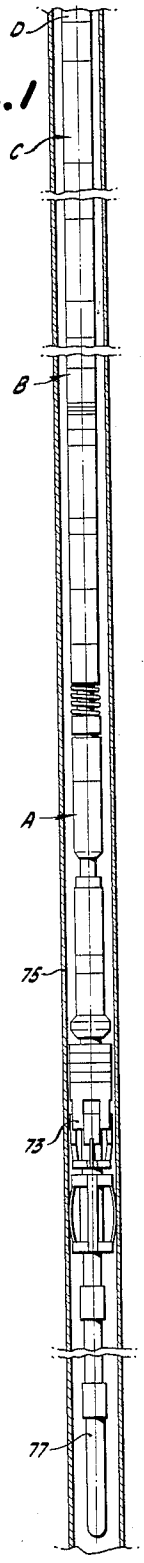
Sept. 13, 1955 M. O. JOHNSTON 2,717,646

BACK CIRCULATOR APPARATUS

Filed July 5, 1951

FIG. 1



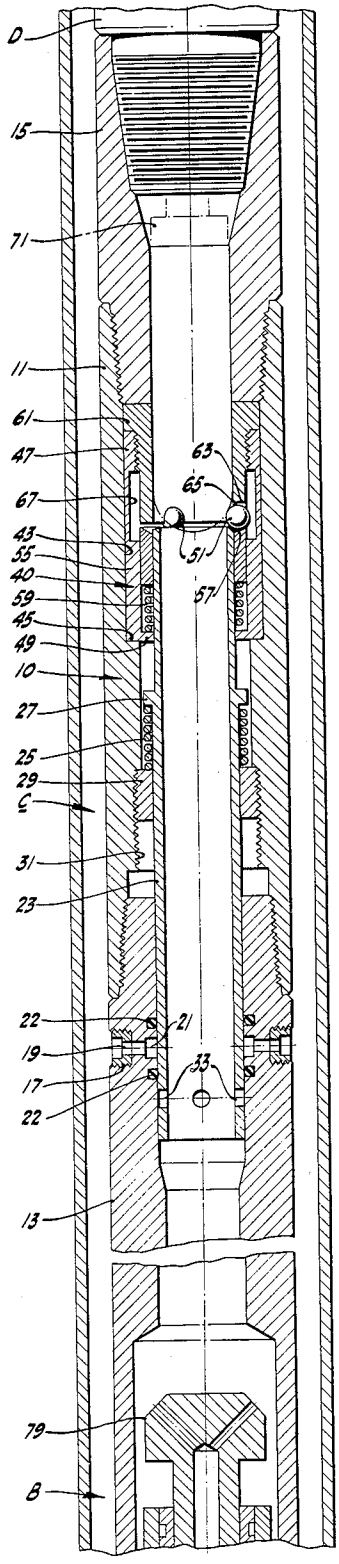


FIG. 2

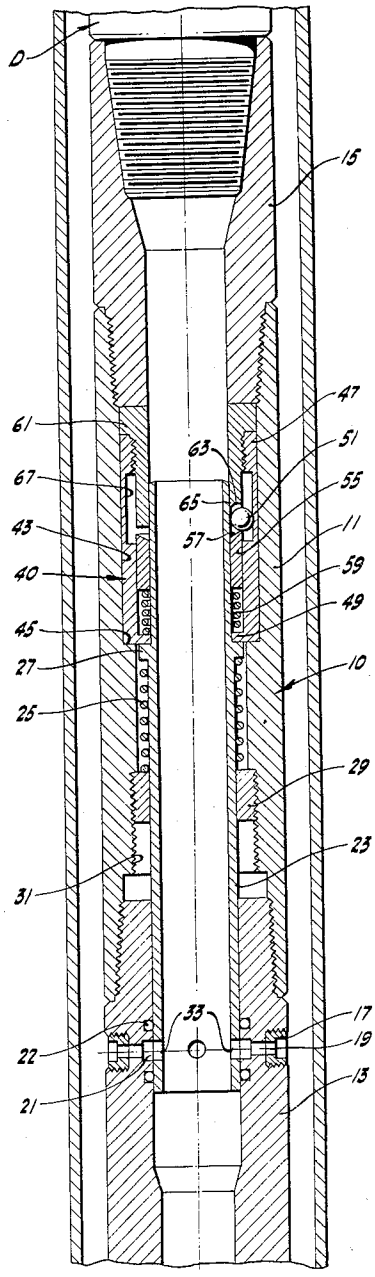


FIG. 3

INVENTOR.
MORDICA O. JOHNSTON

BY

Mellin and Hanscom
ATTORNEYS

United States Patent Office 2,717,646 Patented Sept. 13, 1955

2,717,646

BACK CIRCULATOR APPARATUS

Mordica O. Johnston, Glendale, Calif., assignor, by mesne assignments, to Johnston Testers, Inc., Houston, Tex., a corporation of Delaware

Application July 5, 1951, Serial No. 235,335

5 Claims. (Cl. 166—224)

This invention relates to an oil well tool, particularly to a reverse circulating or back scuttling valve.

In oil well production practice, it is necessary at various times to circulate drilling mud or other fluid down the annular space between a drill string and a casing or bore, through a valve in the drill string and up through the drill string. Sometimes this reverse circulation is performed to back scuttle gas and oil under control from the drill string, for instance to eliminate a fire hazard. Also, sometimes during the pulling of a drill string, it is necessary to reverse circulate to maintain control over the well, which may get somewhat out of control for various reasons, for instance, because the hydrostatic head in the well drops due to the removal of the drill string from the region of the well fluid, allowing high pressure areas previously controlled by the hydrostatic head to get somewhat out of control.

There have been previous back scuttling valves but, in general, these have been operable only when the string was bottomed or set in the well by means of a packer or slips or the like, these valves being operable by relative movement, rotational or longitudinal, between the lower part of the drill string, which is fixed in the well and carries one part of the valve, and the upper free part of the drill string which carries the other part of the valve.

When the necessity for back scuttling or reverse circulation arises, the back scuttling valve must be opened quickly to enable immediate control over the well to avoid damage and waste. In many instances, there is not time nor is it practical or in some cases possible to reset a packer or again bottom the drill string to enable opening of a back scuttling or reverse circulation valve.

It is a main object of the present invention to provide a back scuttling valve adapted to be connected between sections of drill string, which valve can be opened when the drill string is off bottom and without setting a packer or equivalent device.

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

Fig. 1 shows a reverse circulating valve embodying the concepts of the present invention being incorporated in a drill string.

Fig. 2 is a vertical section through the upper portion of the string disclosed in Fig. 1 showing the reverse circulating valve in closed position and showing a trip valve therebelow.

Fig. 3 is a view similar to Fig. 2, showing the reverse circulating valve in open position to permit back scuttling or reverse circulation.

The invention will be described with reference to a drill string having a reverse circulating valve embodying the concepts of the present invention incorporated therein and located above a connate sample tester connected on the lower end of the drill string, but this description is not intended to limit the invention but merely to illustrate a practical application of the present invenion.

Referring to the accompanying drawings, wherein similar reference characters designate similar parts throughout, the drill string disclosed in Fig. 1 includes a connate sample tester generally entitled A, having a trip valve assembly generally entitled B, said parts being disposed below a reverse circulating valve assembly C, which in turn is connected to the upper portion of the drill string D.

The reverse circulating valve assembly C includes a tubular composite valve housing generally entitled **10** composed of an upper tubular valve housing member **11** threadedly connected to a lower tubular valve housing member **13** which preferably takes the form of a sub for connection to lower sections of drill string (not shown) which are in turn connected to the connate tester A, the reverse circulating valve and the connate tester being separated a distance of 100 or 200 feet by such sections of drill pipe for reasons to be explained. The housing member **11** is preferably connected to drill string D by means of an upper sub **15**, as clearly shown in Fig. 3.

Lower sub **13** has externally threaded bushings **17** threadedly received within threaded bores provided in the walls of sub **13** providing ports **19** communicating with the exterior of the housing and with the interior of the housing through the medium of an annular groove **21** provided about the interior of sub **13**.

Slidably disposed within valve housing member **11** is a valve sleeve **23** slidably fitting within sub **13** and normally covering ports **19**, but urged to port-uncovering position, as shown in Fig. 3, by a compression spring **25**. Compression spring **25** at its upper end engages a flange **27** on sleeve **23** and at its lower end engages a spring retaining nut **29** threadedly received within a threaded counterbore **31** provided in valve housing member **11** and slidably receiving sleeve **23**. Suitable O ring seals **22** are carried in annular grooves provided in the interior of sub **13** for sealing engagement with sleeve **23**.

Sleeve **23** is provided with ports **33** at the lower end thereof adapted to be brought into registry with annular groove **21** in sub **13** when the sleeve moves from the position shown in Fig. 2 to the position shown in Fig. 3, permitting circulation through the ports **19** from the exterior to the interior of the composite valve housing or vice versa.

Sleeve **23** is normally retained in port-covering position by means of a valve trip mechanism, generally entitled **40**. The valve trip mechanism **40** is constructed as an assembly which is slidably received as a unit within a counterbore **43** provided in the upper end of valve housing member **11**, said valve trip mechanism **40** resting on an upwardly facing shoulder **45** defining the lower end of the counterbore **43**. The valve trip mechanism is retained in place by the lower end of upper sub **15**, as clearly shown in Figs. 2 and 3.

Valve trip mechanism **40** includes a spring housing **47** having an inwardly extending flange **49** at the lower end thereof slidably receiving the upper portion of sleeve **23** and adapted to engage flange **27** on sleeve **23**, when the sleeve is released and moves upwardly as shown in Fig. 3, to limit upward movement of sleeve **23**. There are a plurality of ball detents **51** engaging the upper edge of sleeve **23**, said upper edge externally beveled so that the upper edge of sleeve **23** effectively urges the ball detents **51** outwardly. Urging ball detents **51** inwardly is a ball retaining sleeve **55** telescopically received between spring housing **47** and sleeve **23** and having an internally beveled upper edge **57** engaging ball detents **51** and serving to dispose ball detents **51** in a position resting partly on the upper edge of sleeve **23** and partly on the upper edge of ball retaining sleeve **55**. Ball retaining sleeve **55** is urged upwardly by compression spring **59** which is disposed between the lower end of ball retaining sleeve **55** and flange **49** on spring housing **47**. There is a ball retaining nut **61** threaded in the upper end of spring

housing 47 and provided with notches 63 around the lower end thereof to receive ball detents 51 and limit upward movement of the balls. The notches 63 may be in part defined by downwardly extending lugs 65 for co-acting with the upper beveled edge of sleeve 23 to prevent inward movement of ball detents 51 into the central passage of the valve assembly.

Spring housing 47 has an annular groove 67 formed interiorly therearound (as shown in Figs. 2 and 3) to accommodate ball detents 51 when the detents are moved outwardly against the resistance of compression spring 59.

As is apparent from Fig. 2, ball detents 51 in the position shown are prevented from outward radial movement by compression spring 59 and prevented from inward movement by the upper beveled edge of sleeve 23 and compression spring 25 for sleeve 23. The ball detents 51 can therefore be moved into the annular groove 67 in spring housing 47 when a reverse circulating valve type go-devil 71 is dropped down the drill string to simultaneously engage the inwardly protruding portions of all the ball detents 51 and force the balls into the annular groove 67 against the resistance of spring 59. When the balls are forced outwardly, sleeve 23 is released and forced upwardly by spring 25 until flange 27 engages flange 49 of spring housing 47, at which position the ports 33 in sleeve 23 are aligned with the annular groove 21 in sub 13. In this position the reverse circulating valve is open and back scuttling or reverse circulation can take place.

One practical application of the reverse circulating valve C is disclosed in Fig. 1, where it is incorporated in the drill string at a point spaced from and above the connate sample tester A, which may be of any suitable type.

This type of tester includes a packer assembly at 73 for setting the tester in a well casing 75 to separate the space below the packer from which the test sample is to be removed from the space above the packer to avoid contamination of the fluid below the packer by fluid, drilling mud and the like, above the packer. The tester includes a perforated anchor 77 through which the connate fluid passes into the tester. There are various valves within the tester, not necessary here to describe, for shutting in and retaining the sample after the sample flows upwardly into the tester and drill string. The trip valve assembly at B, in the type of tester disclosed, has a trip valve 79 adapted to be tripped by a tester type go-devil which is dropped from the surface. This tester type go-devil is constructed so that it will not strike all the ball detents 51 at the same time and, therefore, can be dropped through the drill string to trip valve 79 without tripping valve trip mechanism 40 for the reverse circulating valve. Trip valve 79 is tripped to permit connate fluid to flow upwardly past the trip valve and into the drill string.

In operation, a string as disclosed in Fig. 1 is lowered in a well, the packer 73 set, and the various valves within the tester opened to permit connate fluid to flow upwardly to the trip valve 79. A tester go-devil is then dropped down the drill string and passes by ball detents 51, strikes trip valve 79 tripping the valve and allowing connate fluid to flow upwardly into the drill string. The connate fluid may, and usually does, flow upwardly past the reverse circulating valve to a point at which there is an equilibrium between the height of the connate fluid in the drill string and the pressure of the fluid in the formation. After a sample is trapped, the drill string may be removed and the sample recovered.

However, the connate fluid flowing into the tester may contain a high percentage of gas of a very volatile nature and, also, the fluid may be under fairly high pressure, therefore creating a fire hazard at the surface unless the connate fluid is brought to the surface under control. If the conditions creating a fire hazard are realized befor the packer 73 is collapsed, a reverse circulating valve in the tester can be operated to communicate the annular space between the casing 75 and the tester A with the interior of the tester to allow circulating mud or fluid to be forced downwardly through the annular space between the string and casing, through the reverse circulating valve in the tester, and up through the drill string to force gas and oil upwardly through the string to the surface under control.

It frequently happens, however, after the packer 73 has been collapsed and the string is in the process of being pulled up that it is necessary to back scuttle or reverse circulate to bring gas and oil to the surface under control, or to maintain complete control over the well for other reasons well known in the art. Under these conditions, it is usually imperative that back scuttling or reverse circulation be established immediately, and there may not be sufficient time, nor may it be practical or possible to reset the packer because of the conditions in the well; therefore, a reverse circulating valve type go-devil 71 can be dropped down the drill string to simultaneously strike all the ball detents 51, forcing the balls outwardly to release sleeve 23, enabling the sleeve to be moved upwardly by the compression spring 24, aligning ports 35 in the sleeve with the annular groove 21 and ports 19 in sub 13, to allow drilling mud to be reversely circulated, therefore reassuming control over the well.

It is pointed out that the portion of the connate fluid below the reverse circulating valve may be recovered by removal of the drill string after the reverse circulating operation is completed.

By the present invention, a reverse circulating valve has been provided which can be incorporated in a drill string, and be opened when the drill string is off bottom and without setting a packer or equivalent device. Obviously, the reverse circulating valve could be used to merely open the interior of the drill string to the exterior for other purposes as desired. The reverse circulating valve could obviously also be located at different places along the drill string, and also provided in drill strings built up for other purposes than sample testing.

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

1. A reverse circulating valve of the type adapted to be incorporated in a drill string, comprising a tubular valve housing having a central bore therethrough and having a port in the wall thereof communicating the exterior of the housing with the interior of said housing, a sleeve slidably disposed within the housing bore and covering the port, and releasable means holding the sleeve in port-covering position, said releasable means including at least one sleeve-holding element mounted in said housing for radial movement inwardly and outwardly with respect thereto, means connected to said housing for preventing upward movement of said sleeve-holding element relative to said housing, said element when in its inward position extending inwardly of the housing bore wall to engage said sleeve to prevent port-uncovering movement thereof and adapted to be engaged by a go-devil to be forced outwardly to release the sleeve.

2. A reverse circulating valve of the type adapted to be incorporated in a drill string, comprising a tubular valve housing having a central bore therethrough and having a port in the wall thereof communicating the exterior of the housing with the interior of said housing, a sleeve slidably disposed within the housing bore and covering the port, and releasable means holding the sleeve in port-covering position, said releasable means including at least one sleeve-holding element mounted in said housing for radial movement inwardly and outwardly with respect thereto, means connected to said housing for preventing upward movement of said sleeve-holding element relative to said housing, said element when in its inward position extending inwardly of the housing bore wall to engage said sleeve to prevent port-uncovering movement thereof and adapted to be engaged

by a go-devil to be forced outwardly to release the sleeve, and spring means urging said sleeve against said element.

3. A reverse circulating valve of the type adapted to be incorporated in a drill string, comprising a tubular valve housing having a central bore therethrough and having a port in the wall thereof communicating the exterior of the housing with the interior thereof, a sleeve slidably disposed within the housing and covering the port, releasable means holding the sleeve in port-covering position, said releasable means including a plurality of balls mounted in said housing for radial movement inwardly and outwardly with respect thereto, a thrust member connected to said housing for preventing upward movement of said balls relative to said housing, said balls when in their inward position extending inwardly of the housing more wall to engage said sleeve to prevent port-uncovering movement thereof and adapted to be engaged by a go-devil to be forced outwardly to release the sleeve, and spring means urging the sleeve upwardly against the balls.

4. A reverse circulating valve of the type adapted to be incorporated in a drill string, comprising a tubular valve housing having a central bore therethrough and having a port in the wall thereof communicating the exterior of the housing with the interior thereof, a sleeve slidably disposed within the housing and covering the port, releasable means holding the sleeve in port-covering position, said releasable means including a plurality of balls mounted in said housing for radial movement inwardly and outwardly with respect thereto, a thrust member connected to said housing for preventing upward movement of said balls relative to said housing, said balls when in their inward position extending inwardly of the housing bore wall to engage said sleeve to prevent port-uncovering movement thereof and adapted to be engaged by a go-devil to be forced outwardly to release the sleeve, spring means urging the sleeve upwardly against the balls, said releasable means also including and upwardly biased ball-retaining sleeve surrounding the first-named sleeve and having an inwardly beveled upper edge engaging the balls and urging the same inwardly, means biasing said ball-retaining sleeve upward, and lugs depending from said thrust member limiting such inward movement.

5. A reverse circulating valve of the type adapted to be incorporated in a drill string, comprising a tubular valve housing having a central bore therethrough and having a port in the wall thereof communicating the exterior of the housing with the interior thereof, a sleeve slidably disposed within the housing and covering the port, releasable means holding the sleeve in port-covering position, said releasable means including a plurality of balls mounted in said housing for radial movement inwardly and outwardly with respect thereto, a thrust member connected to said housing for preventing upward movement of said balls relative to said housing, said balls when in their inward position extending inwardly of the housing bore wall to engage said sleeve to prevent port-uncovering movement thereof and adapted to be engaged by a go-devil to be forced outwardly to release the sleeve, spring means urging the sleeve upwardly against the balls, said releasable means also including an upwardly biased ball-retaining sleeve surrounding the first-named sleeve and having an inwardly beveled upper edge engaging the balls and urging the same inwardly, means biasing said ball retaining sleeve upwardly, and lugs depending from said thrust member limiting such inward movement, said spring means exerting a force insufficient to cause said first-named sleeve to move the balls outwardly against the force of said retaining sleeve urging means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,073,107	Johnston	Mar. 9, 1937
2,132,072	Johnston	Oct. 4, 1938