Aug. 25, 1959 B. P. NUTTER 2,901,001

HYDRAULIC TESTER AND SHUT-IN PRESSURE TOOL

Filed March 18, 1955 3 Sheets-Sheet 1

FIG_1

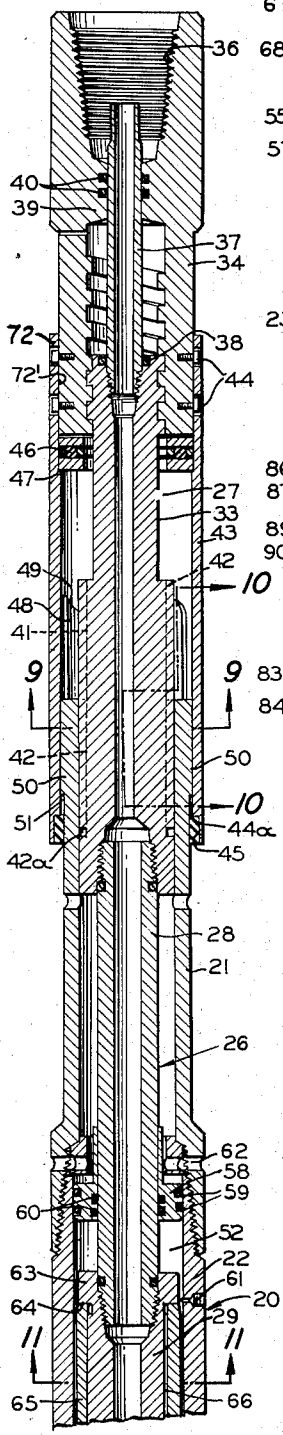


FIG_2

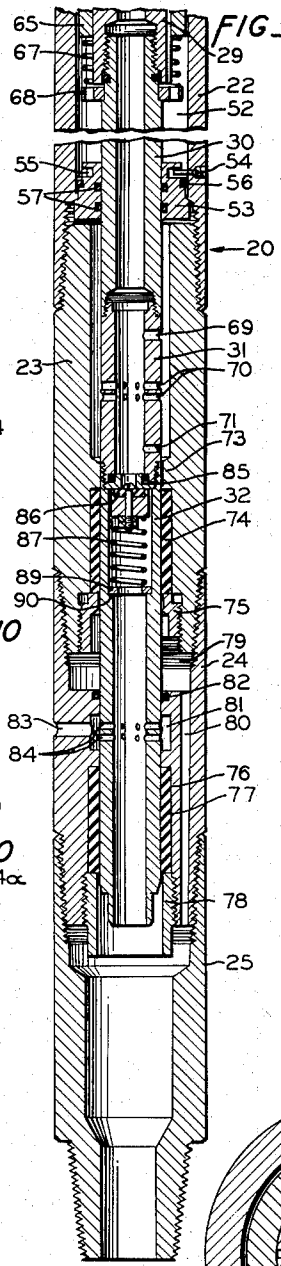


FIG_9

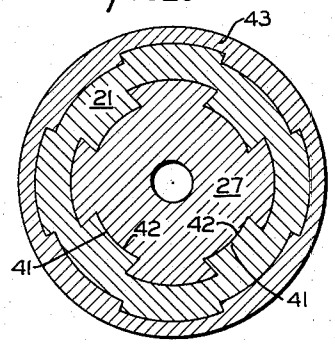


FIG_10

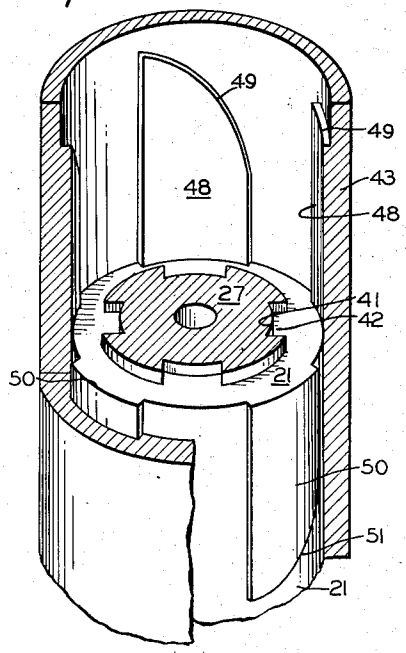
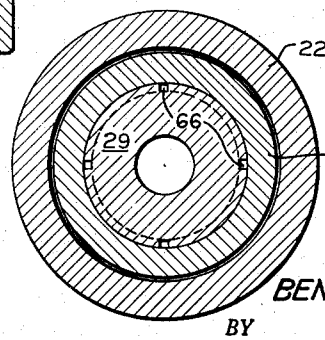


FIG_11



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HYDRAULIC TESTER AND SHUT-IN PRESSURE TOOL

Filed March 18, 1955 3 Sheets-Sheet 2

FIG_3

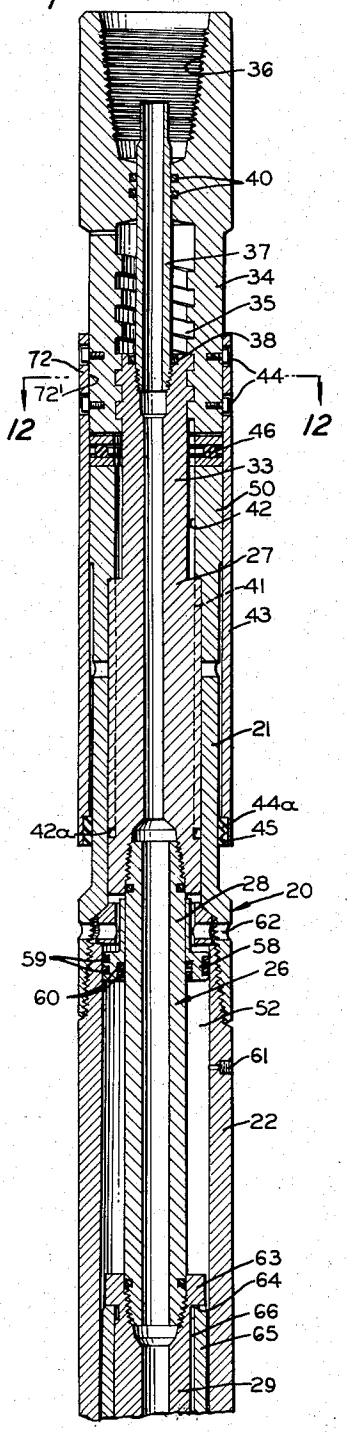


FIG_4

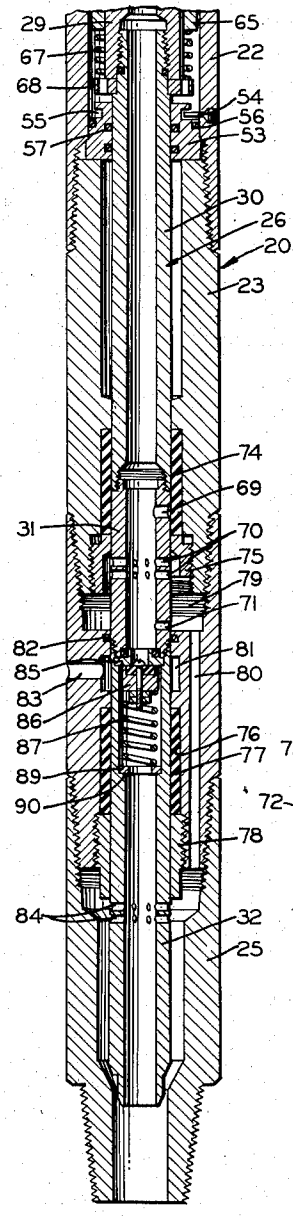
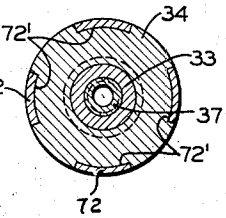


FIG_12



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HYDRAULIC TESTER AND SHUT-IN PRESSURE TOOL

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FIG_5

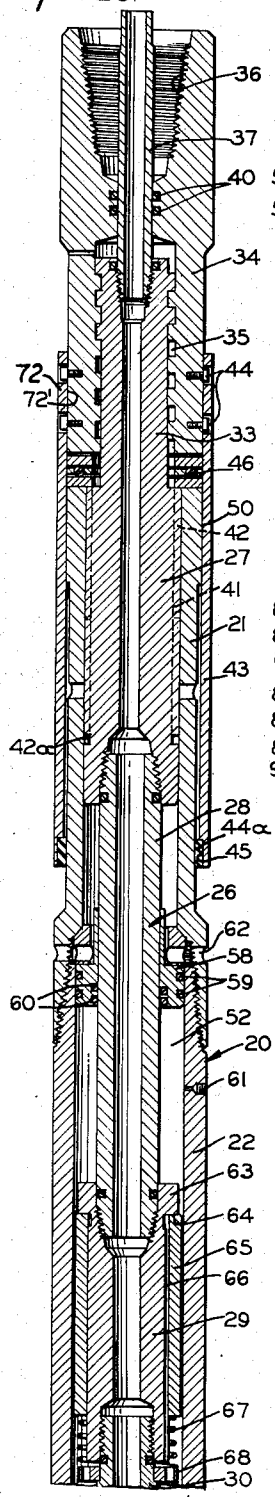


FIG_6

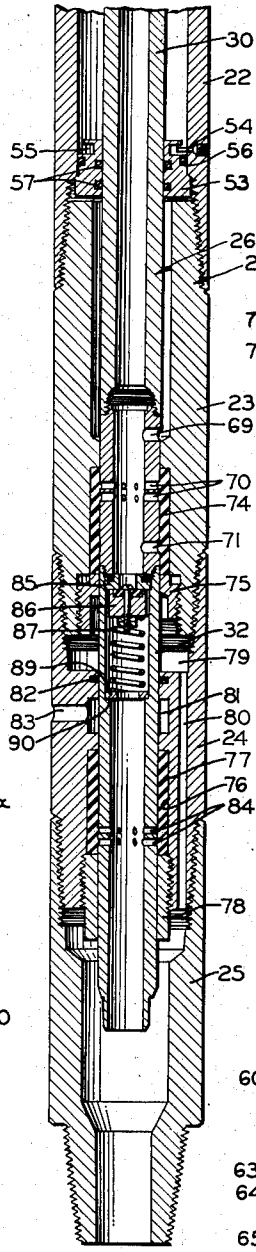


FIG_7

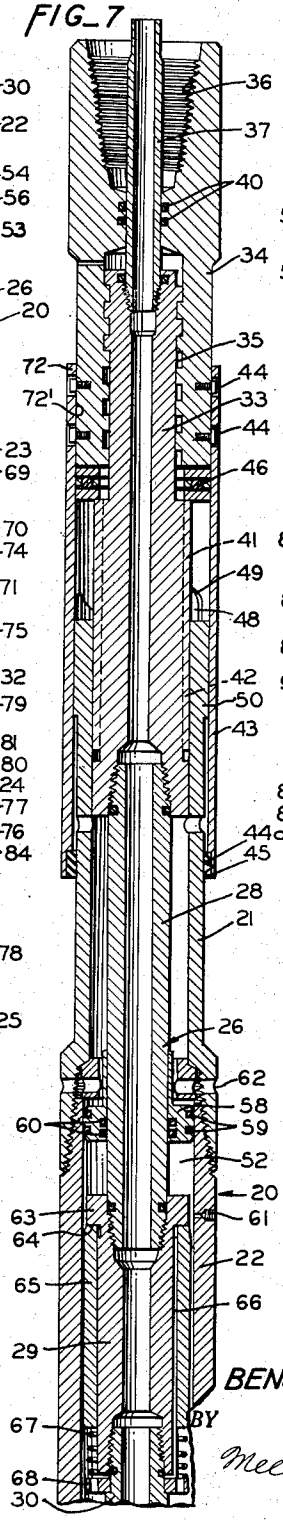
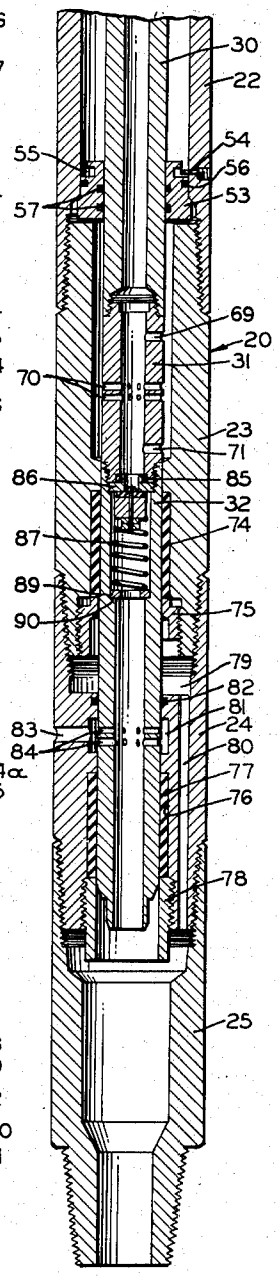


FIG_8



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United States Patent Office 2,901,001
Patented Aug. 25, 1959

2,901,001

HYDRAULIC TESTER AND SHUT-IN PRESSURE TOOL

Benjamin P. Nutter, Houston, Tex., assignor, by mesne assignments, to Johnston Testers, Inc., Houston, Tex., a corporation of Texas

Application March 18, 1955, Serial No. 495,247

16 Claims. (Cl. 137—599.2)

This invention relates to a hydraulic tester. More particularly, the invention relates to a hydraulic tester incorporating a sample taking mechanism and a shut-off valve to permit the measurement of the shut-in pressure as well as the flow pressure.

It is the principal object of this invention to provide a combined hydraulic tester and shut-in pressure valve.

Another object of the invention is to provide a hydraulic tester and shut-in pressure valve wherein the various elements may be operated from the surface by manipulation of the well string.

A further object of this invention is to provide a hydraulic tester adapted to be connected to the upper end of a well packer, wherein the tester valve may be initially opened at a predetermined controlled rate by applying downward pressure on the well string, wherein said valve may be subsequently closed by rotation of the well string to permit measurement of the shut-in pressure, and wherein said valve may finally be opened by upward movement of the well string to bypass fluid through the tool.

A preferred embodiment of the invention is described in the accompanying detailed specification, and illustrated by way of example in the accompanying drawings, wherein:

Figs. 1 and 2 show a longitudinal sectional view of a tool embodying the principles of my invention, the parts being shown in the relative positions occupied as the tool is lowered in the well bore.

Figs. 3 and 4 illustrate the upper and lower portions respectively of the tool shown in Figs. 1 and 2, and illustrates the positions of the various elements with the test valve open.

Figs. 5 and 6 are views similar to Figs. 3 and 4 with the test valve closed to measure the shut-in pressure.

Figs. 7 and 8 are views similar to Figs. 5 and 6 with the bypass ports open during removal of the tool from the well bore.

Fig. 9 shows a sectional view taken on line 9—9 of Fig. 1.

Fig. 10 is a perspective view partially in section taken on line 10—10 of Fig. 1, and illustrating the spline arrangement between the mandrel and housing.

Fig. 11 is a sectional view taken on line 11—11 of Fig. 1.

Fig. 12 is a sectional view taken on line 12—12 of Fig. 3.

Referring now to the drawings, wherein the same reference numerals are used to designate the same elements throughout the various views shown, 20 generally indicates a multi-section tubular housing with the sections 21, 22, 23, 24 and 25 thereof being threadedly connected together in end to end relation. A multi-section tubular mandrel, generally indicated at 26, and comprising sections 27, 28, 29, 30, 31 and 32 threadedly connected in end to end relation, is received within the housing 20. The upper end of the mandrel section 27 is of reduced

diameter, as indicated at 33, and is connected to the lower end of a tubular sub 34 by an Acme thread indicated at 35. The upper end of the sub 34 is adapted to be connected to the lower end of a drill string by a threaded box indicated at 36. A wash pipe 37 is threaded into the upper end of the upper mandrel section 27 and sealed with respect thereto by an O-ring 38. The wash pipe 37 extends upwardly from the mandrel section 27 and is in sliding engagement with an internal shoulder 39 in the sub 34, and is sealed with respect thereto by a pair of O-rings indicated at 40.

As best seen in Fig. 9, the lower enlarged portion of the mandrel section 27 is formed with a plurality of inwardly extending grooves 41 adapted to receive a plurality of inwardly extending splines 42 formed on the inner surface of the upper housing section 21. As can be seen from Fig. 1, the grooves 41 terminate at an annular groove 42*a* formed in the mandrel section 27. The bottom ends of the splines 42 abut the lower surface of the groove 42*a* to limit the upward movement of the mandrel 26 relative to the housing 20.

As can best be seen in Figs. 3 and 12, a sleeve 43 having a plurality of upwardly extending teeth portions 72 is connected to the lower end of the sub 34 by a plurality of cap screws 44 with the teeth 72 received in suitable spline grooves 72′ on the outer surface of the sub 34. The sleeve 43 extends downwardly from the sub 34 around the outside of the upper housing section 21. A rubber seal 44*a* is housed in an annular groove 45 at the lower end of the sleeve 43 and sealingly engages the outer surface of the housing section 21. A thrust bearing 46 is retained adjacent the lower end of the sub 34 by an upwardly facing shoulder 47 within the sleeve 43. The thrust bearing 46 is adapted to be contacted by the upper end of the housing section 21, when the mandrel 26 and sleeve 43 are moved downwardly relative thereto in the manner shown in Fig. 3.

As best seen in Fig. 10, the lower end of the sleeve 43 is provided with a plurality of inwardly extending splines 48 having beveled upper ends 49. The splines 48 are adapted to interengage with a plurality of outwardly extending splines 50 formed on the upper end of the housing section 21. The splines 50 have their lower ends beveled, as shown at 51, whereby the splines 48 and 50 are guided into proper interengaging relation as the sleeve 43 is moved upwardly relative to the housing 21.

Mandrel sections 29 and 30 are spaced from the inner wall of the housing section 22 to provide an annular chamber 52 therebetween. The lower end of the annular chamber 52 is closed by an annular plug 53 fixed with relation to the housing section 22 by a pin 54 extending into an annular groove 55 around the outside of the plug. An O-ring 56 is mounted in a suitable groove on the outside of the plug and sealingly engages the inner wall of the housing section 22, and a pair of O-rings 57 are mounted in suitable grooves on the inner surface of the plug 53 and sealingly engage the outer wall of the mandrel section 30.

The upper end of the chamber 52 is defined by a floating piston 58. A pair of O-rings 59 on the outer surface of the piston 58 sealingly engage the inner surface of the housing section 22, and a pair of O-rings 60 on the inner surface of the piston 58 sealingly engage the outer surface of the mandrel section 28. The chamber 52 is filled with oil though an orifice 61 and then sealed by inserting a suitable plug therein. A plurality of ports 62 in the housing section 21 permit the well fluid to enter the housing 20 above the floating piston 58, whereby the pressure within the chamber 52 is equal to the pressure surrounding the tool.

The upper end of the mandrel section 29 is formed with an outwardly extending flange 63 providing an annular downwardly facing valve seat 64. A valve in the form of a sleeve 65 surrounds the mandrel section 29 in sliding relation therewith. The external diameter of the sleeve 65 is slightly smaller than the internal diameter of the housing section 22 to permit the oil in chamber 52 restricted flow therebetween. The mandrel section 29 is provided with a plurality of longitudinally extending grooves 66 to permit relatively free flow of fluid between the mandrel section 29 and sleeve 65. The sleeve 65 is normally urged upwardly with its upper end in sealing engagement with the downwardly facing valve seat 64 by a spring 67, as one end of the spring 67 abuts the bottom of the sleeve 65, and the other end abuts a spider member 68 fixed to the mandrel section 30.

The mandrel section 31 is provided with a plurality of lateral ports 69, 70 and 71 providing communication in the initial position of the tool between the interior of the mandrel section 31 and the annular space between the mandrel section 31 and the housing section 23. The port 69 is located adjacent the upper end of the mandrel section 31, the port 71 adjacent the lower end thereof and the ports 70 adjacent the mid-portion thereof.

An annular flange 73 extends inwardly from the inner wall of the housing section 23 and in the initial position of the tool, is adjacent the upper end of the mandrel section 32. An upper annular sleeve packing member 74 is confined between the lower surface of the flange 73 and a packing retainer member 75 threaded into the lower end of the housing section 23.

The lower end of the housing section 24 is counterbored, as indicated at 76, to receive a lower sleeve packing element 77 held therein by a packing retaining member 78 threaded into the lower end of the counterbore 76. The upper end of the housing section 24 is counterbored to form an annular chamber 79. The chamber 79 is connected to the interior of the housing section 25 by a plurality of longitudinal passages 80 formed in the walls of the housing section 24. An annular groove 81 is formed in the inner wall of the housing section 24 between the annular chamber 79 and the packing element 77. An O-ring 82 is mounted in a suitable groove in the inner wall of the housing section 24 between the groove 81 and the chamber 79 and sealingly engages the mandrel section 32. A port 83 in the wall of the housing section 24 provides fluid communication between the groove 81 and the exterior of the housing section 24. A plurality of bypass ports 84 is formed in the mandrel section 32 to provide fluid communication between the interior of the mandrel section 32 and the annular groove 81 in the initial position of the tool.

A check valve seat 85 is fixed between the lower end of the mandrel section 31 and the upper end of the mandrel section 32. A downwardly opening check valve 86 is urged upwardly thereagainst by a spring 87 confined between said valve 86 and a ring 89 supported on an upwardly facing shoulder 90 within the mandrel section 32.

In the operation of the tool, the various elements are assembled in the relationship shown in Figs. 1 and 2, the lower end of the housing section 25 is connected to a packer (not shown), and the upper end of the sub 34 is connected to a well string. In this initial position with the well string closed to upward flow of fluid by upper packing 74 and check valve 86, fluid is permitted to bypass the restricted region about the packer by flowing through the packer upwardly through the housing section 25, the lower mandrel section 32, and outwardly through ports 84 and 83, this bypass flow occurring, for example, as the tool is lowered into a well.

After the packer has been set within the well bore, downward pressure is applied through the well string to move the sub 34, mandrel 26 and the sleeve 43 downwardly relative to the housing 20. The downward movement of the mandrel 26 is slowed by the necessity of the fluid in the lower portion of the chamber 52 having to pass upwardly between the sleeve 65 and the inner wall of housing section 22, since the sleeve 65 is seated against the valve seat 64. The downward movement of the mandrel to the position illustrated in Figs. 3 and 4 closes the bypass ports 83, and moves the test ports 70, 71 through the packing 74 into communication with the chamber 79 which, through the passageways 80, is connected with the interior of the housing section 25. It will be noted that as the mandrel 26 moves downwardly, first the single port 71 is exposed to the chamber 79 and subsequently the multiple ports 70 are exposed thereto, thereby effecting a gradual opening of the test valve assembly.

Downward movement of the mandrel 26 and the sleeve 43 disengages the splines 48 and 50 between the housing section 21 and the sleeve 43 to permit rotative movement of the sub 34 relative to the housing 20 and mandrel 26. After the sample has been taken into the well string above the test port 70, the well string is rotated to rotate the sub 34 relative to the mandrel 26, and the threaded connection 35 therebetween causes the mandrel 26 to move upwardly relative to the housing 20 to the position illustrated in Figs. 5 and 6. In this position the bypass ports 84 are within the packing 77 and the ports 70 and 71 are within the packing 74, thus sealing off the passage in the housing section 25 to permit recording of the shut-in pressure, that is, the pressure built up below the testing tool in the formation fluids which no longer may flow upwardly into the well string. It will be understood that the packer remains in its set position during such rotation of the well string to isolate one or more formations and, in its set position, holds the housing 20 and thus mandrel 26 against rotation with the well string.

After the shut-in pressure has been recorded, the well string is pulled upwardly, thus moving the mandrel 26 upwardly to its initial or upper position relative to the housing 20 in the manner shown in Figs. 7 and 8 to reopen the bypass ports. Upon upward movement of the mandrel 26, the sleeve 65 is separated from the seat 64 and the fluid in the upper portion of the chamber bypasses freely within the sleeve 65 through the grooves 66. The mandrel 26 may thus be moved rapidly from its intermediate or shut-in position to its initial or upper position, or it may be moved directly from its second or lower position to its upper position by an upward pull on the well string, without an intervening rotation to the shut-in position, if for example a quick closing of the test ports is desired. When the mandrel has been pulled to its upper, bypass position, the packer may be unseated by further upward pull and the tool raised. In withdrawing the well tool from the borehole, interengagement of splines 48 and 50 permits rotation of the well string to be transmitted through the well tool to the packer therebelow.

While I have shown and described the preferred form of my invention, it should 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. In a well tool, a tubular housing, a tubular mandrel mounted in said housing for limited longitudinal movement relative thereto, means for manipulating said mandrel relative to said housing comprising a sleeve telescopically mounted above the upper end of said housing and threadedly connected to the upper end of said mandrel, means on said sleeve and housing adapted to interengage to prevent rotational movement of said sleeve relative to said housing when said sleeve is in its uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is moved

to its lowermost position relative to said housing, whereby when said sleeve is in its uppermost position relative to said housing said mandrel may be moved from its uppermost position to its lowermost position by downward movement of said sleeve relative to said housing, whereby said mandrel may subsequently be moved upwardly relative to said housing to an intermediate position by rotational movement of said sleeve relative to said mandrel and housing while said sleeve remains in its lowermost position, and whereby said mandrel may be finally returned to its uppermost position by upward movement of said sleeve to an intermediate position relative to said housing.

2. In a well tool, a tubular housing, a tubular mandrel mounted in said housing for limited longitudinal movement relative thereto, means for preventing relative rotational movement between said mandrel and housing, means for manipulating said mandrel relative to said housing comprising a sleeve telescopically mounted over the upper end of said housing and threadedly connected to the upper end of said housing, means on said sleeve and mandrel adapted to interengage to prevent rotational movement of said sleeve relative to said housing when said sleeve is in its uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is moved to its lowermost position relative to said housing, whereby when said sleeve is in its uppermost position relative to said housing said mandrel may be moved from its uppermost position to its lowermost position by downward movement of said sleeve relative to said housing, whereby said mandrel may subsequently be moved upwardly relative to said housing to an intermediate position by rotational movement of said sleeve relative to said mandrel and housing while said sleeve remains in its lowermost position, and whereby said mandrel may be finally returned to its uppermost position by upward movement of said sleeve to an intermediate position relative to said housing.

3. In a well tool, a tubular housing, a tubular mandrel mounted in said housing for limited longitudinal movement relative thereto, means for manipulating said mandrel relative to said housing comprising a sleeve telescopically mounted over the upper end of said housing and threadedly connected to the upper end of said mandrel, a plurality of splines projecting inwardly from the inner surface of said sleeve adjacent the lower end thereof, a plurality of splines projecting outwardly from the outer surface of said housing adjacent the upper end thereof, said splines being adapted to interengage to prevent rotational movement of said sleeve relative to said housing when said sleeve is in uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is moved to its lowermost position relative to said housing, whereby when said sleeve is in its uppermost position relative to said housing said mandrel may be moved from its uppermost position to its lowermost position by downward movement of said sleeve relative to said housing, whereby said mandrel may subsequently be moved upwardly relative to said housing to an intermediate position by rotational movement of said sleeve relative to said mandrel and housing while said sleeve remains in its lowermost position, and whereby said mandrel may be finally returned to its uppermost position by upward movement of said sleeve to an intermediate position relative to said housing.

4. In a well tool, a tubular housing, a tubular mandrel mounted in said housing for limited longitudinal movement relative thereto, means for manipulating said mandrel relative to said housing comprising a sleeve telescopically mounted over the upper end of said housing and threadedly connected to the upper end of said mandrel, a plurality of splines projecting inwardly from the inner surface of said sleeve adjacent the lower end thereof, a plurality of splines projecting outwardly from the outer surface of said housing adjacent the upper end thereof, said splines being adapted to interengage to prevent rotational movement of said sleeve relative to said housing when said sleeve is in its uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is moved to its lowermost position relative to said housing, the upper ends of said sleeve splines being inclined and the lower ends of said housing splines being inclined at substantially the same angle to guide said splines into interengaging relation upon upward movement of said sleeve relative to said housing, whereby when said sleeve is in its uppermost position relative to said housing said mandrel may be moved from its uppermost position to its lowermost position by downward movement of said sleeve relative to said housing, whereby said mandrel may subsequently be moved upwardly relative to said housing to an intermediate position by rotational movement of said sleeve relative to said mandrel and housing while said sleeve remains in its lowermost position, and whereby said mandrel may be finally returned to its uppermost position by upward movement of said sleeve to an intermediate position relative to said housing.

5. A well tool comprising a housing adapted to be connected at its lower end to the upper end of a well packer, a sleeve surrounding the upper end of said housing and mounted for limited longitudinal movement with respect thereto, said sleeve being adapted to be connected at its upper end to the lower end of a well string, means on said housing and said sleeve adapted to interengage to prevent relative rotational movement therebetween when said sleeve is in its uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is in its lowermost position relative to said housing, a tubular mandrel slidably mounted in said housing for limited longitudinal movement relative thereto, the upper end of said mandrel being threadedly connected to said sleeve, means for preventing relative rotation between said mandrel and housing, an annular chamber in said housing, upper and lower sealing means in said housing sealingly engaging said mandrel above and below said chamber respectively, passage means in said housing connecting said chamber with the interior of said housing below the lower end of said mandrel, a plurality of lateral test ports in said mandrel above said upper sealing means when said mandrel is in its uppermost position relative to said housing, a downwardly opening check valve in said mandrel below said test ports, whereby when said sleeve is in its uppermost position relative to said housing downward movement of said sleeve relative to said housing will move said mandrel downwardly to bring said test ports into register with said chamber, whereby subsequent rotational movement of said sleeve relative to said mandrel and housing will move said mandrel upwardly relative to said housing to move said test ports upwardly into register with said upper sealing member, and whereby subsequent upward movement of said sleeve to an intermediate position, relative to said housing will return said mandrel and housing to their initial relative positions.

6. A well tool comprising a housing adapted to be connected at its lower end to the upper end of a well packer, a sleeve surrounding the upper end of said housing and mounted for limited longitudinal movement with respect thereto, said sleeve being adapted to be connected at its upper end to the lower end of a well string, a plurality of short splines projecting inwardly from said sleeve adjacent the lower end thereof, a plurality of short splines projecting outwardly from said housing adjacent the upper end thereof, said splines being adapted to interengage to prevent relative rotational movement between said sleeve and said housing when said sleeve is in its uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is in its lowermost position relative to said housing, a tubular mandrel slidably mounted in said

housing for limited longitudinal movement relative thereto, the upper end of said mandrel being threadedly connected to said sleeve, means for preventing relative rotation between said mandrel and housing, an annular chamber in said housing, upper and lower sealing means in said housing sealingly engaging said mandrel above and below said chamber respectively, passage means in said housing connecting said chamber with the interior of said housing below the lower end of said mandrel, a plurality of lateral test ports in said mandrel above said upper sealing means when said mandrel is in its uppermost position relative to said housing, a downwardly opening check valve in said mandrel below said test ports, whereby when said sleeve is in its uppermost position, relative to said housing downward movement of said sleeve relative to said housing will move said mandrel downwardly to bring said test ports into register with said chamber, whereby subsequent rotational movement of said sleeve relative to said mandrel and housing will move said mandrel upwardly relative to said housing to move said test ports upwardly into register with said upper sealing member, and whereby subsequent upward movement of said sleeve to an intermediate position relative to said housing will return said mandrel and housing to their initial relative positions.

7. A well tool comprising a housing adapted to be connected at its lower end to the upper end of a well packer, a sleeve surrounding the upper end of said housing and mounted for limited longitudinal movement with respect thereto, said sleeve being adapted to be connected at its upper end to the lower end of a well string, a plurality of short splines projecting inwardly from said sleeve adjacent the lower end thereof, a plurality of short splines projecting outwardly from said housing adjacent the upper end thereof, said splines being adapted to interengage to prevent relative rotational movement between said sleeve and said housing when said sleeve is in its uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is in its lowermost position relative to said housing, the upper ends of said sleeve splines and the lower ends of said housing splines each being beveled along the same plane to guide said splines into interengaging relation upon upward movement of said sleeve relative to said housing, a tubular mandrel slidably mounted in said housing for limited longitudinal movement relative thereto, the upper end of said mandrel being threadedly connected to said sleeve, means for preventing relative rotation between said mandrel and housing, an annular chamber in said housing, upper and lower sealing means in said housing sealingly engaging said mandrel above and below said chamber respectively, passage means in said housing connecting said chamber with the interior of said housing below the lower end of said mandrel, a plurality of lateral test ports in said mandrel above said upper sealing means when said mandrel is in its uppermost position relative to said housing, a downwardly opening check valve in said mandrel below said test ports, whereby when said sleeve is in its uppermost position relative to said housing downward movement of said sleeve relative to said housing will move said mandrel downwardly to bring said test ports into register with said chamber, whereby subsequent rotational movement of said sleeve relative to said mandrel and housing will move said mandrel upwardly relative to said housing to move said test ports upwardly into register with said upper sealing member, and whereby subsequent upward movement of said sleeve to an intermediate position relative to said housing will return said mandrel and housing to their initial relative positions.

8. A well tool comprising a housing adapted to be connected at its lower end to the upper end of a well packer, a sleeve surrounding the upper end of said housing and mounted for limited longitudinal movement with respect thereto, said sleeve being adapted to be connected at its upper end to the lower end of a well string, a plurality of short splines projecting inwardly from said sleeve adjacent the lower end thereof, a plurality of short splines projecting outwardly from said housing adjacent the upper end thereof, said splines being adapted to interengage to prevent relative rotational movement between said sleeve and said housing when said sleeve is in its uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is in its lowermost position relative to said housing, the upper ends of said sleeve splines and the lower ends of said housing splines each being beveled along the same plane to guide said splines into interengaging relation upon upward movement of said sleeve relative to said housing, a tubular mandrel slidably mounted in said housing for limited longitudinal movement relative thereto, the upper end of said mandrel being threadedly connected to said sleeve, means for preventing relative rotation between said mandrel and housing, a first annular chamber in said housing, upper and lower sealing means in said housing sealingly engaging said mandrel above and below said first chamber respectively, passage means in said housing connecting said first chamber with the interior of said housing below the lower end of said mandrel, a plurality of lateral test ports in said mandrel above said upper sealing means when said mandrel is in its uppermost position relative to said housing, a downwardly opening check valve in said mandrel below said test ports, a second annular chamber in said housing below said first annular chamber and separated therefrom, a lateral port in said housing providing fluid communication between said second annular chamber and the exterior of said housing, lateral bypass ports in said mandrel below said check valve adapted to register with said second annular chamber when said mandrel is in its uppermost position relative to said housing, whereby when said sleeve is in its uppermost position relative to said housing downward movement of said sleeve relative to said housing will move said mandrel downwardly relative to said housing to move said mandrel bypass ports below said lower seal and said test ports into register with said first annular chamber, whereby subsequent rotation of said sleeve relative to said housing and mandrel will move said mandrel upwardly relative to said housing to move said test ports into register with said upper sealing means and said mandrel bypass ports into register with said lower sealing means and whereby subsequent upward movement of said sleeve to an intermediate position relative to said housing will return said mandrel to its initial position relative to said housing will return said mandrel to its initial position relative to said housing to reopen said tool to bypass.

9. A well tool comprising a housing adapted to be connected at its lower end to the upper end of a well packer, a sleeve surrounding the upper end of said housing and mounted for limited longitudinal movement with respect thereto, said sleeve being adapted to be connected at its upper end to the lower end of a well string, a plurality of short splines projecting inwardly from said sleeve adjacent the lower end thereof, a plurality of short splines projecting outwardly from said housing adjacent the upper end thereof, said splines being adapted to interengage to prevent relative rotational movement between said sleeve and said housing when said sleeve is in its uppermost position relative to said housing and adapted to disengage to permit such rotational movement when said sleeve is in its lowermost position relative to said housing, the upper ends of said sleeve splines and the lower ends of said housing splines each being beveled along the same plane to guide said splines into interengaging relation upon upward movement of said sleeve relative to said housing, a tubular mandrel slidably mounted in said housing for limited longtudinal movement relative thereto, the upper end of said mandrel being threadedly connected to said

sleeve, means for retarding downward movement of said mandrel relative to said housing but permitting free upward movement thereof, means for preventing relative rotation between said mandrel and housing, a first annular chamber in said housing, upper and lower sealing means in said housing sealingly engaging said mandrel above and below said first chamber respectively, passage means in said housing connecting said first chamber with the interior of said housing below the lower end of said mandrel, a plurality of lateral test ports in said mandrel above said upper sealing means when said mandrel is in its uppermost position relative to said housing, a downwardly opening check valve in said mandrel below said test ports, a second annular chamber in said housing below said first annular chamber and separated therefrom, a lateral port in said housing providing fluid communication between said second annular chamber and the exterior of said housing, lateral bypass ports in said mandrel below said check valve adapted to register with said second annular chamber when said mandrel is in its uppermost position relative to said housing, whereby when said sleeve is in its uppermost position relative to said housing downward movement of said sleeve relative to said housing will move said mandrel downwardly relative to said housing to move said mandrel bypass ports below said lower seal and said test ports into register with said first annular chamber, whereby subsequent rotation of said sleeve relative to said housing and mandrel will move said mandrel upwardly relative to said housing to move said test ports into register with said upper sealing means and said mandrel bypass ports into register with said lower sealing means, and whereby subsequent upward movement of said sleeve to an intermediate position relative to said housing will return said mandrel to its initial position relative to said housing to reopen said tool to bypass.

10. A well tool for connection in a string of pipe comprising a tubular housing provided with a bypass port for placing its bore in communication with its exterior, a tubular mandrel slidably received within the bore of said housing for longitudinal movement between upper, lower and intermediate positions relative to said housing, and a tubular member co-rotatively secured to said housing in the upper position of said mandrel and rotatable relative to said mandrel and housing in the lower position of said mandrel, said mandrel being co-rotatively secured to said housing and threadedly connected with said tubular member in its lower position so as to be raised to its intermediate position by relative rotation of said tubular member, said housing and said mandrel interengaging in said upper position to limit further upward movement of said mandrel and together defining a passage through said tool which is closed in said upper and intermediate positions and open in said lower position, said mandrel being arranged to close said bypass port in its lower and intermediate positions.

11. A well tool comprising a tubular housing and mandrel having a passage therethrough and telescopically arranged for longitudinal movement between upper, lower and intermediate positions, a test valve along said passage closed in said upper and said intermediate positions and open in said lower position, a bypass valve along said passage open in said upper position and closed in said intermediate and said lower positions, a tubular member threadedly connected with said mandrel for moving said mandrel between said upper and lower positions and between said intermediate and upper positions by longitudinal movement and between said lower and intermediate positions by rotational movement relative to said mandrel, and means for preventing relative rotational movement between said mandrel and housing at least at and between said lower and intermediate positions while permitting relative longitudinal movement therebetween.

12. A well tool comprising a tubular housing and a tubular mandrel together defining a passage through said tool, said mandrel being telescopically received in said housing for longitudinal movement between upper, lower and intermediate positions relative thereto, a test valve along said passage closed in said upper and intermediate positions and open in said lower position, a bypass valve along said passage open in said upper position and closed in said intermediate and lower positions, hydraulic means for retarding movement of said mandrel from said upper position to said lower position to delay opening of said test valve while permitting unretarded return movement for closing said test valve, a tubular member threadedly connected with said mandrel for moving said mandrel between said upper and lower positions and said intermediate and said upper positions by a longitudinal movement therewith, and means for co-rotatively securing said mandrel and said housing at least at and between said lower and intermediate positions for relative longitudinal movement of said mandrel with respect to said housing from said lower position to said intermediate position by rotation of said tubular member relative to said mandrel and housing.

13. A well tool comprising a tubular housing a, mandrel slidably received by said housing for longitudinal movement between upper, lower and intermediate positions, said housing and mandrel defining a passage through said tool which is closed in said upper and intermediate positions and open in said lower position, said housing being provided with a bypass port near its lower end for placing its bore in communication with its exterior, said bypass port being closed in the lower and intermediate positions of said mandrel, a tubular member threadedly connected with the upper end of said mandrel for moving said mandrel from said upper position to said lower position and from said intermediate position to said upper position by longitudinal movement therewith and from said lower position to said intermediate position by rotational movement relative to said mandrel, means for co-rotatively securing said mandrel and said housing, and means affording a fluid seal between said mandrel and said tubular member bridging the threaded connection therebetween to continue said passage to the upper end of said tool.

14. A well tool comprising a tubular housing and mandrel having a passage therethrough and telescopically arranged for longitudinal movement between upper, lower and intermediate positions, said passage being closed in said upper and intermediate positions and open in said lower position, said housing having a bypass port for placing the lower end of said passage in communication with the exterior of said tool when said mandrel is in its upper position, a tubular member threadedly connected with said mandrel for moving said mandrel between said upper and lower positions and said intermediate and said upper positions by a longitudinal movement therewith and between said lower and intermediate positions by rotational movement relative to said mandrel, means for co-rotatively securing said mandrel and said housing, and a sleeve co-rotatively coupling said tubular member and said housing in said upper position while permitting a relative rotation therebetween in said lower and intermediate positions.

15. A well tool for connection in a string of pipe comprising a tubular housing, a tubular mandrel slidably and non-rotatively received in said housing for longitudinal movement between upper, lower and intermediate positions, said mandrel and said housing defining a passage therethrough which is closed in said upper and intermediate positions and open in said lower position, said housing having a bypass port for placing its exterior in communication with the lower end of said passage in the upper position of said mandrel, a tubular sub having a threaded connection with the upper end of said mandrel for moving said mandrel between said upper and lower positions and said intermediate and upper positions by a longitudinal movement therewith and for mov-

ing said mandrel longitudinally between said lower and intermediate positions by rotational movement of said tubular sub relative to said mandrel, and means for preventing relative rotational movement between said mandrel and housing, said housing and said tubular sub being arranged at their opposite extremities for connection with a pipe string.

16. A well tool for connection in a string of pipe comprising a tubular housing provided with a bypass port for placing its bore in communication with its exterior, a tubular mandrel slidably received within the bore of said housing for longitudinal movement between upper, lower and intermediate positions relative to said housing, a tubular member, and a sleeve extending above said housing to receive said tubular member and having splines for co-rotative engagement with one of said tubular member and said housing in said upper position, and means for co-rotatively securing said sleeve to the other of said tubular member and said housing whereby said tubular member is co-rotatively secured to said housing in the upper position of said mandrel and rotatable relative to said mandrel and housing in the lower and intermediate positions of said mandrel, said mandrel being co-rotatively secured to said housing and threadedly connected with said tubular member so as to be raised from its lower position to its intermediate position by relative rotation of said tubular member while said tubular member is supported by the upper end of said housing, said housing and said mandrel interengaging in said upper position to limit further upward movement of said mandrel and together defining a passage through said tool which is closed in said upper and intermediate positions and open in said lower position, said mandrel being arranged to close said bypass port in its lower and intermediate positions.

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