

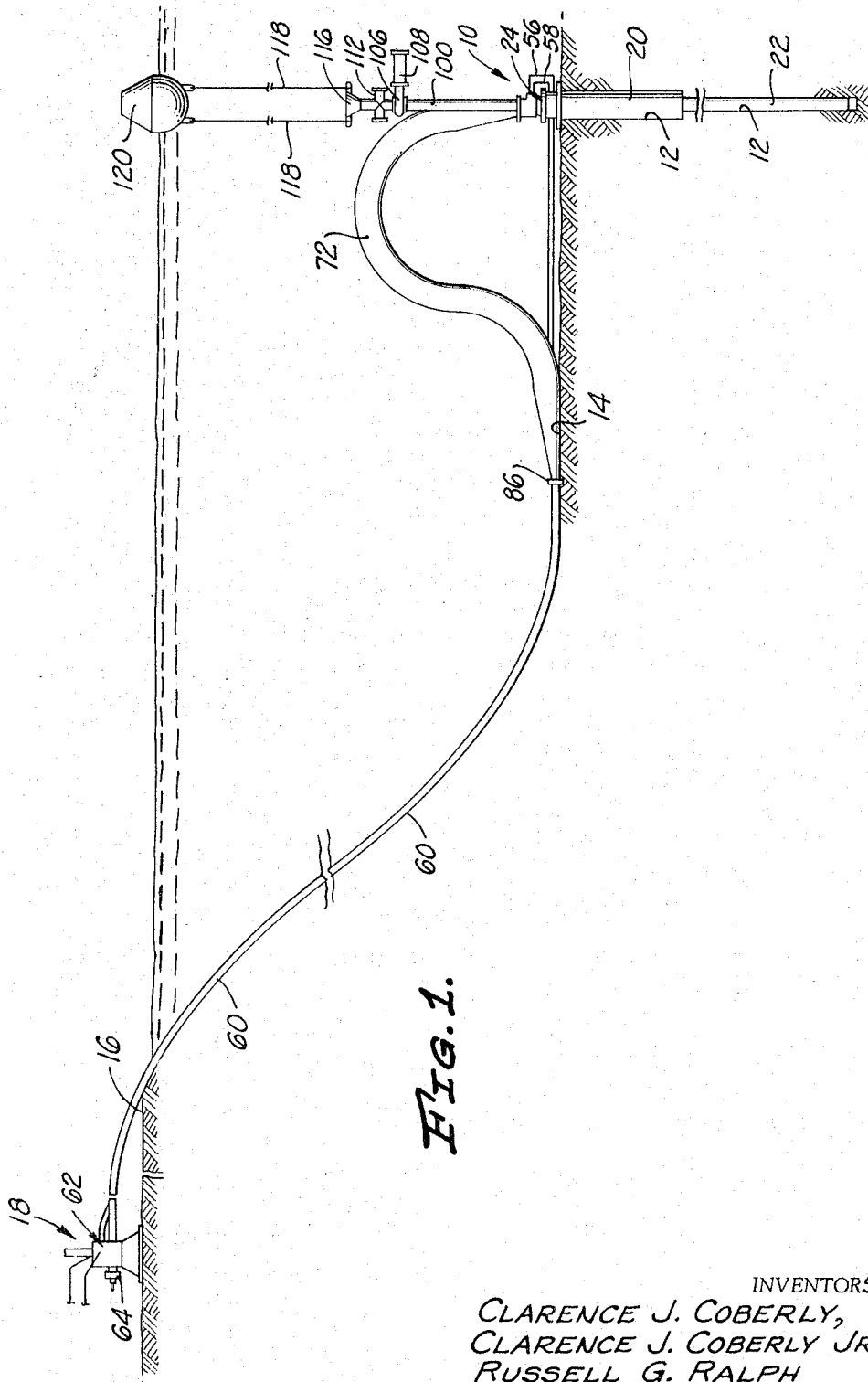
March 7, 1967

C. J. COBERLY ETAL
APPARATUS FOR RUNNING EQUIPMENT INTO AND OUT
OF OFFSHORE WELL COMPLETIONS

3,307,631

Filed April 30, 1963

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

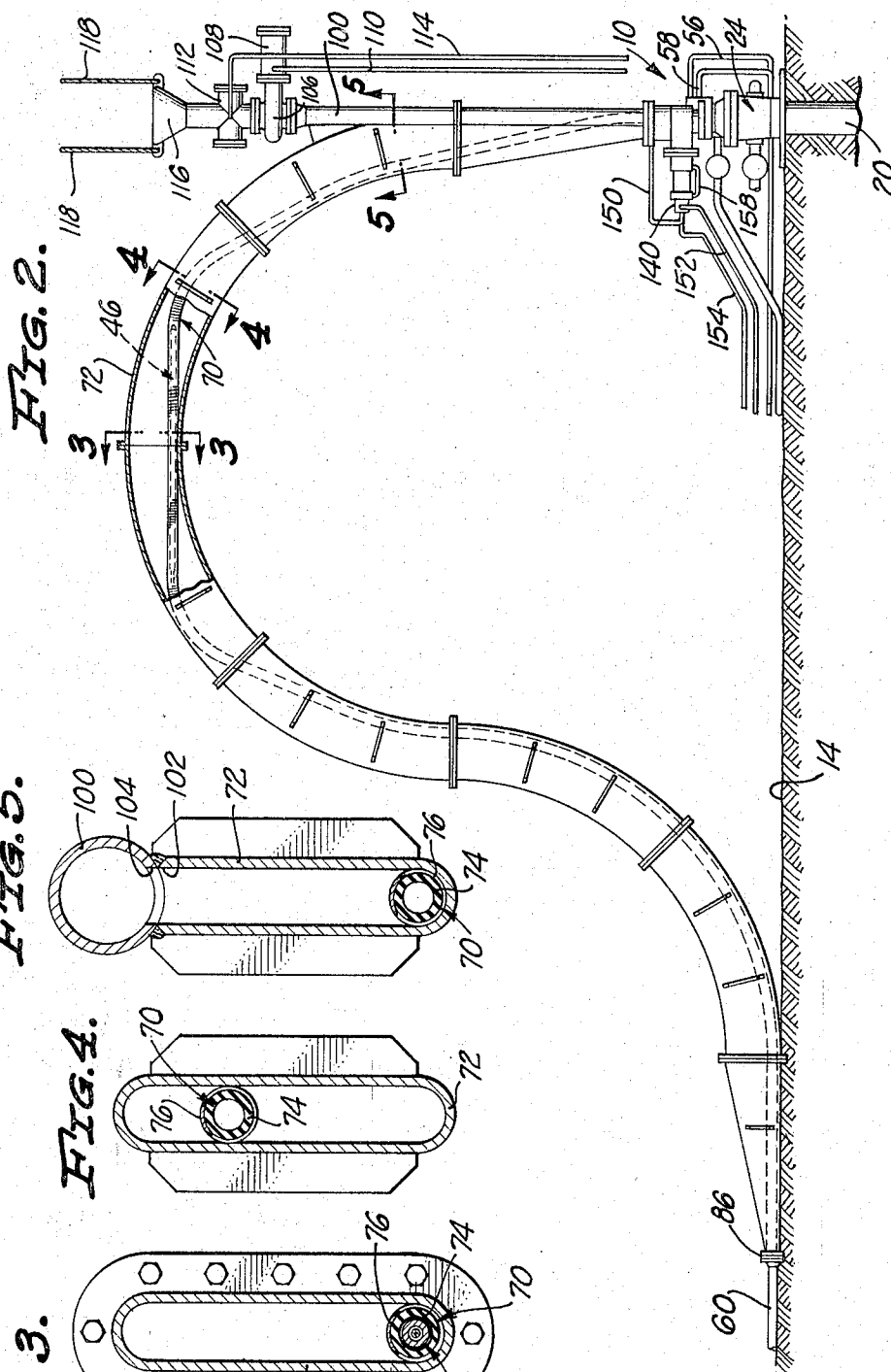


FIG. 2.

FIG. 5.

FIG. 4.

FIG. 3.

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3 Sheets-Sheet 3

FIG. 7.

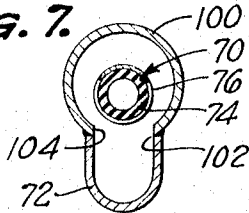


FIG. 6.

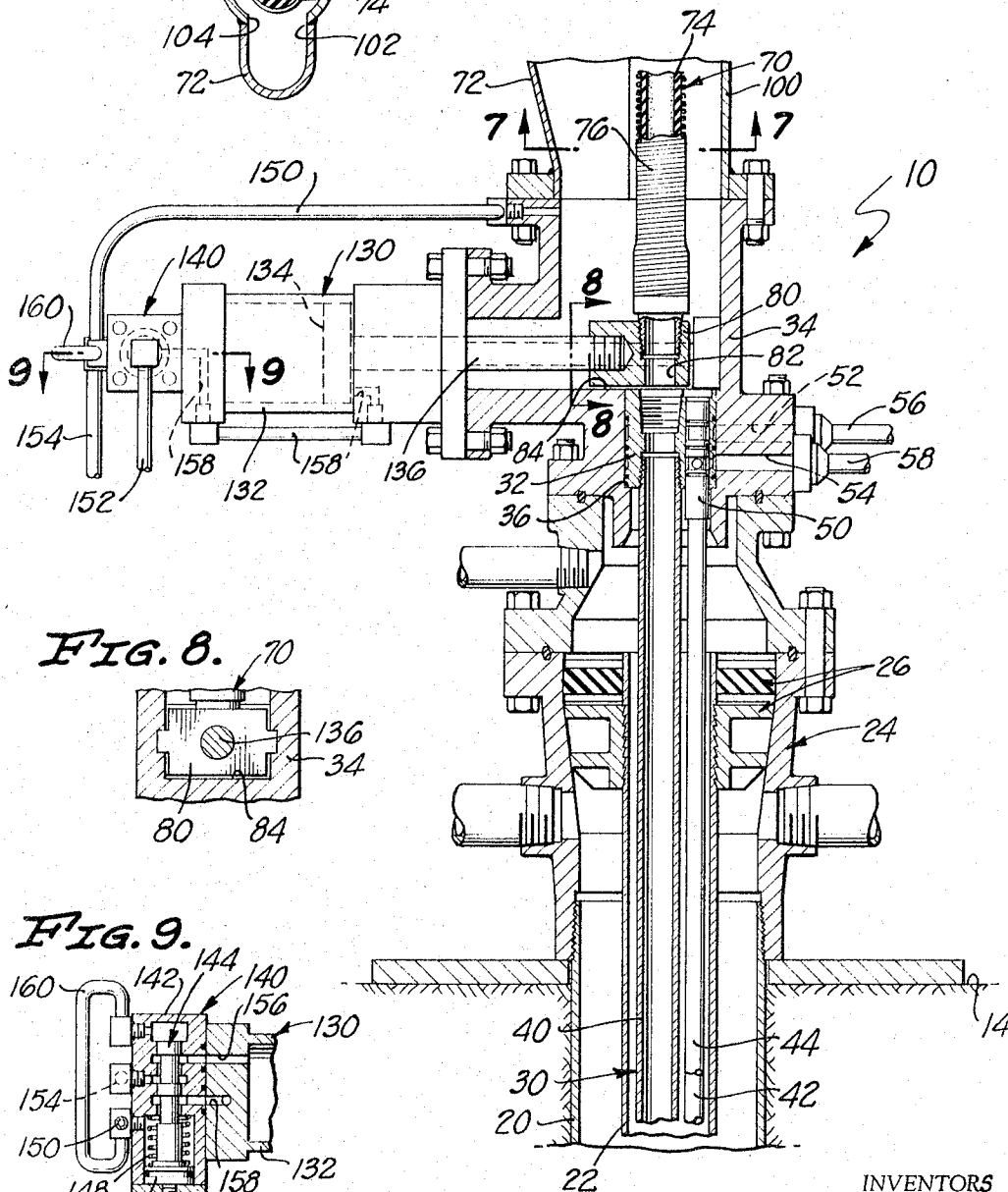


FIG. 8.

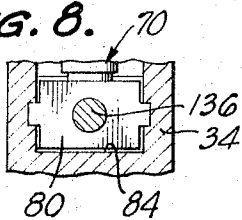
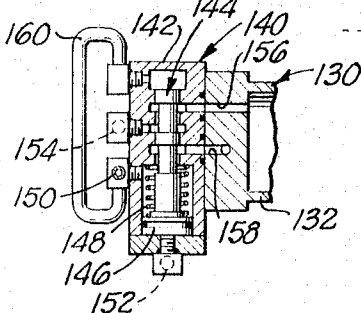


FIG. 9.



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3,307,631

APPARATUS FOR RUNNING EQUIPMENT INTO AND OUT OF OFFSHORE WELL COMPLETIONS

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8 Claims. (Cl. 166—75)

The present invention relates in general to apparatus for running equipment of various types into and out of oil wells, and particularly completed oil wells, in locations which are either entirely inaccessible to personnel, or which do not provide normal accessibility.

For example, the invention finds particular utility in connection with submerged, offshore locations in ocean depths which do not permit the use of divers, e.g., one thousand feet or more, although the invention may, of course, be practiced in shallower water. For convenience in disclosing the invention, it will be considered herein in connection with an offshore well location controlled from an onshore station, but it will be understood that an offshore control station, e.g., a platform, island, or the like, is a possible alternative that might be used in some instances. Therefore, the invention is not to be regarded as limited to the specific environment hereinafter discussed.

A general object of the invention is to provide an apparatus for running production equipment, servicing equipment, and the like, into and out of a submerged, offshore well from an onshore control station spaced horizontally from the well.

Although various equipment may be run into and out of a submerged, offshore well from such an onshore control station in accordance with the invention, this disclosure will be restricted to running a free, fluid operated pump into and out of the well from an onshore pumping station hydraulically as a matter of convenience.

It is contemplated that the submerged, offshore well will have installed therein a tubing system and bottom hole assembly suitable for use with a free, fluid operated pump. The well may be completed with the tubing system and the bottom hole assembly contained in a casing in the usual manner, or it may be a casingless completion having the tubing system and the bottom hole assembly cemented in place, as disclosed in Patent No. 2,939,533, granted June 7, 1960, to Clarence J. Coberly, one of the inventors hereof. The tubing system may either be an open system, wherein the production fluid discharged by the pump and the spent operating fluid discharged thereby are conveyed to the well head through a common, production tubing, or it may be a closed system wherein the production fluid and the spent operating fluid are conveyed to the well head separately. In any event, one of the tubings of the tubing system in the well is a pump tubing of a size to slidably receive the free, fluid operated pump, the latter being hydraulically movable between the well head and an operating position in the bottom hole assembly in a manner which is well known in the art.

The invention further contemplates, and an object thereof is to provide, an apparatus wherein the free, fluid operated pump is circulated between the onshore pumping station and the submerged, offshore well head through a rigid conductor tubing lying on, or substantially on, the bottom of the ocean, or other body of water, between the pumping station and the well location. It will be understood that such conductor tubing for the pump will normally be at least approximately horizontal, whereas the pump tubing in the well will normally be approximately vertical.

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An important object of the invention is to circulate the pump between the conductor tubing and the pump tubing hydraulically through a connecting tubing which is sufficiently flexible and of sufficient length to permit successive portions thereof to straighten to accommodate the pump as it passes through in either direction. In other words, this flexible tubing permits the pump to "turn the corner" between the generally horizontal conductor tubing and the generally vertical pump tubing in the well, which is an important feature of the invention.

Another object is to provide an apparatus of the character under consideration wherein the flexible tubing is essentially a hose which is of a size to slidably receive the pump therein and which is suitably reinforced to withstand the pressure differential necessary to hydraulically circulate the pump therethrough.

A further object of the invention is to enclose the flexible tubing in a sealed housing having a configuration which permits straightening of successive portions of the flexible tubing as the pump passes therethrough, and to employ means providing restricted fluid communication between the flexible tubing and the housing for maintaining the pressure in the housing at a value approaching the pressure applied behind the pump in circulating it through the flexible tubing so as to minimize the pressure differential between the interior and the exterior of the flexible tubing. This minimizes the strength requirements of the flexible tubing and permits the employment of one which flexes readily as the pump passes therethrough.

Another object of the invention is to provide an apparatus of the nature hereinbefore outlined wherein one end of the flexible tubing is movable laterally between an operative position in register with the upper end of the pump tubing and an inoperative position out of alignment with the tubing system, a further object in this connection being to provide means, preferably hydraulic means, operable from the pumping station for moving the recited end of the flexible tubing laterally between its operative and inoperative positions.

With the foregoing construction, the flexible tubing may be moved laterally out of the way in the event that it is necessary to perform servicing or remedial operations on the well, or the tubing system set therein, as by means of equipment lowered from a barge, boat, or the like, floating on the surface of the water above the well location. Thus, there is no necessity for disconnecting the pump conveying system from the well head under such conditions, which is an important feature of the invention.

Another object is to provide a well completion wherein the housing for the flexible tubing communicates with one side of a standpipe or guide tubing aligned with and extending upwardly from the well, the movable end of the flexible tubing being displaceable laterally out of the standpoint and into the adjoining housing when in its inoperative position. Under such conditions, any equipment which may be required to service the well, or the tubing system therein, or to perform remedial operations thereon, may be lowered through the standpipe without interference by the flexible tubing, which is an important feature.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results thereof which will be evident to those skilled in the art to which the invention relates in the light of this disclosure, may be achieved with the exemplary embodiment of the invention described in detail hereinafter and illustrated in the accompanying drawings, in which:

FIG. 1 is a semidiagrammatic view fragmentarily illustrating an offshore oil well completion which embodies the invention;

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FIG. 2 is a view duplicating a portion of FIG. 1 on an enlarged scale and illustrating more specifically the structure of a portion of the invention;

FIGS. 3, 4 and 5 are enlarged sectional views respectively taken along the arrowed lines 3—3, 4—4 and 5—5 of FIG. 2 of the drawings;

FIG. 6 is a vertical sectional view through a well head, and associated structure, of the invention; and

FIGS. 7, 8 and 9 are fragmentary sectional views respectively taken along the arrowed lines 7—7, 8—8 and 9—9 of FIG. 6.

General description and description of structure for running equipment in and out

Referring initially to FIG. 1 of the drawings, the numeral 10 designates an oil well completion associated with a bore 12 drilled into the ocean bottom 14 at a location seaward of the shore 16. The well or well completion 10 is intended to be produced, in the exemplary embodiment illustrated, from an onshore station, e.g., a pumping station, 18.

Considering the well completion 10 more specifically now, it includes a surface casing 20 set in the upper end of the well bore 12 and having therein an inner casing 22. Production fluid may enter the inner casing in various ways. For example, the productive zone may be left uncased, where it is sufficiently consolidated to permit this, in which event the production fluid enters the inner casing 22 through its lower end. Alternatively, production fluid may enter the inner casing through perforations therein, through a perforated liner, not shown, connected to the inner casing, or the like.

As best shown in FIG. 6, connected to the upper end of the surface casing 20 is a suitable well head 24, the inner casing 22 being suspended from and sealed relative to the well head by a slip and sealing arrangement 26. Disposed in the inner casing 22 is a tubing system 30 carried by a tubing head 32 suitably supported by an upper section 34 of the well head 24 in any suitable manner, as by being seated on an annular shoulder 36 therein.

In the particular construction illustrated, the tubing system 30 is a closed system composed of three tubings 40, 42 and 44. The tubing 40 is of a size to slidably receive a conventional fluid operated pump 46, FIG. 2, for movement therethrough between the well head 24 and an operating position in a bottom hole assembly, not shown, at the lower end of the tubing system 30. In view of this function of the tubing 40, it will be referred to as a pump tubing hereinafter. Preferably, but not necessarily, the pump tubing 40 also serves as a production tubing for conveying production fluid discharged by the pump 46, when in its operating position in the well 10, upwardly to the well head 24.

The parallel tubing 42 is a supply tubing for conveying operating fluid under pressure downwardly in the well 10 to the pump 46, when it is in its operating position, to operate it, the spent operating fluid being returned to the well head 24 through the parallel tubing 44. It will be understood that the fluid operated pump 46 is intended to be circulated hydraulically between its operating position in the well and the well head 24. A generally suitable fluid operated pump, and a bottom hole assembly suitable for use with the tubing system 30 to achieve the desired mode of operation, may be found in Patent No. 2,589,671, granted March 18, 1952 to Clarence J. Coberly. Consequently, there is no need to specifically disclose same herein.

Continuing to refer to FIG. 6 of the drawings, the pump tubing 40, which is the largest of the three tubings 40, 42 and 44, is shown as threadedly connected to the tubing head 32. The supply and return tubings 42 and 44 are provided at their upper ends with supply and return fittings seated on annular shoulders at the upper ends of parallel bores in the tubing head 32. The supply fitting is concealed in FIG. 6 by the return fitting, the latter being

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identified by the numeral 50. These supply and return fittings are provided with radial ports respectively communicating with lateral passages 52 and 54 in the well head section 34. Connected to the well head section 34 in communication with the supply and return passages 52 and 54 are supply and return lines 56 and 58, respectively. The supply and return lines 56 and 58 extend along the ocean floor 14 to the onshore pumping station 18 as shown in FIG. 1 of the drawings. At the onshore pumping station 18, the supply line 56 is connected to a suitable source of operating fluid under pressure, such as a triplex pump, not shown. The return line 58 may discharge into an operating fluid reservoir, not shown, which supplies the triplex pump. The operating fluid, as is conventional, may be clean crude oil, although other fluids may be used.

Continuing to refer to FIG. 1, a conductor tubing 60 of a size to permit sliding passage of the fluid operated pump 46 therethrough extends from the pumping station 18 to a point in the vicinity of the well 10. The conductor tubing 60, which may be a steel pipe laid on the ocean floor 14, is so designed that any bends therein have radii of curvature sufficiently large to permit free passage of the fluid operated pump 46 therethrough under the influence of hydraulic pressure. The conductor tubing 60 terminates at the onshore pumping station 18 in a pump head 62 which is adapted to receive the fluid operated pump 46 in a generally horizontal position when the pump is circulated out of the well 10 and to the pump head in a manner to be described hereinafter. The pump head 62 includes a conventional pump catcher 64 which receives and latches onto the fluid operated pump 46 when it arrives at the pumping station 18.

It will be understood, however, that the pump head 62 may receive, and permit insertion of, the fluid operated pump 46 in a generally vertical position. The transition from the generally horizontal conductor tubing 60 to such a generally-vertically-oriented pump head may be effected in the same way as the hereinafter-described transition between the conductor tubing 60 and the pump tubing 40. Such a generally-vertically-oriented pump head may be used, for example, in connection with an offshore control station, such as a platform, not shown, erected on the ocean floor 14 and extending above the surface of the water.

It will be noted that, in moving between the conductor tubing 60 and the pump tubing 40 in either direction, the fluid operated pump 46, or other equipment being circulated in or out, must "turn a corner" of the order of 90°. To accomplish this, the conductor tubing 60 and the pump tubing 40 are interconnected by a flexible tubing 70, which is essentially a hose, of a size to permit passage of the fluid operated pump 46 therethrough, and of sufficient flexibility to permit the particular portion thereof occupied by the pump to straighten to accommodate the pump, this being illustrated in FIG. 2 of the drawings. More particularly, the flexible tubing 70 takes the form of a substantially 270° loop oriented in a generally vertical plane, the bends in the loop having sufficiently large radii to permit passage of the pump 46 in either direction in the manner outlined.

To support the flexible tubing 70 in the desired position, and to protect it, it is enclosed in a complementary housing 72 connected at one end to the conductor tubing 60, as shown in FIG. 2, and at its other end to the upper end of the well head section 34, as shown in FIG. 6 of the drawings. As shown in FIGS. 3, 4 and 5, the housing 72 is laterally elongated in cross section in its generally vertical plane so that successive portions of the flexible tubing 70 can straighten as required to permit passage of the fluid operated pump 46 therethrough. It is thought that the lateral shifting of the flexible tubing 70 relative to the housing 72 which occurs as the pump 46 passes through the flexible tubing will be clear from a comparison of, for example, FIGS. 2, 3 and 4 of the drawings.

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The flexible tubing 70, as hereinbefore indicated, is essentially a hose. Accordingly, it may have any suitable construction and may be made of any appropriate material or materials. As suggested in FIG. 6 of the drawings, the flexible tubing 70 may be an elastomeric tube 74 reinforced by a coil spring 76 telescoped thereover. As will be discussed hereinafter, the pressure in the housing 72 externally of the flexible tubing 70 is maintained at a value approaching the pressure developed in the flexible tubing behind the pump in circulating it in or out, thereby minimizing the pressure differential between the interior and the exterior of the flexible tubing. This minimizes the strength requirements of the flexible tubing 70 and permits the employment of one which flexes quite readily as the pump 46 passes therethrough.

Adjacent the well head 24, the flexible tubing 70 extends downwardly within the housing 72 and is connected to a fitting 80 having a passage 82 therethrough which is of the same diameter as and registers with the interior of the flexible tubing. Thus, the fluid operated pump 46 passes through the passage 82 in the fitting 80 in entering and leaving the flexible tubing 70. When the fluid operated pump 46 is in operation, or is being run in or out, the fitting 80 is in a position such that the passage 82 is in register with and in alignment with the upper end of the pump tubing 40, the inside diameter of the pump tubing, of course, being the same as the inside diameter of the flexible tubing 70 and being the same as the diameter of the passage 82. With the fitting 80 in this position, the pump 46 can pass freely from the flexible tubing 70 into the pump tubing 40, or vice versa. Also, when the fluid operated pump 46 is in operation, the production fluid flows upwardly through the pump tubing 40, the passage 82 in the fitting 80, the flexible tubing 70 and the conductor tubing 60, being suitably disposed of at the onshore station 18. As will be described hereinafter, the fitting 80 is movable laterally from the aforementioned position wherein the passage 82 is aligned with the pump tubing 40 to an inoperative position wherein this fitting and the flexible tubing 70 are completely out of alignment with the inner casing 22. The reason for this will be discussed hereinafter.

It will be noted that there is a slight clearance 84 between the tubing head 32 and the fitting 80 at the adjacent end of the flexible tubing 70. When the pump 46 is being circulated out by fluid pressure applied therebeneath, leakage into the housing 72 occurs by way of the clearance 84 as the pump 46 leaves the pump tubing 40 and enters the flexible tubing 70. This leakage tends to cause the external pressure applied to the flexible tubing 70 to approach the internal pressure applied thereto behind the pump 46 so as to minimize the pressure differential applied between the interior and the exterior of the flexible tubing. Consequently, the strength requirements of this tubing are minimized so as to readily achieve the flexibility necessary to permit free passage of the pump 46. This same clearance 84 also tends to equalize the internal and external pressures applied to the flexible tubing 70 when the fluid operated pump 46 is in its operating position and in operation.

To minimize the pressure differential between the interior of the flexible tubing 70 and the interior of the housing 72 externally of the flexible tubing when the fluid operated pump 46 is being run in, a corresponding bleed or leakage means, not specifically shown, may be provided at the junction 86 of the conductor tubing 60 and the flexible tubing 70. Thus, during running in of the pump 46, as it leaves the conductor tubing 60 and enters the flexible tubing 70, the leakage provided at the junction 86 tends to cause the pressure externally of the flexible tubing 70 to approach the pressure internally thereof behind the pump. This again minimizes the pressure differential applied across the wall of the flexible tubing 70.

It will be understood that, to prevent bypassing of the

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fluid operated pump 46 by the fluid used to circulate it in or out, the pump may be provided with oppositely facing packer cups, not shown, capable of sealing engagement with the pump tubing 40, the conductor tubing 60 and the flexible tubing 70. Such packer cups may be similar to those disclosed in the aforementioned Patent No. 2,589,671.

Operation of structure for running equipment in and out

It is thought that the manner in which the fluid operated pump 46 is circulated between the pumping station 18 and its operating position in the well 10 will be clear with only a brief over-all description.

In running the pump 46 in, it is first necessary to remove the pump catcher 64 and to insert the pump through the pump head 62 into the conductor tubing 60, the pump catcher thereupon being replaced. Then, fluid under a relatively low pressure is introduced into the conductor tubing 60 behind the pump 46 to propel the pump through the conductor tubing 60 toward the well 10. Any fluid ahead of the pump 46 which is displaced by the pump flows through the conductor tubing 60, the flexible tubing 70 and the pump tubing 40 into the bottom hole assembly, and then flows to the pumping station 18 by way of the supply and return tubings 42 and 44 and the supply and return lines 56 and 58. This flow pattern may be achieved by a suitable conventional control valve, not shown, incorporated, for example, in the pump head 62.

As additional fluid under relatively low pressure is injected into the conductor tubing 60 behind the pump 46, the pump makes its way through the conductor tubing and into the flexible tubing 70, the latter flexing as required, and as permitted by the particular cross sectional configuration of the housing 72, to permit passage of the pump therethrough. During this phase, an excessive pressure differential between the interior and the exterior of the flexible tubing 70 is prevented by virtue of the leakage means in the vicinity of the junction 86.

As the pump 46 leaves the flexible tubing 70, it passes through the passage 82 into the pump tubing 40, and thence downwardly through the pump tubing into its operating position in the bottom hole assembly at the lower end of the tubing system 30, being suitably seated in the bottom hole assembly under such conditions, as disclosed in more detail in the aforementioned Patent No. 2,589,671.

Once the fluid operated pump 46 has been circulated into its operating position in the foregoing manner, it may be operated in the usual way by operating fluid under high pressure introduced through the supply line 56 and the supply tubing 42. The production fluid discharged by the pump 46 flows to the pumping station 18 by way of the pump tubing 40, the passage 82, the flexible tubing 70 and the conductor tubing 60. The spent operating fluid is returned to the pumping station through the return tubing 44 and the return line 58.

If it is desired to remove the fluid operated pump 46 for any reason, fluid under relatively low pressure is introduced into the return line 58 at the pumping station 18, the supply line 56 being closed and the conductor tubing 60 being opened at the pump head 62. The fluid thus introduced through the return line 58 flows downwardly through the return tubing 44 and acts on the lower end of the pump 46 to circulate it upwardly through the pump tubing 40, and then through the passage 82 in the fitting 80, the flexible tubing 70 and the conductor tubing 60. As previously explained, the clearance 84 permits enough leakage to partially equalize the internal and external pressures acting on the flexible tubing 70, thereby minimizing the pressure differential across the wall of this tubing. When the pump 46 reaches the pump head 62, it engages and is latched onto by the pump catcher 64, which may then be detached from the pump head 62 to permit withdrawal of the pump.

Thus, the present invention provides a simple and effective

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tive way of running the pump 46, or other equipment, into and out of the well 10 despite its remote location from the pumping station 18. More particularly, the flexible tubing 70 provides a simple and effective way of permitting the pump 46 to make the approximately 90° turn required at the well head.

Structure for servicing well 10

One side of the housing 72 for the flexible tubing 70 communicates, above the well head 24, with an adjacent side of a standpipe or guide tubing 100 which is mounted on the well head section 34 in alignment with the casing 22. As best shown in FIG. 5 of the drawings, the housing 72 and the guide tubing 100 may be welded together above the well head 24 with open sides 102 and 104, respectively, in register. The open sides 102 and 104 of the housing 72 and the guide tubing 100 are wide enough to permit lateral shifting of the end fitting 80 on the flexible tubing 70, and the adjacent portion of the flexible tubing, completely out of alignment with the aligned casing 22 and guide tubing 100. This is to permit access to and/or installation or removal of the tubing system 30 through the guide tubing 100 from a barge, boat or the like.

Considering the guide tubing 100 in more detail, it is provided adjacent its upper end with a shut-off valve 106, which may be of the gate type. The valve 106 is preferably spring-biased toward its closed position in a manner not specifically shown. To open the valve 106 when access to the tubing system 30 is desired, the valve is provided with a hydraulic motor 108 actuatable by fluid pressure supplied through a control line 110 leading from the onshore station 18.

Incorporated in the guide tubing 100 above the valve 106 is a latch unit 112 adapted to latch onto a conductor pipe, not shown, lowered into the upper end of the guide tubing from a barge, boat, or the like. Such conductor pipe, when latched to the guide tubing 100, and sealed relative thereto, prevents communication between the interior of the well 10 and the ocean. The latch unit 112 is preferably spring-biased closed in a manner not specifically shown, and is hydraulically opened, or unlatched. Fluid pressure for unlatching the latch unit 112 is supplied through a control line 114 leading from the onshore station 18. It will be understood that the valve 106 is not opened until after the conductor pipe has been latched in place and sealed by the unit 112.

In the event that further descriptions of the valve 106 and the unit 112 are desired, reference is hereby made to the co-pending patent application of Clarence J. Coberly, Serial No. 286,537, filed June 10, 1963, now Patent No. 3,239,004, issued March 8, 1966.

Above the unit 112 is a downwardly convergent guide funnel 116 for guiding the aforementioned conductor pipe, or other equipment, into the guide tubing 100 so that it can be latched and sealed by the unit 112. In order to mark the location of the well 10, guide lines 118 extend upwardly from the guide funnel 116 to a marker buoy 120, FIG. 1. The guide lines 118 may also be utilized to guide the lower end of a conductor pipe, for example, downwardly into the guide funnel 116.

As previously explained, when access to the tubing system 30 is desired, or when removal or installation of this system is necessary, the flexible-tubing fitting 80 and the adjacent portion of the flexible tubing 70 are moved laterally out of alignment with the guide tubing 100 and the casing 22. This provides unobstructed access through the guide tubing 100.

Considering how the foregoing is accomplished, and referring to FIG. 6 of the drawings, the fitting 80 and the adjacent portion of the flexible tubing 70 are adapted to be laterally moved out of the way by a hydraulic motor 130 comprising a cylinder 132 having therein a piston 134 provided with a rod 136 connected to the fitting 80. The hydraulic motor 130 is controlled by a piston type, differ-

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ential area, four-way selector valve 140. This selector valve may be controlled from the pumping station 18, or from the boat or barge utilized to service the well 10, in a manner which will now be described.

In the construction illustrated, the selector valve 140 is mounted on the end of the cylinder 132 remote from the piston rod 136 and includes a housing 142 containing a valve spool 144 having a piston 146 at one end, all as shown in FIG. 9 of the drawings. The valve spool 144 is normally biased into the position shown in FIG. 9 by a compression spring 148 seated against the piston 146 and against the housing 142. The space or chamber in which the spring 148 is located is in constant communication with the flexible-tubing housing 72 through a line 150. Thus, the spring chamber is at a low pressure, relatively speaking, this pressure acting on one side of the piston 146. A control line 152 is adapted to apply to the other side of the piston 146 a fluid pressure sufficiently high to overcome the force of the spring 148 and the fluid pressure in the spring chamber, whereby to shift the valve spool 144, upwardly as viewed in FIG. 9, to a second operating position thereof. The control line 152 may lead to the onshore pumping station 18, or it may be a flexible line leading upwardly to and connected at its upper end to the buoy 120, thereby permitting operation of the selector valve 140 from a boat, barge, or the like, used to service the well 10.

When the valve spool 144 is in the operating position shown in FIG. 9, it connects a high pressure fluid line 154, which may originate at the pumping station 18, to a passage 156 leading to the left end of the cylinder 132, as viewed in the drawings. At the same time, the valve spool 144 connects the low pressure line 150 to a passage 158 leading to the right end of the cylinder 132. Under these conditions, the piston 134 is biased toward the right to maintain the passage 82 through the fitting 80, and the adjacent end of the flexible tubing 70, in alignment with the pump tubing 40.

When the valve spool 144 is shifted to its other operating position by fluid pressure supplied through the control line 152, it connects the high pressure line 154 to the passage 158 leading to the right end of the cylinder 132, and connects the low pressure line 150 to the passage 156 leading to the left end of the cylinder, this latter connection being by way of a passage 160. The result is to displace the piston 134 to the left, as viewed in FIG. 6, thereby shifting the flexible-tubing fitting 80 and the adjacent end of the flexible tubing 70 out of alignment with the casing 22 and the guide tubing or standpipe 100. Under these conditions, various remedial or other operations may be performed on the tubing system 30 through the standpipe 100 and a conductor pipe secured thereto by the latch unit 112. If necessary, the entire tubing system 30 may be withdrawn from the well.

As described above, the tube 30 receives the pump and also is used as the production tubing during operation of the pump, the tubes 42 and 44 being the operating fluid supply and return tubes.

Under some conditions it is preferable to change the usage of these tubings in the operation of the pump. For instance the produced fluid may contain abrasive material, such as sand, or corrosive water produced with the oil. In such case it may be desirable to use the tube 30 as the return power fluid passage. Thus the housing 72, the fitting 82, the flexible tube 70, the standpipe 100 and the master valve 106 are at all times exposed only to clean power oil under low pressure, rather than sandy or corrosive fluid. Also where the production rates are low it is best to use one of the smaller tubes for produced fluid to maintain sufficient velocity to carry the sand and/or water and prevent settling of these materials. It is particularly desirable to avoid getting sand into the housing 70.

Although an exemplary embodiment of the invention has been disclosed herein for purposes of illustration, it will be understood that various changes, modifications and

substitutions may be incorporated in such embodiment without departing from the spirit of the invention as defined by the following claims.

We claim:

1. In an apparatus for running rigid elongated equipment into and out of a well from a control station spaced horizontally from the well, the combination of:

- (a) an equipment tubing set in said well;
- (b) a conductor tubing extending between said well and said control station;
- (c) a flexible tubing interconnecting said conductor and equipment tubings;
- (d) said equipment being slidable through said tubings between said control station and an operating position in said well;
- (e) said flexible tubing flexing to accommodate said equipment as it passes therethrough;
- (f) means for introducing fluid into said conductor tubing behind said equipment to circulate it through said tubings from said control station to said operating position in said well;
- (g) means for introducing fluid into said equipment tubing behind said equipment to circulate it through said tubings from said operating position in said well to said control station;
- (h) a housing enclosing said flexible tubing;
- (i) said housing having a configuration permitting flexing of said flexible tubing in said housing as said equipment passes through said flexible tubing; and
- (j) means for maintaining the pressure in said housing at a value approaching the pressure applied behind said equipment in circulating it through said flexible tubing so as to minimize the pressure differential between the interior and the exterior of said flexible tubing.

2. In an apparatus for running a fluid operated pump into and out of a well from a control station spaced horizontally from the well, the combination of:

- (a) a pump tubing set in said well;
- (b) a conductor tubing extending between said well and said control station;
- (c) a flexible tubing interconnecting said conductor and pump tubings;
- (d) said pump being slidable through said tubings between said control station and an operating position in said well;
- (e) said flexible tubing flexing to accommodate said pump as it passes therethrough;
- (f) means for introducing fluid into said conductor tubing behind said pump to circulate it through said tubings from said control station to said operating position in said well; and
- (g) means for introducing fluid into said pump tubing behind said pump to circulate it through said tubings from said operating position in said well to said control station.

3. In an apparatus for running a fluid operated pump into and out of a well from a control station spaced horizontally from the well, the combination of:

- (a) a pump tubing set in said well;
- (b) a conductor tubing extending between said well and said control station;
- (c) a flexible tubing interconnecting said conductor and pump tubings;
- (d) said pump being slidable through said tubings between said control station and an operating position in said well;
- (e) said flexible tubing flexing to accommodate said pump as it passes therethrough;
- (f) means for introducing fluid into said conductor tubing behind said pump to circulate said pump through said tubings from said control station to said operating position in said well;
- (g) means for introducing fluid into said pump tubing behind said pump to circulate said pump through

said tubings from said operating position in said well to said control station;

- (h) a housing enclosing said flexible tubing; and
- (i) said housing having a configuration permitting flexing of said flexible tubing in said housing as said pump passes through said flexible tubing.

4. In an apparatus for running a fluid operated pump into and out of a well from a control station spaced horizontally from the well, the combination of:

- (a) a pump tubing set in said well;
- (b) a conductor tubing extending between said well and said control station;
- (c) a flexible tubing interconnecting said conductor and pump tubings;
- (d) said pump being slidable through said tubings between said control station and an operating position in said well;
- (e) said flexible tubing flexing to accommodate said pump as it passes therethrough;
- (f) means for introducing fluid into said conductor tubing behind said pump to circulate said pump through said tubings from said control station to said operating position in said well;
- (g) means for introducing fluid into said pump tubing behind said pump to circulate said pump through said tubings from said operating position in said well to said control station;
- (h) a housing enclosing said flexible tubing;
- (i) said housing having a configuration permitting flexing of said flexible tubing in said housing as said pump passes through said flexible tubing; and
- (j) means for maintaining the pressure in said housing at a value approaching the pressure applied behind said pump in circulating it through said flexible tubing so as to minimize the pressure differential between the interior and the exterior of said flexible tubing.

5. In an apparatus for running a fluid operated pump into and out of a well from a control station spaced horizontally from the well, the combination of:

- (a) a pump tubing set in said well;
- (b) a conductor tubing extending between said well and said control station;
- (c) a flexible tubing interconnecting said conductor and pump tubings;
- (d) said pump being slidable through said tubings between said control station and an operating position in said well;
- (e) said flexible tubing flexing to accommodate said pump as it passes therethrough;
- (f) means for introducing fluid into said conductor tubing behind said pump to circulate said pump through said tubings from said control station to said operating position in said well;
- (g) means for introducing fluid into said pump tubing behind said pump to circulate said pump through said tubings from said operating position in said well to said control station;
- (h) a housing enclosing said flexible tubing;
- (i) said housing having a configuration permitting flexing of said flexible tubing in said housing as said pump passes through said flexible tubing; and
- (j) means providing restricted fluid communication between said flexible tubing and said housing for maintaining the pressure in said housing at a value approaching the pressure applied behind said pump in circulating it through said flexible tubing so as to minimize the pressure differential between the interior and the exterior of said flexible tubing.

6. In an apparatus for running a fluid operated pump into and out of a well from a control station spaced horizontally from the well, the combination of:

- (a) a casing set in said well;
- (b) a pump tubing set in said casing;

- (c) a conductor tubing extending between said well and said control station;
- (d) a flexible tubing connected to said conductor tubing and having an end movable laterally between an operative position in register with the upper end of said pump tubing and an inoperative position out of alignment with said casing; 5
- (e) said pump being slidable through said tubings between said control station and an operating position in said well when said end of said flexible tubing is in said operative position; 10
- (f) said flexible tubing flexing to accommodate said pump as it passes therethrough;
- (g) means for introducing fluid into said conductor tubing behind said pump to circulate it through said tubings from said control station to said operating position in said well; 15
- (h) means for introducing fluid into said pump tubing behind said pump to circulate it through said tubings from said operating position in said well to said control station; and 20
- (i) means for moving said end of said flexible tubing between its operative and inoperative positions.
7. In an apparatus for running a fluid operated pump into and out of a well from a control station spaced horizontally from the well, the combination of: 25
- (a) a casing set in said well;
- (b) a pump tubing set in said casing;
- (c) a conductor tubing extending between said well and said control station; 30
- (d) a flexible tubing connected to said conductor tubing and having an end movable laterally between an operative position in register with the upper end of said pump tubing and an inoperative position out of alignment with said casing; 35
- (e) said pump being slidable through said tubings between said control station and an operating position in said well when said end of said flexible tubing is in said operative position;
- (f) said flexible tubing flexing to accommodate said pump as it passes therethrough; 40

- (g) means for introducing fluid into said conductor tubing behind said pump to circulate it through said tubings from said control station to said operating position in said well;
- (h) means for introducing fluid into said pump tubing behind said pump to circulate it through said tubings from said operating position in said well to said control station; and
- (i) hydraulic means controllable from said control station for moving said end of said flexible tubing between its operative and inoperative positions.
8. In combination:
- (a) a casing set in a submerged, offshore well;
- (b) a first tubing set in said casing;
- (c) a standpipe aligned with and extending upwardly from and connected to the upper end of said casing;
- (d) a housing connected to and communicating with one side of said standpipe;
- (e) a second, flexible tubing having an end movable laterally between an operative position within said standpipe and in register with the upper end of said first tubing and an inoperative position within said housing and out of alignment with said casing; and
- (f) means for moving said end of said second tubing laterally between its operative and inoperative positions.

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