

Sept. 21, 1971

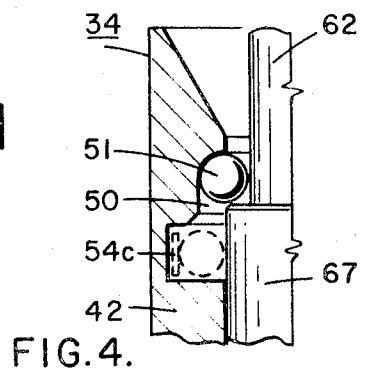
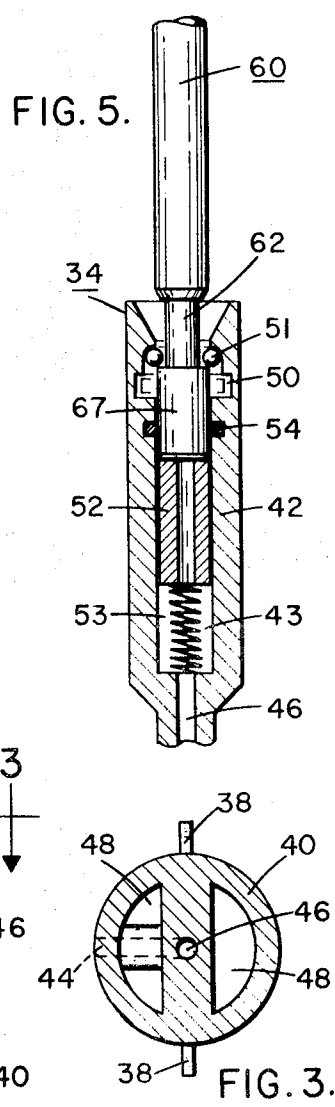
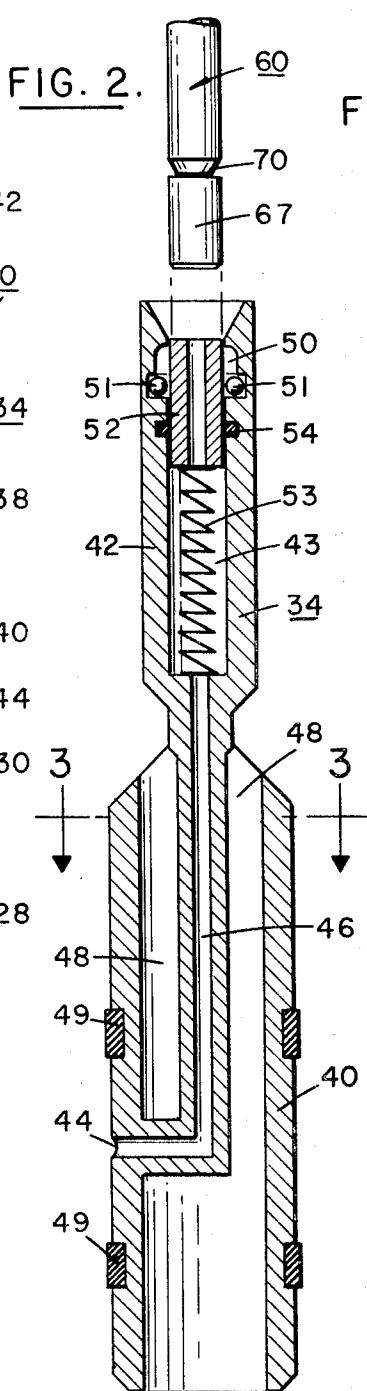
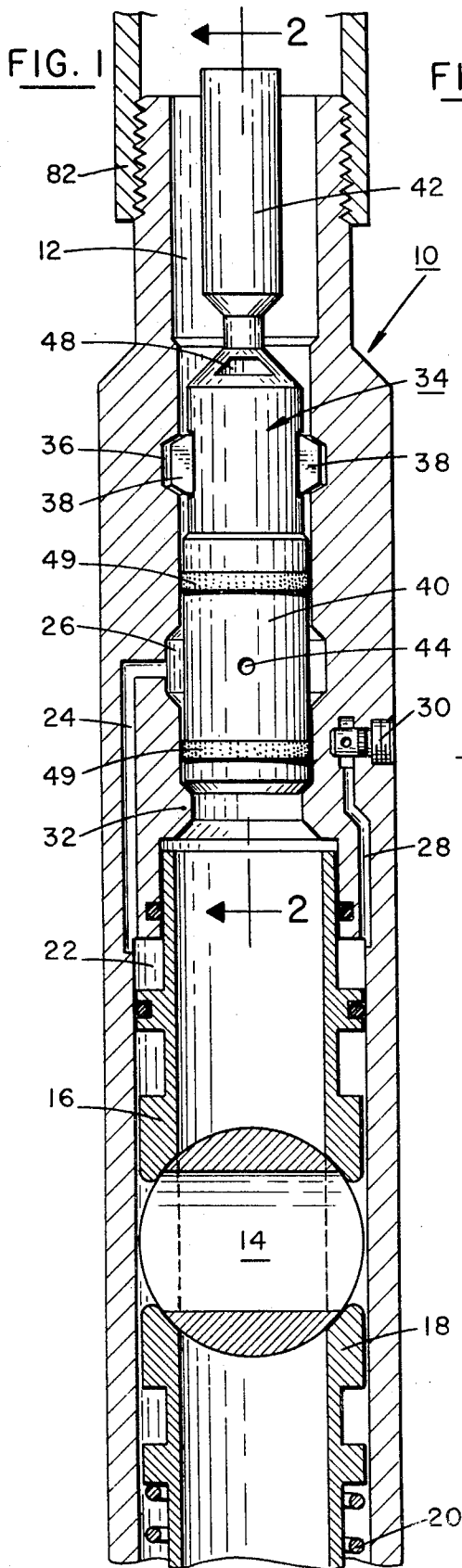
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3,606,927

RUNNING IN AND OPERATION OF VALVES AND THE LIKE IN A WELL

Filed Aug. 14, 1969

3 Sheets-Sheet 1



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RUNNING IN AND OPERATION OF VALVES AND THE LIKE IN A WELL

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FIG. 6.

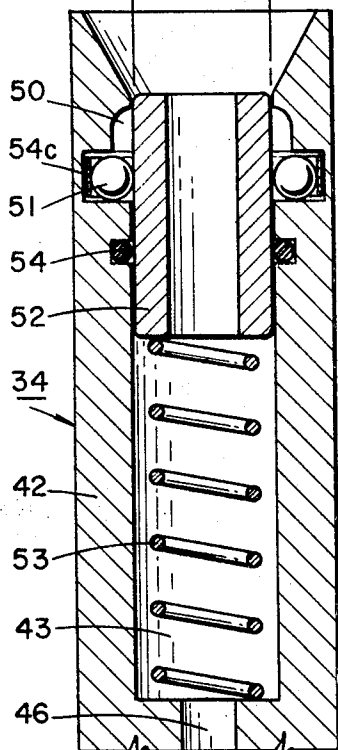
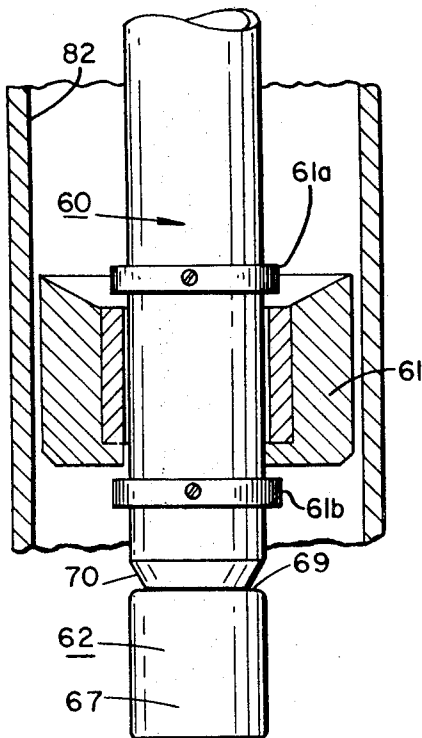


FIG. 7.

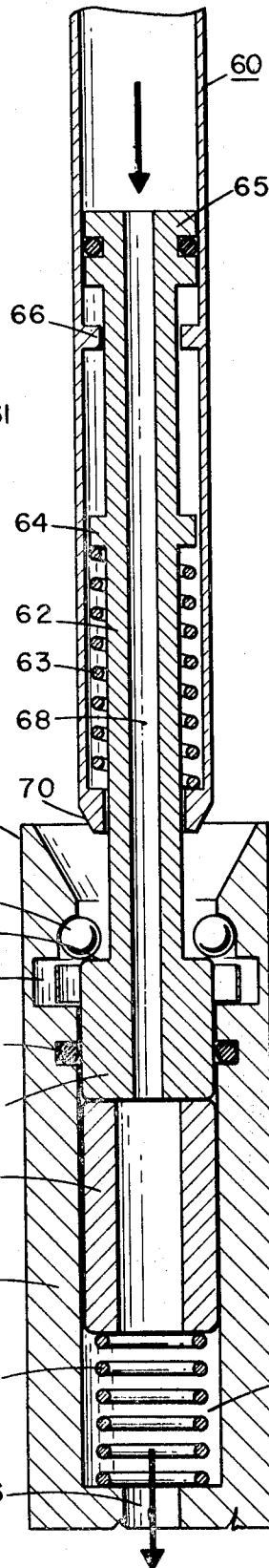
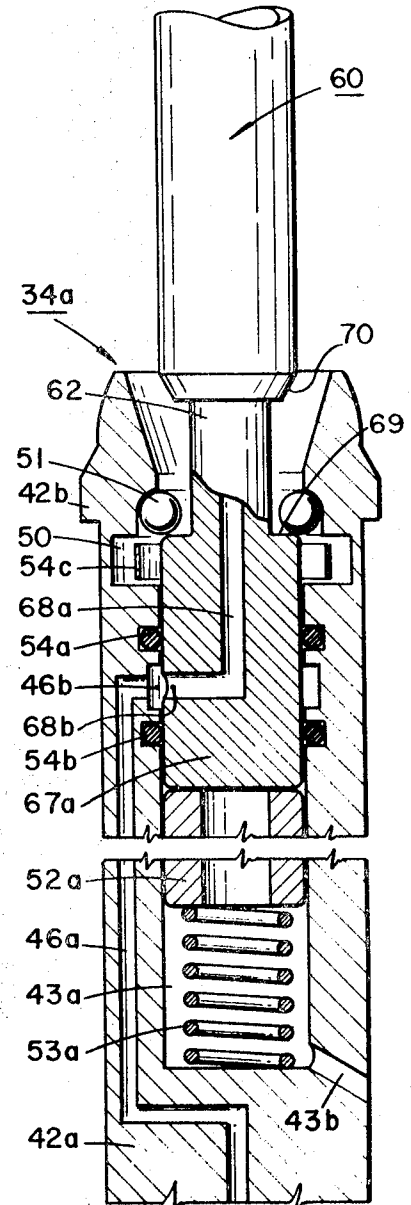


FIG. 8



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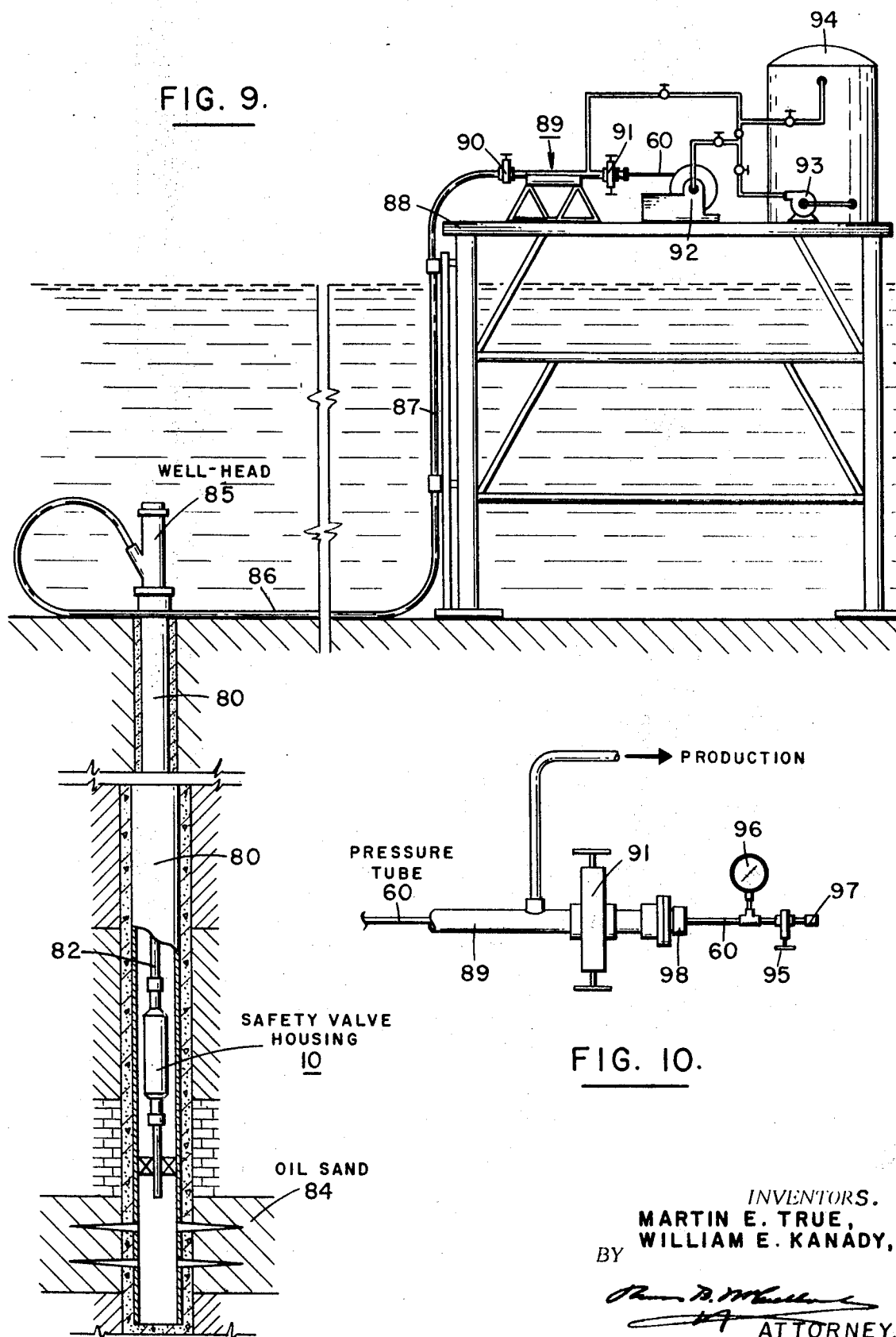
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3,606,927

RUNNING IN AND OPERATION OF VALVES AND THE LIKE IN A WELL

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9 Claims

ABSTRACT OF THE DISCLOSURE

Valves and the like in a well such as a submarine well are operated by running a tubular member into the well production pipe from a reel at the surface and locking the tubular member to said valve and the like apparatus followed by flowing fluid under pressure through the tubular member to operate the valve and the like, the tubular member also being locked by fluid pressure. Thus, a tubular member provided with a telescopic member is run into the well production pipe and locked in a tubular housing connected to the valve and the like.

BACKGROUND OF THE INVENTION

(1) Field of the invention

The present invention is directed to operating subsurface valves and the like by pressure. More particularly, the invention is concerned with method and apparatus for running in and locking a tubular member in a well by exerting fluid pressure. In its more specific aspects, the invention is directed to operations in a submarine well in which a tubular member is run into a well to perform certain operations in said well by locking the tubular member in the well to provide a conduit for delivering fluid to particular apparatus such as valves and the like.

(2) Description of the prior art

It is known to run tools into a submarine well using the so-called through flow line technique. It is also known to run a tubular member into a well from a reel at the earth's surface. The use of hydraulically operated valves in wells is also known, but customarily a separate line (run outside the production tubing) to provide operating fluid has been used which is expensive and subject to operating difficulties and also has to be run simultaneously with the well pipe. In submarine wells, it has been conventional to employ valves at or near the surface to contain pressure in the well; but these valves and that portion of the well containing same if above water bottom must be protected against wave and wind action. In the present invention, the valves are located in the well below water bottom or earth surface just above the productive formation to contain pressure far below the surface and operated by supplying fluid through a continuous tubular member which is run into the well conduit or tubing string eliminating the necessity of a separate line for operating fluid and avoiding operating difficulties. Prior art considered with respect to this invention include: U.S. 3,116,793; 3,394,760; 3,346,045; and 3,373,818.

SUMMARY OF THE INVENTION

The present invention may be briefly described as involving apparatus and method for operating a valve and the like apparatus in which a tubular member is run into a well, preferably a submarine well, from a reel, locked into a valve or other apparatus in the well, and fluid supplied to the valve through the tubular member to operate the same.

The apparatus comprises a tubular member having a telescopic member in its lower end which is extendible by fluid pressure to engage and lock in operative connection

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with a subsurface valve for delivery of operating fluid thereto.

BRIEF DESCRIPTION OF THE DRAWING

The present invention may be briefly described and illustrated by reference to the drawing in which:

FIG. 1 is a view partly in section of a well housing having positioned therein a locking mandrel;

FIG. 2 is an enlarged view of the locking mandrel taken along the line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is an enlarged fragmentary view of the locking assembly of the mandrel;

FIG. 5 is a view showing the lower end of the continuous tubing locked in the upper end of the mandrel;

FIGS. 6 and 7 are views before and after connecting the continuous pressure tubing to the mandrel;

FIG. 8 is a view illustrating a modification of the present invention;

FIG. 9 illustrates the apparatus of the present invention positioned in a submarine well; and

FIG. 10 illustrates a production hookup incorporating the device of the present invention.

DESCRIPTION OF THE PREFERRED MODE AND EMBODIMENT WITH REFERENCE TO THE DRAWING

Referring now to FIGS. 1–5, numeral 10 designates a ball valve housing adapted to be connected into a production tubing string which extends to the earth's surface. Such valve assemblies are well known to the art and are fully illustrated on pages 3820 and 3821 of the Composite Catalog (1968–69) of Oil Field Equipment & Services.

The housing 10 has a central bore 12 extending through the longitudinal axis thereof. A ball type valve 14 is positioned in the bore 12 for operably closing and opening passage through said bore. Operation of the valve 14 is accomplished by movement of a pair of sleeve assemblies 16 and 18, positioned above and below the ball 14 respectively and make sealing contact therewith. The ball valve 14 of FIG. 1 is shown in the closed position and is held in such position by the bias of spring 20 against sleeve 18 in an upward direction. Opening of the valve 14 is accomplished by downward movement of sleeve 16 by means of fluid pressure introduced in chamber 22 formed between sleeve 16 and the bore 12 of housing 10.

A fluid passage 24 is formed in housing 10 and extends from the upper end of chamber 22 to an annular groove 26 formed in the wall of bore 12, above the chamber 22. A second fluid passageway 28 extends from the chamber 22 to a pressure connection means 30 positioned in the outer wall of housing 10. The function of connection 30 and passageway 28 will be hereinafter referred to in regard to FIG. 8.

Formed on the inner wall of bore 12 is an annular shoulder 32 for landing or seating the tubular locking mandrel 34 shown in FIG. 2. A locking-in recess 36 is provided in the bore wall and adapted to receive outwardly biased latching dogs 38 of mandrel 34. As shown, the locking mandrel 34 in FIG. 1 is landed in the bore 12 of housing 10 on shoulder or seat 32 with the spring biased dogs 38 releasably engaged in recess 36.

Referring now to FIG. 2, mandrel 34 is formed of a lower section 40 and an upper throat section 42, the throat section 42 having a bore 43 in fluid communication with an external port 44 of the section 40 by way of passageway 46. Vertical flow passages 48 extend through the entire length of section 40 whereby when the assembly is seated in the bore 12 of housing 10 production fluids may flow therethrough. Seal rings 49 above and below port 44 seal the annulus between mandrel 34 and the wall

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of bore 12 whereby fluid tight communication may be had between passages 46 and 24.

The throat section 42 of mandrel 34 is provided with a locking ball recess 50 containing locking balls 51 which are normally held in unlocking position by a spring biased retainer sleeve 52 which is urged to a retaining position by means of spring 53. Sealing means 54 seal between the cylindrical sleeve 52 and the wall of bore 43. It will be noted that the ball recess 50 is formed of a larger diameter section connected to a smaller diameter section just above. Spring means 54c in the larger diameter urges locking balls 51 outwardly.

As shown more clearly in FIGS. 6 and 7, the throat section 42 of mandrel 34 is adapted to receive the lower end of a pressure tube 60 which is lowered through the pipe string from the earth's surface. The pressure tube 60 is provided with a telescoping member 62 which is designed to be extended out the lower end of tubing 60 by means of fluid pressure within tube 60. The telescoping member 62 is urged to a collapsed position by means of a spring 63 which biases between the lower end of tube 60 and a shoulder 64 on member 62. A piston head 65 is formed on the upper end of telescoping member 62 in sealing engagement with the inner wall of tube 60. A stop means 66 is provided on the inner wall of tube 60 below the piston head 65. It will be noted that the stinger end 67 is of the same O.D. as the pressure tube and is adapted, when extended, to sealingly engage within the bore 43 with sealing ring 54. The telescoping member 62 is provided with a central passageway 68 extending throughout the longitudinal axis thereof. The larger diameter of the stinger 67 provides a shoulder 69 which is adapted to engage the locking balls 51 when the stinger is projected into the bore 12 of throat section 42. The lower end of tubing 60 is also provided with a tapered surface 70 for the purpose of engaging the locking balls 51 when it is desired to disconnect from the mandrel 34.

The modification shown in FIG. 8 provides a locking mandrel whereby the ball valve 14 of FIG. 1 may be run in the well bore or casing in the open position, the difference being in the stinger assembly, the function of the retainer sleeve 52a and the placement of the pressure passageway in the mandrel.

The stinger head 67a of telescoping member 62 extending out of pressure tube 60 is somewhat longer and is provided with a side port 68b which is in fluid communication with passageway 68a. When in the locked-in position as shown in FIG. 8, the port 68b is in contact with an annular recess 46b which by way of passage 46a is in fluid communication with port 44 shown in FIGS. 1 and 2. The bore 43a has a bleed port 43b which allows downward movement of the stinger head 67a and the sleeve 52a. The bore 43a is also grooved above and below the recess 46b to provide seal rings 54a and 54b. It will be obvious that when the stinger head 67a is removed from the bore 43a the retainer sleeve 52a moves up under bias of spring 53a and retains locking balls 51 in the larger portion of recess 50 and also seals off the recess 46b and passage 46a by means of seals 54a and 54b.

The primary purpose however of the placement of recess 46b and passage 46a is to allow pressurizing of chamber 22 of FIG. 1 before running the ball valve assembly 10 in the well bore. It may be desirable at times to run the assembly in the well bore with the ball valve in the open position. For such an operation, the mandrel 34a is placed and locked in the housing 10 with the sleeve 52a acting not only as a ball retainer but also as a sleeve valve to close off the upper end of passageway 46a. With the mandrel so placed, a pressure source (not shown) is screwed into or otherwise connected to the pressure connection 30 (shown in FIG. 1) and the chamber 22 pressurized to move the sleeve piston 16 downwardly and open the ball valve 14. The source is disconnected and the pressure in chamber 22 maintained by means of the check valve type connection 30 and sleeve 52a holding ball valve 14 in the open position.

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The modification in FIG. 8 also provides an external shoulder 42b on section 42a of the mandrel 34a for the purpose of running or retrieving the mandrel 34a by wire line methods; however, it will be understood as heretofore stated that the mandrel 34 or 34a may be installed in the valve housing 10 prior to running the assembly.

FIG. 9 illustrates a possible offshore production installation in which the present invention may be incorporated. A ball valve or safety valve housing 10 is placed in a well casing 80 in a production string or pipe 82 adjacent a production formation 84. The production string 82 is connected to a platform 88 and a lubricator manifold 89 by way of well head 85, flowline 86, and riser 87. Suitable piping and valving connects the manifold 89 to a storage tank 84 and pump means 93. The manifold 89 is also provided with valve means 90 and a ram type closure means 91. A tubing reel 92 is provided for running and removing the continuous pressure tubing 60, and the connecting means attached therein.

OPERATION

The mandrel 34 or 34a may be placed in the housing 10 prior to running the pipe string 82 or it may be run in after by means of tubing 60. Once the mandrel is placed the pressure tubing 60 incorporating the telescoping section thereof is inserted in the lubricator manifold 89 and by mechanical means (not shown) is fed into the flowline and hence into the production string 82 until the stinger head end 67 is in the approximate position shown in FIGS. 2 and 6. Pressure is applied by way of pump 93 to the piston head 65 (FIG. 7). As the head 67 moves down it contacts and pushes down the retainer sleeve 52 until the shoulder 69 is below or adjacent the larger portion of ball recess 50. This allows the ball spring 54c to bias the balls inwardly against the smaller diameter portion of member 62 and above the shoulder 69. As pressure is relieved in tube 60 the spring 63 and also spring 53 force the head 62 upwardly pushing the locking balls 51 into the smaller portion of recess 50 where they are retained by the shoulder 69. An upward strain may then be applied to the pressure tubing 60 to compress spring 63 and provide a force against the locking means whereby it may not be forced downwardly when future pressure is applied through the pressure tubing 60. With the device connected as in FIG. 7 pressure can now be applied to the tube 60 and therefore to chamber 22 of the housing 10, opening the ball valve 14.

FIG. 10 illustrates a hookup for maintaining pressure in chamber 22 and also allowing production flow to storage tank 94. Ram type valve means 91 closes off around tubing 60 therefore affording a seal between it and the inner wall of manifold 89. Gripping means 98 (FIG. 10) maintains a predetermined strain on tubing 60. A gauge 96 indicates the pressure in tubing 60 and chamber 22. Valve means 95 maintains the pressure while connecting means 97 affords a means for connecting to a pressure source when needed.

It may be desirable to run or retrieve the mandrel 34 with the tubing 60 connected thereto as shown in FIG. 7. If it is desirable to disconnect the tubing from the mandrel 34 while in the well bore the tubing is lowered by its own weight with pressure inside the tube relieved. As the tube 60 is lowered the tapered surface 70 pushes the balls 51 downwardly until they are opposite the larger portion of recess 50. This allows the head 67 to snap upwardly under bias of springs 63 and 53, thus allowing the head 67 to be withdrawn from the top of the mandrel 34, and the retainer sleeve 52 to move up under bias of spring 53 whereby it covers the recess 50 and retains the locking balls 51. After disconnecting in the manner shown, the tubular member 60 may be used to perform well servicing operations such as placing inhibitors, removing paraffin, and injecting fluids such as oil, gas, surfactants, and the like or in performing other well servicing operations. Thereafter, the apparatus of the present invention may

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again be connected to the housing 10 as has been described. When using the mandrel assembly 34a of FIG. 8, the ball valve 14 may be opened and held open when running the pipe 82 and housing 10 in the well bore. Mandrel 34a is inserted in housing 10 on seat 32 with sleeve valve and ball retainer 52a, closing off port 46b. Fluid under pressure is introduced into chamber 22 by means of a pressure source, not shown, connected into check valve fitting 30. This causes sleeve valve 14 to be moved to and held in the open position. After positioning the pipe 80 and housing 10 in the borehole (FIG. 9) the tubing 60 with stinger 62 is run in and landed in the mandrel 34a as previously disclosed (FIG. 6). This provides fluid communication between tubing 60 and chamber 22. The tubing 60 may be removed from the mandrel 34a with the ball valve 14 held in the open position (dotted line in FIG. 1) by pressure trapped in the chamber 22 by means of sleeve 52a covering port 46b.

The ball valve housing 10 may be run in the well bore with the valve in the open position or closed position depending upon whether or not the chamber 22 is pressurized. The mandrel 34 without connection to tubing 60 cannot maintain pressure in chamber 22 where the mandrel 34a can.

Although the present invention is illustrated as applied to a single pipe well completion, it will be understood that the device may be also incorporated in a dual completion where two production pipe strings are run parallel to each other and may be interconnected intermediate or adjacent their lower ends with a crossover to provide a fluid circulation path.

While the tubular means 60 may be run into the well by mechanical force exerted by the reel 92 and injection means (not shown), the tubular means 60 may also be run in by fluid pressure introduced into the lubricator 89 by pump 93. If such pressure means is used, the tubing 60 may be provided with piston means attached thereto between the tubing 60 and the well pipe and such piston means may be of the differential pressure type allowing excess pressure encountered to be bypassed through or around the pistons. Such a piston means is shown in FIG. 6. Piston 61 is maintained on tubing 60 by retainer rings 61a and 61b. The piston 60 diameter is slightly less than the inside diameter of pipe 82. When pushing tubing 60 down by pipe 82, fluid pressure is applied to piston 61 with the displaced fluid being forced up the bore of tubing 60. This is especially desirable if one of the two pipe strings were to be used as a service string as may be required in underwater well completions.

While the housing 10 may enclose or comprise a valve, it is contemplated that other well equipment operated by pressure may be used in lieu of the valve. Also while the invention has been described and illustrated with respect to an offshore well with the reel on a platform, the reel may be located at another accessible location such as on a vessel or onshore.

It will be seen from the foregoing description of the best mode and embodiment that the present invention including method and apparatus allows the obtaining of unobvious and improved results.

The nature and objects of the present invention having been completely described and illustrated and the best mode and embodiment contemplated set forth what we wish to claim as new and useful and secure by Letters Patent is:

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1. A method for operating a valve positioned in a valve housing in a well by fluid pressure which comprises:

running said valve and valve housing into the well; running a tubular member into said well from a reel at the surface;

releasably locking said tubular member to said valve housing arranged in said well by fluid pressure exerted through said tubular member to actuate locking means in said well; and

operating said valve by fluid pressure introduced from the surface through said tubular member.

2. A method in accordance with claim 1 in which the tubular member is run into said well by mechanical force exerted against said tubular member at the surface

3. A method in accordance with claim 1 in which the tubular member is run into said well by fluid pressure exerted against said tubular member.

4. A method in accordance with claim 1 in which the valve is maintained in a closed position while being run in.

5. A method in accordance with claim 1 in which the tubular member is released by lowering said tubular member and releasing fluid pressure in said tubular member.

6. A method in accordance with claim 1 in which the valve is maintained in an open position while being run in.

7. A method for operating well equipment in a well by fluid pressure which comprises:

running a tubular member into said well from a reel at the surface to a selected position;

releasably attaching said tubular member at its lower end to well equipment in said well by fluid pressure exerted through said tubular member to actuate locking means in said well;

said well equipment being positioned at a selected position in said well; and

then operating said well equipment by fluid pressure introduced from the surface through said tubular member.

8. A method in accordance with claim 7 in which the well equipment is a valve.

9. A method in accordance with claim 7 in which the well equipment is detached from said tubular member after being operated and said tubular member is retrieved while said well equipment remains in the well.

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U.S. Cl. X.R.

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