

Aug. 13, 1968

J. T. DEAN

3,396,789

STORAGE METHOD AND SYSTEM FOR TFL TOOLS

Filed Sept. 15, 1966

2 Sheets-Sheet 1

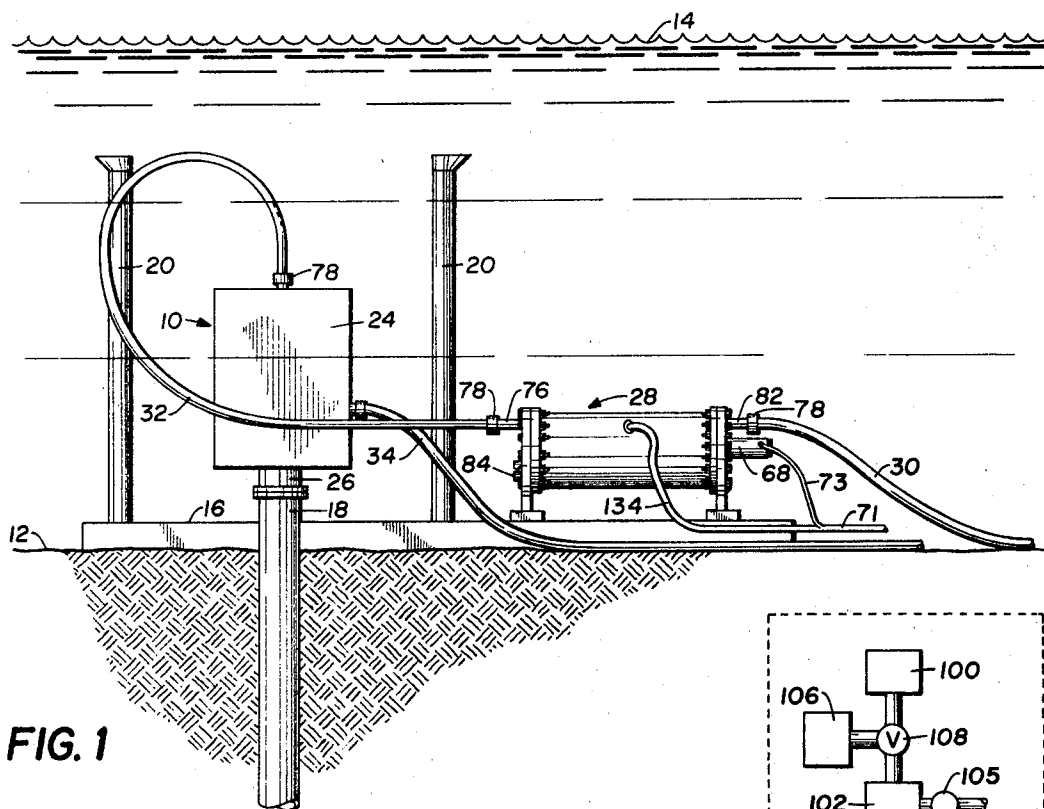


FIG. 1

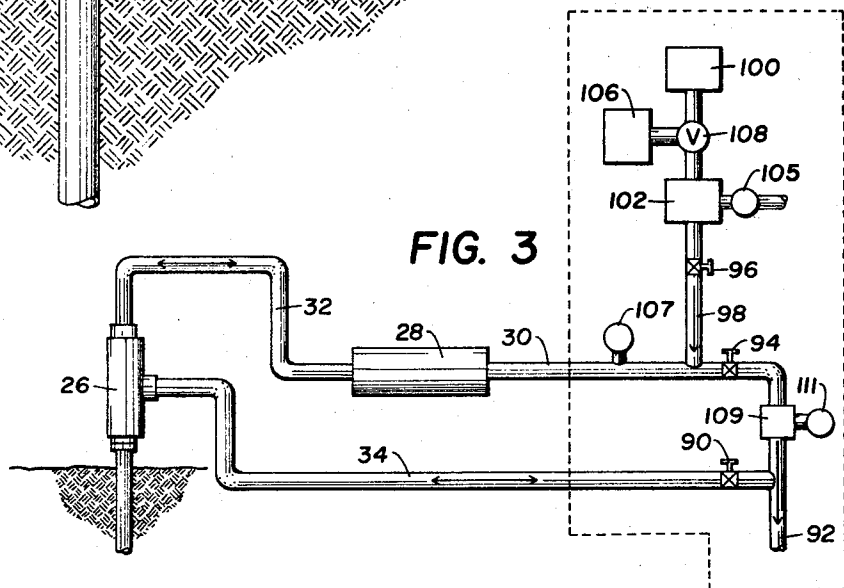


FIG. 3

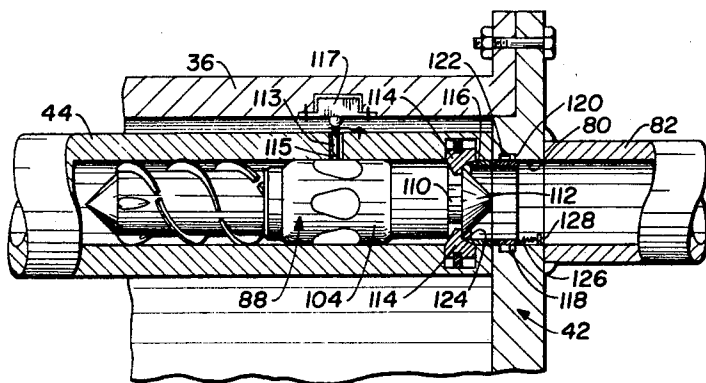


FIG. 4

INVENTOR
JAMES T. DEAN
BY *Alonzo E. Paul*
ATTORNEY

Aug. 13, 1968

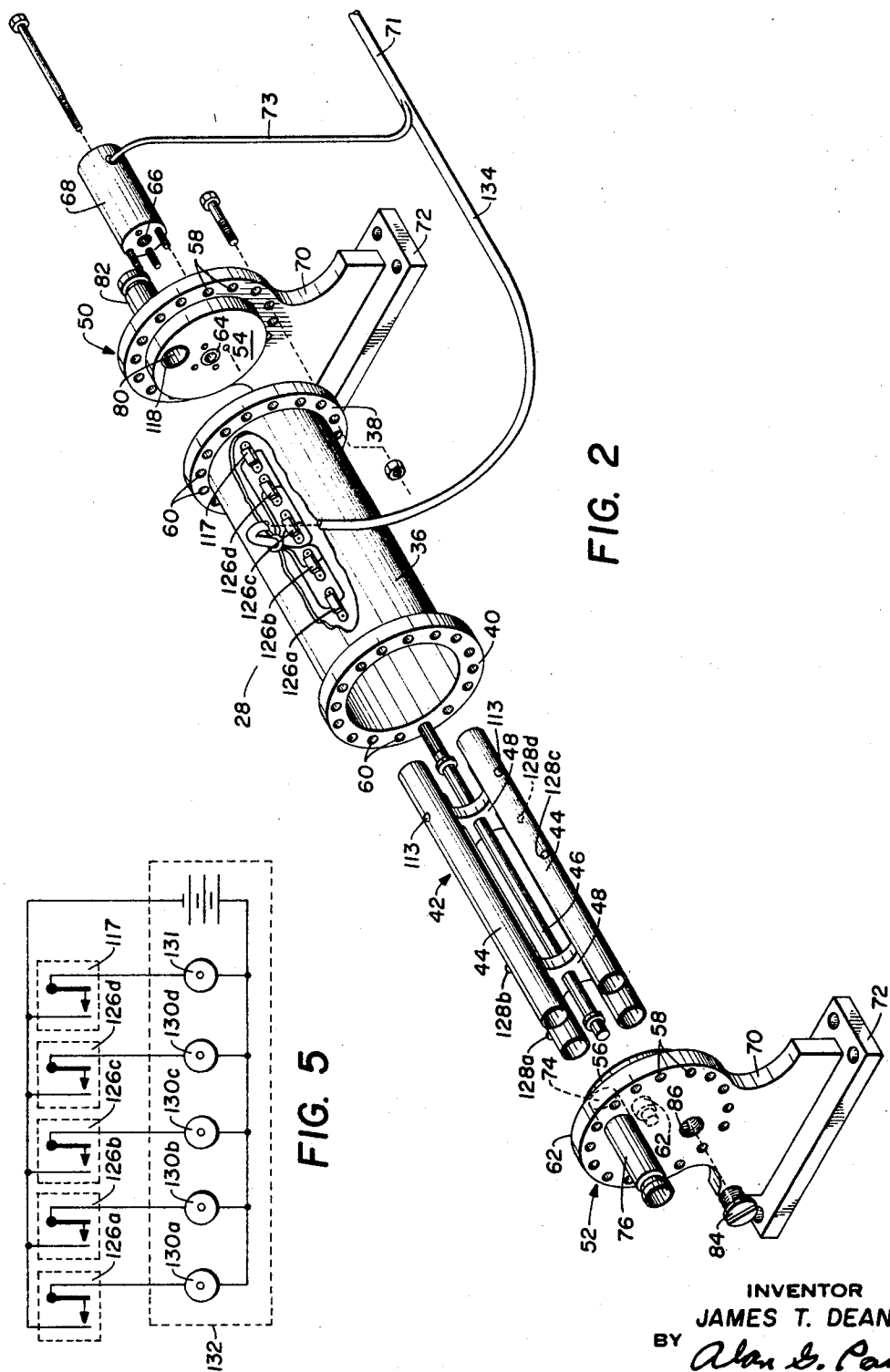
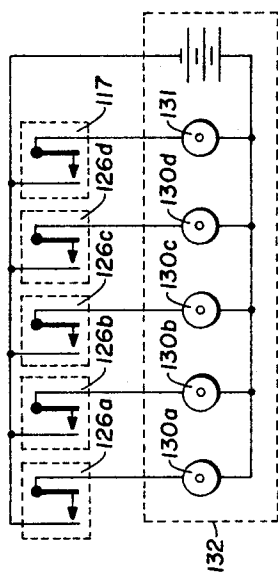
J. T. DEAN

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2 Sheets-Sheet 2



INVENTOR
JAMES T. DEAN
BY *Alan E. Paul*
ATTORNEY

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STORAGE METHOD AND SYSTEM FOR TFL TOOLS

James T. Dean, Dallas, Tex., assignor to Mobil Oil Corporation, a corporation of New York
Filed Sept. 15, 1966, Ser. No. 579,571
5 Claims. (Cl. 166—5)

ABSTRACT OF THE DISCLOSURE

This specification discloses a system for the maintenance of a remotely situated well in conjunction with pumpable tools. A rotatable tool holder, storing a plurality of pumpable tools, is journaled within a barrel or case situated within a flow path extending through the wellhead and into the well. By properly indexing the tool holder, a selected one of the plurality of pumpable tools can be inserted into the tubing string of the well.

This invention relates to the storage of plurality of well maintenance and repair tools so that, automatically and/or remotely, a selected one of the tools can be inserted into the flow path directed through a pipe string and after the inserted tool has performed its function, it may be removed from the flow path and stored. More particularly, the invention relates to apparatus for the storage and retrieval of a plurality of TFL (through flowline) tools for maintenance and workover operations, or data acquisition, in gas, water, or oil well as an isolated location, underwater or on land, and at the well site or in a central control station, so that any one of the tools is automatically and/or remotely accessible for such procedures as paraffin cutting or bottomhole pressure readings.

Since its inception, the offshore oil and gas industry has utilized bottom-supported abovesurface platforms as a principal mechanism for the installation and support of the equipment necessary for the drilling and operating of subaqueous oil and/or gas fields. As the industry has developed over the years a search for offshore oil and gas production has been extended from its early beginning in shallow water areas such as the coastal waters of California and the Gulf of Mexico in the United States, Lake Maracaibo in Venezuela, and the Caspian Sea in Russia, into areas where, because of excessive water depth or other local conditions, the bottom-supported platform is neither as economically nor technology feasible as in the Gulf of Mexico where such facilities are rather commonplace. While, theoretically, there is no limit to the depth for which a bottom-supported platform can be designed and installed, experience to date has illustrated that platform costs increase almost exponentially with the increase of water depth. Thus, the present estimated cost of a platform to carry abovesurface production facilities for a field located where the water is more than 300 feet deep is so high as to indicate that such an installation cannot be justified economically for any but a very productive and prolific field.

In many areas of the world, local conditions other than water depth impose critical limitations on the use of abovesurface production platforms. In such areas as the Arctic, as exemplified by the now very active Cook Inlet in Alaska, a bottom-supported platform must be built to withstand the forces imposed by the ice that forms on the water surface during the winter months of the year. While any abovesurface production platform is subject to the forces exerted by the winds and waves, especially those occurring during hurricanes and other violent storms, in the Arctic areas, these can be exceeded by the forces exerted against the platform by the movement of the thick

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ice layers that freeze on the surface of the water and act in conjunction with the extreme tides in the higher latitudes.

In still other areas, it is not adverse natural but man-made conditions which restrict the use of abovesurface production platforms. Among such conditions can be listed government and/or public objections to oil production facilities near public recreational and/or residential areas, and the presence of heavy marine traffic, as in harbors, channels, rivers, or other navigable bodies of water, which make it necessary or advantageous to install as much of the production equipment beneath the water surface as possible.

To overcome the problems associated with producing off-shore oil and gas from abovesurface platforms, subsea production systems have been designed. These subsea systems generally consist of a plurality of subsea wellheads grouped around a bottom-mounted subsea satellite. The wells are either directionally drilled from points at the marine bottom very close around the satellite, or alternatively, are spread out over a large acreage spacing, depending on whether they are gas or oil wells, the depth of the producing formations, and the permeability of the producing formations. In either case, the various workover and maintenance operations that are performed routinely from a deck of an abovesurface platform in an abovesurface installation must be performed here also. When operations, such as scraping the paraffin from the walls of the production tubing, need be repeated at short intervals, as often as twice a week in some areas, this presents a major problem. It has already been suggested that tools be pumped down into the well for performing such operations as cutting paraffin. The tools would be stored in or adjacent the wellhead, or in the subsea satellite, being pumped into the well tubing through the interconnecting flowlines. While there appears to be no great difficulty, at least in theory, for example, in having a paraffin cutter driven down at time intervals into the well to cut the paraffin therein, no satisfactory solution has been found when more than one different type of tool must be utilized in the same well flowline. In fact, the problem is further complicated when it is considered that the order in which various tools will be used cannot always be predetermined.

Therefore, it is an aspect of the present invention to provide a storage device for selectively positioning a TFL tool in a flowline of a subsea well so that it may be pumped down through the production wellhead or "christmas tree."

It is another aspect of the present invention to provide a storage device for a plurality of TFL tools such that any one of the tools may be selectively inserted into the flowline connected with a subsea production wellhead, in any order.

Other aspects and advantages of the present invention will become readily apparent from the following description, when taken in conjunction with the accompanying drawings which illustrate useful embodiments in accordance with this invention, wherein:

FIGURE 1 is a schematic view illustrating a subsea wellhead assembly positioned on a marine bottom and having the TFL tool storage device of the present invention located adjacent the wellhead;

FIGURE 2 is an exploded view of the TFL storage device of the present invention;

FIGURE 3 is a schematic view of the portion of the fluid circuit used in conjunction with the TFL storage device for controlling the energizing of a TFL tool and directing it into a subsea production wellhead;

FIGURE 4 is a partial cross-sectional view of a storage tube with a TFL tool therewithin illustrating the latching

of the TFL tool into its storage tube in the storage device; and

FIGURE 5 is a schematic view of the circuitry for determining the angular position of the tool holder within the storage device.

Looking now to FIGURE 1 of the drawings, a wellhead assembly, generally designated 10, is shown as being positioned on a marine bottom 12 beneath the surface 14 of a body of water. The wellhead assembly 10 comprises a base foundation 16 secured to the upper end of a conductor pipe 18 extending into the subaqueous formations. Two or more guideposts 20 are vertically positioned on the base foundation to guide equipment from the surface in conjunction with guidelines (not shown), as is well known in the art. A subsea wellhead cover 24 is mounted over a production wellhead or christmas tree 26 fixed atop the conductor pipe 18 and the necessary equipment for remotely controlling the wellhead in response to signals from a central production facility (not shown). Mounted on the base foundation 16, to one side of the wellhead 26 is a TFL storage device 28, connected with the remote central production facility by a fluid pressure line 30, and with the wellhead 26 through the cover 24 by a fluid pressure line 32. A production flowline 34 extends directly between a production passage of the wellhead 26 and the central production facility.

In FIGURE 2 the construction of the TFL storage device 28 is clearly shown. The apparatus includes an enclosed chamber comprising a hollow open-ended barrel or case 36 having flanged ends 38 and 40. A TFL tool holder 42, rotatable within the barrel or case 36, consists of a plurality of parallel open-ended storage tubes 44 fixed with respect to a central shaft 46 by means of connecting webs 48 rigidly fixed at spaced intervals along the shaft 46. The central shaft 46 is rotatably journaled on its axis in end plates 50 and 52 which bolt to the flanges 38 and 40, respectively, on the open ends of the barrel 36, each end plate 50, 52 having an integral spacer plate 54 and 56 on the inner opposing faces thereof, designed to extend into the interior of the barrel or case 36 to form a somewhat fluidtight fit between the ends of the barrel or case 36 and the open ends of the storage tubes 44. O-rings (not shown) may be fitted in peripheral grooves in the spacer plates 54 and 56 to insure a fluidtight fit between the end plates 50 and 52, respectively, and the barrel or case 36. The end plates 50 and 52 have spaced bolt holes 58 extending along the outer edges thereof to register with bolt holes 60 in the flange ends 38 and 40 of the barrel or case 36 for fixedly assembling the device.

The central shaft 46 of the TFL storage device 28 is rotatably journaled between a bushing 62 pressed in a counter barrel central hole in the inner face of the left-hand end plate 52 and a bushing 64 extending completely through the right-hand end plate 50, the right-hand end of the shaft 46 being splined and extending out past the end plate 50. The end plates 50 and 52 are fabricated with vertical planar leg sections 70, each terminating in a horizontal planar foot 72 by which the storage device 28 can be fixedly mounted on any flat surface, in this instance, the base foundation 16 (FIGURE 1). A canned motor 68 is centrally bolted to the outer face of the plate 50 when the storage device 28 is assembled. The motor armature extends to the face of the motor 68 abutting the plate 50 and is provided with an internally splined connection 66 for mating with the splined end of the shaft 46. To index the tool holder 42, a slo-syn synchronous stepping motor, made by Superior Electric Company, for example, type HS25 or HS50 shown on page 9 of the company's 1966-67 Product Guide brochure, properly canned, would be satisfactory. This motor will incrementally step 1.8° per signal pulse with an accuracy of $\pm 3\%$, noncumulative. A preset indexer, as shown on page 10 of the above-described brochure, can be used with these motors for stepping the tool holder 42 any pre-

selected number of steps per actuation. As an alternative, a reciprocating stepping solenoid mounted on the side plate could be used in conjunction with a ratchet wheel on the splined end of the shaft 46. A wiring harness 71, between a distant control station and the tool holder would need to accommodate at least a three-wire bundle 73 for powering and controlling the slo-syn motor and a two-wire bundle if a stepping solenoid is used. An off-center circular fluid port 74, through the wall of the end plate 52, is extended outward by a concentric section of tubing 76 welded thereto. This section of tubing 76 provides means for connecting the fluid pressure line 32 (FIGURE 1) between the production wellhead or christmas tree 26 and one end of the storage device 28. Releasable connectors 78 on both ends of the fluid pressure line 32 provide the means for releasably locking the fluid pressure line 32 between the tubing section 76 and the christmas tree 26. A circular fluid port 80 (FIGURE 2) through the end plate 50 is concentric with the circular port 74 through the end plate 52. A tubing section 82 is welded to the outer face of the end plate 52 to extend concentrically the port 80 for connecting the fluid pressure line 30, extending from the central production facilities, to an end of the storage device 28. A releasable connector 78, on the illustrated end of the fluid pressure line 30 provides the means for releasably locking the fluid pressure line 30 to the tubing section 82. The ports 74 and 80 extending through the end plates 52 and 50, respectively, and their outward extensions are concentric with a line through the cylinder of revolution formed by the centers of the storage tubes 44, as they rotate within the barrel or case 36. Therefore, any one of the storage tubes 44 may be lined up between the ports 74 and 80 to form a substantially continuous passage through the TFL storage device 28. At least the port 74 has the same diameter as the internal diameters of the storage tubes 44. A tool loading flange 84 is threadably received in a tapped loading port 86 extending through the end plate 52, the center line of the loading port 86 also being on the imaginary cylinder formed by the center lines of the rotating storage tubes 44.

Each of the storage tubes 44 is adapted to contain a TFL tool (FIGURE 4), designed for a specific operation such as for perforating the well casing, opening a packer, removing a valve or storm choke, scraping paraffin from a tubing string, cleaning of sand in the well casing, etc. The illustrated tool, generally designated 88, is for cutting paraffin in well tubing and is described in detail in the copending application of William A. Talley, Jr. (D-65-140), Ser. No. 578,247, filed Sept. 9, 1966. Although in the instance shown, only four storage tubes 44 are illustrated as mounted around the shaft 46 in FIGURE 2, the number of storage tubes 44 that may be included in the barrel or case 36 is determined primarily by the number of different operations required, the dimensions of the storage tubes 44 and the circumference of the storage space within the barrel or case 36 being the only limitations. A different type of tool may be included in each of the storage tubes 44 for performing the various functions necessary to the proper operation of the well or more than one storage tube 44 may contain identical tools so that when an often used tool (such as a paraffin cutter) wears out or malfunctions, another one may be substituted without going to the expense of replacing the malfunctioning tool. When the tools are replaced this may be accomplished manually or by a robot, or appendaged submarine through the port 86.

The operation of the storage unit 28 is best described with reference to FIGURE 3 where the fluid circuitry is shown. The produced fluid, such as oil or gas, or a combination thereof, is directed, in a normal flow path, up a tubing string of the well and out through the production wellhead or christmas tree 26 and into the flowline 34 and is ordinarily controlled by a valve 90 located at the central production facilities. The fluid flowing through

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the flowline 34 would normally be conducted through a main conduit 92 to production and/or test separators (not shown). When a TFL tool is to be inserted into the well to perform a maintenance or repair function, the valve 90 in the flowline 34 and a valve 94 controlling the connection of the main conduit 92 with the fluid pressure line 30 would be closed. A valve 96, in a fluid conduit 98 which is connected between a source of fluid 100 and the fluid pressure line 30 between the valve 94 and the storage unit 28, would then be opened. Prior to opening the valve 96, a particular tool, to be inserted into the well tubing string, is lined up between the ports 74 and 80 by actuating the motor 68 to index the tool holder 42. Fluid pressure is then applied through the open valve 96 into the line 30, by a positive displacement pump 102 in the line 98 between the fluid source 100 and the valve 96. The fluid, under pressure, impinges on the rearward end of a pumpable TFL tool, the piston section 104 of the paraffin cutting tool 88 in the lined up storage tubes 44 as shown in FIGURE 4. Under the fluid pressure, the tool 88 would be driven forward through the storage tube 44 and out through the port 74 into the fluid pressure line 32 (shown schematically as having right angle bends), down through the production wellhead or christmas tree 26, and into the well. To move the pumpable tool 88, against the pressure of the fluid being produced, the pump 102 must supply fluid at a greater pressure than that of the produced fluid. To pump the tool to the desired depth a timer 105 is included in the power line of the pump 102 to shut off the pump after a set time interval and therefore a predetermined quantity of fluid has been pumped downhole. The possibility that a tool becomes stuck and some of the fluid bypasses the tool before the tool reaches the desired depth can be sensed by a rise in pressure behind the tool as indicated on a pressure gauge 107 in the fluid pressure line 30. If sticking occurs, for example with a paraffin cutting tool, such as tool 88, the tool 88 can be recycled continuously until no pressure rise occurs during the downward pumping of the tool 88 or the tool 88 can be pumped down at regular intervals. If a pressure rise continues to appear after a predetermined number of continuous recycles or a predetermined number of single cycles at the regularly spaced intervals for paraffin cutting, a major workover is indicated. With the predetermined quantity of fluid pumped through the pump 102, the timer 105 will shut off the pump 102, the valve 96 is then closed, and the valve 94 then is reopened so that the TFL tool will be returned by the pressure of the well fluid being produced and flowing through the TFL storage device 28 and valve 94 to the main conduit 92. When the TFL tool 88 has been driven all the way back up the tubing string and back through the line 32 into the respective storage tube 44 within the TFL storage device 28, an indication would be given to close the valve 94 and reopen the valve 90. For indicating that the tool 88 is back in the respective storage tube 44, a positive displacement pump 109, having a counter 111, is included in the fluid pressure line 30. When a predetermined amount of fluid has passed through the pump 109 and a pressure drop is shown on the gauge 107, it is safe to assume that the tool 88 is restored in its storage tube 44. As an alternative or auxiliary indicating means, an inwardly spring-biased finger 113 is slidably fixed in a radial passage 115 through the wall of each of the storage tubes 44 to coact with a microswitch 117 in the inner wall of the barrel or case 36 when the respective storage tube 44 is lined up between ports 74 and 80 and the tool 88 is stored within the storage tube 44 (FIGURE 4). With the tool 88 restored, the valve 94 closed, and the valve 90 reopened, the well is again produced through the flowline 34. The portion of the system shown in FIGURE 3 as enclosed by the dotted line would be within the central production facilities or an intermediate control station at a distance from the well.

When the tool to be inserted into the well is the paraffin cutting tool 88, a measured amount of paraffin

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solvent and corrosion inhibitor is injected behind the tool 88 as explained in the copending William A. Talley, Jr. application previously mentioned. The paraffin solvent and corrosion inhibitor is contained in a storage tank 106 and connected to the upstream end of the pump 102 in parallel with the source 100 by a two-position three-way valve 108. The valve 108 is turned to a first position so that the measured amount of solvent and corrosion inhibitor is pumped behind the tool 88 and then is turned to a second position, connecting the fluid source 100 with the inlet side of the pump 102 so that the tool 88 and the solvent and corrosion inhibitor can be pumped down through the well.

FIGURE 4 shows an exemplary means for locking, or positively retaining, the TFL tool 88 in its storage tube 44. The tool 88 has a necked down portion 110 and a terminal conical section 112 designed to coact with a series of inwardly spring-biased detent fingers 114 ringing the inner wall of storage tube 44 to latch the tool 88 firmly in the storage tube 44. As the tool 88 moves back into its storage tube 44, returning from a trip through the tubing string, the detent fingers 114 are cammed outwardly by the conical terminal portion 112 of the TFL tool 88. As the terminal portion 112 passes the detent fingers 114, they are spring biased inwardly into the necked down portion 110 to lock the tool 88 in position. A retaining ring 116 is slidably fitted into the end of the storage tube 44 between the detent fingers 114 and the planar inner face of the spacer plate 54. A beveled inner edge of the retaining ring 116, at the end adjacent the detent fingers 114, overlaps the detent fingers 114 to retain them in the wall of the tube 44. A slidable actuating ring 118, mounted in the face of the port 80, is held therein by a locking pin 120 press fitted through the wall of the actuating ring 118 and depending into an axially extending radial groove 122 in the wall of the port 80. The force of the fluid impinging on the upstream end (right-hand end as seen) of the actuating ring 118, when pressure is applied through the port 80, causes the actuating ring 118 to move into the aligned storage tube 44, driving the retaining ring 116 against rearward camming faces 124 of each of the detent fingers 114, causing the detent fingers to be cammed outward into the wall of the storage tube 36 and releasing the tool 88 to be driven by the fluid pressure into the fluid pressure line 32 and therefrom into the tubing string. The actuating ring 118 is drawn back into the port 80, subsequent to the cessation of pressure in the line 30, by a tension spring 126 connected between the actuating ring 118 and an anchoring post 128 fixed in the port 80.

To give an indication of the angular position of the tool holder 42, in the barrel or case 36, at a control board in the distant production facility, or control station, a plurality of microswitches 126A-D, one for each storage tube 44, is mounted within the barrel or case 36. The microswitches 126A-D are set in the inner wall of the barrel or case 36 in axially spaced relationship. Cam fingers 128A-D are mounted, one on each storage tube 44, and are axially positioned on the respective storage tubes 44 so that only one microswitch can be actuated by each one of the cam fingers. The schematic view of FIGURE 5 illustrates an electrical circuit wherein the various microswitches 126A-D and 117 will actuate respective lights 130A-D and 131 on a panel 132 at the distant control station to indicate the angular position of the tool holder 42 and whether a tool is in the storage tube 44 lined up between the ports 74 and 80. As shown in FIGURE 2, the bundle of five wires 134, for the position-indicating circuitry, is enclosed in the wiring harness 71 over the span between the storage device 28 and the control station. A watertight electrical connection is necessary where the bundle of wires 134 enters the barrel 36. Such connections are well known in the art and are available off-the-shelf items.

Although the present invention has been described in connection with details of specific embodiments thereof, it is to be understood that such details are not intended to limit the scope of the invention. The terms and expressions employed are used in a descriptive and not a limiting sense and there is no intention of excluding such equivalents, in the invention described, as fall within the scope of the claims. Now having described the apparatus and methods herein disclosed, reference should be had to the claims which follow.

I claim:

1. In a workover and/or maintenance system for a producing well; a production wellhead fixed atop a well conductor pipe, a device adapted to store two or more reusable, pumpable tools outside of the normal flow path of fluid produced from said well, each of said pumpable tools having a piston section, said storage device forming a part of apparatus for inserting said pumpable tools into a well tubing string forming a portion of said flow path for said fluid being produced from said well through said production wellhead thereof comprising: an enclosed chamber; a first and second port means connected to said enclosed chamber; means for operatively connecting said enclosed chamber through said first port means to a source of fluid, said means for operatively connecting said enclosed chamber to a source of fluid including means for supplying fluid under pressure, greater than the pressure of said produced fluid, from said source of fluid, to said enclosed chamber through said first port means; means for operatively connecting said enclosed chamber through said second port means into said flow path of said fluid produced through said wellhead whereby said enclosed chamber is at least a portion of a fluid connection between said source of fluid and said flow path; a tool holder journaled on an axis in said enclosed chamber, said tool holder being provided with a plurality of storage means fixed in spaced relationship to said axis of said tool holder; a plurality of pumpable tools, each of said pumpable tools being stored in a separate one of said storage means; means for indexing said tool holder about said axis to align each one of said storage means between said first and second port means; and means responsive to the return of a previously injected pumpable tool into the respective storage means of said tool holder for remotely signaling the return of said returning pumpable tool to said tool holder whereby a selected one of said pumpable tools, stored in a selected one of said storage means, can be driven by said greater fluid pressure through said second port means and said production wellhead into said tubing string of said well in a direction opposed to the direction of flow of the fluid being produced through said tubing string and said wellhead and whereby a tool in said tubing string is moved out of said tubing string through said second port means and back into said respective one of said storage means of said tool holder of said storage device.

2. A well workover and/or maintenance system as recited in claim 1, utilized in conjunction with producing fluids from a well completed beneath the surface of a body of water wherein said production wellhead is located beneath the surface of a body of water and is supported above the marine bottom on said well conductor pipe; a first flowline operatively connected between said tubing string of said well through said production wellhead and a central production facility being at least a portion of said flow path; and a second flowline connected between said tubing string, through said production wellhead, and said second port means of said storage device forming at least a portion of said fluid connection.

3. In a well workover and/or maintenance system for a producing well; a production wellhead fixed atop a well conductor pipe, a device adapted to store two or more reusable, pumpable tools outside of the normal flow path of fluid produced from said well through said production wellhead, each of said pumpable tools having

a piston section, said storage device forming a part of apparatus for inserting said pumpable tools into a well tubing string forming a portion of said flow path for said fluid being produced from said well through said production wellhead thereof comprising: an enclosed chamber; a first and second port means connected to said enclosed chamber; means for operatively connecting said enclosed chamber through said first port means to a source of fluid, said means for operatively connecting said enclosed chamber to a source of fluid including means for supplying fluid under pressure, greater than the pressure of said produced fluid, from said source of fluid, to said enclosed chamber through said first port means; means for operatively connecting said enclosed chamber through said second port means into said flow path of said fluid produced through said wellhead whereby said enclosed chamber is at least a portion of a fluid connection between said source of fluid and said flow path; a tool holder journaled on an axis in said enclosed chamber, said tool holder being provided with a plurality of storage means fixed in spaced relationship to said axis of said tool holder; a plurality of pumpable tools, each of said pumpable tools being stored in a separate one of said storage means; means for indexing said tool holder about said axis to align each one of said storage means between said first and second port means; means for positively retaining each of said pumpable tools in the respective storage means even when said respective storage means is aligned between said first and second port means and fluid under pressure is applied thereto and means for releasing said retaining means when a pumpable tool is to be driven by fluid pressure through said second port means and into the tubing string of a well whereby a selected one of said pumpable tools, stored in a selected one of said storage means, can be driven by said greater fluid pressure through said second port means and said production wellhead into said tubing string of said well in a direction opposed to the direction of flow of the fluid being produced through said tubing string and said wellhead and whereby a tool in said tubing string is moved out of said tubing string through said second port means and back into said respective one of said storage means of said tool holder of said storage device.

4. In a well workover and/or maintenance system for a producing well; a production wellhead fixed atop a well conductor pipe, a device adapted to store two or more reusable, pumpable tools outside of the normal flow path of fluid produced from said well through said production wellhead, each of said pumpable tools having a piston section, said storage device forming a part of apparatus for inserting said pumpable tools into a well tubing string forming a portion of said flow path for said fluid being produced from said well through said production wellhead thereof comprising: an enclosed chamber; a first and second port means connected to said enclosed chamber; means for operatively connecting said enclosed chamber through said first port means to a source of fluid, said means for operatively connecting said enclosed chamber to a source of fluid including means for supplying fluid under pressure, greater than the pressure of said produced fluid, from said source of fluid, to said enclosed chamber through said first port means; means for operatively connecting said enclosed chamber through said second port means into said flow path of said fluid produced through said wellhead whereby said enclosed chamber is at least a portion of a fluid connection between said source of fluid and said flow path; a tool holder journaled on an axis in said enclosed chamber, said tool holder being provided with a plurality of storage means fixed in spaced relationship to said axis of said tool holder; a plurality of pumpable tools, each of said pumpable tools being stored in a separate one of said storage means; means for positively retaining each of said pumpable tools in the respective storage means;

means for indexing said tool holder about said axis to align each one of said storage means between said first and second port means; and remotely controlled means for selectively releasing a single pumpable tool within the respective storage means when said respective storage means is aligned between said first and second port means whereby said plurality of pumpable tools can be driven through said tubing string of a well in any selected order whereby a selected one of said pumpable tools, stored in a selected one of said storage means, can be driven by said greater fluid pressure, through said second port means and said production wellhead into said tubing string of said well in a direction opposed to the direction of flow of the fluid being produced through said tubing string and said wellhead and whereby a tool in said tubing string is moved out of said tubing string through said second port means and back into said respective one of said storage means of said tool holder of said storage device.

5. A method for inserting a pumpable tool into a tubing string of a well utilizing a well workover and/or maintenance system and for returning said pumpable tool back into a storage means comprising: a production wellhead fixed atop a well conductor pipe, a device adapted to store two or more reusable, pumpable tools outside of the normal flow path of fluid produced from said well through said production wellhead, each of said pumpable tools having a piston section, said storage device forming a part of apparatus for inserting said pumpable tools into a well tubing string forming a portion of said flow path for said fluid being produced from said well through said production wellhead thereof comprising: an enclosed chamber; a first and second port means connected to said enclosed chamber; means for operatively connecting said enclosed chamber through said first port means to a source of fluid, said means for operatively connecting said enclosed chamber to a source of fluid including means for supplying fluid under pressure, greater than the pressure of said produced fluid, from said source of fluid, to said enclosed chamber through said first port means; means for operatively connecting said enclosed chamber through said second port means into said flow path of said fluid produced through said wellhead; a tool holder journaled on an axis in said enclosed chamber, said tool holder being provided with a plurality of storage means fixed in spaced relationship to said axis of said tool holder; a plurality of

pumpable tools, each of said pumpable tools being stored in a separate one of said storage means; and means for indexing said tool holder about said axis to align each one of said storage means between said first and second port means, said method including the following steps:

- (a) closing a first valve means to shut off the fluid flow path from said well;
- (b) indexing said tool holder of said storage device to align the selected tool between said port means;
- (c) opening a second valve means to apply fluid under pressure from said source of fluid to the selected stored pumpable tool in said storage means to drive said selected pumpable tool into said tubing string, said fluid connection between said source of fluid and said fluid flow path being in communication with said fluid flow path between said tubing string and said first valve means;
- (d) closing said second valve means to interrupt the flow of fluid under pressure from said source;
- (e) opening a third valve means connecting said first port means to said flow path beyond said first valve means whereby fluid produced from said well flows through said storage device and said tool is returned therewith to said storage means; and
- (f) after said tool is returned into said storage means, closing said third valve means and opening said first valve means whereby the fluid flow from said well bypasses said storage device.

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45 CHARLES E. O'CONNELL, *Primary Examiner*.

IAN A. CALVERT, *Assistant Examiner*.