METHOD FOR THROUGH-THE-FLOWLINE TOOL INSTALLATION

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ABSTRACT

There is disclosed a method and apparatus for placing and removing a retrievable tool in a well conduit. The tool is placed by pumping it down the well conduit to a landing area where it is latched in place. The tool is retrieved by pumping a retrieving tool into the conduit into engagement with the retrievable tool and unlatching the retrievable tool with the retrieving tool. The two tools latched together are pumped up the conduit, and the retrieving tool is then disengaged from the retrievable tool when an elevation of lower pressure is reached and both tools are pumped out of the conduit.

5 Claims, 10 Drawing Figures
METHOD FOR THROUGH-THE-FLOWLINE TOOL INSTALLATION

BACKGROUND OF THE INVENTION

This invention relates to method and apparatus for running well tools into and out of a well conduit. Although the invention has particular application to offshore wells, it will be apparent that the invention is not so limited.

Well tools are conventionally run into and retrieved running a tubing string by wire line equipment. Even on land based wells, this technique is somewhat onerous because of the time and expense necessary to set up the necessary equipment. In an offshore environment where a plurality of wells are produced from a single platform, wire line placement of well tools is considerably more difficult since flow lines leading from the surface are inclined or arcuate. In offshore wells completed with a submerged wellhead, the running of wire line tools is exceptionally difficult and expensive.

Proposals have been made in the prior art to place well tools by locating the well tool in the conduit and applying fluid pressure thereto to move the tool down the flowline to the well. These proposals have provided means for applying fluid pressure in the opposite direction to retrieve the well tool. Exemplary of these proposals are the disclosures in U.S. Pat. No. 3,308,880; No. 3,363,693 and No. 3,378,080.

While these proposals have been successful in placing and retrieving tools through the flowline, there exists room for improvement in techniques for hydraulically placing and retrieving well tools.

Well tools proposed by the prior art which are capable of placement and retrieval through the flowline are typically elongate devices which are incapable of traversing a sharp bend in the flowline. Consequently, care must be taken in underwater completions to avoid sharp bends in the flowline. It is consequently established practice for through-flowline tools to provide five foot radius bends in the flowline immediately adjacent the submerged wellhead. Bends of this character are shown in U.S. Pat. No. 3,308,880. Although the use of such bends provides considerable flexibility for the underwater flowline and accommodate passage of conventional through-the-flowline tools, these items constitute an expensive component of the submerged wellhead.

SUMMARY OF THE INVENTION

It is accordingly an object of the invention to provide method and apparatus for placing and retrieving well tools through a flowline having relatively sharp bends therein.

Another object of the invention is to provide a retrieving tool for un-latching a well tool from within a well conduit which is capable of disengagement from the well tool within the conduit.

In summary, a method of pulling a retrievable tool latched in a conduit in accordance with this invention comprises moving a retrieving tool through the conduit into engagement with the retrievable tool, unlatching the retrievable tool from the conduit with the retrieving tool, disengaging the retrieving tool from the retrievable tool and applying fluid pressure to the tools for moving the tools upwardly through the conduit toward the surface.

The retrieving tool of this invention comprises a carrier movable through the conduit, latch means extendable out of the carrier for connection to the retrievable tool and means responsive to decreasing pressure in the conduit for unlatching the latch means from the retrievable tool.

The retrievable tool of this invention comprises first latch means for securing the tool to the conduit, a first reciprocable element having a passage therethrough for manipulating the first latch means, second latch means for holding the first ele-
applicability of these devices to wells making sand. Indeed, merely moving the storm choke through the tubing string may be sufficient to dissolve sand therefrom. Whether storm chokes are replaced at frequent intervals or whether they are merely cycled through the tubing string depends on circumstances of each particular well.

The storm choke 44 has as major components a body or carrier 46 having latches 48 thereof, a reciprocable element 50 for manipulating the latches 48, second latch means 52 for holding the reciprocable element 50 in a position to retain the latches 48 in the expanded position, and an actuator 54 for moving the reciprocable element.

The body 46 is provided with a two-way seal 56 adjacent the rear end thereof for sealably engaging the interior of the tubing string 28. The body 46 also provides a rearwardly facing recess 58 and a central passage 60. The latches 48 are carried by the body 46 and extend toward the front of the choke 44. The latches 48 may be of any desired type and are illustrated as comprising a plurality of spring fingers 62 having outwardly facing lugs 64 thereon. The interior of the latches 48 are provided with first and second cam faces 66, 68.

The reciprocable element 50 comprises a mandrel or sleeve 70 extending through the passage 60 in the body 46 with a seal 72 disposed therebetween. The mandrel 70 is biased by a spring operating against an integral flange 76 on the mandrel 70 and is moving against said flange 76 disposed about the mandrel 70. The annular ring 78 presses against the cam face 68 to bias the latches 48 into the latching position as shown in FIG. 3 when the reciprocable element 50 is moved downwardly with respect to the body 46. It will accordingly be seen that the spring 74 normally biases the reciprocable element 50 toward the position shown in FIG. 3. The latches 48 may normally be biased toward the expanded position shown in FIG. 3 and are retracted upon upward movement of the element 50 by coaction of a cam face 80 on the element 50 with the cam face 66. It will be seen that the well tool 44 comprises means for latching the tool in a landing area in the conduit 28 with means being provided to manipulate the latches 48 into an expanded and a retracted position.

Disposed in the recess 58 is the second latch means 52 comprising a plurality of latch elements 82 pivoted about pins 84 and biased toward the center of the tool 44 by suitable springs 86. As revealed by a comparison of FIGS. 2 and 3, depression of the sleeve 70 allows the lower ends of the latch elements 82 to pivot inwardly to hold the reciprocable element 50 in the depressed position shown in FIG. 3. The latch elements 82 are designed to hold the reciprocable element 50 in the depressed position until the second latch means 52 are physically manipulated by a retrieval tool. It will accordingly be seen that the well tool 44 is securely latched in the tubing string 28.

The actuating element 54 comprises a second reciprocable mandrel or tube 88 slidably positioned in the passage 90 of the sleeve 70. Suitable seals 92 are provided therebetween. A flange 94 is provided on the mandrel 88 and coacts with a spring 96 and a shoulder 98 on the element 50 to normally bias the mandrel 88 downwardly with respect to the element 50.

The mandrel 88 provides a flow path 100 therethrough with a removable choke bean 102 threadably engaged in one end thereof. The other end of the mandrel 88 provides a valve seat 104 cooperating with a ball 106 to provide a check valve preventing fluid flow from the top to the bottom of the well tool 44. The pin 108 comprising a pin 108 in the end of the sleeve 70 is provided to prevent loss of the ball 106.

The well tool 44 is placed in the flow line 32 by a suitable manifold or receiver (not shown) and fluid pressure is applied thereto for moving the tool 44 through the flowline 32 and through the tubing string 28 to the landing nipple 38. It will be apparent that fluid pressure acting against the ball 106 maintains the check valve closed thereby developing a force tending to depress the actuator 54 and the reciprocable element 50. The reciprocable element 50 and the spring 74 and the inherent bias in the latches 48 tend to move the latches 48 outwardly into a latching position. As the well tool 44 enters the landing nipple, the lungs 64 are free to move outwardly into the recess 42 and thereby prevent further downward movement of the tool 44. In order to lock the tool 44 in the landing nipple 38, additional pressure is applied through the flow line 32 by suitable equipment. As the pressure adjacent the rear of the tool 44 builds up, the spring 74 is compressed and the reciprocable element 50 is depressed. As the upper end of the sleeve 70 passes under the free end of the latch elements 82, the latch elements 82 are biased inwardly to retain the element 50 in the position shown in FIG. 3.

Referring now to FIGS. 4 and 5, the landed well tool 44 is illustrated as a storm choke and functions to allow flow therethrough toward the surface at moderate rates of flow and closes at abnormally high rates of flow. The flow bean 102 is selected to produce a pressure drop across the actuator 54 at a predetermined abnormally high rate of flow sufficient to compress the spring 96 and thereby advance the mandrel 88. Upward movement of the mandrel 88 causes the retainer 108 to position the ball 106 in sealing relation with the seat 104 thereby closing the flow path 100 as shown in FIG. 5.

It will accordingly be seen that production through the tubing string 28 is halted upon the occurrence of abnormally high rates of flow. Production may be re-established if the pressure below the storm ring 78 is reduced with fluid 32 to allow the spring 96 to expand into the position shown in FIG. 4. Production may also be established by retrieving the well tool 44 and reinserting the same.

An important feature of this invention resides in the method and apparatus for retrieving the well tool 44. Referring now to FIGS. 6-10, there is shown a retrieving tool 110 having as major components a body or carrier 112, movable means 114 for connection to the well tool 44 and means 116 responsive to decreasing pressure in the tubing string 28 for unlatching the movable means 114 from the tool 44. In operation, the retrieving tool 110 is pumped down the tubing string 28 until the movable means 114 engages and connects to the well tool 44. The well tool 44 is unlatched from the tubing string 28 by the retrieving tool 110. The retrieving tool 110 and well tool 44 are then pumped upwardly through the tubing string 28, the pressure responsive means 116 acting to disengage the retrieving tool 110 from the well tool 44. It is apparent that when the tools 44, 110 are separated, they have the capability of negotiating bends of smaller radius than when the tools are connected together.

The body 112 comprises a piston like head 118 having a two directional seal 120 thereon for sealably engaging the inside of the tubing string 28. A cylindrical extension 122 provides a bore 124 in fluid communication with the rear end of the body 112 through a port 126. The front of the body 112 provides a head 128.

The movable means 114 comprises a piston 130 operative in the bore 124 and sealed thereagainst by a suitable piston ring 132. A piston rod 134 extends through a passage 136 in the head 128 with a seal 138 being provided for the piston rod 134. The free end of the piston rod 134 provides cam and latch means 140 for unlatching the well tool 44 and for connecting the well tool 44 to the retrieving tool 110. The cam and latch means 140 is provided with cam surfaces 142 for engaging the latch elements 82 below the pivot pin 84 to bias the latch elements 82 outwardly into the position shown in FIG. 7.

The cam and latch means 140 is illustrated as comprising a plurality of individual spring members 144 machined from the end of the piston rod 134. Each of the spring members 144 comprises a shoulder 146 coacting with an oppositely facing shoulder 148 on each of the latch elements 82 as shown in FIG. 8.

The pressure responsive means 116 is illustrated as comprising a chamber 150 in the head 128 of the tool 110 communicating with the bore 124 through a passage 152. The pressure responsive means 116 also comprises cam means pro-
vided by the head 128 comprising a conical cam face 154 and a cylindrical retention surface 156 cooperating with a protuberance 158 on each of the spring members 144.

It is desirable for the retrieving tool 110 to disengage automatically from the well tool 44. The pressure responsive means 116 is so designed and the chamber 150 is accordingly provided with a pressurized fluid through a suitable filling port (not shown). As the retrieving tool 110 rises in the tubing 28, the hydrostatic pressure applied to the piston 130 through the port 126 decreases. The pressure in the chamber 150 is selected to bias the piston 130 upwardly some distance above the landing nipple 38 but below the casinghead 22. Although any suitable depth for disengagement may be used, a practical area for disengaging the tools 44, 110 is at about a thousand feed below the casinghead 22.

The overall operation of the retrieving tool 110 should now be apparent. The retrieving tool 110 is inserted in a suitable receiver or manifold (not shown) connected to the flowline 32. Pressure is applied to the flowline 32 to propel the retrieving tool 110 through the flowline 32 and into the tubing string 28. As will be apparent, the pressurized fluid in the chamber 150 will position the movable means 114 in the retracted position shown in FIG. 10 during movement of the tool 110 through the flowline 32 and through part of the tubing string 28. As the retrieving tool 110 passes downwardly through the tubing string 28, the hydrostatic pressure applied against the piston 130 through the port 126 gradually overcomes the pressure applied on the opposite side of the piston by the fluid in the chamber 150. As this depth is passed, the piston 130 moves downwardly with respect to the body 112 into the attitude shown in FIG. 6. When the retrieving tool 110 contacts the well tool 44 as shown in FIG. 6, additional pressure is applied through the flow line 32 to advance the retrieving tool 110 thereby enabling the cam surfaces 142 to bias the latch elements 82 out of engagement with the mandrel 70.

Pressure is then applied through the control conduit 34 to move the retrieving tool 110 upwardly into the relationship shown in FIG. 8. It will be seen that the mandrel 70 moves upwardly causing retraction of the latch elements 64 from the landing nipple 38. Pressure is applied through the control conduit 34 and the flowline 32 is opened. There is consequently a sizeable pressure drop across the retrieving tool 110, as compared to the pressure drop across the well tool 44, thereby propelling the retrieving tool 110 together with the well tool 44 upwardly through the tubing string 28. As the retrieving tool 110 passes into the un latching zone, pressure in the chamber 150 is sufficient to bias the piston 130 upwardly against hydrostatic pressure in the tubing string 28. The piston rod 134 is thereby withdrawn into the body 12 forcing the protuberances 158 against the conical cam surface 154 thereby collapsing the spring members 144 toward the axis thereof. The shoulders 146 thereupon pass inside the shoulders 148 as shown in FIG. 9.

Continued pumping through the control conduit 34 causes the retrieving tool 110 and the well tool 44 to pass separately through the casinghead 22 and the flowline 32 into a suitable receiver or manifold (not shown) at the storage location. It will be apparent that the reduced length of the separate tools, as compared to the overall length of the connected tools, enables the tools 110, 44, to negotiate bends of substantially shorter radius than the prior art. Consequently, great pains and expense need not be made to eliminate short bends from the flowline 32. As will be appreciated, this is of particular importance in offshore underwater completions but is of considerable utility in other environments.

We claim as our invention:

1. The method of pulling a retrievable tool latched in a landing area in a well conduit comprising the steps of:
   moving a retrieving tool downwardly through the conduit into engagement with the retrievable tool;
   connecting the retrieving tool to the retrievable tool;
   unlatching the retrievable tool from the landing area with the retrieving tool;
   raising the connected tools to a higher elevation in the well conduit;
   disconnecting the retrieving tool from the retrievable tool;
   and applying fluid pressure to the tools for moving the same upwardly through the conduit toward the surface.

2. The method of claim 1 wherein the moving step comprises connecting the retrieving tool to the retrievable tool upon engagement therewith and further comprising, after the unlatching step, raising the retrieving tool and the retrievable tool together from the landing area.

3. The method of claim 2 wherein the conduit comprises a port, a control conduit connected thereto, the landing area being below the port and wherein the raising step comprises raising the tools together to a location above the port.

4. The method of claim 3 wherein the pressure applying step comprises passing fluid through the control conduit into the conduit for flowing the tools through the conduit.

5. The method of claim 3 wherein the retrieving tool is on one side of the port and the retrievable tool is on the other side thereof during the unlatching step and wherein the raising step comprises applying fluid pressure through the conduit between the retrieving tool and the retrievable tool; and maintaining pressure in the conduit above the retrieving tool less than the pressure in the conduit below the retrievable tool.

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