HYDRAULIC LUBRICATOR FOR USE AT A WELLHEAD

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ABSTRACT

A lubricator for use at a wellhead such as an oil or natural gas well. The lubricator has a polished rod on which an item, such as a back pressure valve, may be disposed for placement, for example to isolate the wellhead from the well pressure to permit wellhead servicing. The rod is moved by hydraulic power, rather than manually. A piston is connected to the polished rod within the lubricator barrel. Hydraulic pressure within the barrel, above or below the piston, is controlled to cause the rod to move up and down, under power, to permit the rod and items thereon to be lowered and retrieved.
FIG. 1
PRIOR ART
FIG. 2

PRIOR ART
HYDRAULIC LUBRICATOR FOR USE AT A WELLHEAD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of the filing of U.S. Provisional Application Ser. No. 61/400,385, entitled “Hydraulic Lubricator,” filed 27 Jul. 2010, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates to a lubricator for use at oil and gas wells, and in particular to a hydraulic lubricator apparatus and system that minimizes manual manipulation of the lubricator rod.

BACKGROUND OF THE INVENTION

[0003] In many down-hole operations conducted in the oil and gas exploration and extraction industry, “lubricators” are used to manage well pressure when it becomes necessary to access the pressurized well. A lubricator may be supported in a derrick or from a crane jib.

[0004] Accordingly a lubricator, in this field of endeavor, essentially is a high-pressure pipe fitted to the top of a wellhead (e.g. a “Christmas tree” in the art) so that various items and down-hole tools can be inserted into a high-pressure oil or gas (or other) well. U.S. Pat. No. 7,699,099 to Bolding et al., and my co-pending U.S. patent application Ser. No. 12/930, 188 filed 30 Dec. 2010, which are here incorporated by reference, offer recent disclosures regarding well head “Christmas tree” components and configurations.

[0005] The top of the lubricator assembly features a high-pressure section and sealing components. The tool(s) to be placed into the well are placed in the lubricator. The lubricator is temporarily installed upon the “tree” and tested. After testing, lubricator valve(s) are opened to equalize to wellbore pressure. The top valves of the “tree” are then opened to allow the tools to drop (or be pumped by hydraulic pressure) down the bore. Removal of the down-hole tool(s) is accomplished by the reverse process; the tool is pulled up the bore and into the lubricator under wellbore pressure, the tree valves are closed, and the wellbore pressure within the lubricator is bled off. After the high pressure in the lubricator is safely released, the lubricator can be opened. In short, a lubricator provides a sort of “pressure lock” via which tools may be inserted into and retrieved from a well which is under pressure.

[0006] A broad survey of background art for lubricators generally is provided by U.S. Pat. Nos. 6,827,147 to Dallas, 5,893,417 to Pizzalato, 4,062,406 to Akkerman et al., and 3,924,686 to Arnold, the entire disclosures of which are incorporated herein by reference.

SUMMARY OF THE INVENTION

Disclosure of the Invention

[0007] There is disclosed lubricator apparatus and method for use at a wellhead such as an oil or natural gas well. The lubricator has a polished rod on which an item, such as a back pressure valve, may be disposed for placement, for example to isolate the wellhead from the well pressure to permit wellhead servicing. The rod is moved by hydraulic power, rather than manually. A piston is connected to the polished rod within the lubricator barrel. Hydraulic pressure within the barrel, above or below the piston, is controlled to cause the rod to move up and down, under power, to permit the rod and items thereon to be lowered and retrieved.

[0008] In a preferred embodiment, the lubricator has a yoke assembly removably mountable to a wellhead, and a barrel portion, detachably engageable with the yoke assembly. The barrel portion has a barrel housing having a first end and a second end, a rod movable coaxially within the barrel housing and having a segment of the rod variably extendable from the barrel housing second end, and a piston secured to the rod and movable within the barrel housing, there being defined in the barrel housing a head space between the piston and the barrel housing first end and a barrel space between the piston and the barrel housing second end. An upper port is defined in the barrel housing for permitting a hydraulic fluid to enter or exit the head space, and a lower port is defined in the barrel housing for permitting hydraulic fluid to enter or exit the barrel space. At least one valve is provided for regulating hydraulic pressure in the head space or the barrel space, thereby controllably driving the piston to-and-fro within the barrel housing and moving the rod axially in the barrel housing.

[0009] This disclosure provides a means of safely and hydraulically actuating the main rod or tube of a lubricator.

[0010] There is provided lubricator apparatus which replaces known manually-operated lubricator rods.

[0011] Accordingly, there also is provided a method for rapid and safe change-out of devices used in well head equipment.

[0012] A primary object of the present invention is to provide a method and apparatus for hydraulically moving the polished tool rod of an oilfield lubricator.

[0013] A primary advantage of the present invention is that it replaces manual actuation of a lubricator rod with hydraulic actuation of the rod to provide a more secure and safe operation.

[0014] Other objects, advantages and novel features, and further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned by practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The accompanying drawings, which are incorporated into and form a part of the specification, illustrate several embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating a preferred embodiment of the invention and are not to be construed as limiting the invention. In the drawings:

[0016] FIG. 1 is a diagrammatic side view of a type of lubricator generally in accordance with the prior art;

[0017] FIG. 2 is an enlarged view of a portion of the lubricator seen in FIG. 1, diagramming some of the components used to control pressures in the lubricator;

[0018] FIG. 3 is a partially exploded, partial sectional side view of a lubricator apparatus, showing the barrel portion and certain components attachable to the distal end of the polished tool rod;

[0019] FIG. 4 is a side view of the barrel portion of the lubricator apparatus according to the present disclosure;
FIG. 4A is an enlarged view of a portion of the barrel portion of the lubricator depicted in FIG. 4;

FIG. 5 is a side sectional and schematic view of the barrel portion of the lubricator apparatus according to the present disclosure;

FIG. 6 is a perspective illustration of the complete lubricator apparatus according to the present disclosure, suspended by a crane on a service vehicle, and showing the hydraulic cables running from the hydraulic power take-off on the vehicle to the body of the lubricator;

FIG. 7 is an enlarged side view of the lubricator apparatus seen in FIG. 6; and

FIG. 8 illustrates a suitable control panel on the vehicle seen in FIG. 6, usable to remotely control the actuation of the polished tool rod in the lubricator.

The drawings are intended to be diagrammatic only, and are not necessarily to scale either within a particular figure or between figures. Like numerals are used to denote the same or similar components throughout the several figures.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Best Modes for Carrying Out the Invention

The present invention relates to an apparatus and method for the hydraulic operation of a lubricator. To insert down-hole tools into an oil or gas wellbore, or to perform maintenance or repair to the blowout preventer stack (BOP), it frequently is required to isolate the well’s blowout BOP or “Christmas tree” from the pressure within the well. For example, it may be desired to install in the well tubing, below the tree, a back pressure valve (BPV). A properly selected and installed BPV blocks the well pressure coming up from the well during the removal of the BOP and during installation of, or repairs to, the Christmas tree.

Use of the hydraulic lubricator disclosed herein in a correct and controlled environment allows a trained service technician to complete safely the foregoing tasks with no strain. The hydraulic lubricator can be actuated by hydraulic pressure to allow the polished rod inside the described barrel to scope in and out, which allows assorted plugs to be set below the BOP or Christmas tree under wellbore pressure (or without pressure).

The normal purposes and procedural steps known in the art for installing and operating a well head lubricator tool are generally followed per known conventions, except as described in detail below. Rather, the presently disclosed apparatus offers an advantageous improvement, usable in cooperation with known lubricator devices (for example the 10,000 PSI WP Lubricator, Stock Number A1800-4V, available from G. B. International, Ltd., of Friendswood, Tex.). Among the improvements described herein, the present apparatus and system permits the polished tool rod in the lubricator to be manipulated hydraulically rather than manually. Nevertheless, standard safety precautions, and operating protocols, should otherwise be observed and followed.

The lubricator, with a back pressure valve (BPV) attached, is mounted on the top of the Christmas tree. In most operations, a one-way “H” Back Pressure Valve is used. However, if the BOP stack itself is being tested a two-way BPV is indicated.

In the present disclosure, the polished tool rod is extended down through the tree by regulated hydraulic force, allowing the threaded BPV to be screwed into the threaded top of the well’s tubing hanger. The rod is then removed under the controlled hydraulic power. The lubricator may then be removed from the tree. After maintenance or repair has been completed, or the down-hole tool placed, the BPV must be retrieved to resume productive operation of the well. The lubricator is again connected to the tree cap, and the tool rod again hydraulically inserted down the tree. Pressure in the tree can then again be equalized, and the BPV engaged and removed using the lubricator.

Combined reference is invited to FIGS. 1 and 2, diagramming generally a typical lubricator device. In this disclosure, “up” and “down,” and “upper” or “lower,” shall have conventional meanings in the frame of reference provided by FIGS. 1 and 2, as well as by FIGS. 6, 7 and 8, in which the apparatus is seen positioned vertically, which is the use position. The lubricator 10 has a yoke portion 20 and a barrel portion 30. The bottom of the barrel portion 30 is securely yet detachably connectable to the top of the yoke portion 20. A tool rod 34 (which preferably is polished) is within the barrel’s interior bore or hollow, and is movable coaxially relative to the barrel housing 32; a distal or lower segment of the rod extends from the barrel such that a portion of the rod 34 is accessible through the access window 45 of the yoke portion 20.

An eye or hook 35 ordinarily is provided upon the proximate or upper first end 63 of the barrel housing 32 to assist in lifting and manipulating the lubricator 10 into position atop a wellhead 49 for use. In a known lubricator device 10, the tool rod 34 is moved manually by field workers relative to the barrel 30 and yoke assembly 20 to place or retrieve a BPV removable attached to the distal or lower end of the rod 34. Such movement is accomplished manually, in which one or more operators grip the polished tool rod 34, typically with a Parmlee wrench, where the rod 34 is accessible in the open window 45 of the yoke assembly 20. Using the Parmlee wrench(es), the operator(s) with considerable effort manually move the rod 34 up and down within the lubricator 10—a tiring, inefficient, and potentially dangerous activity that is obviated by the present invention. The manual gripping and up or down forced movement is manually applied to the rod 34 only where it is accessible in the yoke window 45.

FIG. 3 shows that the yoke assembly 20 according to the present disclosure has, for example, a 2-inch 1502 Union male 41, with nut, on the adapter end, for securely yet removable connecting the yoke assembly 20 (and thus the lubricator 10) to the wellhead according generally to convention. Similarly, for example, a 2-inch 1502 female union 42 on the extension end of the lubricator yoke assembly 20 provides for the screwed connection of any of a variety of sizes/lengths of barrels 36. Switching of barrel sizes permits the use of tool rods 34 of different lengths, to customize the lubricator 10 to the particular application or the heights of different BOPs or Christmas trees. Again, seen in FIG. 3 running through the yoke assembly 20, is the tool rod 34, which is movable up and down. The rod 34 is used ultimately to manipulate a removable attached item, for common example a BPV 37. In the yoke assembly 20 are two packing glands 22, 22 (ordinarily with Chevron style packing) to retain fluid pressures within the lubricator during use. Central to the functioning of the lubricator 10 are four needle valves 24, 25, 26, and 27, used to equalize and bleed off pressure in the lubricator, according to
known conventions. A pressure gauge 18 normally is installed in the cross portion on the lubricator manifold 33 of the yoke assembly 20.

[0035] Referring to FIG. 3, it is seen that a polished rod adapter 38 is removably but reliably attached to the distal end of the tool rod 34, as by means of a pin-and-channel connection. The polished rod adapter 38 permits a running and retrieving tool 39 (any of a number of running tools known in the art) to be securely but releasably connected to the distal end of the tool rod 34. Such connections often are by means of special set screw type junctions. Running and retrieving tools include, for example, solid stringer type running tools, or sliding thread type running and retrieving tools for larger BVPs 37. The running tool 39 in turn can have a threaded engagement with any of a number of tools, particularly for instance, a BVP 37 of selected and suitable type and specification.

[0036] The advantageous elements of the presently disclosed apparatus are best depicted in FIGS. 4 and 5. According to the invention, a specialized barrel portion 36 is provided for attachment to the female union 42 (FIG. 3) of the usual yoke assembly 20. Thus to practice the present invention, a conventional barrel portion 30 (FIGS. 1 and 2) is removed from the yoke assembly 20 and replaced by the improved barrel portion 36 (FIGS. 4 and 5) of the present disclosure. It is noted that the yoke assembly 20 and its components are assembled and function generally in accordance with known lubricator device, except especially that the rod 34 in the presently disclosed apparatus need not be forced up and down manually via the access of the yoke window 45. Rather, the presently disclosed innovation occurs primarily in the specialized barrel portion 36 which is suited for screwed engagement with a yoke portion 20 by means of a suitable steel swage 43.

[0037] Continued reference is made to FIGS. 4 and 5. In the present apparatus and method, the lower or distal second end 48 of the barrel housing 32 is secured within the female side of the swage 43 by means of a pressure gland 46 having suitable packing to contain fluid pressure within the interior of barrel housing 32. The tool rod 34 movably extends through the gland 46 and axially through the swage 43 and on to the yoke assembly 20. The swage 43 has a secure screwed engagement with the female union 42 (FIG. 3) atop the proximate end of the yoke assembly 20. Thus, the specialized barrel portion 36 of the present apparatus may be interchanged with conventional barrel portions 30 known in the art. (Again, the barrel portion 36 of the present disclosure is substituted for a conventional barrel portion 30 (FIGS. 1 and 2) on the yoke assembly 20.)

[0038] A piston 50 is secured at or near the upper or proximate end of the tool rod 34. The outside diameter of the piston 50 approximates the inside diameter of the barrel housing 32, such that the moveable piston has a snug sliding contact with the inside of the barrel housing. Suitable glands or O-ring packing 51 provide a pressure seal between the piston 50 and the inside wall of the barrel housing 32, yet permit the piston to undergo reciprocal movement within the barrel housing.

[0039] Reciprocal movement of the tool rod 34 is provided by hydraulic pressure acting on the faces of the piston 50. To provide for such regulated pressure changes, a proximate or upper fluid port 52 is defined through the wall of the barrel housing 32 very near its (proximate or upper) first end 63. Upper fluid port 52 permits the flow of hydraulic fluid into or out of the head space 53 between the piston 50 and the closed, upper, first end 63 of the barrel housing 32. Further, a lower fluid port 56 penetrates the wall of the barrel housing 32 near its distal or lower second end 48, near the gland 46. Lower fluid port 56 permits the flow of hydraulic fluid into or out of the barrel space 57 within the barrel housing between the piston 50 and the gland 46.

[0040] Accordingly, axial to-and-fro movement of the piston 50, and thus the tool rod 34, can be controllably accomplished by regulated changes in relative fluid pressure between the head space 53 (FIG. 5) and the barrel space 57. Referring to FIG. 5 and especially FIG. 4A, a first pressure tee 59 is provided in the lower fluid port 56 for providing sealed fluid communication to both a quick-coupling connector 60 and a first aperture of a needle valve 61, which are connected to the tee fixture 59. The first quick-coupling connector 60 is of any suitable connector type known in the art of hydraulic systems for providing a reliable, but readily releasable, sealed fluid connection between the one leg of the tee fixture 59 and a first lower hydraulic pressure hose 65. The first or lower hose 65 is in fluid communication with a source of regulated hydraulic pressure, preferably a conventional power-take-off of an internal combustion engine or other motor, mounted on a service truck 100 (FIG. 6), by which hydraulic fluid can be driven under pressure through the lower hose 65, through the lower fluid port 56 via the lower tee 59, and into the barrel space 57.

[0041] Referring still to FIGS. 4A and 5 particularly, the other, upper, first aperture of the needle valve 61 is in fluid communication with a second, upper, pressure tee fixture 66, which may be mounted by a bracket 71 on the exterior of the barrel housing 32. A first leg of the upper tee fixture 66 is connected to a second or upper quick-coupling connector 68, also a connector known in the art for providing a reliable and releasable fluid connection between the one leg of the upper tee fixture 66 and a second driving hydraulic pressure hose 70. The upper or second driving hose 70 also is in communication with a source of regulated hydraulic pressure, so that an operator of the present apparatus can controllably direct pressurized hydraulic fluid toward the upper tee 66 via the coupling connector 68. The second leg of the upper tee 66 is in fluid communication with a hydraulic transmission hose 72. The upper end (remote from upper tee 66) of the transmission hose 72 has a sealed fluid connection to the upper fluid port 52, so that hydraulic fluid can be conveyed from the upper tee fixture 66 into the piston head space 53.

[0042] The needle valve 61 thus provides a fluid connection between the two tee fixtures 59, 66, and thus a means for controlling hydraulic fluid flow between the upper fluid port 52 and the lower fluid port 56. Closing the needle valve 61 prevents any fluid from moving directly between the ports 52, 56, while an open needle valve 61 allows fluid flow, and thus pressure equalization, to occur between the barrel fluid ports 52, 56. The pressure hoses 65, 70 deliver hydraulic fluid and pressure separately and (when the valve 61 is closed) independently to the respective tees 59, 66, and thus separately to the ports 52, 56. The condition or degree of separate delivery is controlled by the discretionary actuation of the valve 61.

[0043] Thus the valve 61 is in fluid communication with the upper port 52 and with the lower port 56, but also so that the lower port and the upper port are in fluid communication with the hoses 65, 66 which can deliver hydraulic pressure separately to each of the ports (via the respective tees) as indicated in FIG. 5. The valve 61 (preferably but not necessarily a needle valve) may be manipulated to control hydraulic fluid
flow between the upper fluid port 52 and the lower fluid port 56; the valve in a closed condition prevents hydraulic fluid from moving directly between the ports, while when valve is open it allows hydraulic pressure equalization to occur between the ports.

[0044] From the foregoing, and with reference to FIGS. 4, 4A, and 5, it is evident that the power provided by a source of hydraulic pressure, such a hydraulic power take-off of a truck-mounted internal combustion engine (FIG. 6), can be harnessed to drive a controlled reciprocal movement of the piston 50. With the needle valve 61 closed, hydraulic pressure can be delivered via the upper driving hose 70, through the upper tee fixture 66, and to the upper fluid port 52. Fluid passing through the upper fluid port 52 and into the head space 53, increasing the hydraulic pressure in the head space, moves the piston 50 axially downward (i.e., to the right in FIGS. 4 and 5), away from the closed upper end 63 of the barrel housing 32. Because the piston 50 is fixed to the tool rod 34, movement of the piston induces corresponding movement of the tool rod. Likewise, hydraulic fluid can be controllably pumped through the first driving hose 65, through the lower tee fixture 59 and into the barrel space 57 via the lower fluid port 56. Increasing fluid pressure via the lower port 56 will increase fluid volume within the barrel space 57, and the increased pressure within the barrel space will drive the piston 50 axially upward (i.e., to the left in FIGS. 4 and 5), toward the upper first end 63 of the barrel housing 32. The tool rod 34 moves accordingly.

[0045] A person skilled in the art recognizes that when the piston 50 is moving, a vent or “bleed” is required to relieve hydraulic pressure in the confined interior space (either the head space 53 or the barrel space 57) toward which the piston 50 moves. Such pressure relief can be and preferably is provided by employing an essentially closed hydraulic circuit. Thus, for example, when fluid is positively pumped into the head space 53 via the upper fluid port 52, it simultaneously can be permitted to exit the barrel space 57 via the lower fluid port 56 (by active pumping action by the external source of hydraulic power via the hose 65, or merely by the action of the moving piston 50), and vice-versa.

[0046] By regulated operation of the foregoing described hydraulic means, the axial up-and-down movement of the tool rod 34 is accomplished under regulated hydraulic driving power. No special tool need be employed for field technicians to manhandle the rod into and out of place, by gripping the rod 34 with a Parmelle wrench or other tool, is reduced or eliminated.

[0047] The practice of the invention can be further characterized as follows.

[0048] Before using the hydraulic lubricator apparatus 10, it is recommended that a job hazard assessment be prepared and discussed with all well site personnel. The responsible operators should pre-check all equipment, including well equipment, to assure safe operation. The tools and hydraulic lubricator are inspected that everything is in good working condition. Before beginning lifting or working with any equipment, operators should assure that all lifting equipment and tools are the right lift rating and are free from damage.

[0049] The height of the Christmas tree must be determined, since the overall stroke distance of the hydraulic lubricator 10 must exceed the height of the tree. The appropriate size and type of the BPV is determined, and the BPV selected, based on the wellhead equipment type and conditions. The appropriate running and retrieval tool 39 is obtained to install the BPV 37 on the well tubing hanger. The yoke portion 20 of the lubricator itself preferably is pressure-tested (and repaired, if needed) according to known procedures.

[0050] A service truck 100 equipped with a small crane lift (FIG. 6) and a power take-off (PTO) for driving an auxiliary hydraulic system is brought to the well head. A spotter assists the person that is operating the truck 100, to assure safe backing and proper placement of the truck. The parking brake and wheel chocks are applied to secure the vehicle from movement.

[0051] With the installation of a PTO on the transmission on the truck 100, a control valve can actuate up-and-down the tool rod 34 of the lubricator 10. Two fifty-foot hydraulic hoses 65, 70 run from the lubricator to the control valve. In front of the truck’s work bed is a tank (not shown) holding 140 gallons of water, and in the center of the bed is a tank containing for example about 40 gallons of hydraulic oil. The hoist 102 which is mounted at the bed of the truck 100 preferably can extend out to approximatel 15.5 feet and be capable of lifting about 3,200 pounds at 75 degrees—more than capable of rigging up the hydraulic lubricator on any wellhead equipment up to about nine feet tall.

[0052] The running and retrieval tool 39 is attached to the tool rod 34 as indicated in FIG. 3. The BPV 37 is screwed or otherwise appropriately attached onto the running and retrieval tool 39, also as suggested in FIG. 3.

[0053] The Christmas tree itself (not shown, but according to ordinary norms and configurations) is managed according to known protocols for use of conventional lubricators. Sufficiently, the wing valve (or valves) must be closed to stop the flow from the well in the tree. Any equipment above the swab valve that will not be needed to complete the task is removed. The master valve(s) and swab valve are opened to essentially open the “run” of the tree, after which the pressure at the top of the tree is checked and double-checked. The swab valve is closed, pressure bled off, and the tree cap connector disconnected.

[0054] Reference is made to FIGS. 6 and 7. The hoist or crane 102 is attached to the top end (e.g. by eye bolt 35) of the lubricator 10, and the crane actuated to bring the lubricator 10 to an upward position, as seen in FIGS. 6 and 7. Taglines may be attached to the eye bolt 35 on the top of, and also near the bottom (bottom tagline 105 in FIG. 7) of the lubricator 10, to facilitate safely guiding the lubricator to the top of the Christmas tree. Preferably, a work spool and B2P adapter, using a flow tee with a 2-inch ball valve connected on the side, are fastened atop of the Christmas tree.

[0055] The main lubricator hydraulic hoses, i.e., driving hoses 65 and 70 are run to the lubricator 10 from the hydraulic pressure sources at the truck 100. The first driving hose 65 is connected to the lower fluid port 56 of the lubricator barrel 32 by means of the first quick-coupling connector 60, and the second driving hose 70 is connected to the second, upper fluid port 52 by means of the upper quick-coupling connector 68. The power take-off (from truck 100) that actuates the hydraulic pump may then be actuated. The hydraulic lubricator 10 is raised with the hoist 102 to a height sufficient to permit the distal end of the tool rod 34 to be extended from below, out the bottom flange of the yoke assembly 20, permitting attachment of the running and retrieval tool 39 to the rod adapter 38 on the distal end of the rod 34. The lubricator 10 is raised above the wellhead, and its distal end is placed in registration with the top of the Christmas tree (not shown, but according to convention), using taglines to guide the lubricator into position.
The operators then tighten the connector bolts to secure the bottom of the lubricator onto the B2P adapter flange (on the tree).

[0056] Once the lubricator 10 is secured to the top of the tree, the operator opens needle valve 26 and needle valve 27 on the lubricator yoke assembly 20; the operators listen for pressure from below the Christmas tree master valve when the opening of the master valve is begun. (If there is no sign of pressure on yoke valve 27, but there is on yoke valve 26, the lubricator’s equalizing tube might be shut or have an obstruction.) The operator then begins opening slowly the master valve on the Christmas tree.

[0057] It is necessary to calculate the number of incremental strokes of the tool rod 34 needed to move the BPV 37 (attached to the distal end of the rod) the proper distance through the tree for seating into the threads at the top of the tubing hanger. To do so, the depth to the tree’s master valve and tubing plug is measured. (The measurement is taken from the bottom of the wing of lubricator to the middle of the lockdown pin gland nut.) Referring for example to FIG. 3, the length of the segment of the tool rod 34 that is exposed in the window of the yoke assembly 20 (between the gland nuts 44 of the packing glands 22, 22’) is measured. The distance between the gland nuts 44 is then divided by the length of the depth distance to the plug. The rod 34 is marked at the top gland nut 44, and the rod 34 is then stroked slowly down (manually if necessary) until the mark is immediately adjacent the bottom gland nut 44”. This process is repeated to calculate the number of incremental strokes needed to move the tool rod through the accurate full rod stroke distance, to seat the BPV 37 at the plug (i.e., the distance the tool rod will need to be moved to reach the tubing hanger).

[0058] The lubricator 10, installed atop the wellhead’s tree, is then operated. First, needle valve 26 and needle valve 27 on the yoke assembly 20 are closed, and needle valve 24 and needle valve 25 are opened, which equalizes pressure within the lubricator 10 (that is, throughout the yoke assembly 20, according to known lubricator functions). The resulting equalization of pressure allows the tool rod 34 to shift relatively freely up and down.

[0059] The swab valve on the Christmas tree is then slowly opened, the operators taking care to observe whether the lubricator 10 is holding the well pressure. The swab valve is shut immediately if it is evident that the lubricator will not contain the pressure; in the event leaks are discovered, the swab valve is closed again, the lubricator repaired, and swab valve reopened.

[0060] With the lubricator 10 under equalized pressure (the well working pressure), the operators use a control panel 110 (FIG. 8) on the field vehicle 100 to regulate hydraulic pressure in the drive hoses 65, 70 leading from the hydraulic power take-off to the lubricator 10. The control panel 110 seen in FIG. 8 is exemplary only, and is configured according to principles known in the art of vehicle-mounted hydraulic equipment systems. The control panel 110 may have a prime hydraulic pump on-off switch 112, as well as a-valving switch 114 used to regulate both the speed and direction of the movement of the piston 50 within the barrel housing 32.

[0061] The tool rod 34 is lowered from the lubricator 10 and through the Christmas tree toward the tubing hanger by hydraulics. Having reference to FIGS. 4-7, the needle valve 61 is closed. The operator, using the control panel 110, controllably pumps fluid through the upper driving hose 70 to the upper fluid port 52 in the barrel housing 32. The resulting fluid movement is through the upper tee 66 and transmission tube 72 to the upper port 52. Fluid enters the head space 53 between the piston 50 and the closed upper or first end 63 of the barrel housing 32, thus pressurizing the head space and driving the piston, and thus the tool rod 34, downward. Valved regulation (via regulator 114) of the hydraulic system (according to known conventions) permits the operator to control the rate of descent of the tool rod 34. Fluid concurrently exits the lower fluid port 56, so that hydraulic pressure is not increased unduly in the barrel space 57 due to movement of the piston 50.

[0062] The tool rod 34 is pushed down hydraulically until it stops when the BPV 37 contacts the tubing hanger. The operators preferably monitor the distance the rod 34 has travelled, to see that it travels approximately the complete stroke distance (calculated as described above) before stopping, to prevent under- or over-extension of the rod. For example, if movement of the tool rod 34 stops before it has moved the calculated approximate distance, the operators check to assure that all the valves in the well head tree are completely open to permit passage there-through of the rod and BPV 37. In any event, care is taken to assure that the BPV 37 or other tool at the distal end of the rod 34 is not forcibly jammed into the tubing hanger by excessive hydraulic force. Attentive regulation of the hydraulic driving action on the piston 50 prevents over-extension of the rod 34.

[0063] Once the BPV 37 has contacted the threaded top of the tubing hanger, the tool rod 34 is rotated (i.e., counterclockwise) according to convention to threadably engage the BPV into the tubing hanger plug. (This rotation conventionally is done manually with a Parmelee wrench gripped about the portion of the rod 34 exposed in the yoke portion 20.) The needle valve 61 remains open during this process, so that the effort to screw the BPV 37 is not impeded by the pressure in the barrel space 57. The pressure increase in the barrel space 57 otherwise resulting in the further downward movement of the tool rod 34 is relieved through the needle valve 61, which (when open) permits ready pressure equalization between the barrel space 57 and the head space 53. The number of rod rotations is counted to assure that the BPV 37 is properly and fully screwed into place. After the tool rod 34 is rotated two or three times, the operators preferably attempt manually to lift the tool rod to test whether the BPV 37 is secured to the tubing hanger. If the rod 34 is easily pulled up, the need is indicated to move it lower and re-align the BPV 37 with the tubing hanger orifice. Depending on the type of running and retrieval tool 39 being used, there are known modes for determining whether and when the BPV 37 is fully engaged into the tubing hanger.

[0064] Methods known in the art are then employed to disengage the running and retrieval tool 39 from the BPV 37, leaving the latter engaged into the tubing hanger. The proper mode of disengagement depends upon the type of running and retrieval tool 39 being utilized, but is known to those skilled in the art. Whether disengagement has occurred may be tested, checking whether the rod 34 can be manually lifted slightly.

[0065] The tool rod 34 also may be raised hydraulically. First, the needle valve 24 and the needle valve 25 on the yoke 20 are closed. The operators then carefully open the needle valve 26 a small amount to slowly bleed off lubricator pressure.

[0066] The tool rod 34 is raised from within the wellhead equipment or tree by reversing the previously described
hydraulic operations. The needle valve 61 is closed. The operator re-engages the hydraulic system to pressurize the barrel space 57 via fluid movement into the barrel space. Fluid transmission occurs through the first driving hose 65 to the first quick-coupling connector 60, the lower pressure tee 59, and on through the lower fluid port 56. The increasing pressure in the barrel space 57 pushes against the piston 50 driving it axially upward within the barrel housing 32, pulling the tool rod 34 upward with it. Pressure in the head space 53 is correspondingly reduced, and pressure relieved by fluid exiting outward through the upper fluid port 52 and into the transmission tube 72. The tool rod 34 is hydraulically raised the distance required to extract the running and retrieval tool 39 an adequately from the wellhead tree.

After the tool rod 34 is completely raised, it may be removed. The swab valve on the tree is closed securely, and valves 26 and 27 on the lubricator manifold are carefully opened to bleed off all the pressure in the lubricator 10. Once all the pressure is safely bled off from the lubricator 10 according to known protocols, the operators may begin to remove the bolts from the work spool on top of the tree’s master valve. Using the vehicle-mounted hoist or crane 102, the lubricator 10 and work spool are raised, and the lubricator moved carefully away from wellhead and lowered to ground level. The lubricator may then be disassembled as appropriate and stowed on the vehicle 100 for transport. The necessary equipment is installed or re-installed on the wellhead, and tested as needed.

The system allows a service person to set a tubing hanger with a back pressure valve under pressure, and to retrieve that same tubing hanger in a controlled environment. The system may include a service truck to be able to perform a hydro test and operate the hydraulic lubricator. A hydraulic lubricator according to this disclosure can pull up to about 7,830 pounds of upward force and push up to about 9,800 pounds of downward force.

It is seen, therefore, that a hydraulic lubricator is provided which eliminates the need to move the tool rod 34 up and down manually during well maintenance. While the proper seating and screwing of a BPV 37 may require manual rotation of the rod according to known procedures, the technician no longer must lift and lower the rod 34 through its full stroke by gripping the rod with a wrench, and forcing it up or down incrementally—often while in an awkward bodily position or at a potentially hazardous location many feet above the ground. Rather, the tool rod 34 is lifted and lowered within the lubricator 10 by means of hydraulic power, controlled at a control panel 110 safely and conveniently located upon the service vehicle 100, such as a diesel engine truck.

Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover all such modifications and equivalents. The entire disclosures of all applications and patents cited above are hereby incorporated by reference.

What is claimed is:

1. A wellhead lubricator apparatus comprising:
   a barrel portion detachably engageable with a yoke assembly mountable upon a wellhead, the barrel portion comprising:
   a barrel housing;
   a rod movable coaxially within the barrel housing and having a segment of the rod variably extendable from an end of the barrel housing and into the yoke assembly;
   a piston secured to the rod and movable within the barrel housing; and
   hydraulic means for controllably driving the piston to-and-fro within the barrel housing, thereby moving the rod axially in relation to the barrel housing and yoke assembly.

2. A lubricator apparatus for use at an oil or gas wellhead, comprising:
   a yoke assembly removably mountable to a wellhead, and a barrel portion, detachably engageable with the yoke assembly, comprising:
   a barrel housing having a first end and a second end;
   a rod movable coaxially within the barrel housing and having a segment of the rod variably extendable from the barrel housing second end;
   a piston secured to the rod and movable within the barrel housing, there being defined in the barrel housing a head space between the piston and the barrel housing first end and a barrel space between the piston and the barrel housing second end;
   an upper port defined in the barrel housing for permitting a hydraulic fluid to enter or exit the head space;
   a lower port defined in the barrel housing for permitting hydraulic fluid to enter or exit the barrel space; and
   a valve for regulating hydraulic pressure in the head space or the barrel space, thereby controllably driving the piston to-and-fro within the barrel housing and moving the rod axially in the barrel housing.

3. An apparatus according to claim 2 wherein the barrel portion has a screwed engagement with the yoke portion by means of a steel swage.

4. An apparatus according to claim 3, wherein the second end of the barrel housing is secured within a female side of the swage by a pressure gland for containing hydraulic pressure within an interior of the barrel housing.

5. An apparatus according to claim 4 wherein the swage has a screwed engagement with a union atop the yoke assembly, and the tool rod movably extends axially through the gland and the swage, and into the yoke assembly.

6. An apparatus according to claim 2 wherein the valve comprises a valve in fluid communication with the upper port and with the fluid port, and further wherein the lower port and the upper port are in fluid communication with hoses for delivering hydraulic pressure separately to each of the ports.

7. An apparatus according to claim 6 wherein the valve comprises a needle valve for controlling hydraulic fluid flow between the upper fluid port and the lower fluid port, whereby the needle valve closed prevents hydraulic fluid from moving directly between the ports while the needle valve open allows hydraulic pressure equalization to occur between the ports.

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