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METHOD OF AND APPARATUS FOR COMPLETING WELLS UNDER PRESSURE

Filed Dec. 7, 1935

3 Sheets-Sheet 1

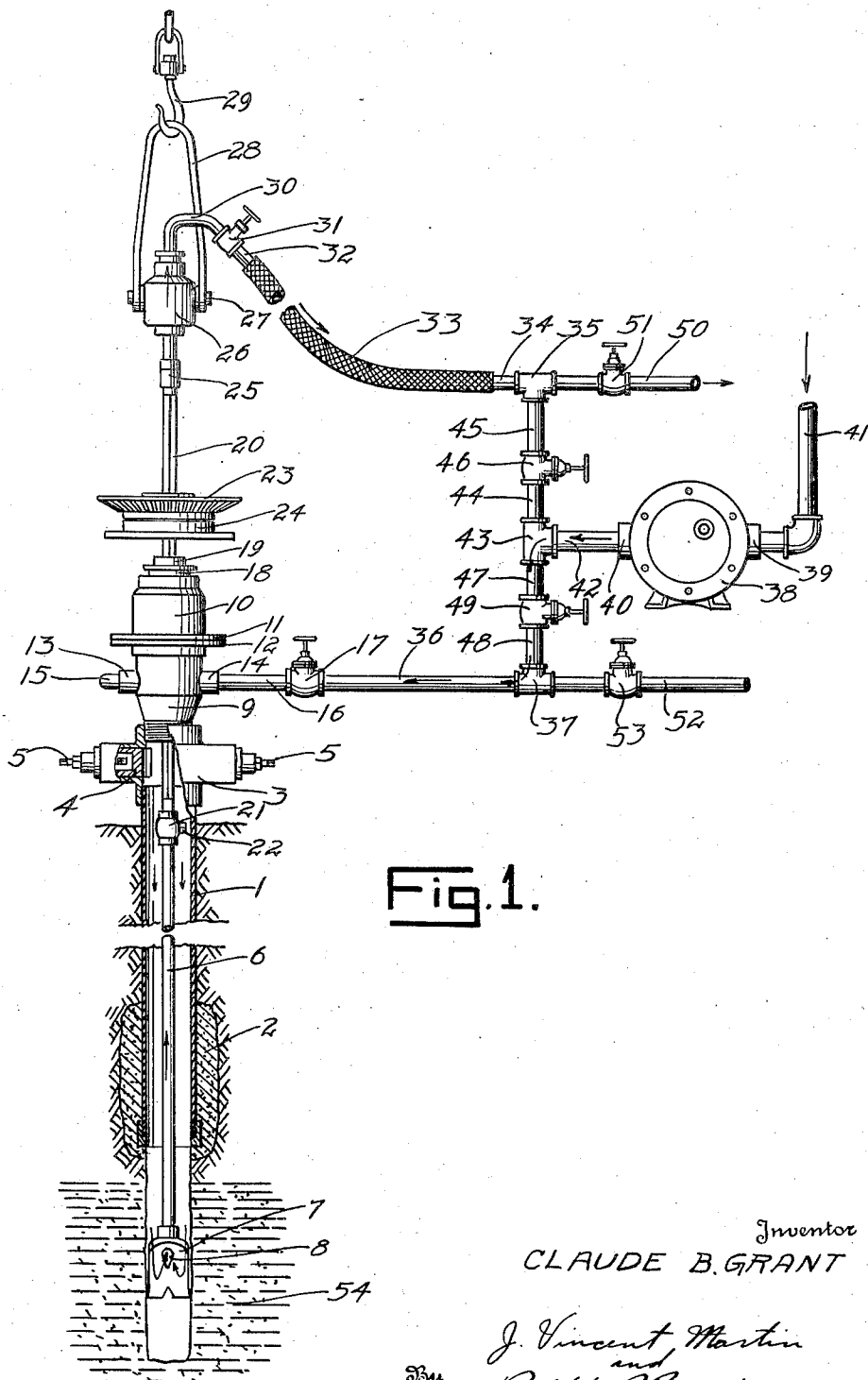


Fig. 1.

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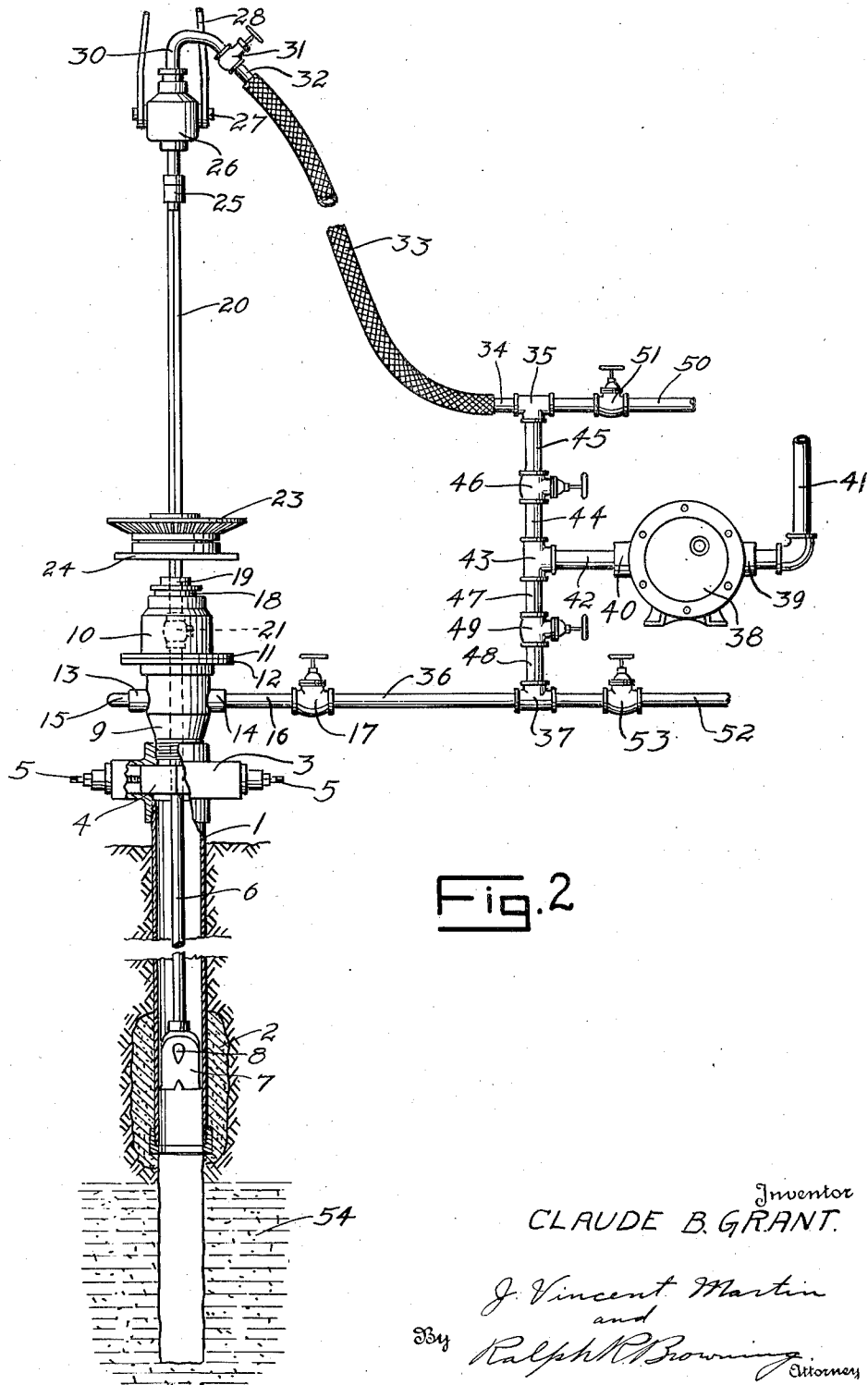
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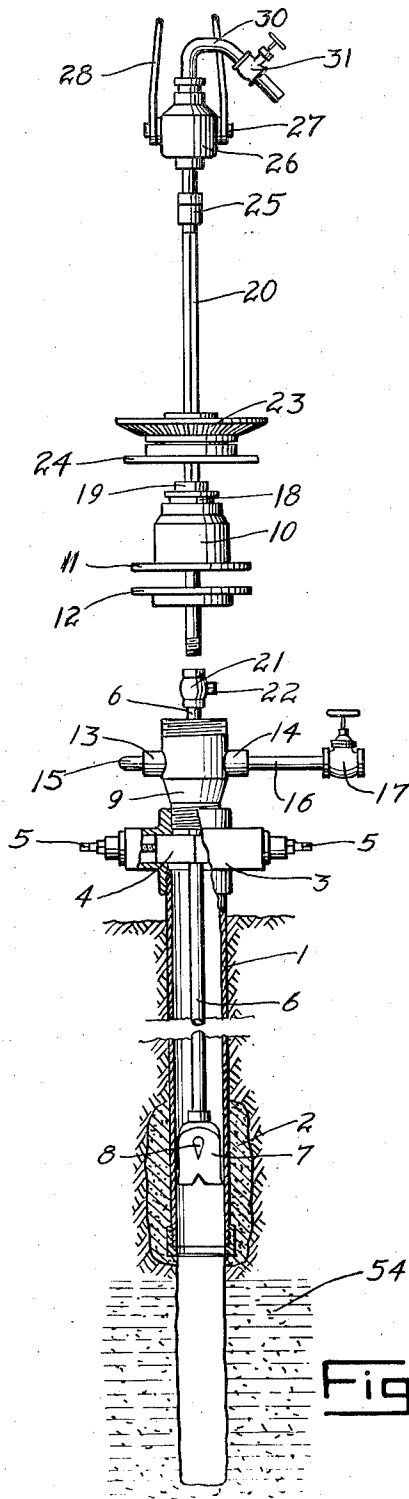


Fig. 3.

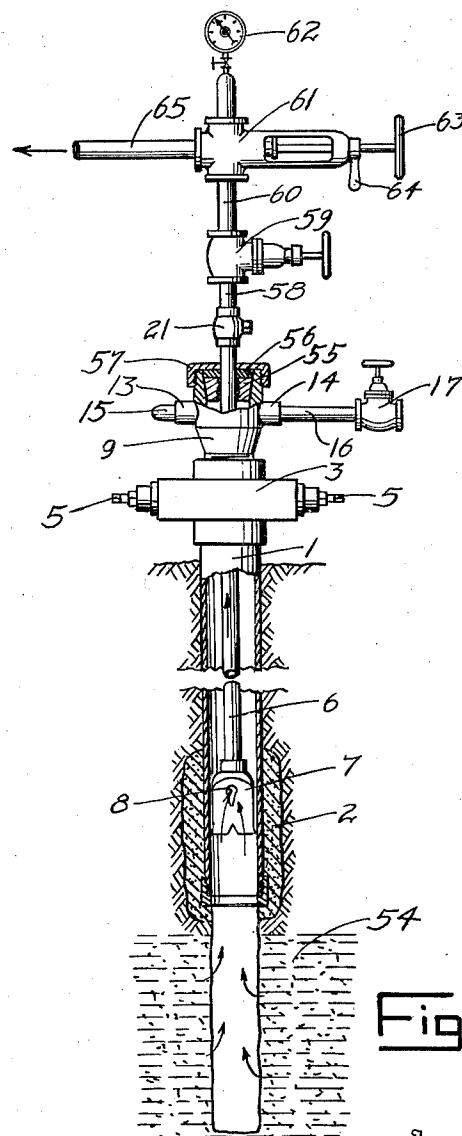


Fig. 4.

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METHOD OF AND APPARATUS FOR COM-
PLETING WELLS UNDER PRESSUREClaude B. Grant, Muskogee, Okla., assignor to
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8 Claims. (Cl. 255—24)

This invention relates in general to wells, and more particularly has reference to a method and apparatus for completing the same.

In the drilling of deep wells for the production of natural gas or oil, natural pressures are frequently encountered in the producing formations which in many instances reach extremely high values. Where any great amount of pressure is encountered, the problem of controlling the pressure becomes paramount because such pressures, if allowed to get out of control, may and sometimes do cause a great deal of trouble, and produce disastrous results. The time at which this pressure becomes most difficult to control is during the removal of the drilling equipment from the well after it has been completed, and the substitution therefor of the so-called Christmas tree or other various connections through which the well is to be flowed.

It has been customary in completing wells of the nature just referred to, to pump into the wells a considerable quantity of mud, or the like, of a greater specific gravity than the material which the well is adapted to produce, such an amount of mud being employed as to overcome the natural pressure within the well, and enable the drilling equipment to be removed and the various connections put in place without the pressure of the well getting out of control.

While the method just described does enable the pressure to be kept under control while making the changes referred to, it is a very uncertain method in that if the pressure of the mud is not sufficient to overbalance and kill the natural pressure in the well, there will be an upward flow when the well is opened. In wells where high pressures are encountered, if the flow begins in an upward direction, the loading pressure due to the mud is rapidly decreased and becomes over-balanced by the natural pressure of the well, in which instance the well may get out of control. Accordingly, it is necessary for the sake of safety to load the well until the natural pressure is definitely over-balanced, and there is a flow in a downward direction which kills the natural pressure. Where this is done and flow does take place in a downward direction, the mud which is employed is forced into the producing formation, and many times impairs the later flow of the well because of clogging of the producing formation. At times, it even clogs this formation to the extent that the well can never be brought back. Valuable wells have been permanently killed in this manner.

It is an object of this invention to provide a

method and apparatus for finishing a well under pressure without loading the well with mud, or otherwise killing it. It is a further object that the pressure of the well may at all times be kept under positive control, both while the well is being finished, and while the drilling equipment is being removed and the flow connections put in place.

With the above and other objects in view, this invention consists in the various parts and combinations, as well as the various steps in the process set forth and claimed hereinafter.

It is to be understood, however, that the following description and accompanying drawings are for the purpose of illustration and example only, and are not to be taken as limiting the scope of this invention. Such limitation is to be only by the prior art, and by the terms of the appended claims.

Referring now to the drawings, in which like numerals indicate corresponding parts throughout:

Fig. 1 is a view illustrating the apparatus for finishing a well at the close of the drilling operation.

Fig. 2 is a view similar to Fig. 1, but illustrating the parts in position for the removal of the drilling equipment.

Fig. 3 is a view illustrating a portion of the apparatus shown in Figs. 1 and 2 after the drilling equipment has been removed from the well.

Fig. 4 is a similar view illustrating the flow connections in place on the well.

Referring more particularly to Fig. 1, there is illustrated a well in which is located the customary casing 1, sealed at its lower end to the surrounding formation by means of cement 2, or the like, and provided at its upper end with a ram type blow-out preventer 3. This blow-out preventer 3 employs a pair of opposed rams 4 actuated by externally operated screw threaded actuators 5, and is of conventional construction. Within the well there is provided a tubing 6 of ordinary construction, on the lower end of which is secured a drill 7 used in finishing a well. The drill 7 is provided with the customary openings 8 so that the fluid may be circulated through the casing and the tubing during the drilling operation, as will be hereinafter set forth.

Above the blow-out preventer 3 there is mounted a casinghead 9, to the upper end of which is secured a bonnet 10 by means of the flanges 11 and 12. The flange 11 is made integral with the bonnet 10, and the flange 12 is detachably secured to the casinghead 9. The casinghead is

provided with lateral openings 13 and 14, respectively, the opening 13 in this instance being plugged as at 15, and the opening 14 being provided with a nipple 16 carrying a valve 17.

The bonnet 10 is provided at its upper end with a pair of packings 18 and 19, the packing 18 being adapted for rotative movement with respect to the bonnet 10, and the packing 19 being adapted to form a slidable seal with a drill rod 20. The drill rod 20 is secured to the upper end of a stopcock 21 mounted on the upper end of the tubing 6. The stopcock 21 is actuated by some means such as illustrated at 22, and is of such a size as to freely pass through the casing 1, the blow-out preventer 3, and the casinghead 9.

For the purpose of rotating the drill rod 20 and the tubing and drill secured thereto, there is provided the customary rotary 23 mounted on the support 24. The details of this mechanism are not illustrated, because they form no part of this invention per se, and are of conventional construction.

During the drilling operation the tubing, the drill and the drill rod are connected by means of a coupling 25 to a swivel 26, which is in turn pivotally supported at 27 by a yoke 28 and a hook 29. Leading from the swivel 26 is a connection 30 through which fluid is adapted to pass in circulating through the tubing and drill rod. To the opposite end of the connection 30 is secured the valve 31 and the pipe 32. Pipe 32 in turn receives the flexible hose 33, and is connected by the short pipe 34 to a T-coupling 35.

A pipe 36 is connected to the valve 17, and at its opposite end to the T-coupling 37. For the purpose of circulating fluid during the drilling operation there is provided a pump 38 having an inlet 39 and an outlet 40. The inlet 39 is connected by pipe 41 to a reservoir or tank containing the circulating fluid, and the outlet 40 is connected by pipe 42 to the T-coupling 43. The T-coupling 43 is connected by nipples 44 at 45 to the T-coupling 35, the valve 46 being interposed between the nipples 44 and 45. Likewise, the T-coupling 43 is connected by means of nipples 47 and 48 to the T-coupling 37, the valve 49 being interposed therebetween. For the purpose of returning the circulating fluid to the reservoir or tank just referred to, the T-coupling 35 is connected by a pipe 50 to such tank, and the flow through this pipe is regulated by the valves 51. In like manner, the T-coupling 37 is connected through the pipe 52 to the same tank, and the flow through the pipe 52 is controlled by the valve 53. It will be seen that the apparatus just described provides for the circulation of fluid by the pump 38 in either direction during the drilling operation.

In completing a well in accordance with this invention the apparatus is set up as illustrated in Fig. 1, and the drilling into the producing formation 54 proceeds in the ordinary manner until the well is completed. During this drilling operation the blow-out preventer 3 is in open position as is also the stopcock 21. It is preferred that the circulation of fluid during this drilling operation be downward through the casing in the direction of the arrows, and upward through the tubing and drill rod, although it is contemplated that it may be in the opposite direction if preferred.

Upon the completion of the drilling, the circulation is stopped, the tubing 6 is drawn up until the stopcock 21 is in the position illustrated in Fig. 2, the rams 4 of the blow-out preventer

3 are closed about the tubing 6, and the valves 31 and 17 are closed. The pump 38 and associated equipment may now be removed with the valve 31 holding the pressure in the tubing, and the blow-out preventer 3 holding the pressure in the casing. The bonnet 10 is then removed, together with the removable flange 12. The stopcock 21 is then accessible and may be closed, thus holding the pressure within the tubing. Slips 55 placed within the casinghead 9 will serve to support the tubing 6 in this position, and packing 56 placed over these slips may be held in position by means of a cap 57 or the like as shown more in detail in Fig. 4. The drill rod 20 may then be removed, together with the remainder of the drilling equipment, and suitable connections, such as the nipple 58 and the valve 59, may be made with the upper end of the stopcock 21. Since the tubing pressure may now be controlled by the valve 59, the stopcock 21 may be opened and remain so thereafter. There are shown connected with the valve 59, a nipple 60 and a choke 61 carrying a pressure indicator 62 and means at 63 for controlling and at 64 for locking the choke. Any suitable line 65 may be connected to the choke for conveying away the flow from the well. Likewise, any desired connections may be made to the interior of the casing through the valve 17, and the blow-out preventer 3 may at any time desired be opened for the purpose of permitting flow through the casing in either direction.

It will readily be perceived that there has by the foregoing apparatus and process been set forth an invention which accomplishes the objects set forth, and which enables the finishing of a well without necessity for killing the same, and without at any time permitting the well pressure to get out of control. Although the parts employed are for the most part of conventional construction in themselves, they are in accordance with this invention combined in a novel manner to provide for the practicing of the process set forth. It will be understood, however, that this process is not limited in its practice to the particular apparatus disclosed, it being quite conceivable that other apparatus capable of functioning in a similar manner might be employed in the process. The present apparatus, however, is highly desirable for use in connection with the present process, and is such as to make it possible to carry out the process in a highly efficient and practical manner.

I claim:

1. The process of completing a well having a casing comprising lowering into said well a tubing having a rotary drilling tool on the lower end thereof, securing to the upper end of said tubing means for rotating the same, closing said casing about said means with a rotatable and slidable sealing connection therewith, rotating said tubing and tool while circulating washing fluid downwardly through said casing and upwardly through said tubing until the well is completed to remove the debris displaced by the drilling tool, drawing the tubing and tool upwardly upon completion of the drilling operation until the connection between the tubing and said means for rotating the tubing is just below the point at which the casing was closed about said means, closing the casing about said tubing just below said connection, opening the casing above said connection, closing the tubing adjacent said connection, removing the means for rotating the tubing, connecting 75

flow lines to the tubing, and opening the tubing to flow the well.

2. The process of completing a well having a casing comprising lowering into said well a tubing having a rotary drilling tool on the lower end thereof, securing to the upper end of said tubing means for rotating the same, closing said casing about said means with a rotatable and slidable sealing connection therewith, rotating said tubing and tool while circulating washing fluid therethrough until the well is completed, drawing the tubing and tool upwardly upon completion of the drilling operation until the connection between the tubing and said means for rotating the tubing is just below the point at which the casing was closed about said means, closing the casing about said tubing just below said connection, opening the casing above said connection, closing the tubing adjacent said connection, removing the means for rotating the tubing connecting flow lines to the tubing, and opening the tubing to flow the well.

3. In combination with a well having a casing, a ram-type blow-out preventer adjacent the top of said casing, a casing head on said casing, a tubing in said well of a size to receive the rams of said preventer, a drill on the lower end of said tubing, a cock on the upper end of said tubing, a drill rod connected at its lower end to said cock, a bonnet surrounding said drill rod and secured to said casing head to close the same, a valve at the upper end of said drill rod, a second valve adjacent to and connected to said casing head and means connected to said first valve and to the interior of said casing above said preventer through said second valve for circulating fluid through said tubing and casing.

4. The process of completing a well having a casing comprising lowering into said well a tubing having a rotary drilling tool on the lower end thereof, forming a seal between said tubing and said casing, rotating said tubing and tool while circulating washing fluid therethrough to remove debris displaced by the drilling tool until the well is completed, drawing said tubing upwardly to position the bottom thereof at the desired level for flowing the well while maintaining said seal, closing the tubing adjacent said seal, removing all connections from said tubing above the point of said closure, connecting flow lines to the tubing and opening the tubing to flow the well.

5. The process of completing a well having a casing comprising lowering into said well a tubing having a rotary drilling tool on the lower end thereof, closing said casing about said tubing with a rotatable and slidable sealing connection, rotating said tubing and said tool while circulating washing fluid therethrough to remove the debris displaced by the drilling tool until the well is completed, drawing said tubing upwardly to position the lower end thereof at the desired level for flowing the well while maintaining said seal, forming a seal between the casing and tubing below said first mentioned seal, removing said first mentioned seal, closing the tubing adjacent the position occupied by said first mentioned seal, removing all connections from said tubing above

the point of said closure, connecting flow lines to the tubing, and opening the tubing to flow the well.

6. The process of completing a well having a casing comprising lowering into said well a tubing having a rotary drilling tool on the lower end thereof, closing said casing about said tubing with a rotatable and slidable sealing connection, rotating said tubing and said tool while circulating washing fluid therethrough to remove the debris displaced by the drilling tool until the well is completed, drawing said tubing upwardly to position the lower end thereof at the desired level for flowing the well while maintaining said seal, forming a seal between the casing and tubing below said first mentioned seal, removing said first mentioned seal, closing the tubing adjacent the position occupied by said first mentioned seal, forming a permanent seal between said casing and tubing, and handing said tubing above said temporary seal, removing all connections from said tubing above the point of said closure, connecting flow lines to the tubing, and opening the tubing to flow the well.

7. The process of completing a well having a casing with lateral flow lines communicating therewith comprising lowering into said well a tubing having a rotary drilling tool on the lower end thereof, closing said casing about said tubing above said flow line with a rotatable and slidable sealing connection, rotating said tubing and said tool while circulating washing fluid therethrough by means of said flow line and said tubing to remove the debris displaced by the drilling tool until the well is completed, drawing said tubing upwardly to position the lower end thereof at the desired level for flowing the well while maintaining said seal, forming a seal between the casing and tubing below said flow line, removing said first mentioned seal, closing the tubing adjacent the position occupied by said first mentioned seal, forming a permanent seal between said casing and tubing above said flow line and hanging said tubing, removing all connections from the tubing above the point of said closure, connecting flow lines to the tubing and selectively opening the tubing and the space between the tubing and the casing below the casing flow line as desired to flow the well.

8. In a drilling apparatus the combination of a well casing, a drill tubing rotatable therein and having a fluid tight fit with the upper end thereof, a pump, a connecting pipe between said pump and said casing, a second connecting pipe between said drill tubing and said pump, a valve controlled outlet in each of said pipes, a further valve adjacent said drill tubing and in the pipe between said drill tubing and said pump and a second further valve adjacent to and connected to said casing in the pipe between said pump and said casing whereby fluid may be circulated from said pump through said drill tubing in either direction but when said further valves are closed and said connecting pipes and pump are disconnected from said drilling apparatus, said casing and said tubing will not communicate with the atmosphere.

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