

Oct. 5, 1954

J. A. MOOSMAN

2,690,807

COMBINATION OIL WELL TOOL

Filed April 27, 1953

2 Sheets-Sheet 1

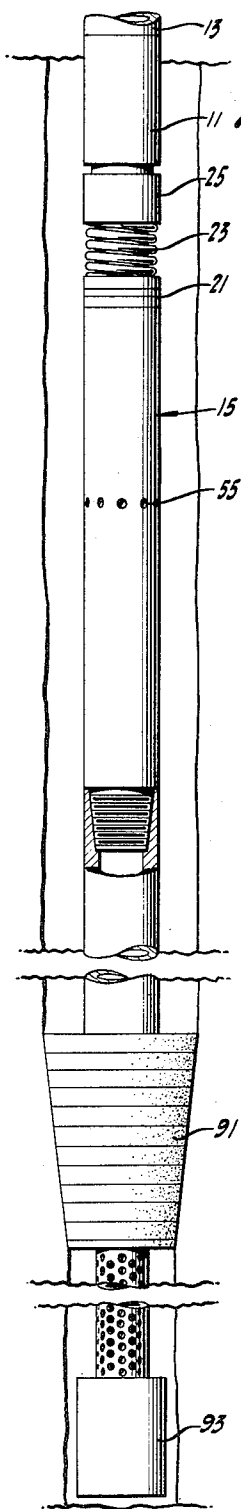


FIG. 1

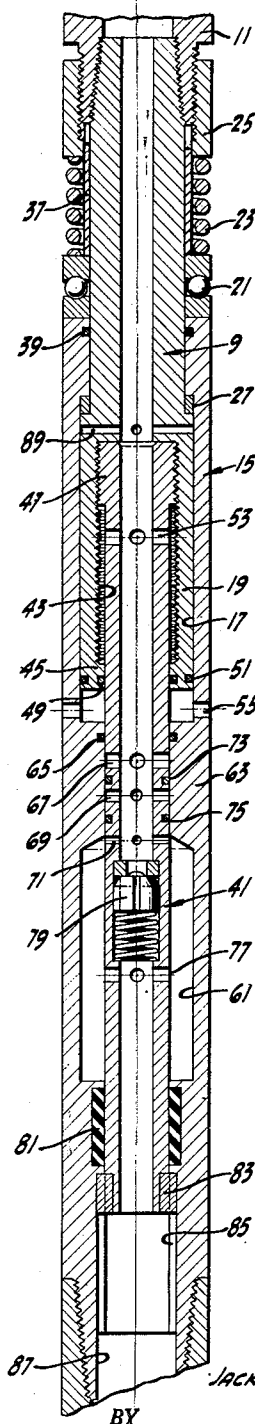


FIG. 2

INVENTOR.
JACK A. MOOSMAN

BY
Mellin and Hanson
ATTORNEYS

Oct. 5, 1954

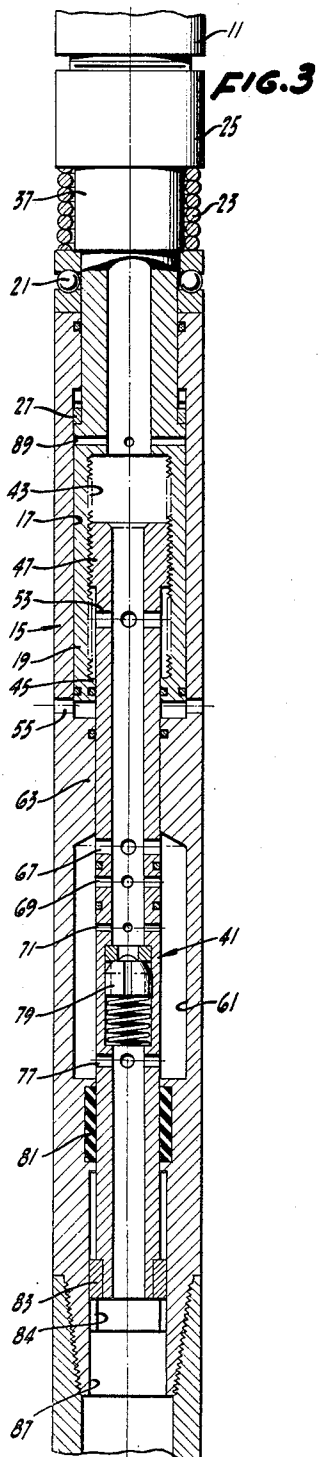
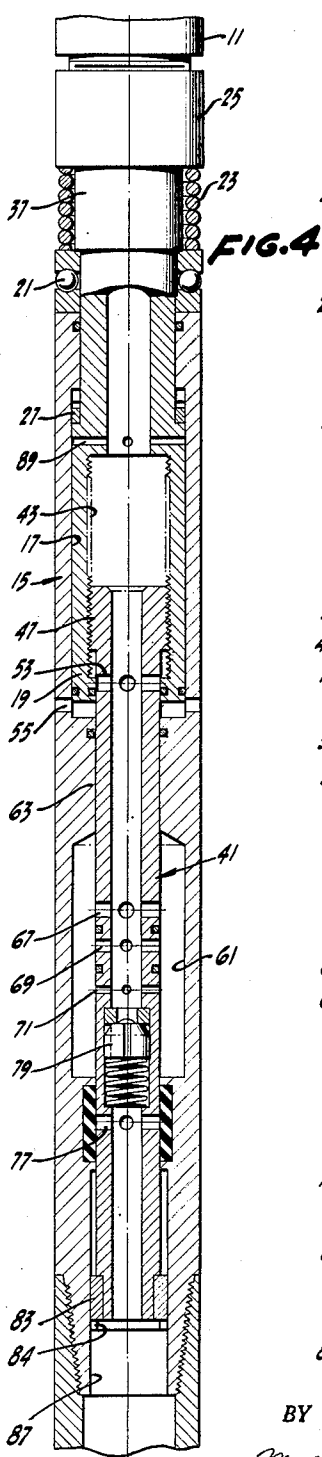
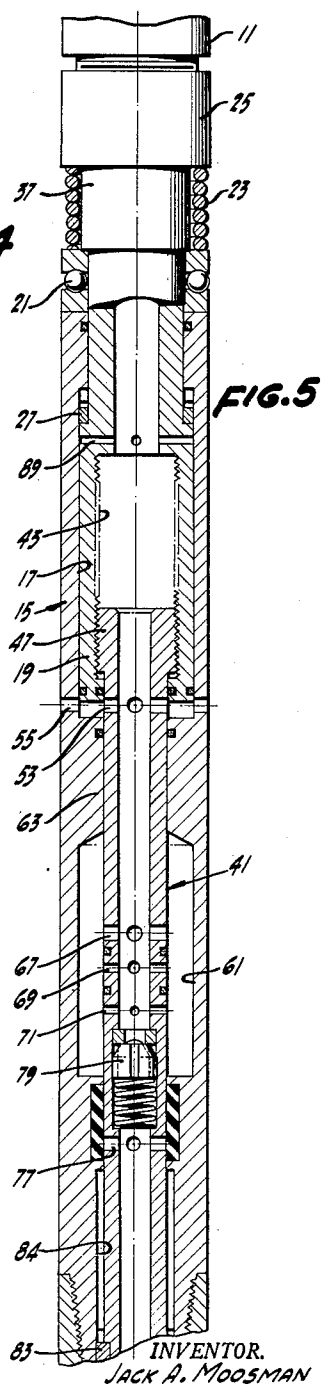
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2 Sheets-Sheet 2



INVENTOR.
JACK A. MOOSMAN

BY

Mellin and Hanson
ATTORNEYS

UNITED STATES PATENT OFFICE

2,690,807

COMBINATION OIL WELL TOOL

Jack A. Moosman, Glendale, Calif., assignor to
Johnston Testers, Inc., Houston, Tex., a corpo-
ration of Delaware

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11 Claims. (Cl. 166—150)

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The present invention relates to an oil well formation testing tool.

In making a test of a formation where the connate fluid is under high pressure, it is desirable to progressively open the tool to the upward flow of fluid therethrough so as to prevent damage to the tool which might be caused by high velocity fluid jetting uncontrolled through the tool. Also, after the test is made and the sample collected, it is frequently desirable to be able to make a shut-in test, that is to take the pressure of the fluid in the formation with the bore above the formation completely closed off by the tool. This is conventionally accomplished by closing off upward flow of fluid through the tool, the tool being provided with a packer of some type for sealing engagement with walls of the well bore or casing within which the tool is lowered. Furthermore, frequently it is desirable to reversely circulate drilling mud or other liquid down the well around the exterior of the string of pipe supporting the tool and then into the tool and upwardly through the tool for the purpose of bringing connate fluid to the surface, and also for various other purposes.

It is a main object of the present invention to provide a simple and inexpensive tool by which the three operations above described may be readily carried out.

It is a more particular object of the present invention to provide a tool by which the above-named operations may be carried out in the sequence above enumerated, and by merely rotating the string of pipe supporting the tool to effect such a sequence of operations.

Various other objects of the present invention will be apparent from the following description taken in connection with the accompanying drawings, wherein:

Fig. 1 is a fragmental elevational view illustrating portions of a tool embodying the present invention, the parts being shown in the running-in relationship.

Figs. 2, 3, 4 and 5 are fragmental mid-sectional views of portions of the tool, the parts being shown in the different relationships by which the operation is varied.

Referring to the accompanying drawings, wherein similar reference characters designate similar parts throughout, there is disclosed a tool embodying the concepts of the present invention, including an upper mandrel 9 provided with a sub 11 at its upper end for connection to a string of pipe, fragmentarily shown at 13, by which the tool may be run into or out of a well

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bore and by which rotation of mandrel 9 may be effected. Slidably receiving upper mandrel 9 is a tubular housing 15, said housing having its central bore enlarged at 17, within which there is slidably received the lower enlarged end 19 of said mandrel. Although housing 15 is shown as one integral unit, it is contemplated that the same may be composite in construction and therefore, comprises a plurality of parts suitably threaded or otherwise connected together. The axial length of portion 19 of mandrel 9 is less than that of enlarged bore portions 17, so that the lower end of enlarged portion 19 is spaced above the end wall defining the lower end of enlarged bore portion 17.

Supported by the upper end of housing 15 is a thrust bearing 21. Bearing against the thrust bearing is a strong compression spring 23 engaging at its upper end an adjustment nut 25 threaded on the lower end of sub 11. Spring 23 urges housing 15 downwardly against portion 19 and functions to releasably hold mandrel 9 in engagement with a key and keyway type locking device 27 formed on the housing and mandrel. This locking device functions to releasably retain the mandrel and housing against relative rotation. When mandrel 9 is lowered relative to the housing from the position shown in Fig. 2 to the position shown in Fig. 3, locking device 27 releases the mandrel for rotation relative to the housing.

Limiting downward movement of mandrel 9 relative to the housing is a stop sleeve 37 surrounding mandrel 9 and being surrounded by spring 23. Sleeve 37 is connected to and carried by nut 25, and hence adjustment of the nut functions to vary the maximum downward travel of mandrel 9 relative to said housing.

A sealing means is provided at 39 on the housing and engages the exterior of mandrel 9 to prevent escape of fluid upwardly between the housing and mandrel.

Also slidably received by housing 15 is a second tubular mandrel 41, the upper end of which is received within an undercut bore 43 formed within lower enlarged portion 19 of mandrel 9, said bore being defined at its lower end by lips 45. Tubular mandrel 41 slidably engages lips 45 and has an enlarged upper end 47 provided with threads engaging complementary threads formed on the walls of bore 43. Lips 45 carry sealing means 49 and 51, which sealingly engage mandrel 41 and the walls of bore 17, respectively.

Reverse circulating ports 53 are formed in the walls of lower mandrel 41 and are initially dis-

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posed as shown in Fig. 2 well above sealing means 49. Housing 15 is also provided with reverse circulating ports 55 communicating with the unoccupied lower portion of bore 17 and adapted to communicate with reverse circulating ports 53 of mandrel 41 when mandrel 9 has been rotated an extent to move ports 53 into registry with ports 55, i. e., in communication with the lower unoccupied part of bore 17.

The central bore of housing 15 is also enlarged at a place below and spaced from enlarged bore portion 17 to provide a recess or cavity 61 surrounding mandrel 41. The thickened portion or rib entitled 63 of housing 15 disposed between and effectively separating bore 17 and recess 61 slidably engages mandrel 41 and is provided with sealing means 65 sealingly engaging the exterior of said mandrel.

Below sealing means 65 there is formed in mandrel 41 a series of flow bean ports 67, 69 and 71 decreasing in size from top to bottom. Lower flow bean ports 71 are initially disposed within recess 61, while flow bean ports 69 and 67 are covered by rib 63 of housing 15. Appropriate sealing means are provided at 73 and 75 on mandrel 41 to seal off ports 67 from ports 69, and ports 69 from recess 61, respectively.

Formed in mandrel 41 below the flow bean ports are connate fluid ports 77 exposed in recess 61 and hence disposed in communication with flow bean ports 71. Between the flow bean ports and the connate fluid ports is disposed a downwardly opening spring-biased check valve 79 for preventing upward flow of fluid through mandrel 41 in the region thereof between ports 77 and 71.

Housing 15 is provided with packing 81 sealingly engaging mandrel 41 at a place spaced below connate fluid ports 77. At its lower end, mandrel 41 is provided with keys 83 slidably engaging keyways 85 formed within the central bore of housing 15. The keys and keyways allow sliding, but prevent rotary movement between mandrel 41 and housing 15. Keyways 85 terminate at a counterbore 87. When mandrel 41 has been lowered to an extent to dispose keys 83 totally within counterbore 87, relative rotary movement between mandrel 41 and housing 15 is permitted.

It is frequent practice to at least partially fill the tool and string of pipe with a fluid when the tool is run into the well bore to prevent collapse of the tool against the force of outside pressure. Enlarged portion 19 of upper mandrel 9 is provided with ports 89 communicating the exterior of said enlarged portion with the interior thereof to permit the fluid pressure within the tool to be effective upwardly on the housing shoulder at locking device 27 and downwardly on the adjacent shoulder on upper mandrel 9 to help counterbalance the force caused by fluid pressure effective between mandrel 9 and mandrel 41.

As is apparent from Figs. 2 through 5 the spacing of reverse circulating ports 53 from the lower unoccupied portion of bore 17 is greater than the spacing of connate fluid ports 77 from packing 81, and that the spacing of flow bean ports 67 from recess 61 is less than the spacing of connate fluid ports 77 from packing 81.

The operation of the tool is as follows. When running into the well, strong compression spring 23 maintains the tool in locked position until after a packer 91, provided on the lower end of the tool, has been set in the well or in the casing within which the tool is lowered. Various valves, such as equalizing valves and retaining valves

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are normally provided in the portion of the tool below housing 15, but a description of these elements is not essential to an understanding of the present invention. In fact, the tool of the present invention may be utilized in installations not including such elements.

After packer 91 has been set, string 13 is further lowered to compress strong compression string 23 to release mandrel 9 for rotation relative to housing 15. Sleeve 27 functions to prevent enlarged portion 19 of mandrel 13 from closing reverse circulating ports 55 by limiting downward movement of mandrel 9 relative to housing 15. Upon rotation of string 13 ports 69 and then 67 are brought into registry with recess 61 to allow an increased flow of fluid upwardly through mandrel 41, out through ports 77 and in through ports 71, 69 and 67, and upwardly through the tool, as shown in Fig. 3.

After a sample has been taken, string 13 can be further rotated to bring ports 77 within the confines of packing unit 81 and hence close ports 77 and trap the sample disposed within the tool below ports 77 and check valve 79 within the tool. At this time, reverse circulating ports 53 are still disposed above sealing means 49, as shown in Fig. 4.

A shut-in test is now made, a suitable pressure recording device such as 93 being provided on the lower end of the tool for such purpose. The tool is now run out of the well, if desired, or if reverse circulation through the tool is desired, string 13 can be further rotated to bring reverse circulating ports 53 into registry with reverse circulating ports 55, whereupon drilling mud or other liquid can be forced downwardly in the well bore along the exterior of string 13 and the tool of the present invention and thence inwardly through ports 55 and 53, and then upwardly through the tool for the purpose of bringing the sample above check valve 79 to the surface, or for any other purpose. This positioning is shown in Fig. 5.

As a safety feature, it is pointed out that keys 83 will be moved downwardly into counterbore 87, as ports 53 are brought into registry with ports 55, therefore, releasing mandrel 41 for rotary movement relative to housing 15. Consequently further rotation of the string 13 functions to merely rotate the mandrels in unison and relative to housing 15, and thus injury to the mandrels is avoided.

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. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threaded together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, said lower mandrel, between the flow bean ports and the connate fluid ports, being closed to the upward flow of fluid therethrough, a tubular hous-

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ing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having reverse circulating ports formed in the walls thereof initially spaced below the reverse circulating ports in the mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of said housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports, when such ports are brought into registry with the reverse circulating ports in the housing, means slidably but non-rotatably connecting the lower mandrel and the housing, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

2. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, said lower mandrel, between the flow bean ports and the connate fluid ports, being closed to the upward flow of fluid therethrough, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having reverse circulating ports formed in the walls thereof initially spaced below the reverse circulating ports in the mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of said housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports, when such ports are brought into registry with the reverse circulating ports in the housing, means slidably but non-rotatably connecting the lower mandrel and the housing, spring means urging the housing downwardly relative to the mandrels, whereby when the housing is held against rotation and said upper man-

drel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

3. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different cut adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, said lower mandrel, between the flow bean ports and the connate fluid ports, being closed to the upward flow of fluid therethrough, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having reverse circulating ports formed in the walls thereof initially spaced below the reverse circulating ports in the mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of said housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports, when such ports are brought into registry with the reverse circulating ports in the housing, means slidably but non-rotatably connecting the lower mandrel and the housing, spring means urging the housing downwardly relative to the mandrels, and means locking the upper mandrel against rotation relative to the housing, and therefore relative to the lower mandrel, releasable upon downward movement of the upper mandrel relative to said housing to permit rotation of said upper mandrel relative to the housing and therefore relative to the lower mandrel, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

4. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, and at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate

fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, a downwardly opening check valve in the lower mandrel between the fluid flow bean ports and the connate fluid ports, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having ports in the walls thereof initially spaced below the reverse circulating ports in the lower mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of the housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports when such ports are brought into registry with the reverse circulating ports of the housing, means slidably but non-rotatably connecting the lower mandrel to the housing, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

5. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, and at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, a downwardly opening check valve in the lower mandrel between the fluid flow bean ports and the connate fluid ports, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having ports in the walls thereof initially spaced below the reverse circulating ports in the lower mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of the housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to

uncover such ports when such ports are brought into registry with the reverse circulating ports of the housing, means slidably but non-rotatably connecting the lower mandrel to the housing, spring means urging the housing downwardly relative to the mandrels, and means locking the upper mandrel against rotation relative to the housing, and therefore relative to the lower mandrel, releasable upon downward movement of the upper mandrel relative to said housing to permit rotation of said upper mandrel relative to the housing and therefore relative to the lower mandrel, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

6. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, said lower mandrel, between the flow bean ports and the connate fluid ports, being closed to the upward flow of fluid therethrough, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having reverse circulating ports formed in the walls thereof initially spaced below the reverse circulating ports in the mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of said housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports, when such ports are brought into registry with the reverse circulating ports in the housing, means slidably but non-rotatably connecting the lower mandrel and the housing, being releasable after the reverse circulating ports in the lower mandrel have been brought into registry with the reverse circulating ports in the housing, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upper flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought

into registry with the reverse circulating ports in the housing.

7. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, said lower mandrel, between the flow bean ports and the connate fluid ports, being closed to the upward flow of fluid therethrough, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having reverse circulating ports formed in the walls thereof initially spaced below the reverse circulating ports in the mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of said housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports, when such ports are brought into registry with the reverse circulating ports in the housing, means slidably but non-rotatably connecting the lower mandrel and the housing, being releasable after the reverse circulating ports in the lower mandrel have been brought into registry with the reverse circulating ports in the housing, spring means urging the housing downwardly relative to the mandrels, and means locking the upper mandrel against rotation relative to the housing, and therefore relative to the lower mandrel, releasable upon downward movement of the upper mandrel relative to said housing to permit rotation of said upper mandrel relative to the housing and therefore relative to the lower mandrel, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating port in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

8. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, and at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow

bean ports increase in size from the lowermost to the uppermost, a downwardly opening check valve in the lower mandrel between the fluid flow bean ports and the connate fluid ports, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having ports in the walls thereof initially spaced below the reverse circulating ports in the lower mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of the housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports when such ports are brought into registry with the reverse circulating ports of the housing, means slidably but non-rotatably connecting the lower mandrel to the housing, being releasable after reverse circulating ports in the lower mandrel have been brought into registry with the reverse circulating ports in the housing, spring means urging the housing downwardly relative to the mandrels, and means locking the upper mandrel against rotation relative to the housing, and therefore relative to the lower mandrel, releasable upon downward movement of the upper mandrel relative to said housing to permit rotation of said upper mandrel relative to the housing and therefore relative to the lower mandrel, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

9. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, said lower mandrel, between the flow bean ports and the connate fluid ports, being closed to the upward flow of fluid therethrough, a tubular housing carried by the slidably receiving mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid

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ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having reverse circulating ports formed in the walls thereof initially spaced below the reverse circulating ports in the mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of said housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports, when such ports are brought into registry with the reverse circulating ports in the housing, means slidably but non-rotatably connecting the lower mandrel and the housing, said reverse circulating ports closing means including a bored portion of the upper mandrel sealingly telescopically receiving the portion of the lower mandrel containing the lower mandrel reverse circulating ports, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

10. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, said lower mandrel, between the flow bean ports and the connate fluid ports, being closed to the upward flow of fluid therethrough, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having reverse circulating ports formed in the walls thereof initially spaced below the reverse circulating ports in the mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of said housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports, when such ports are brought into registry with the reverse circulating ports in the housing, means slidably but non-rotatably connecting the lower mandrel and the housing, said reverse circulating port closing means including a bored portion of the upper mandrel sealingly telescopically receiving the portion of the lower mandrel containing the lower mandrel reverse circulating ports, said slidably but non-rotatably connecting means

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being releasable after the reverse circulating ports in the lower mandrel have been brought into registry with the reverse circulating ports in the housing, spring means urging the housing downwardly relative to the mandrels, and means locking the upper mandrel against rotation relative to the housing and therefore relative to the lower mandrel, releasable upon downward movement of the upper mandrel relative to the housing to permit rotation of said upper mandrel relative to said housing and therefore relative to said lower mandrel, whereby when the housing is held against rotation and said upper mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through the mandrels, and subsequently said connate fluid ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

11. A tool of the class described, comprising an upper tubular mandrel and a lower tubular mandrel operatively threadedly connected together and adapted to be lowered into a well bore by a string of pipe, said lower mandrel having formed in the walls thereof at one level one or more reverse circulating ports, at a lower level one or more connate fluid ports, and between the reverse circulating ports and the connate fluid ports at different but adjacent levels a series of flow bean ports, wherein said flow bean ports increase in size from the lowermost to the uppermost, said lower mandrel, between the flow bean ports and the connate fluid ports, being closed to the upward flow of fluid therethrough, a tubular housing carried by and slidably receiving the mandrels and closing the uppermost and at least some of the lower flow bean ports, and having a recess within which the connate fluid ports are exposed and within which at least the lowermost flow bean ports are exposed to be in communication with the connate fluid ports, said housing sealingly engaging the lower mandrel at a place spaced below the connate fluid ports a distance exceeding the spacing of the uppermost flow bean ports above said recess, said housing having reverse circulating ports formed in the walls thereof initially spaced below the reverse circulating ports in the mandrel a distance exceeding the spacing of the connate fluid ports above the place of sealing engagement of said housing below said connate fluid ports, means closing the reverse circulating ports in the lower mandrel responsive to downward movement of said lower mandrel to uncover such ports, when such ports are brought into registry with the reverse circulating ports in the housing, means slidably but non-rotatably connecting the lower mandrel and the housing, said reverse circulating port closing means including a bored portion of the upper mandrel sealingly telescopically receiving the portion of the lower mandrel containing the lower mandrel reverse circulating ports, said slidably but non-rotatably connecting means being releasable after the reverse circulating ports in the lower mandrel have been brought into registry with the reverse circulating ports in the housing, spring means urging the housing downwardly relative to the mandrels, and means locking the upper mandrel against rotation relative to the housing and therefore relative to the lower mandrel, releasable upon downward movement of

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the upper mandrel relative to the housing to permit rotation of said upper mandrel relative to said housing and therefore relative to said lower mandrel, said upper mandrel having lateral ports in the walls thereof disposed between the last 5 named means and the upper end of the lower mandrel to provide a hydrostatic balance of the mandrels within the housing, whereby when the housing is held against rotation and said upper 10 mandrel is rotated, the covered flow bean ports will be progressively exposed within the recess and hence progressively brought into communication with the connate fluid ports to allow an increased upward flow of connate fluid through 15 the mandrels, and subsequently said connate fluid

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ports will be closed, and still subsequently the reverse circulating ports in the lower mandrel will be brought into registry with the reverse circulating ports in the housing.

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