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MULTI-PURPOSE WELLHEAD APPARATUS FOR OIL WELLS

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2 Sheets-Sheet 1

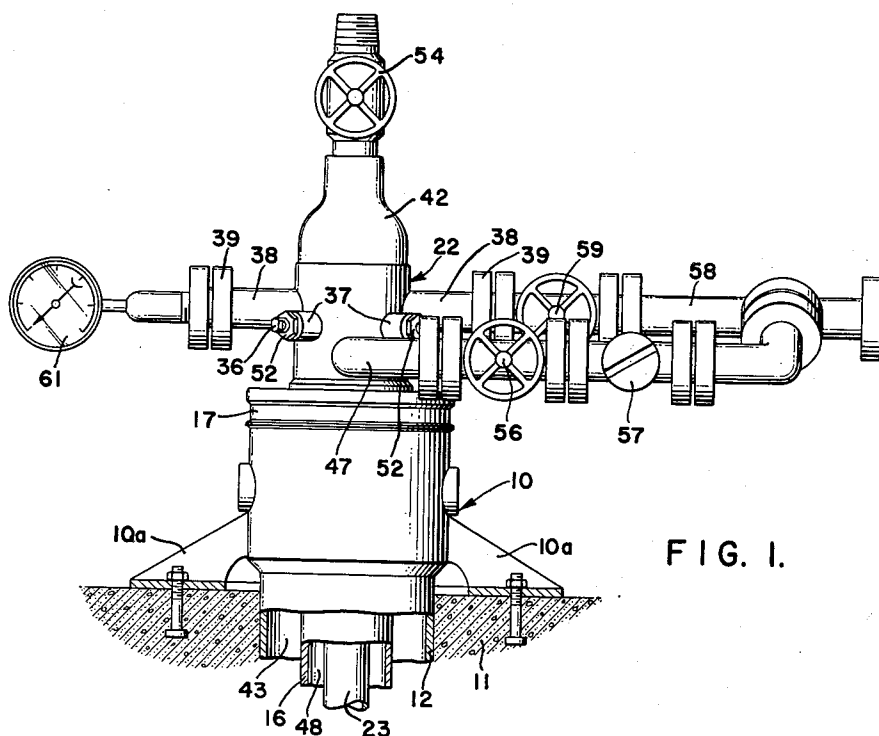


FIG. 1.

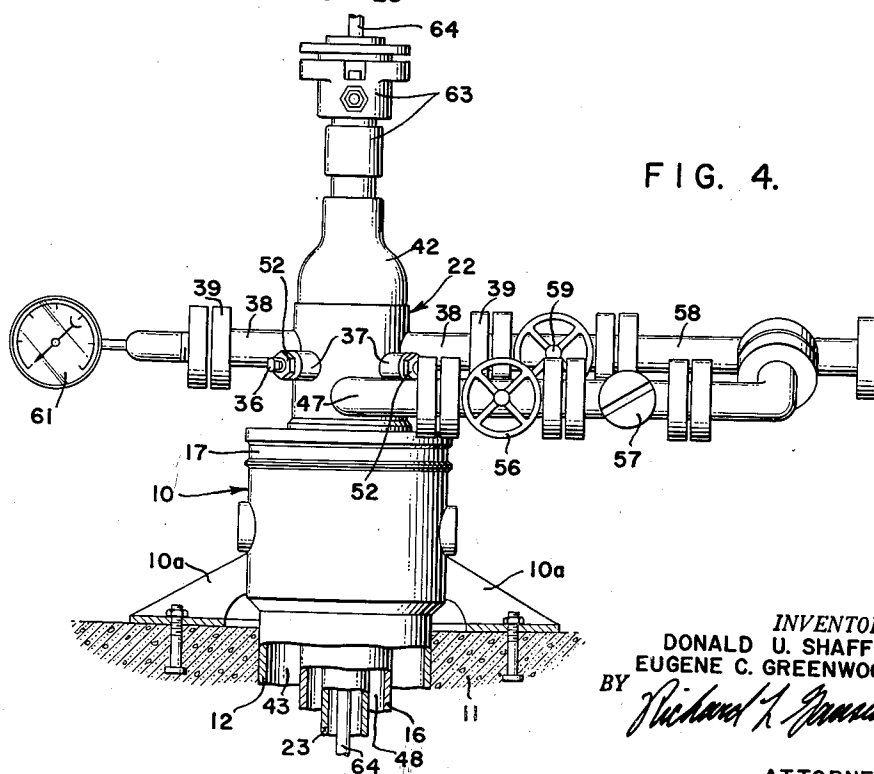


FIG. 4.

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FIG. 2.

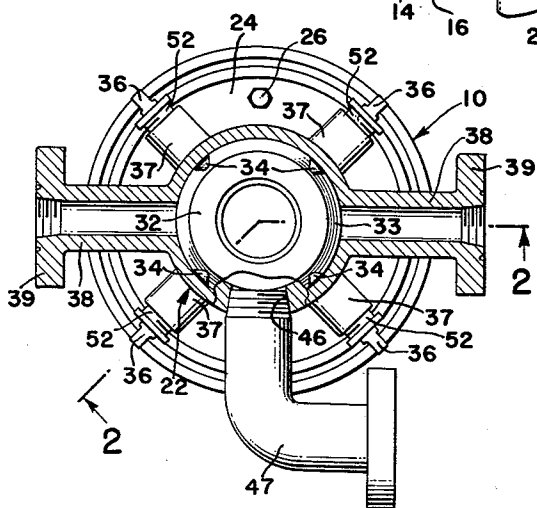
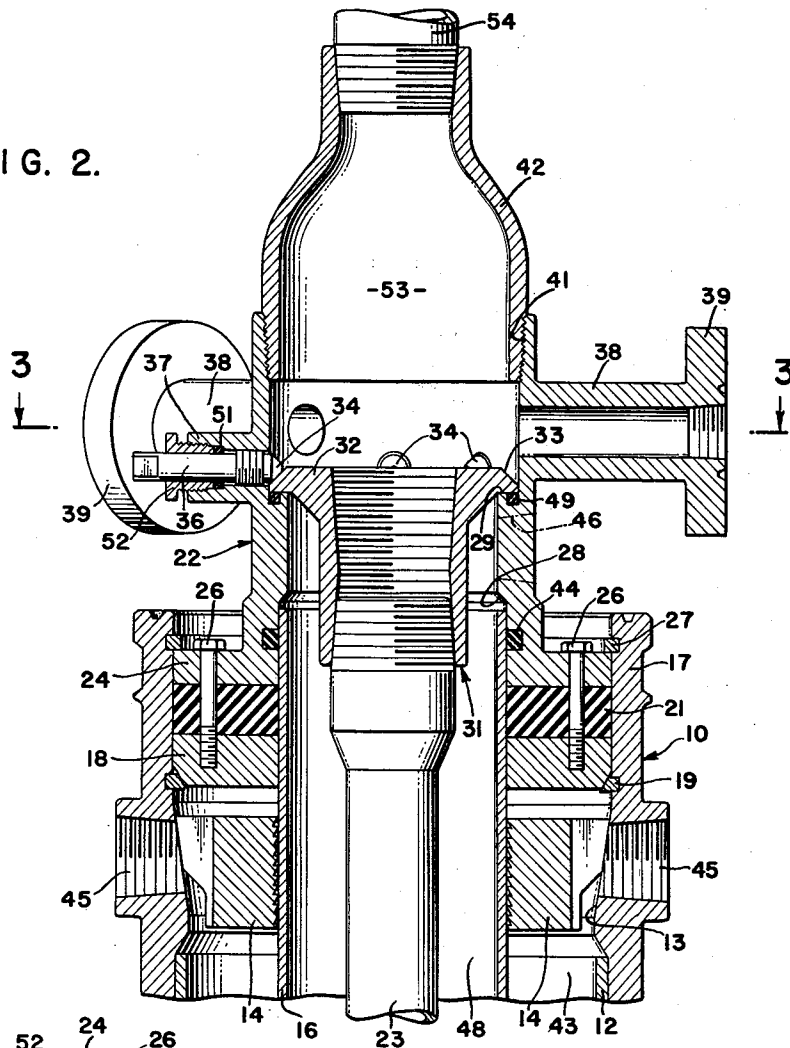


FIG. 3.

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MULTI-PURPOSE WELLHEAD APPARATUS
FOR OIL WELLS

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1 Claim. (Cl. 166—89)

This invention relates to a multi-purpose wellhead apparatus adapted to be employed in connection with both flowing wells and pumping wells.

An object of the present invention is to provide an improved wellhead apparatus which makes it possible to convert from flowing operation to pumping operation, or to pull the tubing, without the necessity that the Christmas tree (or equivalent thereof) be disturbed in any way.

Another object of the invention is to provide a wellhead apparatus which reduces the danger involved in pulling the tubing, it being unnecessary to place the Christmas tree in inoperative condition at any time.

A further object of the invention is to provide a wellhead apparatus which makes it possible to convert from flowing operation to pumping operation, or to pull the tubing, without danger of damage to API rings and consequent leaks upon re-assembly.

A further object is to provide a highly simple and economical wellhead apparatus incorporating relatively few parts.

These and other objects and advantages of the invention will be more fully set forth in the following specification and claim, considered in connection with the attached drawings to which they relate.

In the drawings:

FIGURE 1 is an elevational view of an apparatus incorporating the invention, and connected for flow operation;

FIGURE 2 is a vertical sectional view of the upper portion of the apparatus illustrated in FIGURE 1, the section being taken on broken line 2—2 of FIGURE 3;

FIGURE 3 is a horizontal section on line 3—3 of FIGURE 2; and

FIGURE 4 is an elevation corresponding to FIGURE 1 but illustrating the apparatus connected for pumping operation.

Referring to the drawings, the invention is illustrated as incorporated in a wellhead apparatus comprising a base (casing) head body 10 the legs 10a for which are suitably anchored in concrete 11 disposed around the outer string 12 of casing. The base head body 10 is sealingly mounted coaxially over the upper end of the casing string 12, and comprises a downwardly-convergent frustoconical or tapered-bowl portion 13 adapted to receive the slips 14 for the second and smaller-diameter string 16 of casing. The body 10 further comprises an upper generally-tubular portion 17 extending upwardly from the tapered-bowl portion 13. The second casing string 16 is shown as being cut off in approximately the same plane as the upper end of tubular portion 17.

Mounted in the annulus between casing head portion 17 and the upper end of second casing string 16 is a lower rigid packer plate or ring 18, such plate being supported by a lower snap ring 19 and also by the fluid pressure therebeneath. An elastomeric packing ring 21, having a radial dimension corresponding generally to that of the annulus, is mounted on the packer plate 18 in order to seal off the annulus as will be described hereinafter.

Supported on the packing ring or rubber 21 is a multi-purpose or combination body element 22 adapted to vent the annulus within second casing string 16, to discharge the well fluid which flows upwardly through the tubing

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string 23, and to compress the packing rubber 21 in order to effect the above-indicated seal of the annulus within outer casing string 12. The multi-purpose body 22 is preferably an integral casting having a generally tubular shape, the inner diameter of the tube being at least as large as the inner diameter of the second casing string 16. The lower end of body 22 is formed with a radially-outwardly extending flange 24 the lower surface of which has a shape corresponding to the upper surface of packing rubber 21. A plurality of cap screws 26 are extended downwardly through suitable holes in flange 24 and packing rubber 21 and are threaded into suitable interiorly-threaded openings in the lower packer plate 18. An upper snap ring 27 is mounted in body portion 17 upwardly adjacent flange 24 to insure against upward shifting of the assembly due to factors such as excessive fluid pressure in the outer annulus.

The multi-purpose element 22 is necked-down slightly, in spaced relation above the upper end of casing string 16, to create the downwardly-facing shoulder indicated at 28. A counterbore is provided in the upper end of element 22 in order to form an upwardly-facing radial shoulder 29 adapted to seat a tubing hanger 31. More specifically, the tubing hanger is illustrated as having an upper radial flange 32 the peripheral portion of which rests on shoulder 29, the flange being beveled at its upper portion to form an upwardly-convergent peripheral surface portion 33. Surface portion 33 is adapted to be engaged by the conical inner ends 34 of radially-inwardly extending lock screws 36 which are threaded into boss portions 37 of element 22. Four such boss portions 37 and corresponding lock screws 36 are illustrated in FIGURE 3 as being spaced at ninety-degree intervals, each lock screw having a squared outer end so that a wrench may be employed to thread the screws to seated positions (FIGURE 2) against surface 33 and thereby insure against upward movement of the tubing hanger 31.

The multi-purpose element 22 is formed, above flange 32, with at least one and preferably several side-outlet connecting conduits 38 which are illustrated as being of the flanged type having radial flanges 39 at their outer ends. Referring to FIGURE 3, it is pointed out that in the illustrated embodiment the side-outlet conduits 38 are diametrically opposite each other and are spaced approximately forty-five degrees from the adjacent boss portions 37 for lock screws 36. The extreme upper end or rim of the multi-purpose element 22 is internally threaded at 41 to receive the correspondingly-threaded wide end portion of a swaged nipple 42. The upper and smaller-diameter end of the swaged nipple 42 is internally threaded to receive elements employed during both flow-operation and pumping-operation of the well, as will be described subsequently. The swaged nipple constitutes a cover means (including a plug) for the multi-purpose element.

As previously indicated, the annulus 43 between casing strings 12 and 16 is sealed off by means of the elastomeric packing element 21. This is effected either by tightening of the cap screws 26 to compress the ring 21, or by hanging of the tubing string 23 so that the weight of the string is transmitted to the packing rubber 21 to compress the same, or by both of these means acting in combination. If desired, a seal may be provided around the upper end of casing string 16, as indicated at 44. Such seal may be of the type in which viscous sealing material is introduced under pressure around a ring.

The annulus 43 is vented through openings 45 located adjacent tapered bowl 13. A vent opening for the inner annulus is provided in the multi-purpose element 22 between the shoulders 28 and 29, and is numbered 46 (FIGURE 3). Opening 46 is suitably threaded to receive a flanged elbow 47 or other conduit element.

The above-indicated inner annulus (numbered 48) between tubing string 23 and casing string 16 is suitably sealed by means of a sealing ring 49 mounted in the upwardly-facing shoulder portion 29 of element 22. Seal 49 acts in combination with seals 44 and 21. In addition to the above-indicated seals for the various annuluses, a seal is provided around each lock screw 36 in the form of a sealing ring 51 held in place by a threaded plug 52. Leakage of well-fluid from the chamber 53 defined by the swaged nipple 42 and also by the upper portion of multi-purpose element 22 (above hanger flange 32) is thus prevented.

Operation

Let it be assumed that the second casing string 16 has been run into the well and cut off in generally the same plane as the upper end of base head body 10, such casing string being supported by slips 14 as previously indicated. The lower snap ring 19 is then inserted and the lower packer plate 18 is supported thereon. It is then merely necessary to mount the packing rubber 21 and multi-purpose element 22 in place, as stated above, and to insert the cap screws 26 through the openings therefor and thread them into the openings in lower packer plate 18. This seals the outer annulus 43.

The tubing string 23 is then run into the well and is supported by the tubing hanger 31, the flange 32 of the latter resting on the shoulder 29 of element 22 as previously described. The weight of the tubing string is thus transmitted through element 22 to the packing rubber 21 for annulus 43, and supplements or replaces the effect of cap screws 26 in maintaining packing rubber 21 compressed. The lock screws 36 are threaded inwardly until the ends 34 thereof are seated against conical shoulder 33, so that upward shifting of the tubing hanger due to factors such as unusual pressures in annulus 48 is prevented. The swaged nipple 42 is threaded into internally-threaded upper portion 41 of element 22.

Let it next be assumed that the particular well is of the type which flows, during a period subsequent to drilling, due to its natural pressure and in the absence of pumping. Referring to FIGURE 1, a suitable valve 54 is threaded into the upper and smaller-diameter end of swaged nipple 42 and is normally maintained in closed condition. A second valve 56 is connected to the flanged elbow 47, and a third valve 57, of the one-way or check-valve type, is connected in series with valve 56. Check valve 57 is connected through an additional flanged elbow to a T 58 which, in turn, is connected to the flow line (unshown) and also to a third valve 59. Valve 59 is connected to one of the side-outlet conduits 38 communicating with chamber 53. The connections between the various elements are illustrated as being of the flanged variety incorporating suitable API rings, but they may be of other suitable types. A pressure gauge 61 is shown as being connected to the other side-outlet conduit 38 from chamber 53.

The valve 56 communicating with inner annulus 48 is normally maintained closed. The valve 59 communicating with chamber 53 is normally maintained open. Well fluid thus passes upwardly through the tubing string 23 into chamber 53, and thence laterally through the side-outlet conduit 38 and open valve 59 to T 58 and the flow line. When it is desired to vent annulus 48, valve 59 is closed and valve 56 is opened, so that gas flows through opening 46 (FIGURE 3) and elbow 47, valve 56, check valve 57 and T 58 to the flow line. Check valve 57, which is adapted to permit flow only in a direction from the casing head to the flow line, insures against entrance of production fluid into annulus 48.

When the pressure in the well is reduced to such an extent that the well ceases to flow sufficiently, so that pumping becomes necessary, it is merely required to remove the valve 54 and introduce a pump and a string of sucker rods downwardly through the swaged nipple 42,

tubing hanger 31 and tubing string 23. A stuffing-box assembly 63 (FIGURE 4) is sealingly mounted around the polished rod 64 at the upper end of the string of sucker rods (unshown) to prevent leakage of production fluid from chamber 53. Pumping operation is then commenced, and the production fluid flows upwardly through tubing 23 and out the side-outlet conduit 38 and valve 59 to the flow line as in the case of flow operation.

From the above it will be understood that the well may be converted from flow operation to pumping operation without the necessity of disturbing the Christmas tree (or equivalent thereof) in any way. Furthermore, the present apparatus makes it possible to pull the tubing without disturbing the Christmas tree, this being accomplished by retracting the lock screws 36 outwardly, removing the swaged nipple 42 from multi-purpose element 22, making a threaded connection with the upper portion of tubing hanger 31, and then lifting the tubing out of the well.

Because of the fact that the well may be converted from flow operation to pumping operation without disturbing the Christmas tree, and because of the fact that the tubing may be pulled without disturbing the Christmas tree, there is no danger that API rings will be damaged so that the apparatus will leak when the assembly is again made. The present apparatus also makes it substantially safer to pull the tubing. If the well starts to flow while the tubing is being pulled, it is merely necessary to plug the upper end of multi-purpose element 22. The Christmas tree is never laid down and out of position.

The present apparatus is also substantially cheaper and more compact than conventional wellhead apparatus. The need for an adapter flange and cross is eliminated, thus saving a substantial amount of money both for materials and labor.

Various embodiments of the present invention, in addition to what has been illustrated and described in detail, may be employed without departing from the scope of the accompanying claim.

We claim:

A wellhead incorporating a combination tubing head and upper packer member, which comprises a generally tubular base head body having legs which are adapted to be anchored to and supported on a mass of concrete at the wellhead of an oil well, said base head body being telescoped over and welded to a first and outer string of casing, said base head body having an interior downwardly-convergent frustoconical portion located above the upper end of said first string of casing, said base head body also having at least one vent opening therethrough and communicating with said frustoconical portion, a plurality of slips seated in said base head body on said frustoconical portion thereof, a second and inner string of casing telescoped into said base head body and into said first string of casing and supported by said slips, being grooved to permit communication between the annulus defined between said first and second casing strings and said vent opening in said base head body, a snap ring mounted interiorly in said base head body above said slips, a lower packer ring seated on said snap ring and extending between the outer surface of said second string of casing and the inner surface of said base head body, said lower packer ring being formed of rigid material and having an upper horizontal surface, said lower packer ring having a plurality of vertical threaded bores therein, a packing rubber seated on said horizontal surface of said lower packer ring and extending between the outer surface of said second casing string and the inner surface of said base head body, said packing rubber having bores therethrough registered with said threaded bores in said lower packer ring, a multi-purpose element having a horizontally-disposed radially-outwardly extending flange portion seated on the upper surface of said packing rubber and extending between the outer surface of said second casing string and the inner surface of

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said base head body, said multi-purpose element having a generally tubular body extending upwardly to a region above the upper end of said second casing string, said tubular body having a radial internal shoulder formed therein, a side-outlet conduit communicating with said multi-purpose element above said radial shoulder, a plurality of cap screws extended downwardly through holes in said flange portion of said multi-purpose element and through said bores in said packing rubber and threaded into said threaded bores in said lower packer ring, said cap screws being adapted to be tightened to compress said packing rubber between said flange portion and said lower packer ring, portions of said screws at said flange portion being unthreaded to permit downward movement of said multi-purpose element due to the weight of the tubing string, a second snap ring mounted interiorly of said base head body adjacent the upper surface of said flange portion of said multi-purpose element, a tubing hanger having an internal passage therethrough and having a radially outwardly-extending hanger flange at the upper end thereof, said hanger flange being seated on said internal shoulder in said multi-purpose element, seal means provided between said radial flange and said multi-purpose element, a plurality of lock screws inserted through said multi-purpose element and engaged with said hanger flange to maintain the same seated on said internal shoulder, the upper end of said multi-purpose element being internally threaded to receive the wide end of a swaged nipple, a swaged nipple threaded into said upper end of said multi-purpose element and having a swaged-down upper end, said upper end being internally threaded to receive a pipe, said internally-threaded up-

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per end of said multi-purpose element being sufficiently large to permit upward withdrawal of said tubing hanger therethrough upon outward shifting of said lock screws, and a string of tubing threadedly associated with said tubing hanger to deliver well fluid thereto and thus to said swaged nipple and said side-outlet conduit, the weight of said tubing being transmitted through said multi-purpose element to said packing rubber for compression thereof and sealing of the annulus between said first and second casing strings.

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