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R. P. KNAPP ET AL
METHOD FOR INSTALLING CONTROLS TO
AND OPERATING AN UNDERWATER WELL

2,970,646

Filed Jan. 30, 1958

2 Sheets-Sheet 1

FIG. 1.

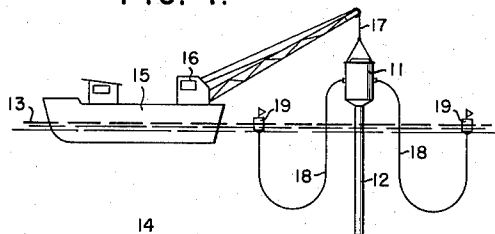


FIG. 2.

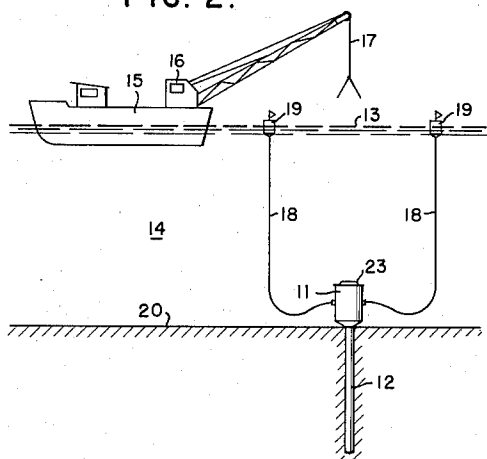


FIG. 3.

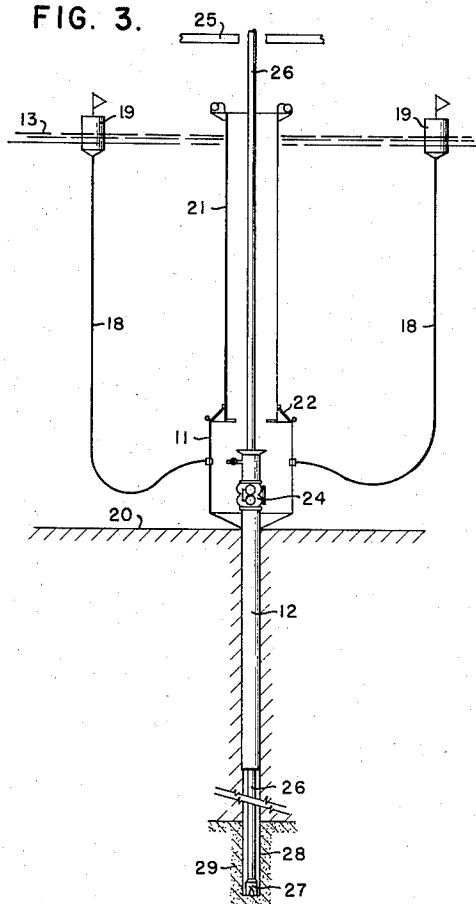
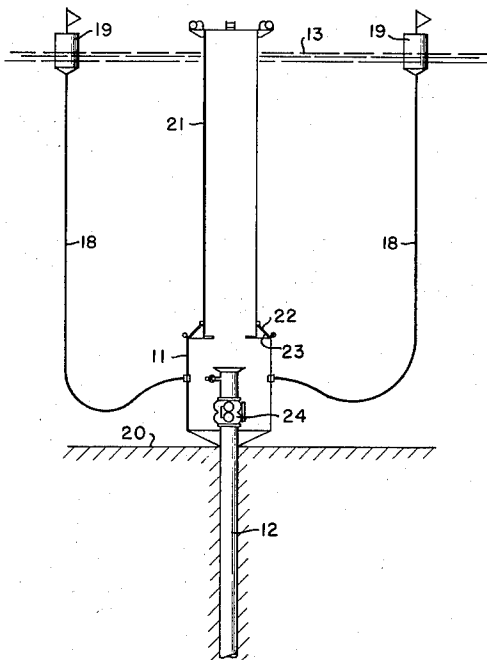


FIG. 4.



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FIG. 5.

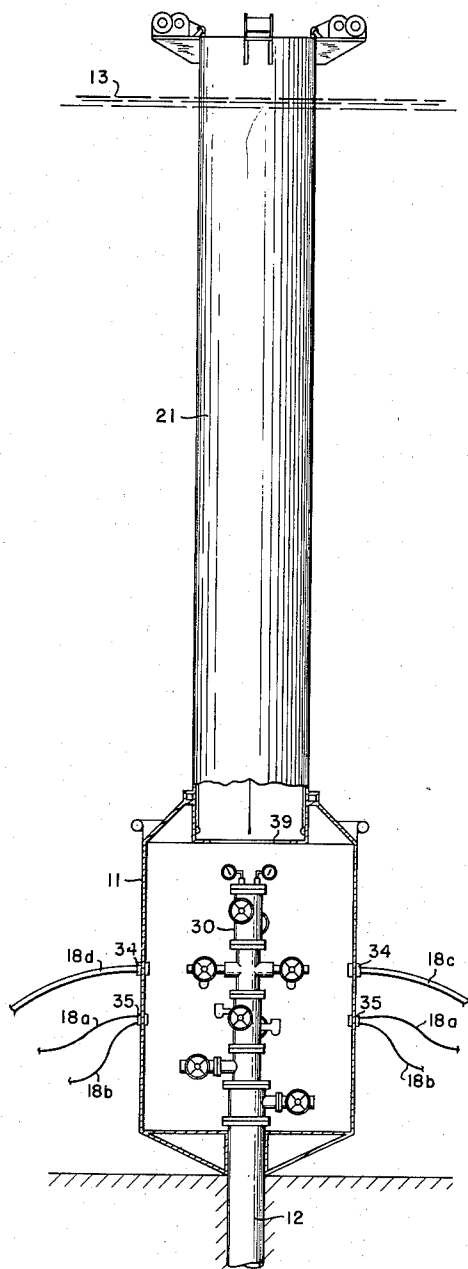
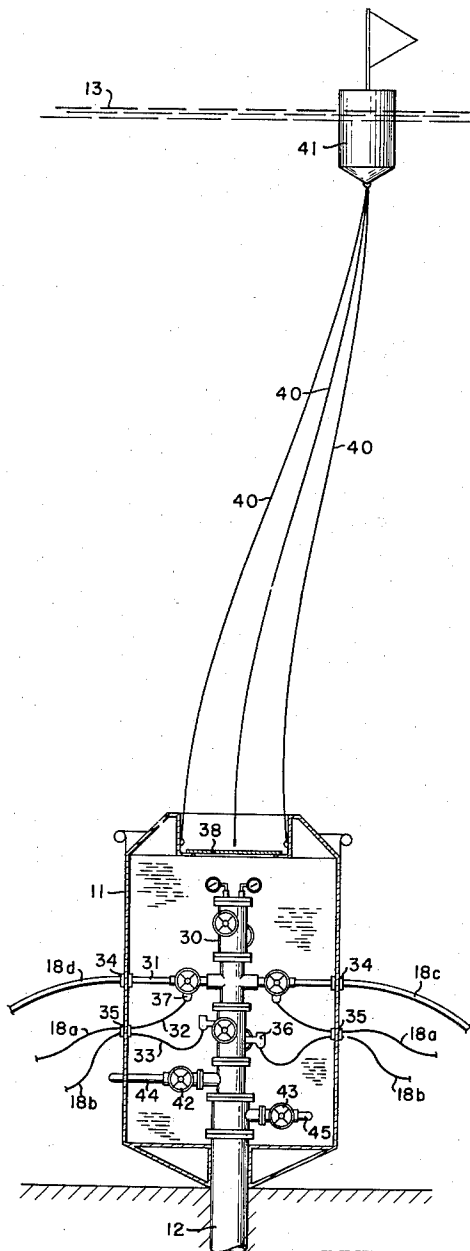


FIG. 6.



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METHOD FOR INSTALLING CONTROLS TO AND OPERATING AN UNDERWATER WELL

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16 Claims. (Cl. 166—45)

The present invention is directed to a method for installing controls to an underwater well. More particularly, the invention is directed to controlling and operating an underwater well. In its more specific aspects, the invention is concerned with a method for controlling and operating an underwater well from a remote location.

The present invention may be briefly described as a method for installing controls to and operating an underwater well. In the present invention, lines which may be flexible are connected to a vessel at the water's surface and thereafter the vessel is sunk at the site of a well with water being removed from the sunk vessel. A well is then drilled through the water-free vessel to penetrate a subterranean productive zone. A valved well head is placed on the well and the lines are then connected to the well head from the interior of the vessel. The vessel is then filled with a liquid which may contain a corrosion inhibitor and a poison for marine growth. Thereafter, fluids, such as hydrocarbons, including crude petroleum and gaseous hydrocarbons, may be produced from the well through one of the lines by operating the valved well head through another of said lines from a remote location.

The present invention is quite advantageous and useful in that the employment of divers is avoided to make up connections. Thus, all connections are made in air without the necessity for sending divers on bottom. This is especially important, for example, with electrical and other control systems for remotely controlling the Christmas tree valves of a well head. Furthermore, the invention is of considerable advantage and usefulness in that the top of the underwater chamber surrounding the well head is free of flow lines and control lines, making ready access thereto without the danger of fouling the lines through which control is effected and through which fluid is produced.

The present invention will be further illustrated by reference to the drawing in which Figs. 1 to 6 inclusive are a stepwise illustration of the practice of the present invention.

Referring now to the drawing in which identical numerals will be employed to identify identical parts, numeral 11 designates an underwater chamber for a subterranean well. The underwater chamber 11 has a conductor casing 12 attached thereto. The underwater chamber 11 is shown in an elevated position above the water's surface 13 of a body of water 14 (in Fig. 1). The chamber 11 is held in the elevated position by a work boat or platform, floating or mobile, or vessel 15 provided with a crane 16, which holds the chamber 11 in the position shown, by means of a line 17. At the water's surface 13 the chamber 11 has attached to it control lines 18 which may be flow lines for conducting well fluids away from well head and service lines such as providing electrical energy, pneumatic or hydraulic energy, and the like, to the chamber 11. These flow or

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control lines are suitably attached to buoys 19 floating on the water's surface 13.

As shown in Fig. 2 the conductor casing 12 has been lowered into the water in an open condition such that water enters the vessel 11. The conductor casing 12 is then caused to penetrate through the water bottom 20 and the underwater chamber or vessel 11 is resting below the water's surface 13 with the lines 18 carried to or remaining on the water's surface 13 by attachment to the buoys 19. Where water depths of less than about 125 feet are encountered, the vessel 11 rests on bottom. In water depths greater than about 125 feet, the vessel 11 may be positioned about 125 feet below the water's surface 13. In either instance, the conductor casing 12 may be driven or it may be set in place and cemented in a drilled hole. Where the vessel 11 is not resting on bottom it may be provided with suitable auxiliary supporting means as may be required. The vessel 15 and the crane 16 may then be moved away.

Referring to Fig. 3 a caisson 21 is then floated in as desired and then sunk such that it is matingly engaged with its lower end 22 on the conical surface 23 of the chamber 11. The caisson is matingly engaged with chamber 11 and drilling operations are conducted by methods such as described in the patent to Knapp et al., No. 2,906,500, issued September 29, 1959. It will be noted that the control lines 18 remain carried to the water surface by buoys 19, as shown in Fig. 3. Thereafter, blowout preventers 24 are then installed on the conductor casing 12. These blowout preventers may be of the conventional type employed in well drilling operations. After the blowout preventers 24 have been installed on the conductor pipe 12 and mud return lines installed, a platform or other suitable means 25 may be installed above the caisson 21 to provide for a drilling operation with a drill string 26 carrying on its lower end a drill bit 27. The platform or means 25 may be installed prior to this latter operation, as may be desired. It will be noted that the drill string 26 extends through the caisson 21, the vessel 11, and the conductor pipe 12 to form a borehole 28 penetrating a plurality of subterranean earth formations, such as strata, horizons or zones 29, which may be productive of hydrocarbons, such as crude petroleum, gas and other valuable fluids. During this operation the control lines 18 remain connected to the buoys 19. This latter operation is particularly illustrated in Fig. 4.

Referring now to Fig. 5, the drill string 26 with the drill bit 27 has been removed and a tubing, not shown, suitably installed in a casing lining the borehole 28, also not shown. The platform 25 may be removed as shown in Fig. 5, and thereafter a well head, such as a dual Christmas tree 30, is installed (prior to removing rig) on the conductor pipe 12, as shown in detail in Fig. 4. The control lines 18 may extend to the water's surface 13, as shown in Fig. 4, or may be carried to the land at some distance away or to a suitable control platform, vessel, and the like where they are accessible to personnel. It is to be understood that the control lines 18 will include service lines, such as lines 18a and 18b, which may be either electric service lines, hydraulic or pneumatic service lines, for operating the valves of the Christmas tree 30, and flow lines 18c and 18d.

Referring to Fig. 6, the flow lines 18c and 18d and service lines 18a and 18b are then connected by connecting means 31, 32 and 33 to the flanged or other connections 34 and 35 which carry the several lines through the exterior wall of the vessel 11.

The lines 31 connect to the flow lines of the Christmas tree while the lines 32 and 33 connect to remote control valve operators 36 and 37. The remote control valve operators may suitably be operated electrically,

hydraulically, or pneumatically or by a combination of any two of these means. These valve operators may be of the type such as manufactured by Cameron Iron Works, Inc., Houston, Texas, and as shown and illustrated in the valve catalog of that company dated June, 1954.

After the connections 31, 32 and 33 have been made to the flow lines 18c and 18d and to the service lines 18a and 18b, these several lines are carried to the remote location which may be onshore tanks and onshore operating means or tanks located on a vessel or a platform and/or sources of energy remote from the well site. The chamber or vessel 11 is then filled with a liquid such as one containing a corrosion inhibitor and a poison for marine life and the cover plate 38 is then attached to the vessel 11, closing the opening 39, which is shown in Fig. 5. Thereafter, the caisson 21 is removed over the flexible guide lines 40 and the flexible guide lines 40 are then attached to a suitable buoy 41 to mark the well site. Thereafter, the valve controls are operated remotely to allow production of the well.

In the description, especially with respect to Fig. 6, the lower valves 42 and 43 of the Christmas tree are provided with bull plugs 44 and 45. The bull plug 44 may extend through the exterior wall of the vessel 11 for use as may be desired.

As examples of corrosion inhibitors may be mentioned sodium chromate, caustic solution, commercial polar amine, carbon disulfide, soda ash, sodium silicate, disodium phosphate.

As examples of poisons for marine life may be mentioned copper sulfate, caustic solution, copper citrate, sodium pentachlorophenate, sodium hypochlorite, sodium arsenate, mercuric chloride, copper chromate.

While the present invention has been described with the stub lengths of the connections being attached to a floating buoy and remaining with their ends at the water's surface during the several operations, the free ends of the connections may be allowed to sink and connected to the floating buoys by a suitable line which may be flexible or which may be at least semi-rigid. Usual pipe has sufficient flexibility for this purpose although flexible metallic or other pipe may be desirable in some instances. The free ends of the stubs may be closed to prevent them filling with salt water.

The nature and objects of the present invention having been completely described and illustrated, what we wish to claim as new and useful and secure by Letters Patent is:

1. A method for installing controls to and operating an underwater well which comprises connecting lines to the exterior surface of a vessel at the water's surface, sinking said vessel at the site of a well, connecting a caisson which extends to above the water's surface to the upper end of sunk vessel, removing water from said caisson and sunk vessel, thereafter drilling said well through said caisson and the sunk vessel to penetrate a subterranean productive zone, placing a valved production well head on said well, operatively connecting said well head to said lines from the interior of said vessel, and then producing fluids and the like from said well through one of said lines by operating said valved well head through another of said lines with energy provided from an accessible remote location.

2. A method for installing controls to and operating an underwater well which comprises connecting control lines to the exterior surface of a vessel at the water's surface, sinking said vessel at the site of a well, connecting a caisson which extends to above the water's surface to the upper end of said sunk vessel, removing water from said caisson and sunk vessel, thereafter drilling said well through said caisson and the sunk vessel to penetrate a subterranean hydrocarbon productive zone, placing a valved production well head on said well, operatively connecting said well head to said control lines from the

interior of said vessel, and then producing hydrocarbons and the like from said well through said control lines by operating said valved well head with energy provided from an accessible remote location.

3. A method for installing controls to and operating an underwater well which comprises connecting at least one flow line to the exterior surface of a vessel at the water's surface, sinking said vessel at the site of a well, connecting a caisson which extends to above the water's surface to the upper end of said vessel, and removing water from said caisson and the sunk vessel, thereafter drilling said well through said caisson and the sunk vessel to penetrate a subterranean hydrocarbon productive zone, placing a valved production well head on said well in said water-free vessel, operatively connecting said well head to said flow line from the interior of said water-free vessel, filling said water-free vessel with a liquid, closing said filled vessel, removing said caisson, and then producing hydrocarbons and the like from said well through said flow line by operating said valved well head with energy provided from an accessible remote location.

4. A method for installing controls to and operating an underwater well which comprises connecting at least one service line to the exterior surface of a vessel at the water's surface, sinking said vessel at the site of a well, connecting a caisson which extends to above the water's surface to the upper end of said sunk vessel, removing water from said caisson and sunk vessel, thereafter drilling said well through said caisson and the sunk vessel to penetrate a subterranean hydrocarbon productive zone, placing a valved production well head on said well, operatively connecting said well head to said service line from the interior of said vessel, filling said vessel with a liquid, and then producing hydrocarbons and the like from said well by operating said valved well head by said service line with energy provided from an accessible remote location.

5. A method in accordance with claim 4 in which pneumatic energy is provided through the service line.

6. A method in accordance with claim 4 in which hydraulic energy is provided through the service line.

7. A method in accordance with claim 4 in which hydraulic and pneumatic energy are provided through the service line.

8. A method in accordance with claim 4 in which electrical energy is provided through the service line.

9. A method in accordance with claim 4 in which electrical and hydraulic energy are provided through the service line.

10. A method in accordance with claim 4 in which electrical and pneumatic energy are provided through the service line.

11. A method in accordance with claim 4 in which electrical, hydraulic and pneumatic energy are provided through the service line.

12. A method for installing controls to and operating an underwater well which comprises connecting control service and flow lines to the exterior surface of a vessel at the water's surface, sinking said vessel at the site of a well, connecting a caisson which extends to above the water's surface to the open end of said vessel, and removing water from said caisson and the sunk vessel, thereafter drilling said well through said caisson and the sunk vessel to penetrate a subterranean hydrocarbon productive zone, placing a valved production well head on said well in said water-free vessel, operatively connecting said well head to said control service and flow lines from the interior of said water-free vessel, filling said water-free vessel with a liquid, closing said vessel and then producing hydrocarbons and the like from said well through said flow lines by operating said valved well head by said service lines with energy provided from an accessible remote location.

13. A method for installing controls to and operating an underwater well which comprises connecting lines to

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the exterior surface of a vessel at the water's surface, said vessel having a conductor casing attached to one end, sinking said vessel at the site of a well, and penetrating the water bottom with said casing, connecting a caisson which extends to above the water's surface to the upper end of said sunk vessel, removing water from said caisson and sunk vessel, thereafter drilling said well through said caisson and the sunk vessel and through said casing to penetrate a subterranean hydrocarbon productive zone, placing a valved Christmas tree on said well, operatively connecting said Christmas tree to said lines from the interior of said vessel, filling said vessel with a liquid, closing said vessel, and then producing hydrocarbons and the like from said well through one of said lines by operating said valved Christmas tree by another of said lines with energy provided from an accessible remote location.

14. A method in accordance with claim 13 in which the casing penetrates the water bottom by driving.

15. A method in accordance with claim 13 in which the casing penetrates the water bottom by setting and cementing the casing in a drilled hole.

16. A method for installing controls to and operating an underwater well which comprises connecting lines to the exterior surface of a vessel at the water's surface,

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sinking said vessel at the site of a well, connecting a caisson which extends to above the water's surface to the upper end of said sunk vessel, removing water from said caisson and sunk vessel, thereafter drilling said well through said caisson and the sunk vessel to penetrate a subterranean zone, placing a valved production well head on said well in said water-free vessel, operatively connecting said well head to said lines from the interior of said water-free vessel, and then producing fluids and the like from said well through one of said lines by operating said valved well head through another of said lines with energy provided from an accessible remote location.

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