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Amended claims in accordance with Rule 137(2) EPC.

(54) A FLUID PUMPING DEVICE TO BE INSTALLED IN AN OFFSHORE FACILITY, RELATED OFFSHORE FACILITY AND PUMPING METHOD

(57) The fluid pumping device (25) is installed in an offshore facility (10) on a body of water (35) to pump fluid from or to the offshore fluid facility (10).

The fluid pumping device (25) comprises an upper buoyant body (140) intended to float at the surface (36) of the body of water (35) and to vertically move with the surface of the body of water; a plunger (110) configured to move within a cylinder volume (105) defined in the facility (10); and a rod (100) attached to the upper buoyant body (140) to jointly move vertically with the upper body (140) in the body of water (35). The rod (100) is connected to the plunger (110) to generate a pumping movement of the plunger (110) within the cylinder volume (105). The device (25) comprises a guide (60, 90, 50) to guide the vertical movement of the rod (100) in the body of water.

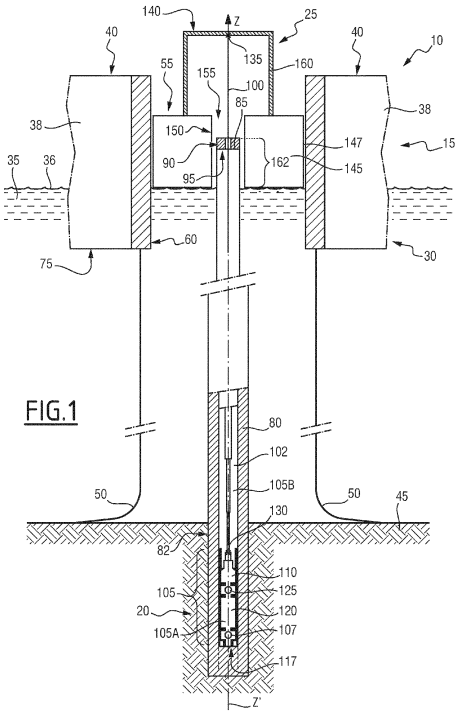

FIG.1

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Description

[0001] The present invention concerns a fluid pumping device to be installed in an offshore facility on a body of water to pump fluid from or to the offshore fluid facility.

[0002] The invention also concerns an offshore fluid production or/and injection facility comprising such a pumping device, and a method of pumping fluid in an offshore facility.

[0003] An offshore production site generally comprises fluid collection equipment located at the bottom of a body of water for collecting fluid from wellbores drilled through a subterranean reservoir. Numerous fluid injection and/or production lines extend through the body of water, through which the fluid flows to a surface installation.

[0004] In a first operation phase, if the pressure in the fluid reservoir is sufficient, the fluid can flow up naturally. However, in a second phase of reservoir operation, a well pump equipment is required to provide an artificial lift for the wellbore fluids.

[0005] Well pumps are generally placed at a lower point in the well. They are electrically or hydraulically powered, which requires that utilities are provided to the well.

[0006] Some offshore wells in which the fluid pressure was initially large enough to allow fluid production have been abandoned due to the decrease in fluid pressure, when they are not equipped with a subsurface pump.

[0007] Although these wells may still contain significant amounts of valuable fluids, equipping the well with a pump and connecting the pump to electrical power would lead to capital expenditures too high to make the well production valuable.

[0008] Moreover, fluid pumping requires energy, which is often produced with combustion of the produced fluid. This leads to production of greenhouse gasses, which should be decreased.

[0009] One aim of the invention is thus to provide a fluid pumping device for an offshore facility, which requires low capital expenditures, while having a reduced carbon footprint and, in particular, which does not require self-consumption of the fluid pumped.

[0010] To this aim, one subject matter of the invention is a fluid pumping device, characterized by:

- an upper buoyant body intended to float at the surface of the body of water and to vertically move with the surface of the body of water;
- a plunger configured to move within a cylinder volume defined in the facility;
- a rod attached to the upper buoyant body to jointly move vertically with the upper body in the body of water, the rod being connected to the plunger to generate a pumping movement of the plunger within the cylinder volume;
- a guide to guide the vertical movement of the rod in the body of water.

[0011] The fluid pumping device according to the invention may comprise one or more of the following feature(s), taken solely, or according to any technical feasible combination:

- the fluid pumping device comprises a mooring device attached to the buoyant body and configured to keep the upper buoyant body in a predetermined range of horizontal positions relative to the bottom of the body of water, the guide being fixed at the bottom of the body of water or under the bottom of the body of water;
- the fluid pumping device comprises a surface installation floating or fixed at the surface of the body of water, the guide being borne by the surface installation;
- the rod is directly connected to the plunger, the plunger being movable vertically jointly with the upper buoyant body and with the rod;
- the fluid pumping device comprises a transmission mechanism configured to transform a translational vertical motion of the rod into a translational or rotational motion of the plunger;
- the transmission mechanism is configured to transform a translational vertical motion of the rod into a translational or rotational motion of the plunger exclusively with mechanical energy; and
- the transmission mechanism is configured to transform the reciprocating translational motion of the rod along a first axis into a reciprocating translational motion of the plunger along a second axis offset with the first axis.

[0012] Another subject matter of the invention is a fluid production or/and injection facility extending in a body of water, comprising:

- a cylinder volume intended to receive fluid to be pumped, the cylinder volume being located below the bottom of the body of water or at the bottom of the body of water;
- a fluid pumping device as defined above, the plunger being movably received in the cylinder volume.

[0013] The facility according to the invention may comprise one or more of the following feature(s), taken solely, or according to any technical feasible combination:

- a well extending below the surface of the body of water, the cylinder volume being located in the well;
- a wellhead located at the bottom of the body of water, closing the well, the guide being positioned at the wellhead; and
- a surface installation, the wellhead being located at the surface installation, the guide extending above the wellhead.

[0014] Yet another subject matter of the invention is a

method of pumping fluid in an offshore facility on a body of water comprising:

- providing an upper buoyant body and a plunger connected to a rod;
- inserting the plunger into a cylinder volume defined in the facility;
- attaching the rod to the upper buoyant body;
- having the buoyant body float at the surface of the body of water and move vertically with the surface of the body of water;
- and letting the rod move vertically in the body of water jointly with the upper buoyant body, the vertical movement of the rod in the body of water being guided with a guide provided in the offshore facility,

the rod thus generating an alternating movement of the plunger which enables fluid to be pumped into the cylinder volume.

[0015] The method according to the invention may comprise the following feature:

- the offshore facility comprises a well extending below the surface of the body of water to reach a downhole fluid reservoir, the cylinder volume being located in the well and receiving fluid from the reservoir.

[0016] The invention will be better understood based on the following description, given solely as an example, and made in reference to the appended drawings, in which:

- [Fig.1] Figure 1 is a schematic sectional view, taken along a central axial plane, of a first fluid production or/and injection facility according to the invention;
- [Fig.2] Figure 2 is a schematic sectional view, taken along a central axial plane, of a second fluid production or/and injection facility according to the invention.

[0017] Figure 1 illustrates a first offshore fluid production or/and injection facility 10 located in a body of water 35.

[0018] The facility 10 comprises a surface installation 15 positioned above at least a fluid production well 20 bored in the underground below a bottom 45 of the body of water 35, and a pumping device 25 configured for pumping fluid from a fluid reservoir (not represented) in the underground through the well 20 and up to the surface installation 15.

[0019] The surface installation 15 is for example a semi-submersible installation comprising a buoyant platform 30 floating on a body of water 35.

[0020] The body of water 35 is typically a sea, an ocean or a lake, at the surface 36 of which waves, such as swell, can form and travel.

[0021] The platform 30 has equipment to recover and treat fluids, such as hydrocarbons, including oil and gas. More particularly, the platform 30 has a hull 38 and a deck 40 on which may be placed, for example, cranes, storage devices, and crew quarters (not represented).

[0022] The surface installation 15 is kept stationary in a predetermined range of horizontal positions relative to the bottom 45 of the body of water 35, and as well, relative to the well 20. To this effect, the platform 30 is connected to the bottom of the body of water 45 with several mooring lines 50.

[0023] The surface installation 15 comprises at least an opening 55 extending through the hull 38 along a vertical axis Z'Z when the body of water 35 is at rest.

[0024] The opening 55 opens downwardly in the body of water 35. To this end, the opening 55 is delimited by a guide wall 60, part of which extends under the surface 36 of the body of water 35 up to a base 75 of the hull 38.

[0025] The well 20 is bored under the bottom 45 of the body of water 35 to the subterranean fluid reservoir (not represented). Fluid, such as hydrocarbons, including oil and gas, is to be pumped from the fluid reservoir to the well 20.

[0026] The well 20 is connected to the platform 30 through at least one production tubing 80 in fluidic connection with the reservoir.

[0027] The production tubing 80 extends in a casing 82 of the well 20 from the reservoir up to the bottom 45 of the body of water and then to an upper end 85 located above the surface 36 of the body of water 35.

[0028] The upper end 85 is here positioned within the opening 55.

[0029] The upper end 85 is provided with a surface wellhead 90 having a stuffing box forming a structural and pressure interface between the production tubing 80 and the surface installation 15.

[0030] In particular, the wellhead 90 comprises a through hole 95 configured for the tight insertion of a rod 100 of the pumping device 25, which will be described below.

[0031] The production tubing 80 comprises an inner fluid collection and transportation volume 102, which extends below the wellhead 90 down to at least an opening located underground, near the reservoir.

[0032] In this example, a cylinder body is positioned at a lower part of the well 20. The cylinder body defines a cylinder volume 105.

[0033] The cylinder body is closed at its lower end by standing valve 107. It is open at its upper end emerging in the inner fluid collection and transportation volume 102.

[0034] The standing valve 107 is movable between a closed position and an open position. In the open position, fluid can flow from the reservoir into a lower part 105A of the cylinder volume 105, contrary to the closed position.

[0035] The pumping device 25 comprises a plunger 110 movable in reciprocable translation within the cylinder 105, a buoyant body 140 floating at the surface 36 of the body of water 35 and guided by the surface installa-

tion 15 to move vertically jointly with the surface 36 of the body of water 35, and the rod 100 connecting the buoyant body 140 to the plunger 110 through the production tubing 80.

[0036] The plunger 110 of the pumping device 25 is engaged in the cylinder volume 105.

[0037] The plunger 110 is movable in vertical translation in two directions along the vertical axis Z'Z relative to the cylinder volume 105.

[0038] The plunger 110 separates the lower part 105A and an upper part 105B of the cylinder volume 105.

[0039] The plunger 110 is provided at an upper end 112 with through openings 115, allowing fluidic connection between an inner volume 120 of the plunger 110 and the upper part 105B of the cylinder volume 105.

[0040] The plunger 110 is provided at a lower end 117 with a traveling valve 125.

[0041] The plunger traveling valve 125 is movable between a down position and an up position. In the up position, fluid can flow from the lower part 105A of the cylinder volume 105 into the inner volume 120 or reciprocally, contrary to the down position.

[0042] The upper end 112 of the plunger 110 is attached to a lower end 130 of the rod 100 of the pumping device 25.

[0043] The rod 100 extends vertically along the vertical axis Z'Z between the lower end 130 and an upper end 135.

[0044] The lower end 130 of the rod 100 is engaged in the cylinder volume 105. The upper end 135 of the rod 100 protrudes outside the through hole 95, above the wellhead 90.

[0045] The upper end 135 of the rod 100 is fixed to the upper buoyant body 140. The rod 100 is thus configured to directly transmit a vertical up and down movement of the upper buoyant body 140 to the plunger 110 which then follows this up and down movement.

[0046] An intermediate region of the rod 100 is engaged and guided vertically by the wellhead 90.

[0047] In the example of figure 1, the upper buoyant body 140 comprises a floating buoy 145 and an upper arch 160 carried on the floating buoy 145 to hold the rod 100.

[0048] The floating buoy 145 is positioned in the opening 55 and is movable in vertical translation in the opening 55. It is here vertically guided by the guide wall 60.

[0049] In this example, the floating buoy 145 defines a through hole 155 through which the upper end 85 of the production tubing 80 and the rod 100 are received.

[0050] The upper arch 160 is fixed to the floating buoy 145. It extends above the floating buoy 145 and above the upper end 85.

[0051] The upper end 135 of the rod 100 is attached to the upper arch 160.

[0052] The floating buoy 145 floats on the body of water 35. It is moved substantially vertically, being guided by the guide wall 60, in a reciprocal movement by the movements of the body of water 35 resulting from swell.

[0053] A method of pumping fluid in the facility 10 is described hereafter.

[0054] First, the surface installation 15 is provided above the well 20.

[0055] The floating buoy 145 is positioned at the surface installation 15, for example within the opening 55 of the surface installation 15.

[0056] Next, the plunger 110 attached to the lower end 130 of the rod 100 is engaged into the cylinder volume 105 of the production tubing 80.

[0057] The rod 100 is tightly fitted at the wellhead 90. It extends through the through hole 95 with the upper end 135 of the rod 100 being positioned above the wellhead 90.

[0058] Then, the upper end 135 of the rod 100 is attached to the upper arch 160.

[0059] The upper buoyant body 140 moves vertically as waves and swell travel across the surface 36 of the body of water 35.

[0060] The movement of the floating buoy 145 is guided by the guide wall 60. Thus, the movement of the floating buoy 145 is mainly vertical along the vertical axis Z'Z.

[0061] The floating buoy 145 follows the wave amplitude and the wave frequency of the body of water 35.

[0062] This vertical movement of the floating buoy 145 is transmitted to the rod 100 through the upper arch 160. Consequently, the rod 100 goes up and down simultaneously along the vertical axis Z'Z, and as well, the plunger 110 relative the cylinder volume 105.

[0063] Each time the plunger 110 goes up, at each upstroke of the plunger 110, the plunger traveling valve 125 moves to the down position and the standing valve 107 moves to the open position. Hence, fluid is drawn from the reservoir into the inner volume 120 through the lower part 105A of the cylinder volume 105.

[0064] Each time the plunger 110 goes down, at each downstroke of the plunger 110, the standing valve 107 moves to the closed position and the plunger traveling valve 125 moves to the up position. Consequently, fluid is ejected from the inner volume 120 into the upper part 105B of the cylinder volume 105. It can then flow up to the wellhead 90 and be recovered and treated on the surface installation 15.

[0065] An advantage of this method of pumping fluid is that no energy source other than the waves and swell traveling across the surface 36 is required.

[0066] The effective stroke length and the velocity of the pumping device 25 is determined by amplitude of waves and their period.

[0067] By way of an example, the mean amplitude of the waves in the North Sea is of the order of 1 meter and the mean period is of the order of 5 seconds.

[0068] Hence, operating the pumping device 25 according to the invention with wave energy is feasible in well-chosen offshore sites and makes it possible to produce fluid in these offshore sites with reduced carbon footprint, and without having to provide the well 20 or the

surface installation 15 with connections to utilities, hence leading to low capital expenditures.

[0069] In other variants (not shown), the movement of the floating buoy 145 is guided by vertical structural beams in the surface installation 15 and/or the floating buoy 145 is located at a side of the surface installation 15.

[0070] Figure 2 represents a second fluid production or/and injection facility 10.

[0071] In the second installation, the wellhead 90 is located at the bottom 45 of the body of water 35.

[0072] The production tubing 80 is connected to a flow line 165 through a valve 170 in the wellhead 90.

[0073] The flow line 165 leads the pumped fluid to a distant surface or onshore fluid recovery installation.

[0074] The floating buoy 145 is positioned above the wellhead 90.

[0075] It is maintained in a predetermined range of horizontal positions relative to the bottom 45 of the body of water 35, and as well, relative to the wellbore 20, thanks to several mooring lines 50.

[0076] A first end of each mooring line 50 is fixed to the floating buoy 145. The second end of each of the mooring lines 50 is fixed on the bottom 45 of the body of water 35.

[0077] The mooring lines 50 are slack and thus allow a vertical movement of the floating buoy 145 under the influence of waves and/or swell.

[0078] The upper end 135 of the rod 100 is directly attached to the floating buoy 145.

[0079] The rod 100 is vertically and tightly inserted in the wellhead 90 through a stuffing box. It is able to move vertically through the wellhead 90 while preserving fluid tightness. The wellhead 90 is thus a guide to guide the vertical movement of the rod 100 in the body of water 35.

[0080] The method of pumping fluid in the second offshore facility 10 is analogous to the one of the first offshore facility, except that the floating buoy 145 is positioned above and vertically apart from the wellhead 90.

[0081] In this case, the movement of the floating buoy 145 is guided by the mooring lines 50 and this movement guides the movement of the rod 100.

[0082] In a variant of the previous embodiments (not shown), the plunger 110 moves along an axis which is offset from the translation axis of the rod 100.

[0083] To this end, the pumping device 25 comprises a transmission mechanism (not shown) configured to transform the vertical motion of the floating buoy 145 and of the rod 100 into a movement of the plunger in the cylinder volume 105.

[0084] The transmission mechanism operates exclusively with a mechanical energy transmission chain. More specifically, the operation of the transmission mechanism requires no conversion of mechanical power to electrical power.

[0085] Further, the transmission mechanism makes it possible to have an effective stroke length and/or stroke frequency, which is different from the wave amplitude (respectively wave frequency).

[0086] In another variant, the plunger 110 is mounted rotative in the cylinder (e.g. like in a so-called Moineau pump).

[0087] The transmission mechanism converts a translation movement of the rod 100 into a rotation movement of the plunger 110.

Claims

1. A fluid pumping device (25) to be installed in an offshore facility (10) on a body of water (35) to pump fluid from or to the offshore fluid facility (10), the fluid pumping device (25) being **characterized by**:

   - an upper buoyant body (140) intended to float at the surface (36) of the body of water (35) and to vertically move with the surface of the body of water;
   - a plunger (110) configured to move within a cylinder volume (105) defined in the facility (10);
   - a rod (100) attached to the upper buoyant body (140) to jointly move vertically with the upper body (140) in the body of water (35), the rod (100) being connected to the plunger (110) to generate a pumping movement of the plunger (110) within the cylinder volume (105);
   - a guide (60, 90, 50) to guide the vertical movement of the rod (100) in the body of water.

2. The fluid pumping device (25) according to claim 1, further comprising a mooring device (50) attached to the buoyant body (140) and configured to keep the upper buoyant body (140) in a predetermined range of horizontal positions relative to the bottom (45) of the body of water (35), the guide (90, 50) being fixed at the bottom (45) of the body of water or under the bottom (45) of the body of water.

3. The fluid pumping device (25) according to claim 1, further comprising a surface installation (15) floating or fixed at the surface (36) of the body of water (35), the guide (60) being borne by the surface installation (15).

4. The fluid pumping device (25) according to any one of the preceding claims, wherein the rod (100) is directly connected to the plunger (110), the plunger (110) being movable vertically jointly with the upper buoyant body (140) and with the rod (100).

5. The fluid pumping device (25) according to any one of claims 1 to 3, comprising a transmission mechanism configured to transform a translational vertical motion of the rod (100) into a translational or rotational motion of the plunger (110).

6. The fluid pumping device (25) according to claim 5, wherein the transmission mechanism is configured

to transform a translational vertical motion of the rod (100) into a translational or rotational motion of the plunger (110) exclusively with mechanical energy.

7. The fluid pumping device (25) according to claim 6, wherein the transmission mechanism is configured to transform the reciprocating translational motion of the rod (100) along a first axis into a reciprocating translational motion of the plunger (110) along a second axis offset with the first axis.

8. An offshore fluid production or/and injection facility (10), extending in a body of water (35), comprising:

- a cylinder volume (105) intended to receive fluid to be pumped, the cylinder volume (105) being located below the bottom (45) of the body of water (35) or at the bottom (45) of the body of water(35);
- a fluid pumping device (25) according to any one of the preceding claims, the plunger (110) being movably received in the cylinder volume (105).

9. The facility (10) according to claim 8, comprising a well (20) extending below the surface (36) of the body of water (35), the cylinder volume (105) being located in the well (20).

10. The facility (10) according to claim 9, comprising a wellhead (90) located at the bottom (45) of the body of water (35), closing the well (20), the guide being positioned at the wellhead (90).

11. The facility (10) according to claim 9, comprising a surface installation (15), the wellhead (90) being located at the surface installation (15), the guide (60) extending above the wellhead (90).

12. A method of pumping fluid in an offshore facility (10) on a body of water (35) comprising:

- providing an upper buoyant body (140) and a plunger (110) connected to a rod (100);
- inserting the plunger (110) into a cylinder volume (105) defined in the facility;
- attaching the rod (100) to the upper buoyant body (140);
- having the buoyant body float (140) at the surface (36) of the body of water (35) and move vertically with the surface (36) of the body of water (35);
- and letting the rod (100) move vertically in the body of water (35) jointly with the upper buoyant body (140), the vertical movement of the rod (100) in the body of water (35) being guided with a guide (60,90) provided in the offshore facility (10), the rod (100) thus generating an alternating movement of the plunger (110) which enables fluid to be pumped into the cylinder volume (105).

13. A method according to claim 12, in which the offshore facility (10) comprises a well (20) extending below the surface (36) of the body of water (35) to reach a downhole fluid reservoir, the cylinder volume (105) being located in the well (20) and receiving fluid from the reservoir.

Amended claims in accordance with Rule 137(2) EPC.

1. An offshore fluid production or/and injection facility (10) extending in a body of water (35) and comprising:

- a well (20) extending below the surface (36) of the body of water (35);
- a cylinder volume (105) intended to receive fluid to be pumped, the cylinder volume (105) being located in the well (20), below the bottom (45) of the body of water (35) or at the bottom (45) of the body of water (35) ; and
- a fluid pumping device (25) to pump fluid from or to the offshore fluid production or/and injection facility (10),

the fluid pumping device (25) comprising:

- an upper buoyant body (140) intended to float at the surface (36) of the body of water (35) and to vertically move with the surface of the body of water (35);
- a plunger (110) being movably received in the cylinder volume (105);
- a rod (100) attached to the upper buoyant body (140) to jointly move vertically with the upper body (140) in the body of water (35), the rod (100) being connected to the plunger (110) to generate a pumping movement of the plunger (110) within the cylinder volume (105);
- a guide (60, 90, 50) to guide the vertical movement of the rod (100) in the body of water.

2. The offshore fluid production or/and injection facility (10) according to claim 1, wherein the fluid pumping device (25) further comprises a mooring device (50) attached to the buoyant body (140) and configured to keep the upper buoyant body (140) in a predetermined range of horizontal positions relative to the bottom (45) of the body of water (35), the guide (90, 50) being fixed at the bottom (45) of the body of water or under the bottom (45) of the body of water.

3. The offshore fluid production or/and injection facility (10) according to claim 1, wherein the fluid pumping

device (25) further comprises a surface installation (15) floating or fixed at the surface (36) of the body of water (35), the guide (60) being borne by the surface installation (15).

4. The offshore fluid production or/and injection facility (10) according to any one of the preceding claims, wherein the rod (100) is directly connected to the plunger (110), the plunger (110) being movable vertically jointly with the upper buoyant body (140) and with the rod (100).

5. The offshore fluid production or/and injection facility (10) according to any one of claims 1 to 3, wherein the fluid pumping device (25) comprises a transmission mechanism configured to transform a translational vertical motion of the rod (100) into a translational or rotational motion of the plunger (110).

6. The offshore fluid production or/and injection facility (10) according to claim 5, wherein the transmission mechanism is configured to transform a translational vertical motion of the rod (100) into a translational or rotational motion of the plunger (110) exclusively with mechanical energy.

7. The offshore fluid production or/and injection facility (10) according to claim 6, wherein the transmission mechanism is configured to transform the reciprocating translational motion of the rod (100) along a first axis into a reciprocating translational motion of the plunger (110) along a second axis offset with the first axis.

8. The offshore fluid production or/and injection facility (10) according to any of the preceding claims, comprising a wellhead (90) located at the bottom (45) of the body of water (35) and closing the well (20), the guide being positioned at the wellhead (90).

9. The offshore fluid production or/and injection facility (10) according to any of the preceding claims, comprising a surface installation (15), the wellhead (90) being located at the surface installation (15), the guide (60) extending above the wellhead (90).

10. A method of pumping fluid in an offshore fluid production or/and injection facility (10) according to any of the preceding claims comprising:

- having the buoyant body float (140) at the surface (36) of the body of water (35) and move vertically with the surface (36) of the body of water (35);
- and letting the rod (100) move vertically in the body of water (35) jointly with the upper buoyant body (140), the vertical movement of the rod (100) in the body of water (35) being guided with the guide (60,90),

the rod (100) thus generating an alternating movement of the plunger (110) which enables fluid to be pumped into the cylinder volume (105).

11. A method according to claim 10, in which the well (20) extends below the surface (36) of the body of water (35) to reach a downhole fluid reservoir, the cylinder volume (105) being located in the well (20) and receiving fluid from the reservoir.

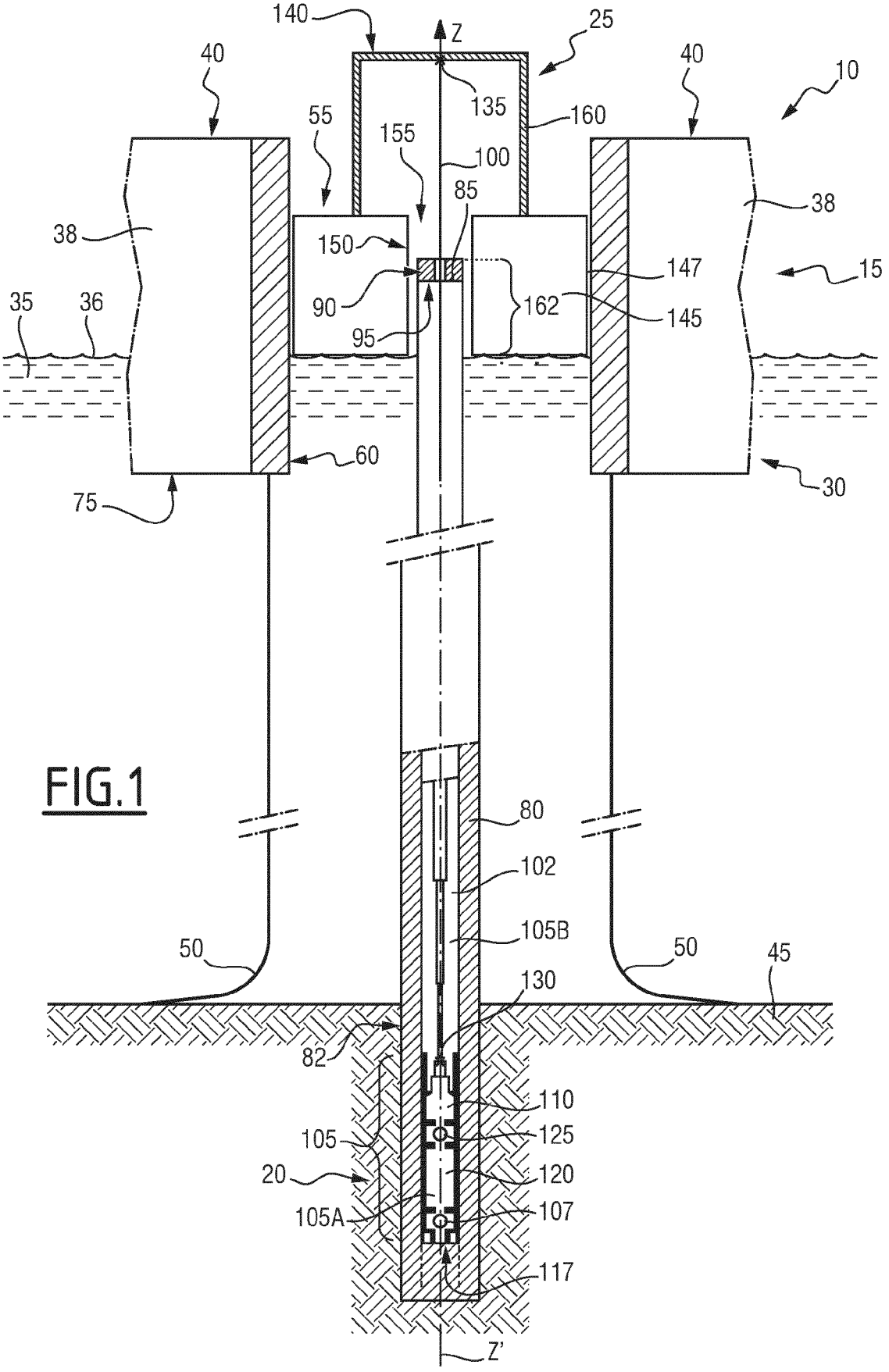
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FIG.1

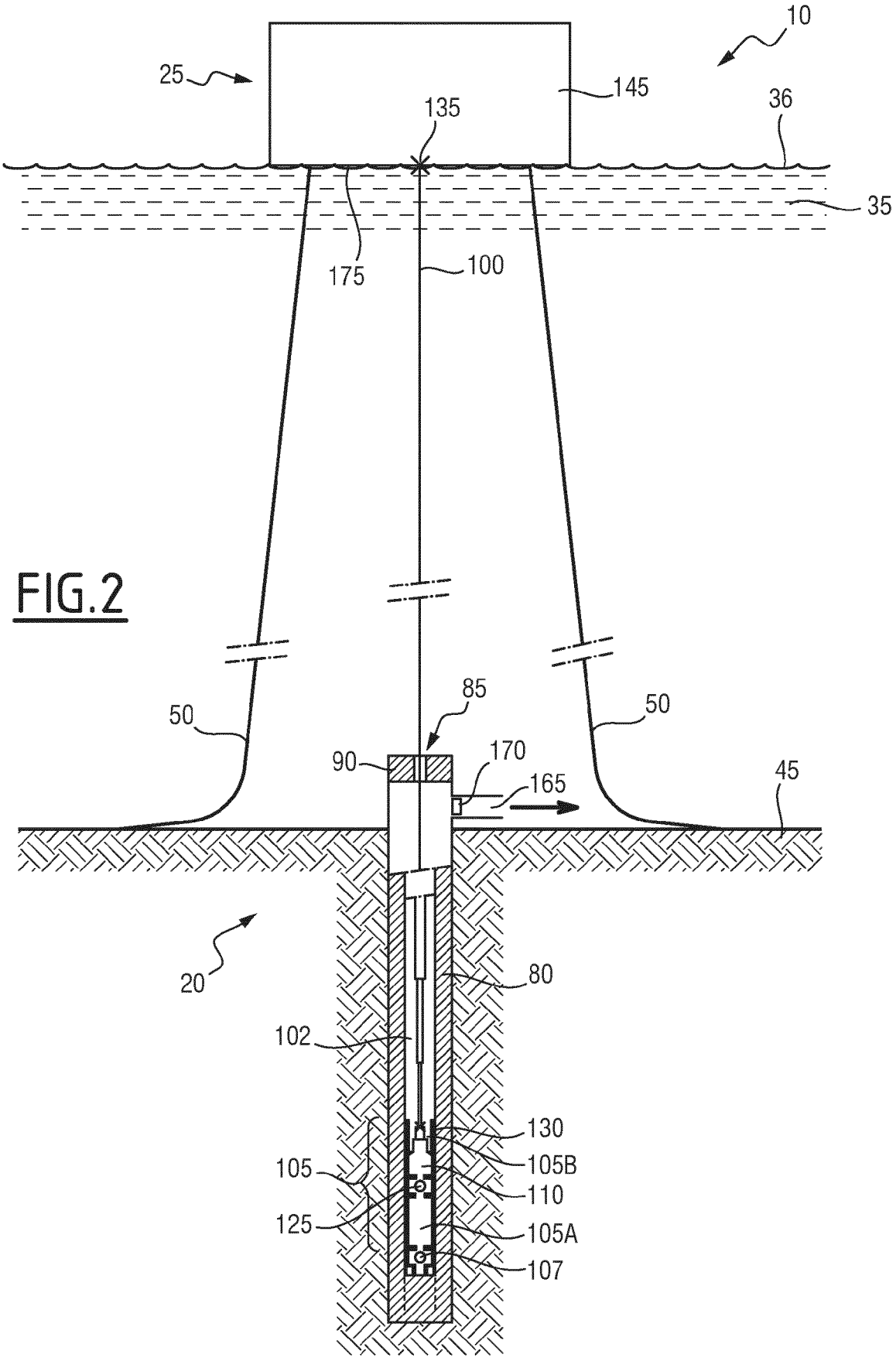
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FIG.2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 30 6754

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	WO 2010/076283 A1 (SHELL INT RESEARCH [NL]; LUGTMEIER LUBBERTUS [NL]) 8 July 2010 (2010-07-08) * the whole document * * figure 1 *	1-13	INV. E21B43/12 F03B13/00 F03B13/18 E21B43/01
X	AU 2017 397 650 A1 (GEOALTA ENG PTY LTD [AU]) 18 April 2019 (2019-04-18) * figure 4 * * page 6, paragraph 25 - page 14, paragraph 20; figures 1-3,5-8 * * the whole document *	1-6,8,12	
X	GB 2 445 951 A (SMITH ALVIN [GB]) 30 July 2008 (2008-07-30) * figures 1-7 * * the whole document *	1-6,8,12	
X	US 4 249 084 A (VILLANUEVA JUAN T ET AL) 3 February 1981 (1981-02-03) * the whole document *	1-6,8,12	
			TECHNICAL FIELDS SEARCHED (IPC) E21B F03B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 February 2024	van Berlo, André

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