March 8, 1960 H. H. MEREDITH, JR., ET AL 2,927,642

CHRISTMAS TREE BY-PASS

Filed Aug. 29, 1955 2 Sheets-Sheet 1

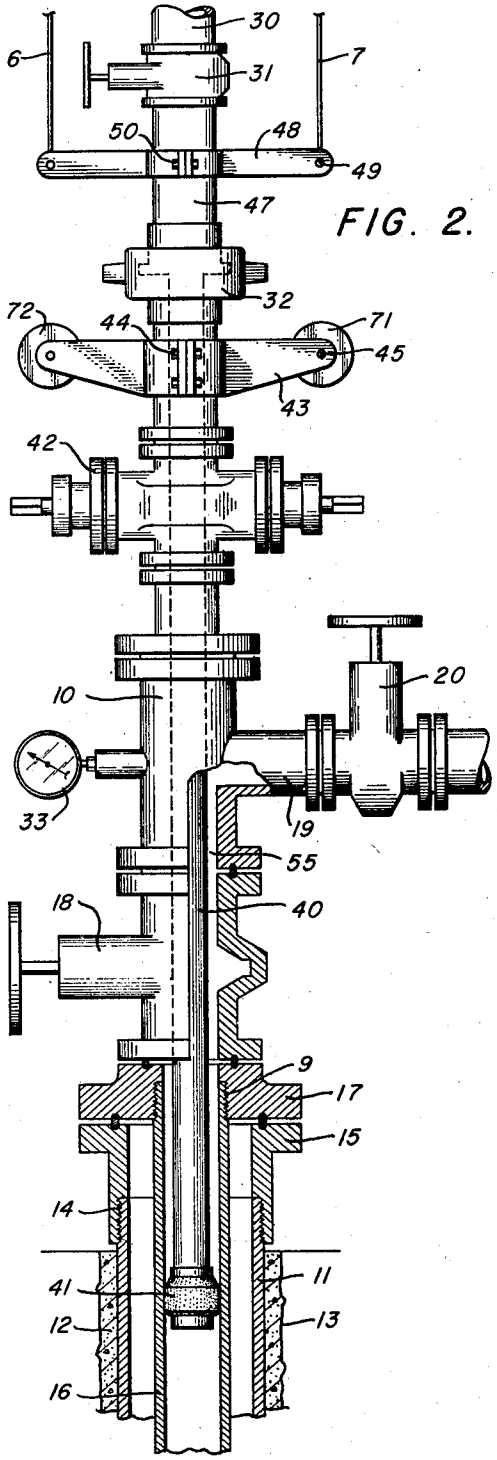


FIG. 2.

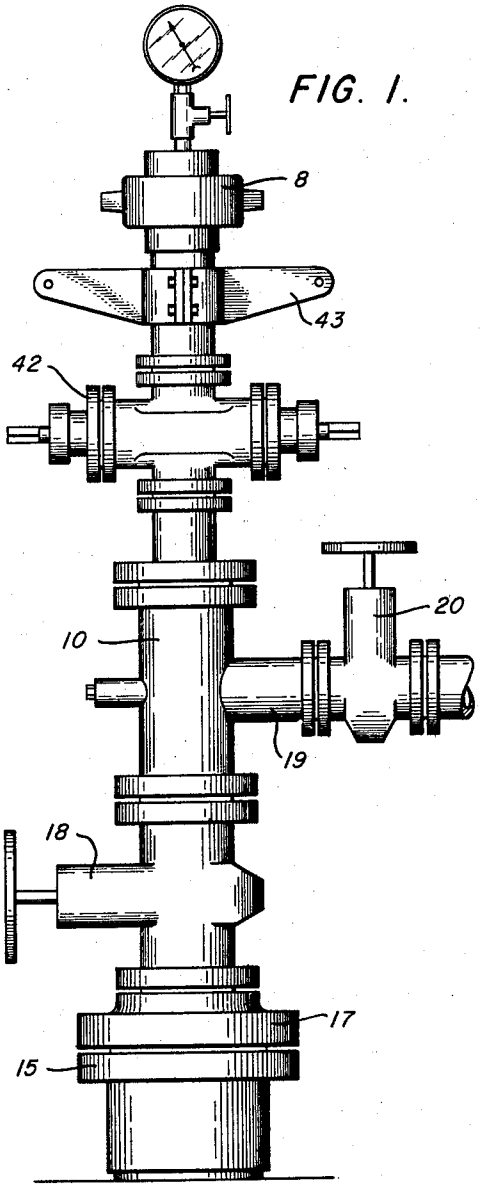


FIG. 1.

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FIG. 3.

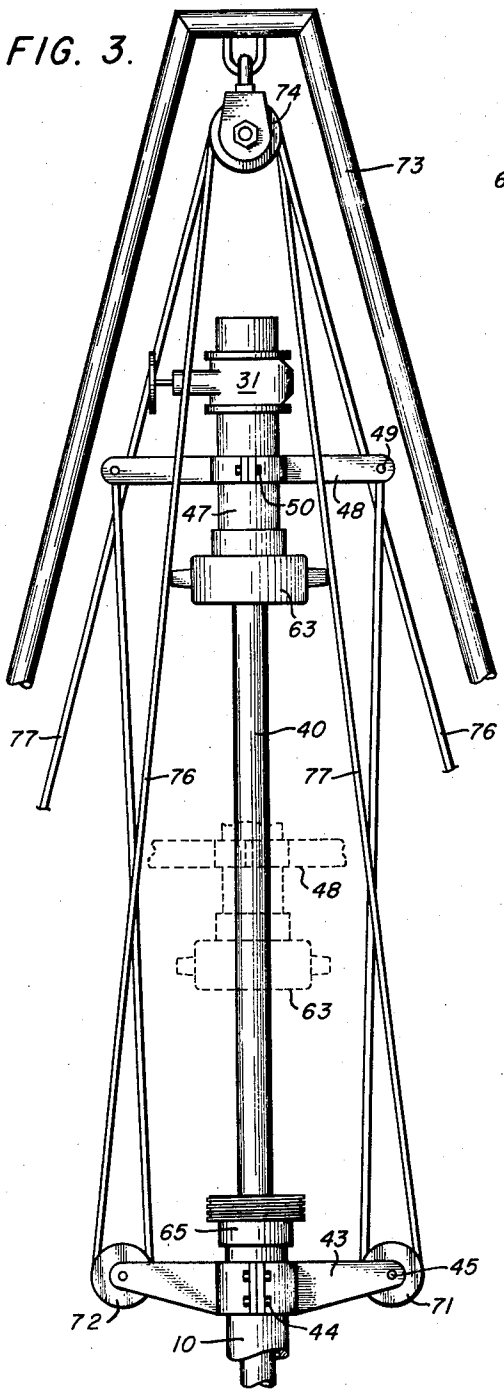


FIG. 4.

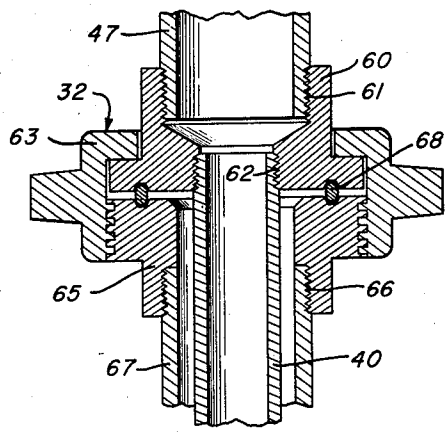
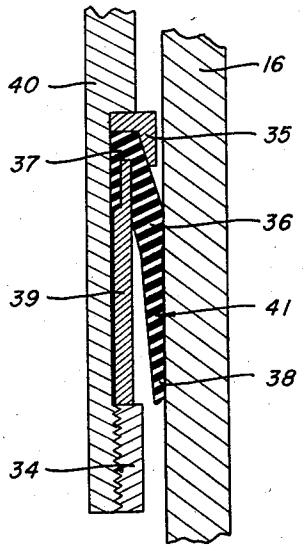


FIG. 5.



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CHRISTMAS TREE BY-PASS

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Application August 29, 1955, Serial No. 531,084

5 Claims. (Cl. 166—75)

This invention relates to a by-pass apparatus and method for using same. More particularly, it relates to by-passing the bores and flow controls of a well Christmas tree by providing a passageway sealingly isolated from the bores and flow controls. In its more specific aspects, it relates to a high pressure tubing provided with a sealing arrangement adjacent its lower end inserted through the length of the bore of a Christmas tree to seal off the bore and valves of the tree from permanent well completion operations carried out through the tubing.

The invention consists essentially of a tubing whose outside diameter is less than the diameter of the bore of the Christmas tree. This tubing may be a rigid or flexible tubular member constructed of metal or resilient or deformable material. This tubing is fastened or secured at the top to the upper half of a union which normally is the top connection on the Christmas tree and extends through the length of the tree into the production tubing string. The end extending into the tubing string is provided with a sealing means to exclude tubing pressure from the annulus formed between the bore of the tree and the inserted tubing. The top of the inserted by-pass tubing is connected to the top half of the union. The lower half of the union is connected to the top of the tree and the union makes a pressure-tight connection so that fluid pressure applied to the opening in the top half of the union connection will be confined to the bore of the by-pass tubing and the bore of the production tubing. If there is little or no pressure in the well bore or in the production tubing positioned therein, the by-pass tubing is lowered through the bore of the tree and the connecting union then made up. However, if there is substantial pressure in the well bore or production tubing which prevents the by-pass tubing from being lowered, a snubbing device is connected to the by-pass tubing and the tree, and the by-pass tubing is then snubbed or forced into position.

Permanent well completion techniques, such as acidizing, fluid fracturing, sealing tubing leaks, squeeze cementing and other operations requiring high pressure, are carried on through the Christmas tree instead of through squeeze tools set at the completion formation interval. In permanent-type well completion, the tubing and well-head are set in place only once in the life of the well and the completion or remedial work is performed through the tubing. A more complete discussion of permanent well completion and the various techniques employed therewith may be found in "Permanent-Type Well Completion" by T. A. Huber and G. H. Tausch, Journal of Petroleum Technology, vol. 5, page 11, 1953, TP3494. In permanent-type well completion practice, the valves on Christmas trees may be permanently damaged if all cement, acid, sand, etc. which are used in such practice are not flushed out by operating the valves while circulating clear water through the tree and associated valves. Also, the pressures used in permanent-type well practice are substantially in excess of the rated working pressure of the valves on the Christmas tree, although well within the safe-working pressure of the production tubing which begins immediately below the Christmas tree. Our invention makes possible fluid fracturing and squeeze cementing operations using permanent-type well completion techniques and pressures in excess of the rated working pressure of the Christmas tree without the pressure or the pumped fluid coming in contact with the internal working parts or the bore of the valves.

The invention will be further described by reference to the drawings in which:

Fig. 1 is a vertical view of a Christmas tree;

Fig. 2 is a vertical view, partly in section, of the Christmas tree of Fig. 1 with the by-pass tubing in operative position;

Fig. 3 is a fragmentary view of the upper end of the Christmas tree with the by-pass tubing being inserted in the tree by means of a snubbing apparatus;

Fig. 4 is an enlarged vertical sectional view of the tubing and tree union connection; and

Fig. 5 is an enlarged fragmentary sectional view of the lower end of the by-pass tubing and sealing means in operative position in the production tubing.

Referring to the drawings in greater detail.

In Fig. 1 a Christmas tree assembly **10** is shown having a casing head **15**, an adapter flange **17** connected thereto, a master valve **18**, a tree wing **19** and a tree wing valve **20**. A conventional closure connection **8** for closing off the upper end of the bore of the tree is shown at the top of the tree. The tree is provided with horizontally extending arms **43** and a control sealing unit **42**.

In Fig. 2 is shown the Christmas tree assembly with the by-pass tubing **40** in operative position. The Christmas tree assembly **10** is connected to a casing **11** which is cemented as at **12** in borehole **13**. The casing **11** is screw threadedly connected as at **14** to the casing head **15** of the Christmas tree assembly. The production tubing **16** is screw threadedly connected to the adapter flange **17** as at **9**. By-pass tubing **40** extends into production tubing **16** and is provided with a pack-off assembly **41** at its lower end. The full opening type master valve **18** is shown positioned above the adapter flange **17**. The Christmas tree wing **19** with tree wing valve **20** is shown positioned above master valve **18**. Valves **18** and **20** control fluid flow through the center bore of the tree and the bore of the wing, respectively.

A pressure gauge connection **33** may be provided on the tree, shown positioned adjacent tree wing **19** for measuring pressure in the annulus **55** between the by-pass tubing and the bore of the tree.

A control sealing unit **42** may be employed and is shown connected to the tree above the tree wing **19**. This control sealing unit may be of any conventional design and is utilized to seal off the annulus between the bore of the tree **10** and the inserted by-pass tubing **40**. The control sealing unit **42** may be operated in any desired manner, such as hydraulically or manually, and when in closed or operative position by-pass tubing **40** is sealingly slidable therethrough.

Arms **43** are shown positioned above the control sealing unit **42** and securely fixed to the tree **10** by bolts as at **44**. These arms **43** are employed in the snubbing operation which is shown and described more clearly with reference to Fig. 3.

The Christmas tree and by-pass tubing union assembly **32**, shown positioned above arms **43**, is shown and described more fully with reference to Fig. 4.

Fig. 3 shows one type of snubbing arrangement that may be used. The dotted lines indicate a lowered by-pass tubing position as the tubular member **40** is forced through the master valve **18** into the high pressure pro-

duction tubing 16. Arms 43 are provided with pulleys 71 and 72 positioned on axles 45. The supporting structure, such as gin pole 73, has affixed thereto, at the apex, double pulleys 74. Lines or cables 76 and 77 are connected to arms 48 as at 49. Cable 76 passes under pulley 72 and over one of the double pulleys 74. Cable 77 passes under pulley 71 and over the other of the double pulleys 74. Thus, downward force applied to lines 76, 77 will exert a downward force to arms 48 thereby driving the by-pass tubing 40 downwardly through the bore of the tree 10 as clearly shown by the dotted line position of arms 48.

The union assembly 32, shown in greater detail in Fig. 4, comprises an upper half composed of a plain hub 60, the upper portion of which is screw threadedly connected as at 61 to a nipple 47. The lower end of plain hub 60 is screw threadedly connected as at 62 to by-pass tubing 40 and nut 63 is positioned on hub 60. The lower half of the union comprises lug hub 65, the lower end of which is screw threadedly connected as at 66 to a nipple 67 of the Christmas tree. The union is provided with a sealing ring 68 for sealingly engaging the upper and lower hubs 60 and 65, respectively, of the union. Lug hub 65 is provided with threads for making connection to nut 63 such that rotation of nut 63 forcibly brings plain hub 60 into sealing contact with seal ring 68. Lugs or any desired connecting means may be used instead of the threads.

As more clearly seen in Fig. 2, laterally extending arms 48 are secured to nipple 47 by bolts as at 50. These arms are provided with eyes 49 for attaching lines or cables 6 and 7 thereto which are employed for raising and lowering by-pass tubing 40.

A valve 31 may be provided on nipple 47 for sealing off the upper end of the by-pass tubing and for controlling the well completion operations. A nipple 30 for connection with fluid storage for use in the permanent-type well completion operations is connected to valve 31. These fluids may be cement slurries, water, treating agents, and the like.

Referring specifically to Fig. 5, the pack-off assembly 41 shown in expanded or sealing position, preferably comprises an annular backing thimble 35 and a resilient pack-off element 36 made of rubber or other expansible sealing material. An upper anular part 37 of the pack-off member 36 is retained by thimble 35 and an outer lip portion 38 of the pack-off member 36 engages with the wall of the production tubing 16 upon application of fluid pressure upwardly against outer lip 38. A cylindrical retaining sleeve 39 is provided adjacent by-pass tubing 40 and is held upwardly against the upper part 37 of the pack-off member 36 by means of retaining nut 34 screw threadedly connected to the lower end of the by-pass tubing 40.

Operation

In operation, the by-pass tubing 40 is made up to the lower side of plain hub 60 on the upper nut half of the union 32. The upper half of plain hub 60 is made up on nipple 47 to which also valve 31 has been connected and valve 31 is made up to nipple 30. Valve 31 is closed and an upper closure member such as element 8 of Fig. 1 of the tree 10 is removed from the tree.

If there is no pressure on production tubing 16, master valve 18 is opened and the lower end of by-pass tubing 40 is inserted into the bore of the Christmas tree supported by cables 6, 7 connected to arms 48 (Fig. 2). The tubing is then lowered through the length of the bore of the tree 10 into production tubing 16 until the sealing assembly 41 at the lower end of the by-pass tubing 40 is positioned inside production tubing 16. The two halves of union 32 are then made up by securing nut 63 to hub 65. The fluid storage to be used in the well completion operation is then connected to nipple 30 and valve 31 opened. High pressure permanent well completion operations may then be carried out through valve 31 and by-pass tubing 40 without damage to the bore of the tree or the valves on the tree. The high fluid pressure operating through by-pass tubing 40 will exert upwardly against packoff 36 which seals against the wall of production tubing 16 thereby sealing off the annulus between by-pass tubing 40 and production tubing 16.

If there is pressure on production tubing 16, master valve 18 is closed and the upper tree closure member 8 is removed from the tree. The by-pass tubing 40 is then lowered into the bore of the Christmas tree to adjacent master valve 18 by means of cables 6, 7 connected to arms 48 similarly to when the production tubing 16 is not under pressure as described supra.

Control sealing unit 42, if employed, is then closed about by-pass tubing 40. Master valve 18 is then opened and simultaneously therewith force is applied to lines 76, 77 (Fig. 3) which in turn applies a downward force to arms 48 by means of pulleys 71, 72 and 74 thereby driving by-pass tubing 40 into production tubing 16 against the pressure therein. Once by-pass tubing 40 is positioned inside production tubing 16, the pressure within production tubing 16 will exert upwardly against packoff 36 on by-pass tubing 40 and seal off the annulus between production tubing 16 and by-pass tubing 40. The tree and by-pass tubing union assembly 32 are then made up by securing nut 63 to hub 65. The force exerted on lines 76, 77 is maintained until the union connection is made. Nipple 30 is then connected to the well completion fluid storage and valve 31 opened. Permanent-type well completion operations are then carried out through valve 31 and by-pass tubing 40.

In removing the by-pass tubing 40 from the well bore the above steps are reversed; that is, if no pressure is on production tubing 16, the valve 31 is closed and the well completion fluid storage disconnected from nipple 30. Then the union assembly 32 is disconnected by unscrewing nut 63 from hub 65. By-pass tubing 40 is then lifted by means of lines 6, 7 on arms 48 from the well and top closure member 8 is replaced on the tree. If pressure is on production tubing 16, valve 31 is closed and the well completion fluid storage disconnected from nipple 30. Force is applied to cables 76, 77, sealing unit 42 (if used) remains closed and union assembly 32 is disconnected as noted supra. By-pass tubing 40 is then eased upwardly through the bore of the tree by means of the snubbing apparatus by releasing the force applied to cables 76, 77 until the lower end of by-pass tubing 40 is above master valve 18. Master valve 18 is then closed and by-pass tubing 40 and connecting parts lifted from the well by means of lines 6, 7 connected to arms 48. Top closure member 8 is then replaced on the tree.

Any leaks from either end of by-pass tubing 40 may be detected by opening tree wing valve 20 and ascertaining if there is any fluid flow therethrough when pressure is on the bore of by-pass tubing 40. Another means may be employed for determining leaks by closing tree wing valve 20 after charging the annular space 55 with clear fluid through valve 20 and tree wing 19 under a pressure equal to the rated working pressure of the valves. Any pressure build-up in the annulus 55 between the by-pass tubing 40 and the bore of the tree may be detected on pressure gauge 33.

The problem solved by our invention is important since many Christmas trees now in operation have 3,000 pound working pressure while the normal fluid fracturing pressure is 4,800 pounds per square inch. Fluid fracturing is employed to obtain or increase the flow of oil from formations by injecting into the formations aqueous or oily medium fluids containing granular material such as sand or the like at pressures in excess of the break-down pressure of the formations. These fluids fracture or break down the formation sands and the granular material contained in the fluids serve to prop these fractures open thereby permitting freer flow into

the well bore. The operational choices in these instances are to either exceed the working pressure of the tree by more than 50 percent, or plug the tubing and replace the trees with others having a working pressure of 5,000 pounds per square inch. The former choice is dangerous because many of these trees have been used for several years making the trees more prone to structural failure. The latter choice obviously involves a prohibitive expense.

In many other instances there have been known cases where failure to properly flush Christmas tree valves after squeeze cement jobs has caused them to be rendered inoperative, entailing the expense of plugging the tubing and replacing the valves. Our invention eliminates all of these problems and allows safe, economical application of the permanent well completion techniques involving pumped slurries through Christmas trees.

While only one valve, one Christmas tree wing, and one production tubing have been shown and described, this invention is operative with any number of valves, Christmas tree wings, and tubing, the only requirement, of course, being that the by-pass tubing be of lesser diameter than the tubing and tree bore into which it is inserted and extend and seal at least through that part of the bore which it is desired to seal off.

We claim:

1. In a Christmas tree provided with at least one flow conduit therethrough and at least one valve for controlling fluid flow through said flow conduit, apparatus for by-passing said flow conduit and valve comprising a tubing arranged within said flow conduit, packing means sealing off between said tubing and the conduit wall below the valve, means connecting said tubing to said Christmas tree, sealing means sealing off between said tubing and the conduit wall above the valve, and

means including another valve connected to said Christmas tree for controlling fluid flow through said tubing.

2. Apparatus as recited in claim 1 wherein said tubing is flexible.

3. In a Christmas tree provided with at least one flow conduit therethrough and at least one valve for controlling fluid flow through said flow conduit; and a production tubing suspended from said Christmas tree, apparatus for by-passing said valve and flow conduit comprising a tubing extending through said flow conduit into said production tubing, packing means sealing off between said tubing and said production tubing below said valve, sealing means sealing off between said tubing and the conduit wall above said valve, and means including another valve connected to the upper end of said Christmas tree for permitting and preventing fluid flow through said tubing and production tubing, said tubing providing an isolated flow passageway through said Christmas tree.

4. Apparatus as recited in claim 3 wherein said packing means includes a downwardly extending expansible lip portion adapted to expand into sealing engagement with said production tubing upon application of fluid pressure upwardly against said lip.

5. Apparatus as recited in claim 3 wherein said conduit is flexible.

References Cited in the file of this patent

UNITED STATES PATENTS

1,944,573	Raymond et al.	Jan. 23, 1934
1,946,304	Bryant	Feb. 6, 1934
2,673,615	Humason	Mar. 30, 1954

FOREIGN PATENTS

70,001	Netherlands	May 15, 1952