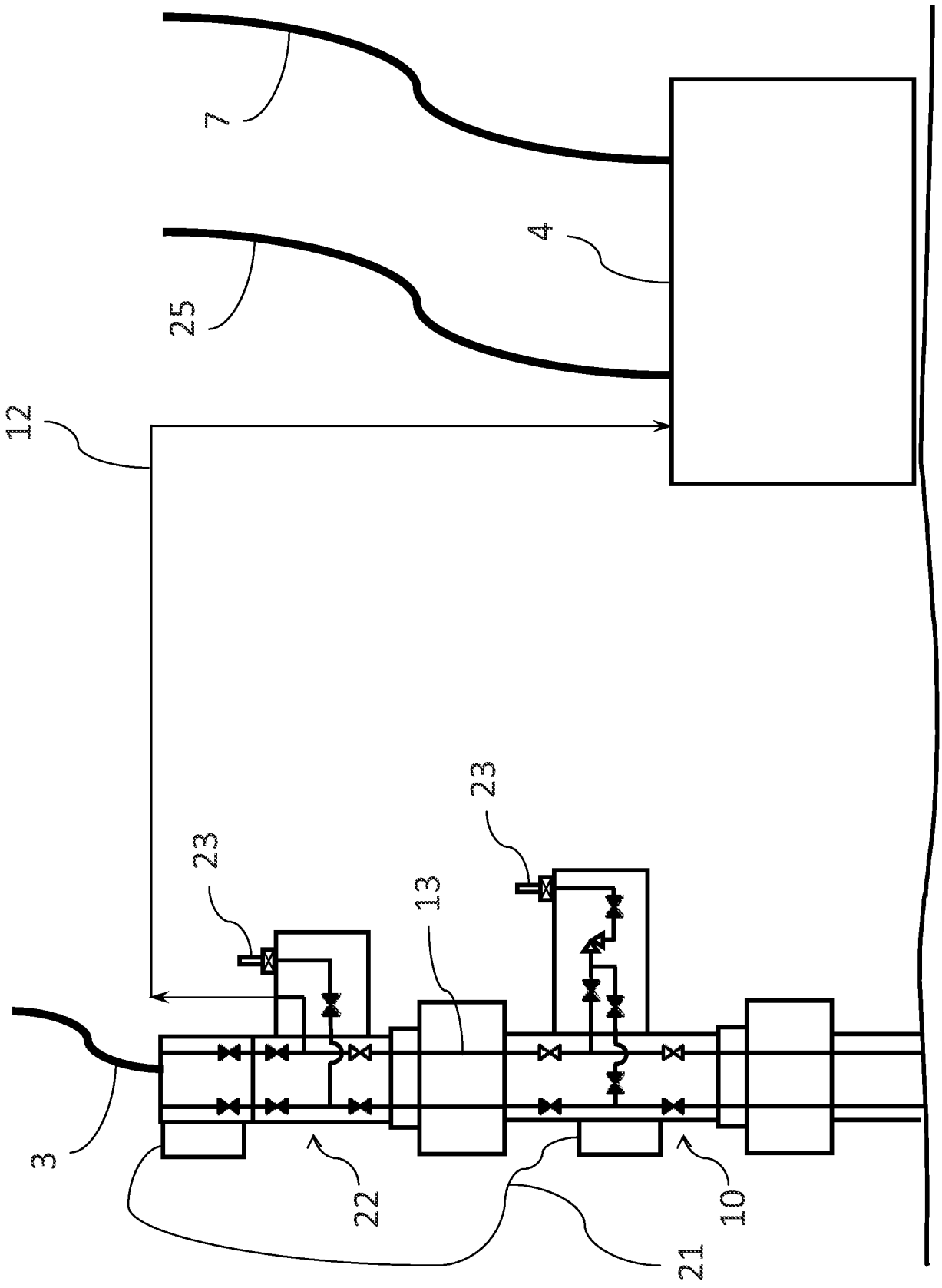

Fig. 7

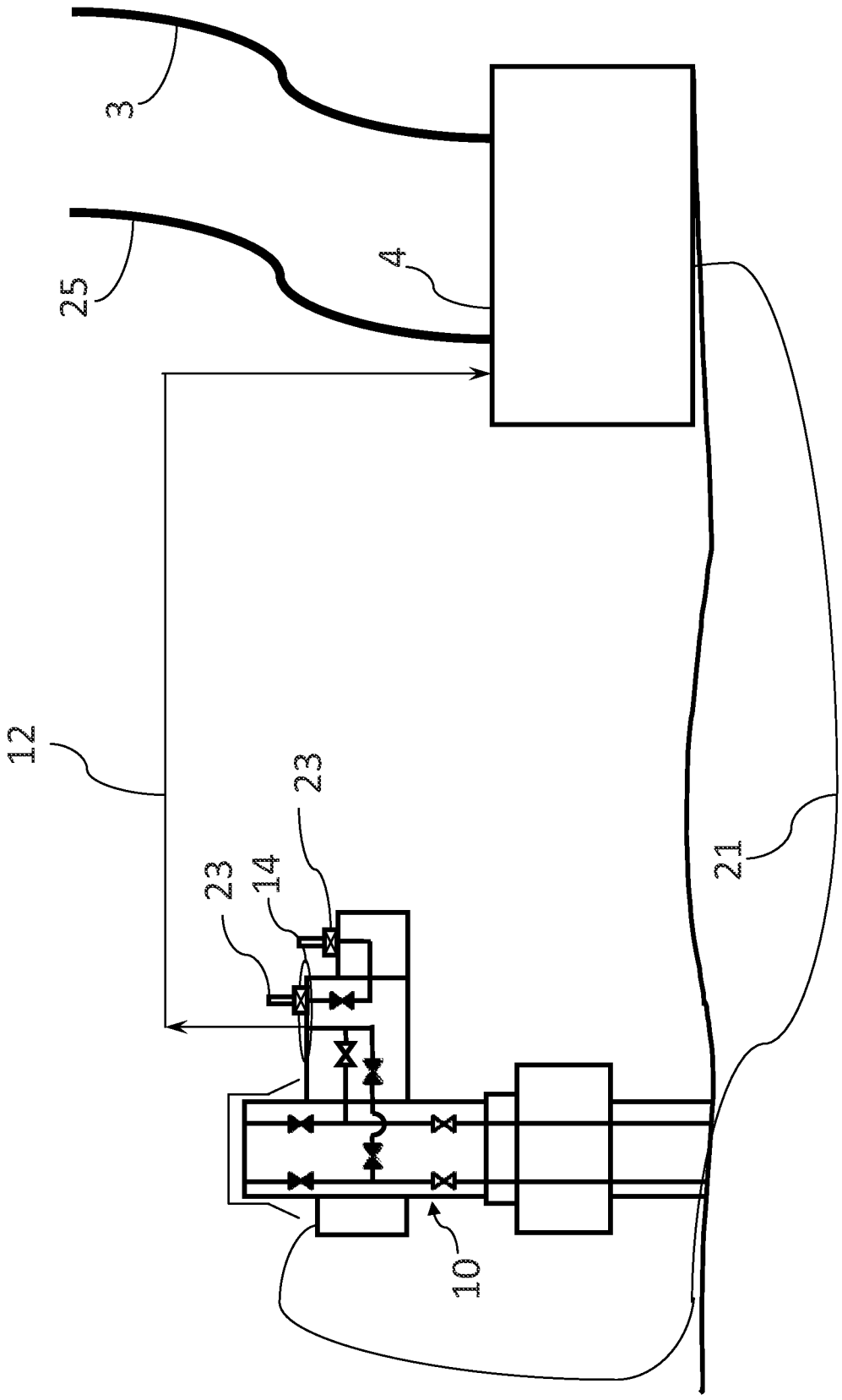

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US12/44559

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - E21B 19/02, 21/01, 21/06, 34/04 (2012.01)
USPC - 114/257; 166/357, 311; 405/210
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): E21B 7/12, 12/06, 15/02, 17/18, 19/02, 21/01, 21/06, 34/04, 37/06, 37/08 (2012.01)
USPC: 114/257; 166/357, 344, 311, 345, 355, 338, 351, 244.1; 405/210

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent (US-Granted, US-Applications, EP-A, EP-B, WO, JP, DE-G, DE-A, DE-T, DE-U, GB-A, FR-A); DialogPRO (Derwent, INSPEC, NTIS, PASCAL, Current Contents Search, Dissertation Abstracts Online, Inside Conferences); Google.com; Google Scholar; vessel*; boat*; tanker*; barge*; transporter*; ship*; cutting*; waste*; drilling; return; well; boring; fluid*1; mud*; stream; sub*1sea

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6527054 B1 (FINCHER, RW et al.) March 4, 2003; figures 1, 2, 5; abstract; column 2, lines 5-10; column 3, lines 13-35; column 3, lines 40-45; column 4, lines 5-25; column 4, lines 55-60; column 5, lines 1-10; column 5, lines 35-45; column 5, lines 55-60; Claim 9	1, 2, 3/1, 3/2, 13, 14, 15/13, 15/14, 16/13, 16/14, 17/13, 17/14, 25, 26, 27/25, 27/26, 28/27/25, 28/27/26, 35-37, 38/35, 38/36, 38/37, 39/36, 39/37
Y	US 2012/0037376 A1 (LE MOIGN, Y et al.) February 16, 2012; paragraphs [0002], [0003], [0005]-[0008], [0023], [0036]	1, 2, 3/1, 3/2, 13, 14, 15/13, 15/14, 16/13, 16/14, 17/13, 17/14, 25, 26, 27/25, 27/26, 28/27/25, 28/27/26, 35-37, 38/35, 38/36, 38/37, 39/36, 39/37
Y	US 7958948 B2 (STAVE, R) June 14, 2011; figures 1, 2, 7, 8; column 1, lines 12-35 and lines 55-60; column 3, lines 5-20; column 4, lines 20-25	1, 2, 3/1, 3/2, 25, 26, 27/25, 27/26, 28/27/25, 28/27/26, 35-37, 38/36, 38/37, 39/36, 39/37
Y	US 7225877 B2 (YATER, RW) June 5, 2007; figures 1, 2, 4; column 1, lines 15-25; column 1, lines 35-50; column 2, lines 32-35; column 4, lines 53-60	2, 3/2, 14, 15/14, 16/14, 17/14
Y	US 7261164 B2 (HOLLIER, G) August 28, 2007; figure 1; column 3, lines 1-10	17/13, 17/14

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 August 2012 (30.08.2012)	16 OCT 2012
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US12/44559

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

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-12, 18-24, 29-34, 40-45
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

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

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.