March 9, 1954 M. O. JOHNSTON 2,671,509

WELL TESTING APPARATUS

Filed Aug. 28, 1951 2 Sheets-Sheet 1

FIG. 1

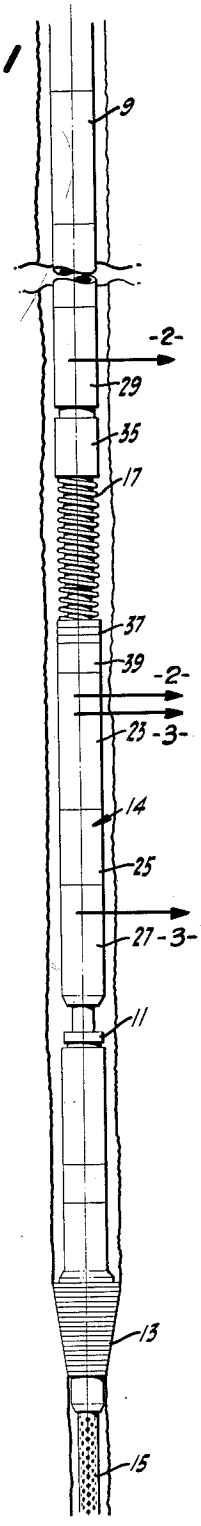
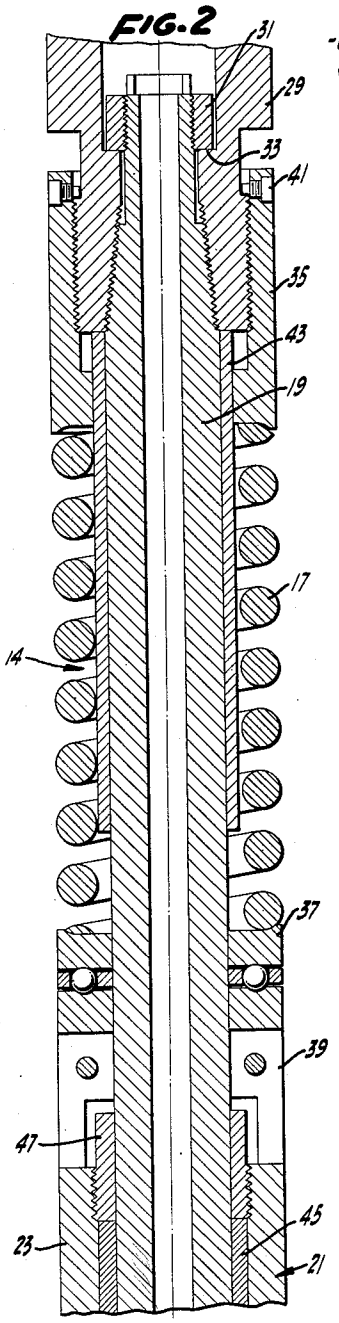


FIG. 2



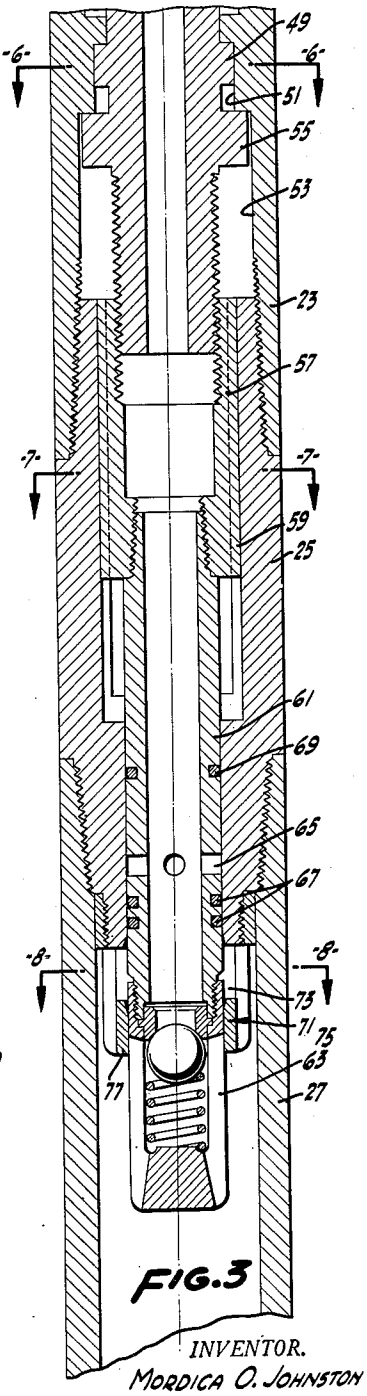


FIG. 3

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WELL TESTING APPARATUS

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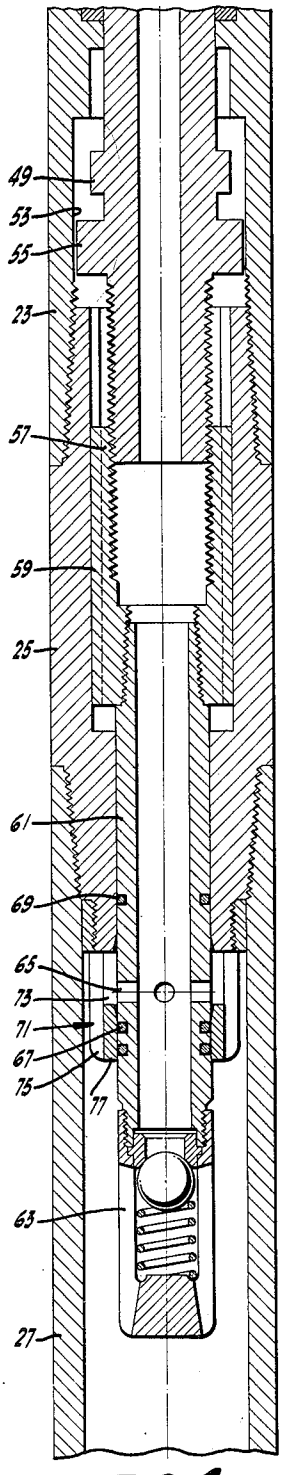


FIG. 4

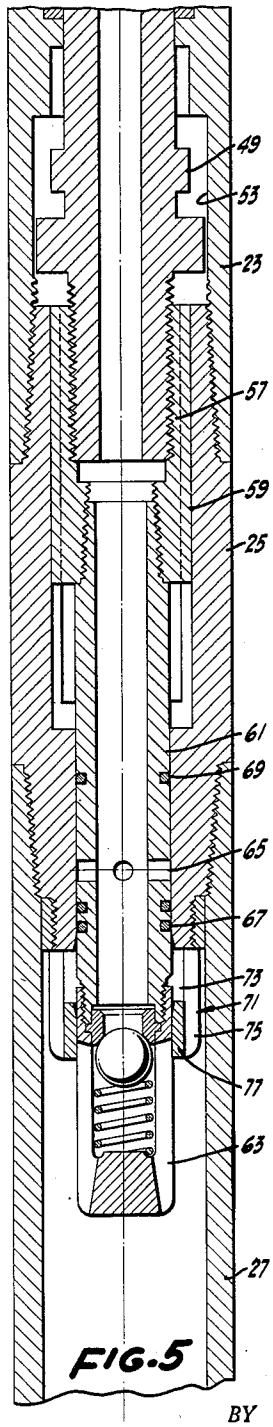


FIG. 5

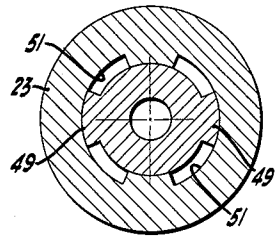


FIG. 6

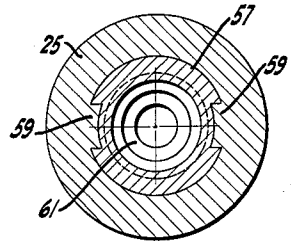


FIG. 7

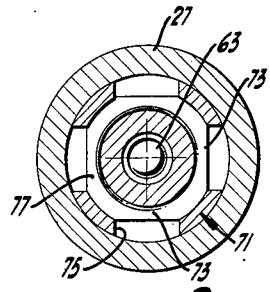


FIG. 8

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2,671,509

WELL TESTING APPARATUS

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Application August 28, 1951, Serial No. 244,079

3 Claims. (Cl. 166—1)

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This invention relates to an oil well tool and particularly to an oil well tool adapted to be incorporated in a formation tester or similar device.

Although the present invention will be described in connection with a formation tester, the invention is not intended to be limited to such use, the particular description being given to disclose a practical application of the present invention.

In making formation tests, it is usual practice to lower a formation tester into the well and seal off or block off the well bore or casing so as to separate the lower testing zone from the upper well fluid. It is also usual practice to thereafter open the formation tester to the formation fluid and take a test of the connate or formation fluid by trapping a body of this fluid within the formation tester. Normally, the interior of the formation tester is at approximately atmospheric pressure, whereas the pressure in the formation zone is normally very high and, therefore, the formation fluid obviously jets into the formation tester at an extremely high velocity. Also, it is frequently desired to make a shut-in test after the connate sample has been obtained by closing the formation tool and shutting in the formation fluid below the packer. A suitable recorder disposed below the packer then records the pressure of the formation fluid.

A main object of the present invention is to provide a new and improved oil well tool by which the above or similar operations can be carried out.

It is common practice and construction in formation testers now on the market to open a retaining valve in the formation tester by partially telescoping the formation tester while compressing a strong spring which urges the telescoped parts of the tester to extended position. It is also desirable to be able to make a shut-in test with a part of the weight of the drill string imposed on the packer to maintain the packer securely in position. This means that the retaining valve will normally be open at the time it is desired to make a shut-in test.

Another object of the present invention is to provide an oil well tool similar in construction to the construction of the oil well tool above described in the immediately above paragraph in which a shut-in test can be effected while maintaining the weight of the drill string on the packer and therefore compressing the strong spring previously identified, by providing means for moving the retaining valve upwardly independently of the operation of the compression spring to close the retaining valve and therefore to dispose the parts of the formation tester in position for a shut-in test.

A more particular object of the present invention is to provide an oil well tool having a tubular housing slidably receiving a tubular mandrel therein and having a large bore into which the lower end of the tubular mandrel is adapted to be projected, which mandrel is laterally ported adjacent its lower end and provided with packing means below the ports, and which tool has means disposed within the large bore for protecting the packing means against the eroding effect of the high velocity fluid jetting into the tubular mandrel through the ports.

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Various other objects will be apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 shows a formation tester having the novel tool of the present invention incorporated therein.

Fig. 2 is an enlarged longitudinal central section through the upper part of the tool of the present invention, being taken generally along line 2—2 of Fig. 1.

Fig. 3 is an enlarged longitudinal central section through the lower portion of the tool disclosed in Fig. 1, Fig. 3 being taken along line 3—3 of Fig. 1.

Fig. 4 is a view similar to Fig. 3 but showing the tubular mandrel therein being moved downwardly to expose the ports thereof.

Fig. 5 is a view similar to Fig. 3 but showing the ports as having been moved upwardly into the confines of the walls of the small bore.

Fig. 6 is a horizontal section taken along line 6—6 of Fig. 3 showing the manner of keying the upper tubular mandrel to the housing.

Fig. 7 is a horizontal section taken along line 7—7 of Fig. 3, showing the manner of keying the traveling nut to the housing.

Fig. 8 is a horizontal sectional view taken along line 8—8 of Fig. 3, the view being taken through the cage which protects the exposed packing on the lower tubular mandrel.

Referring to the accompanying drawings, wherein similar reference characters designate similar parts throughout, Fig. 1 discloses a formation tester of the type disclosed in the patent to M. O. Johnston 2,073,107, granted March 9, 1937 the formation tester disclosed in Fig. 1 differing in the respects to be named hereinafter.

The formation tester disclosed in Fig. 1 is similar to the formation tester disclosed in said patent in that the formation tester in Fig. 1 includes a trip valve 9 at its upper end adapted to be opened by a go-devil dropped down the drill string, an equalizing valve 11 disposed below the trip valve 9 and adapted to be closed when a packer 13 is set, there being a perforated anchor 15 below the packer, and below the anchor there is a pressure recorder (not shown). In the formation tester disclosed in the above mentioned patent, between the trip valve and the equalizing valve, there is a retaining valve which is opened

by a partial telescoping of the upper part of the formation tester into the lower part thereof against the resistance of a strong compression spring adapted to return the parts of the tool to a position closing the retaining valve after a fluid sample has been taken and when the weight of the drill string is relieved.

The present invention includes a strong compression spring 17 operable to normally close a retaining valve, generally entitled 14 which while being somewhat similar in functioning to the retaining valve disclosed in said patent, is specifically different, as will be apparent from the following description.

Figs. 2 and 3 show a tool embodying the concepts of the present invention and including an upper tubular mandrel 19 slidably extending into a composite tubular housing generally entitled 21 and composed of an upper sub 23, a lower sub 25 and a tubular drill section 27, all suitably threadedly connected together as shown.

Adjacent its upper end, upper tubular mandrel 19 is threadedly connected to a connecting sub 29, and at its upper end threadedly receives a nut 31 threaded into engagement with a shoulder 33 formed on connecting sub 29. The strong compression spring 17 previously mentioned surrounds upper tubular mandrel 19, and at its upper end engages an adjustment collar 35 threadedly engaging the exterior of the lower end of connecting sub 29. At its lower end compression spring 17 rests on and bears against a thrust bearing 37 which rests on a split ring 39 which bears against the upper end of upper sub 23. Set screws 41 are provided in adjustment collar 35 for holding the collar 35 in any position of adjustment. A spacer sleeve 43 may be provided and surrounds tubular mandrel 19 and serves to laterally support strong compression spring 17.

Sealingly engaging upper tubular mandrel 19 adjacent its lower end is packing 45 which is retained in place by a packing gland 47 threadedly received by the upper end of sub 23. Also adjacent its lower end, upper tubular mandrel 19 is provided with keys 49 slidable within keyways 51 formed in upper sub 23, said keys being adapted to be moved within an enlarged bore 53 in upper sub 23 to clear the keyways and thereby permit relative rotative movement between top mandrel 19 and upper sub 23, and therefore composite tubular housing 21. Upper tubular mandrel 19 preferably has a flange 55 formed adjacent its lower end below keys 49 for abutting against the shoulder of upper sub 23 defining the upper end of large bore 53 and limiting upward movement of mandrel 19 relative to sub 23.

At its lower end, upper tubular mandrel 19 threadedly engages a traveling nut 57 which is slidably but non-rotatably received within lower sub 25 by a key and keyway connection generally entitled 59. At its lower end, traveling nut 57 has fixedly threadedly secured thereto a lower tubular mandrel 61 which is slidably received through a small bore formed in the lower end of lower sub 25. The lower end of lower tubular mandrel 61 is closed by a downwardly opening spring-loaded circulation valve 63.

Adjacent its lower end, lower tubular mandrel 61 is laterally ported at 65 to allow formation fluid to enter the lower tubular mandrel when the ports 65 are exposed, as shown by the position of the parts in Fig. 4. Below ports 65, lower tubular mandrel 61 carries a pair of O rings 67 in annular grooves, and above ports 65 carries a single O ring 69 in an annular groove, said O rings being in sealing engagement with the lower end of lower sub 25 when the parts are in the position as shown in Fig. 3. The upper O ring 69 is adapted to constantly sealingly engage the lower end of lower sub 25 (compare Figs. 3, 4 and 5).

The ported portion of lower tubular mandrel 61 is adapted to be projected from within the confines of lower sub 25 by a downward movement of upper tubular mandrel 19 upon lowering of the drill string after the tester is set in the well bore, strong compression spring 17 being compressed during such movement. The position of the parts will then be as depicted in Fig. 4, with the keys 49 out of the keyways 51 and the ports 65 exposed below the lower end of lower sub 25. As previously mentioned, the interior of the drill string and formation tester will normally be at a relatively low pressure, approximately atmospheric pressure, whereas the formation fluid below the packer 13 will be at a relatively high pressure. The fluid therefore jets at high velocity into the lower tubular mandrel and formation tester through the ports 65, said fluid having a high eroding effect.

To protect O rings 67 from this high velocity fluid, a sleeve-type cage 71 is provided and threadedly engages at its upper end the lower end of lower sub 25. Cage 71 is laterally ported at 73 and grooved at 75 (compare Figs. 5 and 8) to allow formation fluid to flow upwardly through the grooves 75 into ports 73, through ports 65 and into the lower tubular mandrel. As shown in Fig. 8, the external diameter of cage 71 is substantially the same as the interior diameter of tubular drill section 27 and therefore the cage is slidably received within the tubular drill section 27. The above construction of cage 71 therefore leaves a sleeve or collar portion 77 supported in depending relationship with respect to the lower end of lower sub 25. As clearly shown in Fig. 4, when the upper tubular mandrel 19 is lowered relative to the composite housing 21, O rings 67 are disposed within the confines of sleeve portion 77 and therefore protected from the eroding effect of the high velocity fluid jetting into lower tubular mandrel 61. It follows that when the packing is once again disposed within the small bore of sub 25 that the undamaged packing will be effective to prevent leakage of formation fluid out of lower mandrel 61 and also prevent well fluid from entering the lower mandrel and contaminating the trapped formation fluid.

As previously mentioned, it is desirable in many instances to make a shut-in test after a suitable sample has been trapped within the formation tester and drill string, and it is also not only desirable but necessary to have packer 13 firmly held in place during the shut-in test. For all practical purposes, this means that the strong compression spring 17 must be held under compression by the weight of the drill string thereabove. By the present invention, the spring 17 can remain under compression and yet the ported portion of the lower tubular mandrel can be retracted within the confines of the small bore of lower sub 25 to cover the ports 65 and therefore shut in the formation fluid below ports 65 to enable a suitable shut-in test to be made. This upward movement of lower tubular mandrel 61, independently of spring 17, is possible by rotating the drill string to the right and therefore rotating tubular mandrel 19 to draw up

traveling nut 57 and therefore retract lower tubular mandrel 61. The pressure recorder, which has been previously mentioned and is not shown but is disposed below anchor 19, then makes a suitable record of the formation pressure in shut-in condition.

By the present invention, an oil well tool has been provided which permits the opening of a formation tester to the formation fluid to make a test of the formation fluid and then allows the formation zone to be closed in, all the while maintaining the packer tightly in place. Furthermore, the present invention provides a tool in which a ported portion of a tubular mandrel can be projected into an enlarged bore to expose the ports, which tubular mandrel carries packing below the ports, which packing is adapted to be protected, when the tubular mandrel is projected, from the eroding effect of the high velocity fluid jetting into the tubular mandrel.

While I have shown the preferred form of my invention, it is to be understood that various changes may be made in its construction by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. An oil well tool, comprising a tubular housing adapted to be fixed in a well bore and having an upper small bore and a lower large bore formed one above the other in the housing, a lower tubular mandrel slidably received within the small bore and being laterally ported adjacent its lower end and being normally disposed in a position with the ported portion thereof disposed within the small bore, packing on the lower tubular mandrel below the ports and normally disposed within the small bore and sealingly engaging the walls thereof, an upper mandrel telescopically received within the upper end of the housing, spring means urging the housing and upper mandrel apart, a nut on the upper end of the lower mandrel slidably keyed to the housing and threadedly engaging screw threads formed on the lower end of the upper mandrel, whereby the ported portion of the lower mandrel can be projected into the large bore by forcing the upper mandrel downwardly relative to the housing against the resistance of the spring means, and thereafter the ported portion may be retracted to within the small bore with the spring means remaining compressed by rotating the upper mandrel to thread the same into the nut to draw the nut and lower mandrel upwardly, and means for protecting the packing when exposed against the eroding effects of high velocity fluid jetting into the lower mandrel through the ports therein.

2. An oil well tool, comprising a tubular housing adapted to be fixed in a well bore and having an upper small bore and a lower large bore formed one above the other therewithin, a lower tubular mandrel slidably received within the small bore and being laterally ported adjacent its lower end and being normally disposed in a position with the ported portion thereof disposed within the small bore, packing on the lower tubular mandrel below the ports and normally disposed within the small bore and sealingly engaging the walls thereof, an upper mandrel telescopically received within the upper end of the housing, spring means urging the housing and upper mandrel apart, a nut on the upper end of the lower mandrel slidably keyed to the housing and threadedly engaging screw threads formed on the lower end of the upper mandrel, whereby the ported portion of the lower mandrel can be projected into the large bore by forcing the upper mandrel downwardly relative to the housing against the resistance of the spring means, and thereafter the ported portion may be retracted within the small bore, with the spring means remaining compressed, by rotating the upper mandrel so as to thread the same into the nut to draw the nut and lower mandrel upwardly, and means for protecting the packing, when exposed, against the eroding effects of high velocity fluid jetting into the lower mandrel through the ports therein, the last-named means comprising a sleeve-type laterally ported cage carried by the housing and slidably receiving the lower end of the lower mandrel and being spaced from the walls of the large bore of the housing to provide space for the passage of fluid from below the cage upwardly to the ports of the cage.

3. An oil well tool, comprising a tubular housing adapted to be fixed in a well bore and having an upper small bore and a lower large bore formed one above the other therewithin, a lower tubular mandrel slidably received within the small bore and being laterally ported adjacent its lower end and being normally disposed in a position with the ported portion thereof disposed within the small bore, packing on the lower tubular mandrel below the ports and normally disposed within the small bore and sealingly engaging the walls thereof, an upper mandrel telescopically received within the upper end of the housing, spring means urging the housing and upper mandrel apart, a nut on the upper end of the lower mandrel slidably keyed to the housing and threadedly engaging screw threads formed on the lower end of the upper mandrel, whereby the ported portion of the lower mandrel can be projected into the large bore by forcing the upper mandrel downwardly relative to the housing against the resistance of the spring means, and thereafter the ported portion may be retracted within the small bore, with the spring means remaining compressed, by rotating the upper mandrel so as to thread the same into the nut to draw the nut and lower mandrel upwardly, and means for protecting the packing, when exposed, against the eroding effects of high velocity fluid jetting into the lower mandrel through the ports therein, the last-named means comprising a sleeve-type laterally ported cage carried by the housing within the large bore and slidably receiving the lower end of the lower mandred, said cage having grooves formed in the exterior thereof extending from the ports therein downwardly to the lower end thereof to provide passages for the passage of fluid from the lower end of the cage to the cage ports.

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