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(54) **OFFSHORE COILED TUBING SYSTEM**

(57) The present invention relates to an offshore coiled tubing system for running a coiled tubing into a subsea well offshore, comprising a well comprising a well tubular metal structure having a top and an inner face, a blowout preventer (BOP) arranged in the top of the well tubular metal structure, and a sluice having a top part for entry of coiled tubing, the BOP being arranged between the well tubular metal structure and the sluice, the sluice having a sealing unit arranged in the top part of the sluice for sealing around the coiled tubing, a vessel comprising a deck, a coiled tubing reel comprising coiled tubing, the coiled tubing having a first end, and a first driving unit for assisting in driving the coiled tubing into/from the well, the first driving unit being configured to be movable in relation to the deck to compensate for heave motion of the vessel, and a second driving unit for assisting in driving the coiled tubing into/from the well, wherein the second driving unit is movable in relation to the BOP. The present invention also relates to an offshore coiled tubing method.

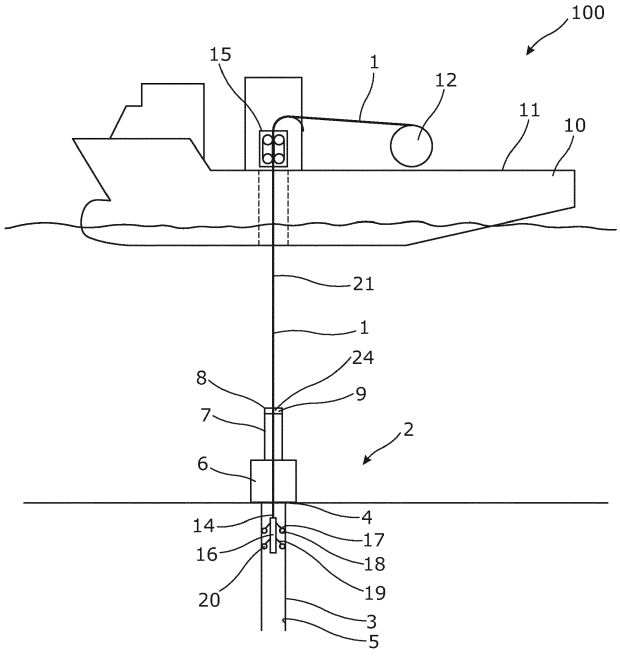

Fig. 2

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Description

[0001] The present invention relates to an offshore coiled tubing system for running a coiled tubing into a subsea well offshore, comprising a well comprising a well tubular metal structure having a top and an inner face, a blowout preventer (BOP) arranged in the top of the well tubular metal structure, and a sluice having a top part for entering of coiled tubing, the BOP being arranged between the well tubular metal structure and the sluice, the sluice having a sealing unit arranged in the top part of the sluice for sealing around the coiled tubing; a vessel comprising a deck, a coiled tubing reel comprising coiled tubing, the coiled tubing having a first end, and a first driving unit for assisting in driving the coiled tubing into/from the well, the first driving unit being configured to be movable in relation to the deck to compensate for heave motion of the vessel; and a second driving unit for assisting in driving the coiled tubing into/from the well. The present invention also relates to an offshore coiled tubing method.

[0002] Coiled tubing has many uses in relation to a hydro-carbon-containing subsea well. Coiled tubing (CT) is usually transported to the subsea well W on a vessel V where the coiled tubing is coiled around a reel R arranged on the deck D of the vessel, as shown in Fig. 1. When running the coiled tubing into the subsea well, a heave compensator CT injector HCI slidably arranged, e.g. in a moonpool M of the vessel, assists the CT, and a subsea injector SI arranged on top of a sluice on top of a blowout preventer (BOP) runs the coiled tubing into the well. The heave compensated CT injector slides up and down, compensating for the heave of the vessel, while assisting the coiled tubing into the well. The heave compensated CT injector is pre-set to keep the coiled tubing in tension through the sea, which is performed manually today.

[0003] A coiled tubing injector is a delicate system with many moving parts. It is critical for correct deployment and retrieval of the coiled tubing to working depth without causing physical damage to the coiled tubing pipe. A subsea injector is a marinised version of a standard injector head. Positioning at the seabed leaves the coiled tubing injector out of reach for ad hoc maintenance if required, except for a few functions that can be exercised using an ROV (remotely operated vehicle). Inability to operate the injector controls may result in the CT having to be cut and left in the well. The subsea injector is a heavy piece of machinery of approximately 10 tons that needs to be deployed through the water column for each run in the well. Positioned at the top of the sluice, it introduces an additional bending moment to the sluice and the wellhead connectors.

[0004] 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 offshore coiled tubing system which has a smaller risk of the CT being left in the well if failing, and/or is easier to repair/maintain while the CT can still be operated in the well.

[0005] 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 an offshore coiled tubing system for running a coiled tubing into a subsea well offshore, comprising:

- a well comprising:
  - a well tubular metal structure having a top and an inner face,
  - a blowout preventer (BOP) arranged in the top of the well tubular metal structure, and
  - a lubricator or sluice having a top part for entry of coiled tubing, the BOP being arranged between the well tubular metal structure and the lubricator or sluice, the lubricator or sluice having a sealing unit arranged in the top part of the lubricator or sluice for sealing around the coiled tubing,
- a vessel comprising:
  - a deck,
  - a coiled tubing reel comprising coiled tubing, the coiled tubing having a first end, and
  - a first driving unit for assisting in driving the coiled tubing into/from the well, the first driving unit being configured to be movable in relation to the deck to compensate for heave motion of the vessel, and
- a second driving unit for assisting in driving the coiled tubing into/from the well, wherein the second driving unit is movable in relation to the BOP.

[0006] Furthermore, the second driving unit may be connected to the first end of the coiled tubing.

[0007] In addition, the second driving unit may have an outer diameter which is smaller than an inner diameter of the BOP, or the lubricator or the sluice.

[0008] In another embodiment, the second driving unit moves along with the coiled tubing.

[0009] The offshore coiled tubing system may be a riserless coiled tubing system.

[0010] Moreover, the second driving unit may be configured to be moved into the well tubular metal structure together with the coiled tubing.

[0011] The second driving unit may be moved with the same speed as that with which the coiled tubing is being driven.

[0012] Furthermore, the second driving unit while driving the coiled tubing may be positioned inside the BOP and/or inside the well tubular metal structure. Hence, the second driving unit operates within the BOP and/or within the well tubular metal structure.

[0013] Also, the second driving unit may comprise several projectable parts configured to engage the inner face of the well tubular metal structure.

[0014] Furthermore, the projectable parts may each comprise a wheel on an arm, and each wheel may comprise a motor, such as a hydraulic or electrical motor.

[0015] The arm may be projectable by means of pressurised fluid.

[0016] Moreover, the first driving unit may be configured to drive the coiled tubing by engaging an outer face of the coiled tubing, and the second driving unit may be configured to drive the coiled tubing by engaging the inner face of the well tubular metal structure.

[0017] In addition, the second driving unit may be configured to provide a tension in the coiled tubing.

[0018] The sluice may be a riser or a lubricator.

[0019] The sealing unit may be a stripper or a tandem (dual) stripper.

[0020] The present invention also relates to an offshore coiled tubing method for running a coiled tubing into a well offshore, comprising:

- positioning a vessel of an offshore coiled tubing system according to the present invention,
- connecting the second driving unit to the first end of the coiled tubing,
- introducing the second driving unit and part of the coiled tubing into the lubricator or sluice,
- pressurising the lubricator or sluice for providing a pressure inside the lubricator or sluice, said pressure being substantially equal to a pressure in the well tubular metal structure, and
- driving the coiled tubing into the well tubular metal structure by means of the second driving unit.

[0021] Furthermore, the driving of the coiled tubing into the well tubular metal structure by means of the second driving unit may be performed by moving the second driving unit together with the coiled tubing into the well tubular metal structure.

[0022] Moreover, the driving of the coiled tubing into the well tubular metal structure by means of the second driving unit may be performed by providing the second driving unit with several projectable parts configured to engage the inner face of the well tubular metal structure.

[0023] 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

[0024] Fig. 1 shows a schematic prior art offshore coiled tubing system, and

[0025] Fig. 2 shows a schematic offshore coiled tubing system according to the present invention.

[0026] 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.

[0027] Fig. 2 shows an offshore coiled tubing system 100 for driving or injecting coiled tubing 1 into a subsea well 2. The offshore coiled tubing system 100 comprises a subsea well 2 having a well tubular metal structure 3 with a top 4 and an inner face 5. The offshore coiled tubing system 100 further comprises a blowout preventer (BOP) 6 arranged in the top of the well tubular metal structure and a sluice 7 having a top part 8 for entry of coiled tubing 1. The BOP is arranged between the well tubular metal structure 3 and the lubricator or sluice 7, so that the BOP 6 is at its lower end connected to the top of the well tubular metal structure and at its upper end to the lower part of the sluice. The lubricator or sluice 7 has a sealing unit 9 arranged in the top part 8 of the sluice 7 for sealing around the coiled tubing 1. The offshore coiled tubing system 100 further comprises a vessel 10 comprising a deck 11, and a coiled tubing reel 12 for storing coiled tubing having a first end 14. The system further comprises a first driving unit 15 for assisting in injection/driving of coiled tubing into the well or pulling of coiled tubing out of the well. The first driving unit 15 is movable in relation to the deck 11, e.g. slidable in a tower and/or moonpool of the vessel, to compensate for heave motion of the vessel, when positioned in the water above the well. The offshore coiled tubing system 100 further comprises a second driving unit 16 for assisting mainly in driving coiled tubing into the well, but also for assisting when pulling the coiled tubing out of the well. As can be seen, the second driving unit 16 is movable in relation to the BOP 6 and not fixed at the top of the sluice 7 as in prior art.

[0028] By having the second driving unit 16 as a movable part in relation to the BOP 6 inside the lubricator or sluice 7, the well 2 or the BOP 6, the second driving unit does not have to be controlled in relation to the first driving unit as in known solutions. When the second driving unit moves along with the coiled tubing, the first and second driving units do not have to be controlled very accurately as in the known solutions, where the second driving unit is arranged in the top of the well on top of the BOP. This is due to the fact that when entering the well, the second driving unit provides the tension in the coiled tubing and the first driving unit can thus just let the coiled tubing roll around it into the well, and likewise when retracting the coiled tubing from the well, the first driving unit pulls and the second driving unit provides no force at all. Thus with the present solution, the first and the second driving units need not be controlled simultaneously and in relation to each other.

[0029] Furthermore, by the present solution of having the second driving unit within the well and not on top of the BOP, the second driving unit is much smaller than the known subsea injector and does not result in a large bending moment on the top of the well, i.e. on top of the BOP and the lubricator or sluice.

[0030] By sluice is meant a chamber in which e.g. a tool is provided and pressure tested and thereafter let into the well when the chamber has approximately the

same pressure as the well. The sluice may have further means for changing the fluid inside the chamber. Thus, the sluice may be a lubricator or a small riser.

[0031] By having the second driving unit 16 as a movable part in relation to the BOP 6 inside the lubricator or sluice 7, the well 2 or the BOP 6, the second driving unit can be made less complex and large, and the offshore coiled tubing system has a smaller risk of the CT being left in the well if failing, since the system is easier to repair. The CT can therefore still be operated in the well even though the second driving unit needs repairing.

[0032] Coiled tubing is "bendable" tubing which is capable of being coiled around the reel on the deck without losing its properties by such coiling. Coiled tubing is therefore not as rigid as drill pipe and cannot hold a straight shape in the water like drill pipe can. There is therefore a need for driving units to keep the coiled tubing in a straight line in the sea, so that it does not bend too much due to current and its own mass, hence preventing damage caused by such bending. There is also a need for driving units ensuring that the coiled tubing is not stretched too much due to the heave in the vessel. The second driving unit is capable of providing such straight shape of the coiled tubing together with the first driving unit even though the second driving unit is moving in relation to the BOP.

[0033] The second driving unit 16 is connected to the first end 14 of the coiled tubing 1 and thus pulls in the CT 1 while moving forward in the well tubular metal structure 3 of the well 2 together with the CT 1. The second driving unit 16 is thus moving with the same speed as the coiled tubing. The second driving unit 16 is thus configured to provide a tension in the coiled tubing 1, so that the coiled tubing 1 is kept substantially straight between the vessel and the second driving unit 16.

[0034] By having the second driving unit 16 arranged in front of the coiled tubing 1 while pulling it downwards, the coiled tubing is kept substantially straight over a longer part, as the coiled tubing is also kept straight at the part being in the well 2 and not just between the vessel and the top of the well as in the known solutions where the second driving unit is arranged in the top of the riser above the BOP.

[0035] In Fig. 2, the second driving unit 16 comprises several projectable parts 17 each comprising an arm 19 having a wheel 18, which is configured to engage the inner face of the well tubular metal structure 3. Each wheel 18 comprises a motor 20 so that each wheel contributes to propelling the second driving unit 16 forward in the well tubular metal structure 3. The motor 20 in the wheel 18 may be a hydraulically driven motor, which is driven directly or indirectly by the pressurised fluid supplied in the CT. By indirectly is meant e.g. using a pump driven by the pressurised fluid supplied in the CT or a turbine/generator driving a motor driving a pump. In another embodiment, the motor is an electrical motor being driven by electricity from a generator driven by a turbine arranged in the second driving unit 16 and powered by the pressurised fluid supplied in the CT.

[0036] The arm 19 of the second driving unit 16 is projectable by means of pressurised fluid, e.g. from a second pump in the second driving unit 16. The second pump may be driven directly or indirectly by means of the pressurised fluid supplied in the CT in the same way as the wheels. The arms may, in another embodiment, be driven by gears and motor in the body of the second driving unit 16.

[0037] In yet another embodiment, the second driving unit may be a crawler-type where a first part and a second part are movable in relation to each other. The first part has projectable parts engaging the inner face of the well tubular metal structure while the second part with retracted projectable parts 17 moves in relation to the first part and then engages the inner face, after which the projectable parts 17 of the first part are retracted, and then the first part moves towards the second part and in this way crawls forward in the well like a worm. In yet another embodiment, the second driving unit may have a chain drive or caterpillar track like the traction units of a tank.

[0038] The first driving unit 15 of Fig. 2 is thus configured to drive the coiled tubing 1 by engaging an outer face 21 of the coiled tubing 1, while the second driving unit 16 is configured to drive the coiled tubing 1 by engaging the inner face 5 of the well tubular metal structure 3 while pulling in the first end 14 of the CT 1.

[0039] The sluice 7 is configured to be pressurised to obtain substantially the same pressure as in the well 2 before opening the BOP 6, and thus pressure testing such equipment and BOP, sluice/lubricator and stripper connections before they are lowered into the well. Therefore the sluice 7 comprises a sealing unit 9 in the top part 8 for sealing the sluice 7 from its surroundings, e.g. the sea and the hydrostatic pressure. In Fig. 2, the sealing unit 9 is a stripper 24. The sluice 7 may be a short riser which does not extend all the way to the vessel, or be a lubricator.

[0040] The invention also relates to an offshore coiled tubing method for driving a coiled tubing 1 into a well 2 offshore, comprising positioning a vessel 10 of the above mentioned offshore coiled tubing system 100, connecting the second driving unit 16 to the first end 14 of the coiled tubing 1, introducing the second driving unit 16 and part of the coiled tubing 1 into the sluice 7, then pressurising the sluice 7 for providing a pressure inside the sluice, said pressure being substantially equal to a pressure in the well tubular metal structure 3, and subsequently driving the coiled tubing 1 into the well tubular metal structure by means of the second driving unit 16.

[0041] The driving of the coiled tubing 1 into the well tubular metal structure 3 by means of the second driving unit 16 is performed by moving the second driving unit together with the coiled tubing 1 into the well tubular metal structure. The driving of the coiled tubing into the well tubular metal structure by means of the second driving unit 16 is in Fig. 2 performed by providing the second driving unit with several projectable parts 17 in the form

of arms 19 having wheels 18, which are configured to engage the inner face 5 of the well tubular metal structure 3. The wheels 18 have a wheel ring engaging the inner face. The wheel ring may have a friction enhancing pattern for providing a better grip in the inner face of the well tubular metal structure.

[0042] 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.

[0043] By a casing or well tubular metal structure is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0044] The second driving unit 16 may be a downhole tractor having projectable arms having wheels, wherein the wheels contact the inner surface of the casing/well tubular metal structure for propelling the tractor and a tool forward in the casing. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

[0045] 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. An offshore coiled tubing system (100) for running a coiled tubing (1) into a subsea well (2) offshore, comprising:

- a well (2) comprising:
  - a well tubular metal structure (3) having a top (4) and an inner face (5),
  - a blowout preventer (6) arranged in the top of the well tubular metal structure, and
  - a sluice (7) having a top part (8) for entry of coiled tubing (1), the blowout preventer being arranged between the well tubular metal structure and the sluice, the sluice having a sealing unit (9) arranged in the top part of the sluice for sealing around the coiled tubing,
- a vessel (10) comprising:
  - a deck (11),
  - a coiled tubing reel (12) comprising coiled tubing, the coiled tubing having a first end (14), and
  - a first driving unit (15) for assisting in driving the coiled tubing into/from the well, the first driving unit being configured to be movable in relation to the deck to compensate for heave motion of the vessel, and
- a second driving unit (16) for assisting in driving the coiled tubing into/from the well,

wherein the second driving unit is movable in relation to the blowout preventer.

2. An offshore coiled tubing system according to claim 1, wherein the second driving unit is connected to the first end of the coiled tubing.

3. An offshore coiled tubing system according to any of the preceding claims, wherein the second driving unit is configured to be moved into the well tubular metal structure together with the coiled tubing.

4. An offshore coiled tubing system according to any of the preceding claims, wherein the second driving unit comprises several projectable parts (17) configured to engage the inner face of the well tubular metal structure.

5. An offshore coiled tubing system according to claim 4, wherein the projectable parts each comprises a wheel (18) on an arm (19), and each wheel comprises a motor (20), such as a hydraulic or electrical motor.

6. An offshore coiled tubing system according to claim 5, wherein the arm is projectable by means of pressurised fluid.

7. An offshore coiled tubing system according to any of the preceding claims, wherein the first driving unit is configured to drive the coiled tubing by engaging an outer face (21) of the coiled tubing, and the second driving unit is configured to drive the coiled tubing by engaging the inner face of the well tubular metal structure.

8. An offshore coiled tubing system according to any of the preceding claims, wherein the second driving unit is configured to provide a tension in the coiled tubing.

9. An offshore coiled tubing system according to claim 1, wherein the sluice is a riser or a lubricator.

10. An offshore coiled tubing system according to claim 1, wherein the sealing unit is a stripper.

11. An offshore coiled tubing method for running a coiled

tubing into a well offshore, comprising:

- positioning a vessel of an offshore coiled tubing system according to any of the preceding claims above a well,
- connecting the second driving unit to the first end of the coiled tubing,
- introducing the second driving unit and part of the coiled tubing into the sluice,
- pressurising the sluice for providing a pressure inside the sluice, said pressure being substantially equal to a pressure in the well tubular metal structure, and
- driving the coiled tubing into the well tubular metal structure by means of the second driving unit.

12. An offshore coiled tubing method according to claim 11, wherein the driving of the coiled tubing into the well tubular metal structure by means of the second driving unit is performed by moving the second driving unit together with the coiled tubing into the well tubular metal structure.

13. An offshore coiled tubing method according to claim 11 and/or 12, wherein the driving of the coiled tubing into the well tubular metal structure by means of the second driving unit is performed by providing the second driving unit with several projectable parts configured to engage the inner face of the well tubular metal structure.

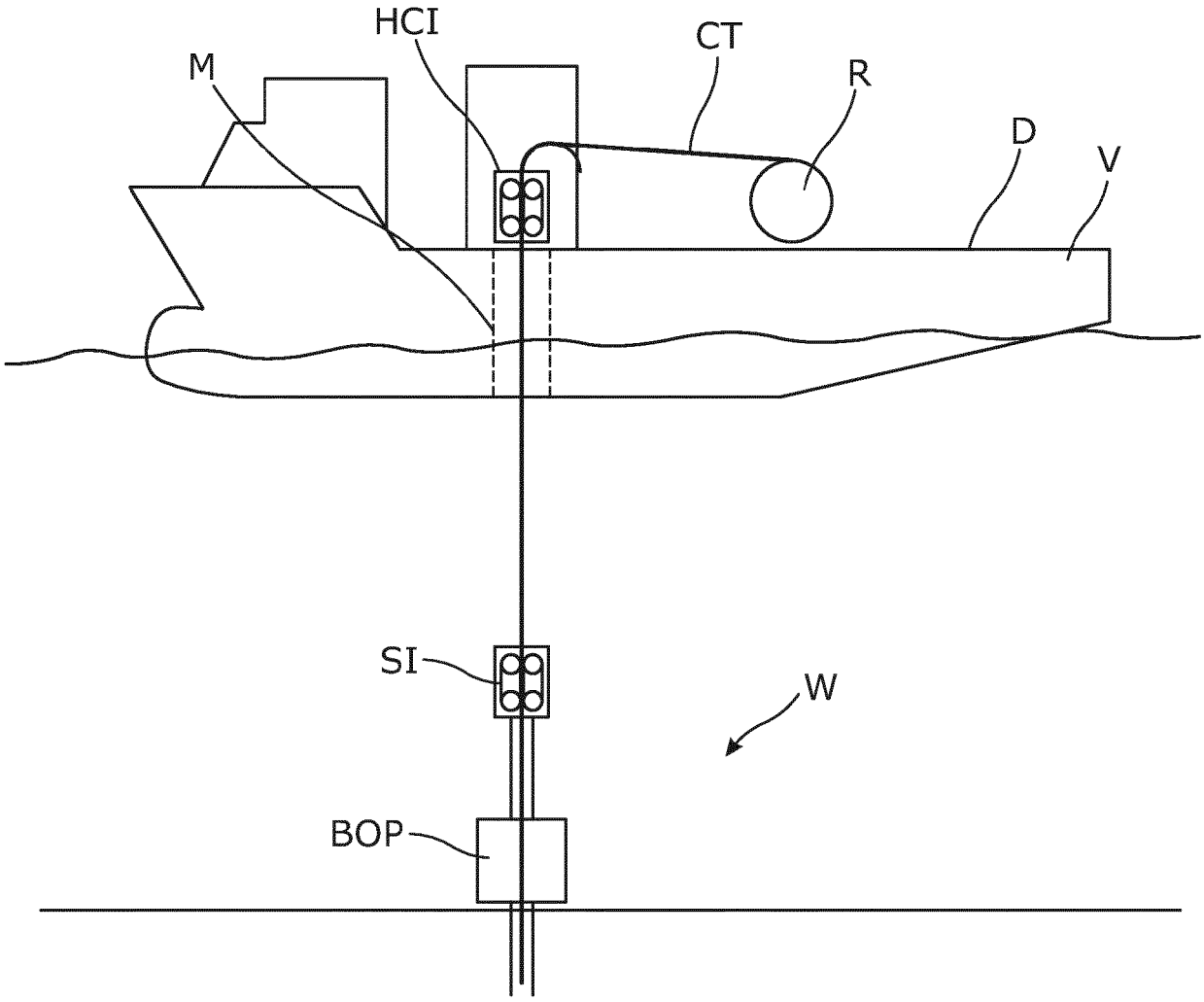

Fig. 1

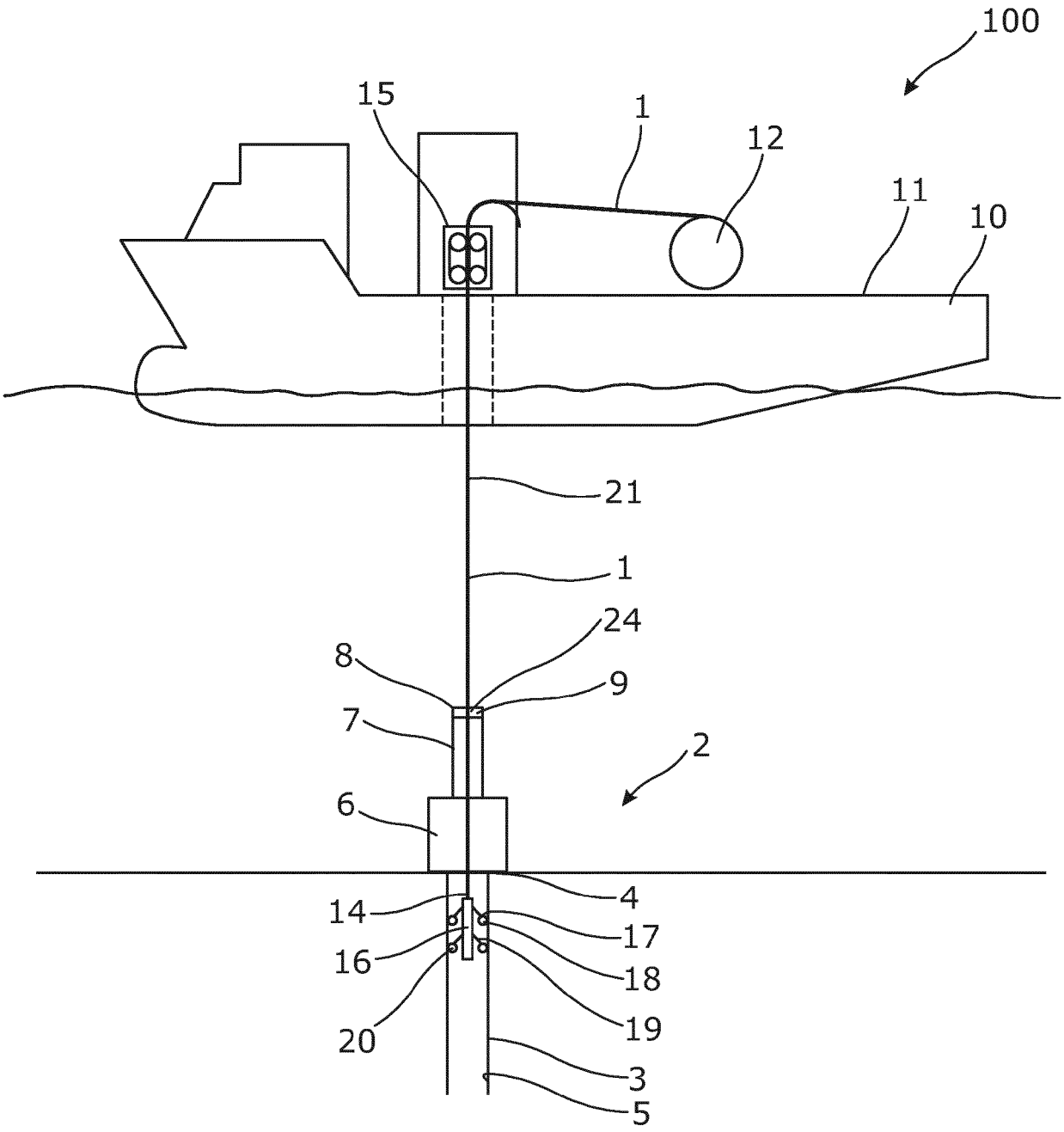

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 18 15 2553

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 July 2018	Altamura, Alessandra

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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