March 8, 1955 B. A. DETERS ET AL 2,703,696

HYDRAULIC VALVE

Filed Sept. 23, 1952

2 Sheets-Sheet 1

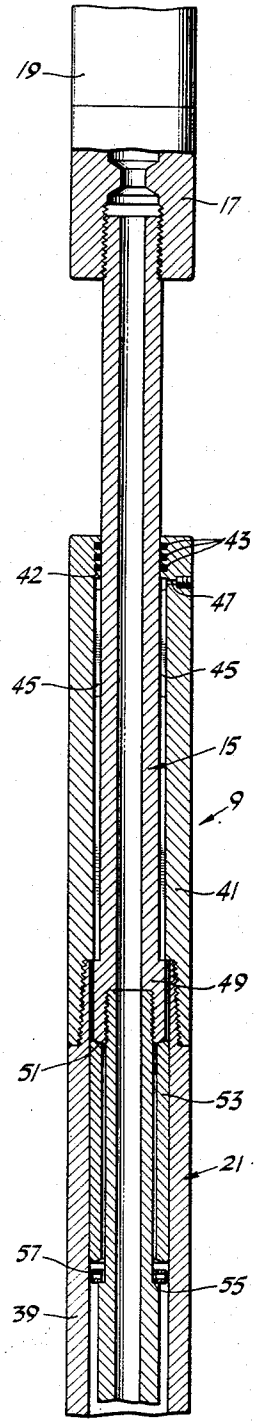


FIG. 1a.

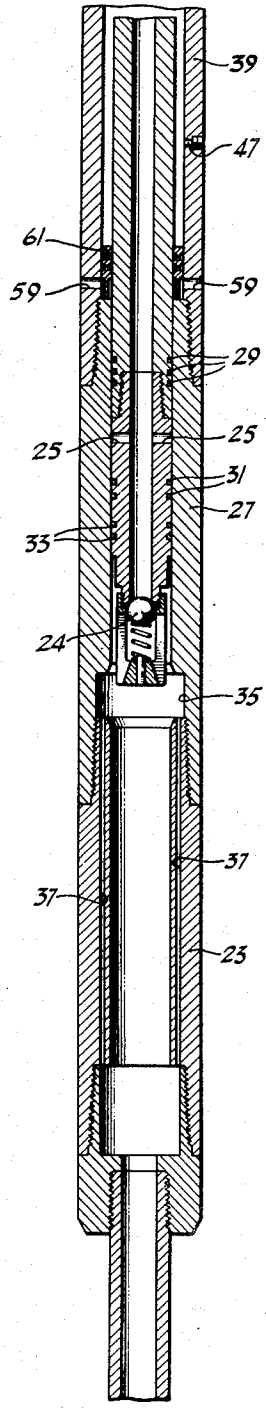


FIG. 1b.

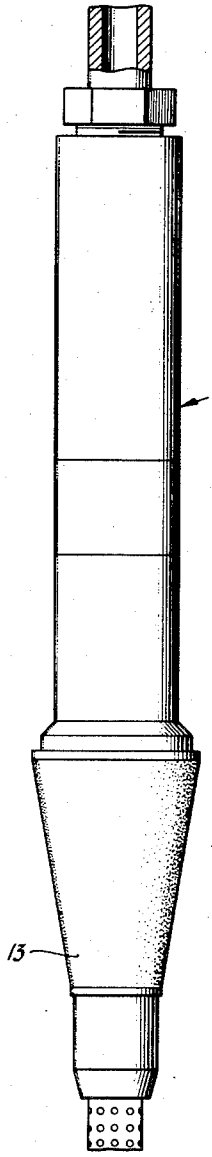


FIG. 1c.

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HYDRAULIC VALVE

Filed Sept. 23, 1952 2 Sheets-Sheet 2

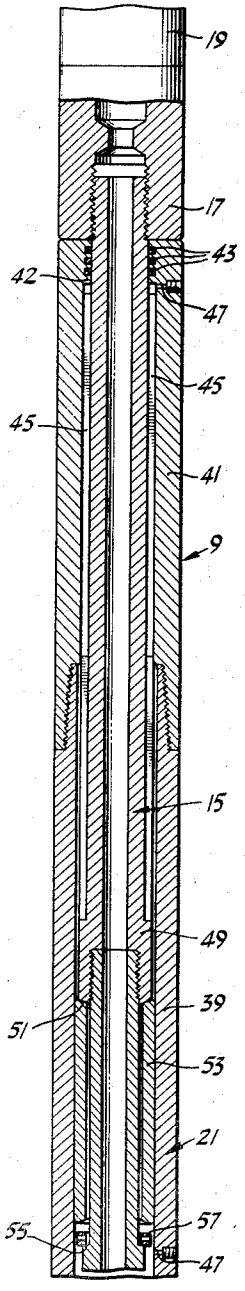


FIG. 2a.

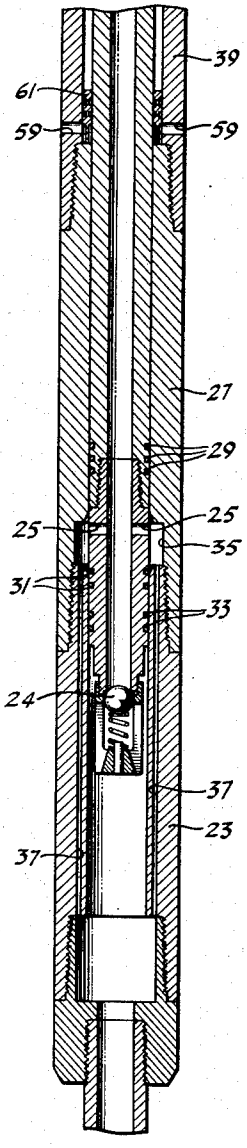


FIG. 2b.

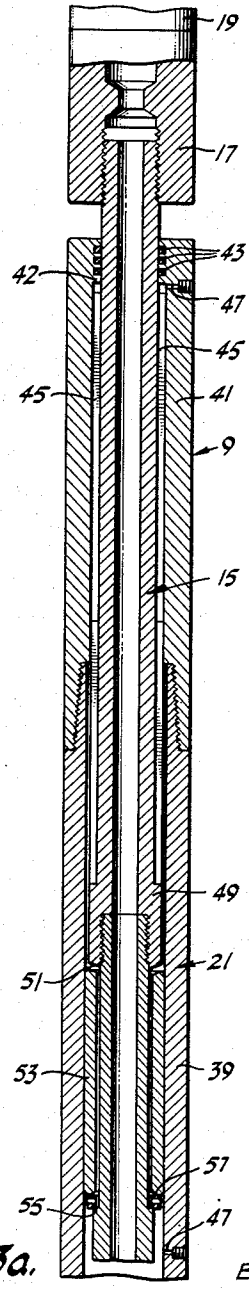


FIG. 3a.

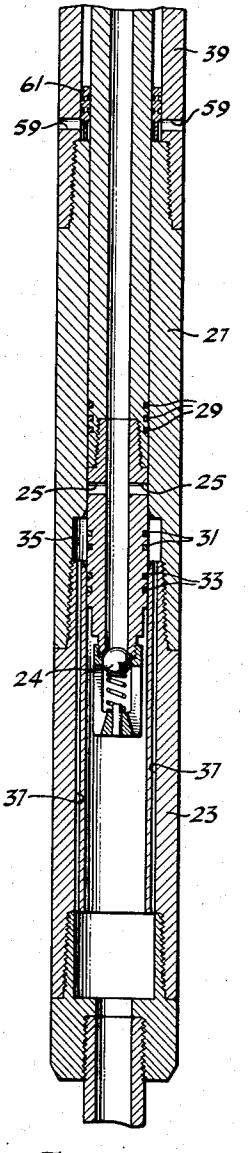


FIG. 3b.

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HYDRAULIC VALVE

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Application September 23, 1952, Serial No. 311,107

6 Claims. (Cl. 251—54)

This invention relates to oil well tools and in particular to a tool including a valve and a hydraulic arrangement for operating the valve. The novel tool of the present invention is ideally suited for incorporation in a formation fluid tester as a substitute for certain assemblies thereof, and the specific embodiment of our invention to be described hereinafter is shown incorporated in such a tester, but the invention is not intended to be limited to such use.

In a formation tester, such as disclosed in the patent to Mordica O. Johnston entitled Formation Tester and granted Mar. 9, 1937, there is included a main valve in the body of the tester, a trip valve adjacent the top, and a packer to be set prior to the opening of the trip valve and at least partially and preferably fully set before the opening of the main valve. The main valve is opened by a partial telescopic movement of parts of the tester, while the trip valve is opened by dropping a go-devil down the drill string supporting the tester.

In cold climates or during cold seasons, mud and water freeze on the inside of the drill pipe while it is at the surface, and when the pipe is added to the string, and lowered into a well, the mud and water melts because of the higher temperatures in the well, so that the liquid trickles down the pipe and collects above the trip valve. It is apparent that this liquid has a cushioning effect on the go-devil, rendering operation of the trip valve uncertain.

It is a main object of the present invention to provide a valve and an arrangement for operating the valve which is not affected by liquid collecting at the top of the tester.

Another main object of the present invention is to provide a valve and a valve operating arrangement of the above general type which can be incorporated in a formation fluid tester to replace both the main valve and the trip valve thereof; to provide a hydraulic valve operating arrangement having delayed valve-opening characteristics so that the valve it controls will not be suddenly opened upon encounter of the tool, as it is lowered into a well, with a bridge or other similar obstruction; and to provide a tool having a valve carrying resilient sealing means which are moved to a position of protection when formation fluid is jetting through the open valve.

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

Figs. 1*a*, 1*b*, and 1*c* are successive longitudinal mid-sectional views of a formation fluid tester having a tool embodying the concepts of the present invention incorporated therein, showing the parts in running-in condition with the valve closed.

Figs. 2*a* and 2*b* are views similar to Figs. 1*a* and 1*b*, showing the parts in the positions they assume after the packer has been set and the valve opened.

Figs. 3*a* and 3*b* are views similar to Figs. 1*a* and 1*b*, showing the parts during closing of the valve.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, there is disclosed a formation fluid tester including an upper section **9**, which comprises the tool of the present invention, and a lower section **11** which forms the lower part of the conventional formation fluid tester. Lower section **11** includes a packer **13** adapted to be set in a well bore to separate the zone to be tested from the drilling mud and other liquid above said zone.

Upper section **9** includes an inner composite tubular mandrel **15**, connected at its upper end by a sub **17** to the lower end of a string of drill pipe **19**, and an outer composite tubular mandrel **21**, connected at its lower end by a sub **23** to the lower section **11** of the tester, and slidably receiving the inner tubular mandrel.

Inner tubular mandrel **15** is closed at its lower end by a spring loaded downwardly opening check valve **24**, and has valve ports **25** formed therein adjacent said lower end. Ports **25** are normally closed by a valve sub **27** within which they are normally disposed. The lower end of the inner mandrel carries on its exterior a series of O rings **29** disposed above ports **25** in sealing engagement with sub **27**, and an upper set **31** and a lower set **33** of O rings below ports **25** in sealing engagement with sub **27**.

Valve sub **27** and lower sub **23** are connected to one another by the usual box and pin connection, and valve sub **27** has formed therein, above the upper end of the pin on lower sub **23**, an annular recess **35** larger than its tubular bore and communicating with longitudinal passages **37** formed in the walls of said lower sub.

It is apparent from Fig. 1*a* that inner mandrel **15**, in running in condition, extends upwardly out of outer mandrel **21**, and can be moved downwardly until sub **17** engages the upper end of said outer mandrel, such movement moving ports **25** down into registry with recess **35** to open said ports to formation fluid passing up through passages **37** into said recess. Such movement does not occur (and is not desired to occur) until after packer **13** has been set, and a means for preventing the opening of valve ports **25** until the packer is set will now be described.

Connected to valve sub **27** is a tubular section **39**, and to section **39** a tubular section **41**, the latter section at its upper end having an inwardly extending flange **42** provided with O rings **43** in sealing engagement with inner mandrel **15**. Section **41** is also slidably but non-rotatably held in contact with said inner mandrel by splines **45**. It is evident that there is an annular chamber provided between sections **39** and **41** and the inner mandrel **15**, which is filled with hydraulic fluid through openings **47** closed by suitable plugs.

Formed on mandrel **15** intermediate its ends is an enlargement **49**, the bottom of which provides a frusto-conical valve seat **51** normally engaging the upper complemental end of a valve sleeve **53**. Valve sleeve **53** is interiorly fluted to provide hydraulic fluid passages between said sleeve and mandrel **15**. The exterior of the valve sleeve has a diameter only slightly less than the interior of tubular section **39** so as to provide a restricted annular hydraulic fluid passage between said valve sleeve and outer tubular mandrel **21** (tubular section **39** obviously being a part of said outer composite tubular mandrel).

Below enlargement **49**, inner mandrel **15** is formed with an upwardly facing shoulder **55** supporting a radially ported ring **57**, which has its interior spaced from the interior of inner mandrel **15**. When valve sleeve **53** is seated on the ring, hydraulic fluid can readily travel from above to below said valve sleeve by passing down between seat **51** and the upper end of said valve sleeve, between said valve sleeve and mandrel **15** and out through the ports in ring **57**.

In order to prevent the formation of voids in the hydraulic fluid chamber, the lower end of tubular section **39** is ported at **59** to allow the pressure of well fluid and drilling mud to be exerted against the lower end of an annular piston **61**, disposed between section **39** and inner mandrel **15** in sealing engagement with each. Upon the escape of any fluid from the chamber, the piston will be moved up by well pressure to maintain the effective volume of the chamber equal to the volume of the fluid therewithin.

In operation, the tool is arranged in the condition shown in Fig. 1*a* with valve sleeve **53** against valve seat **51**, and mandrel **15** disposed at the upper end of its stroke so that valve ports **25** are closed by sub **27**. When running into the well, the valve ports will not be opened because of engagement of the lower end of the

tester with a bridge or similar obstacle, because ready upward movement of outer mandrel **21** relative to inner mandrel **15** is prevented by valve sleeve **53** being seated on its seat.

When the testing zone is reached, the packer can be set by operations (described in the aforementioned patent) including a partial imposition of the weight of the drill string on the upper end of the tester, on inner mandrel **15** in the present instance, which force is transmitted through the hydraulic valve operating arrangement to outer mandrel **21** and thence downwardly to section **11** of the tester. This partial imposition of the weight of the drill string on inner mandrel tends to force said mandrel downwardly relative to the outer mandrel, which movement is resisted by the trapped hydraulic fluid below valve sleeve **53**, said sleeve being firmly seated against seat **51** to prevent upward flow of the trapped fluid between said sleeve and the mandrel, and hence the fluid is slowly forced through the restricted passageway between said sleeve and the outer mandrel. The delay period before said inner mandrel has been forced downwardly to expose ports **25** within recess **35**, is sufficient to allow setting of packer **13**. Therefore, the information zone is separated from the drilling mud and other fluids above the zone prior to the opening of the main valve (ports **25**) of the tester. This insures the entrapment of a less contaminated sample than would otherwise be the case.

It is pointed out that O rings **31** and **33** will be disposed within the protective confines of sub **23**, when inner mandrel is moved downwardly to expose ports **25**, while O rings **29** will remain within the protective confines of valve sub **27**. Contact of the rings with formation fluid jetting up through passages **37** in sub **23** and into inner mandrel **15** will be avoided, therefore maintaining the sealing rings in condition for effective sealing engagement with the interior of valve sub **27** after the formation fluid sample has been taken.

After the testing period is over, an upward pull on the drill string raises inner mandrel **15** to separate seat **51** from the upper end of valve sleeve **53**, and brings ring **57** into engagement with the lower end of said valve sleeve, see Fig. 3*a*. Further upward movement of the drill string is readily permitted because the hydraulic fluid above valve sleeve **53** can freely pass between valve seat **51** and the upper end of said valve sleeve, down between the valve sleeve and inner mandrel **15**, and out through the ports in ring **57**.

If during the test, sand has settled or collected within recess **35**, rings **31** will loosen the sand enough to permit rings **33** to come through the sand without damage, so that rings **33** may correctly seal against the interior of valve sub **27** to retain the sample within the tester and drill string.

It is apparent that the tool can readily be reset by picking up on drill string **19**, if for any reason, such as spudding, the inner and outer mandrel have been telescoped toward valve-opening position.

By the present invention, a tool has been provided including a valve and a hydraulic valve operating arrangement therefor, which valve operating arrangement is effective to transmit a force therethrough to enable setting of a packer therebelow, and operable upon a continued application of such force to open the valve. Because of the delayed operating characteristics of the valve operating arrangement, the valve will not be suddenly opened because of the engagement of the tester (or other tool in which the tool of the present invention is incorporated) with a bridge or similar obstacle within the well. Although the hydraulic valve operating arrangement has been shown and described as being disposed above the main valve (ports **25**), it is apparent that the arrangement could be reversed.

While we have shown the preferred form of our invention, various changes may be made therein by persons 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 device of the class described, comprising inner and outer mandrels telescopically arranged for longitudinal movement relative to one another, a valve formed on the mandrels adapted to be opened upon relative longitudinal movement one way between the mandrels, hydraulic means for retarding such movement, said hydraulic means being operable to readily permit relative longitudinal movement of said mandrels the opposite way, said hydraulic means including a fluid-filled passage formed in the outer mandrel, a plug carried by the inner mandrel obstructing the passage, a restricted passageway by-passing the plug, said plug including a sleeve slidably fitting within the passage and surrounding the inner mandrel, and a valve member on the inner mandrel adapted to seat against the sleeve.

2. A device of the class described, comprising inner and outer mandrels telescopically arranged for longitudinal movement relative to one another, a valve formed on the mandrels adapted to be opened upon relative longitudinal movement one way between the mandrels, hydraulic means for retarding such movement, said hydraulic means being operable to readily permit relative longitudinal movement of said mandrels the opposite way, said hydraulic means including a fluid-filled passage formed in the outer mandrel, a plug carried by the inner mandrel obstructing the passage, a restricted passageway by-passing the plug, said plug including a sleeve slidably fitting within the passage and surrounding the inner mandrel, and a valve member on the inner mandrel adapted to seat against the sleeve, there being a passageway extending between the sleeve and inner mandrel.

3. A device of the class described, comprising an outer tubular mandrel and an inner tubular mandrel telescopically arranged for longitudinal movement relative to one another, said inner mandrel having a lateral port adjacent the lower end thereof, said lower end being closed to the upward flow of fluid therethrough, said outer mandrel having an enlarged recess into which the ported portion of the inner mandrel can be projected, upon downward movement thereof, to establish communication between the recess and the interior of the inner mandrel, hydraulic means for retarding such downward movement, said hydraulic means including a fluid-filled passage formed in the outer mandrel, a plug carried by the inner mandrel obstructing the passage, a restricted passageway by-passing the plug, said plug including a sleeve slidably fitting within the passage and surrounding the inner mandrel, and a valve member on the inner mandrel adapted to seat against the sleeve.

4. A device of the class described, comprising an outer tubular mandrel and an inner tubular mandrel telescopically arranged for longitudinal movement relative to one another, said inner mandrel having a lateral port adjacent the lower end thereof, said lower end being closed to the upward flow of fluid therethrough, said outer mandrel having an enlarged recess into which the ported portion of the inner mandrel can be projected, upon downward movement thereof, to establish communication between the recess and the interior of the inner mandrel, hydraulic means for retarding such downward movement, said hydraulic means including a fluid-filled passage formed in the outer mandrel, a plug carried by the inner mandrel obstructing the passage, a restricted passageway by-passing the plug, said plug including a sleeve slidably fitting within the passage and surrounding the inner mandrel, and a valve member on the inner mandrel adapted to seat against the sleeve, there being a passageway extending between the sleeve and inner mandrel adapted to be closed when the valve member seats on the sleeve.

5. A device of the class described, comprising an outer tubular mandrel and an inner tubular mandrel telescopically arranged for longitudinal movement relative to one another, said inner mandrel having a lateral port adjacent the lower end thereof, said lower end being closed to the upward flow of fluid therethrough, said outer mandrel having an enlarged recess into which the ported portion of the inner mandrel can be projected, upon downward movement thereof, to establish communication between the recess and the interior of the inner mandrel, and hydraulic means for retarding such downward movement, said inner mandrel carrying spaced sealing means thereon below the port, said outer mandrel having a reduced portion below the recess dimensioned to slidably receive the lower end of the inner mandrel, said outer mandrel having passages formed therein by-passing the reduced portion and communicating with the recess.

6. A device of the class described, comprising an outer tubular mandrel and an inner tubular mandrel telescopically arranged for longitudinal movement relative to one

another, said inner mandrel having a lateral port adjacent the lower end thereof, said lower end being closed to the upward flow of fluid therethrough, said outer mandrel having an enlarged recess into which the ported portion of the inner mandrel can be projected, upon downward movement thereof, to establish communication between the recess and the interior of the inner mandrel, and hydraulic means for retarding such downward movement, said inner mandrel carrying spaced sealing means thereon below the port, said outer mandrel having a reduced portion below the recess dimensioned to slidably receive the lower end of the inner mandrel, said outer mandrel having passages formed therein by-passing the reduced portion and communicating with the recess, there being sealing means on the inner mandrel above said port, said hydraulic means being operable to readily permit upward movement of the inner mandrel to withdraw said ported portion of the inner mandrel from the recess.

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