March 18, 1969 T. A. KENNARD 3,433,252

FLUID CONDUIT VALVE

Filed Dec. 5, 1966 Sheet 1 of 2

Fig. 1

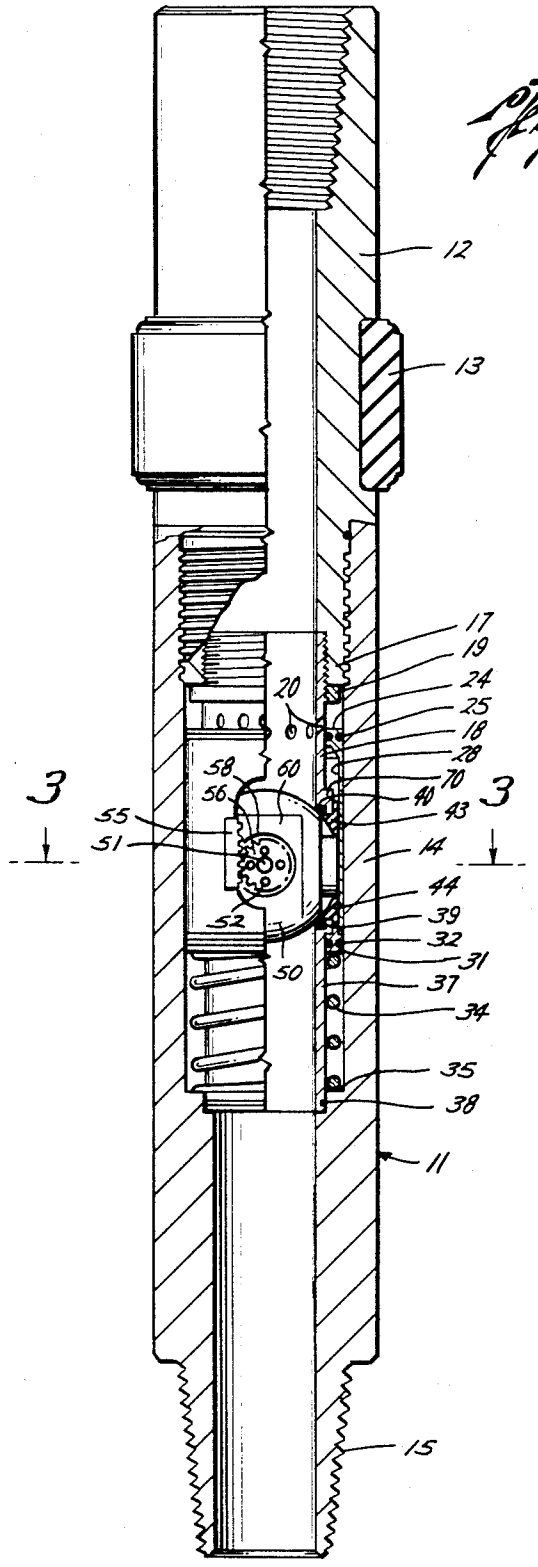


Fig. 3

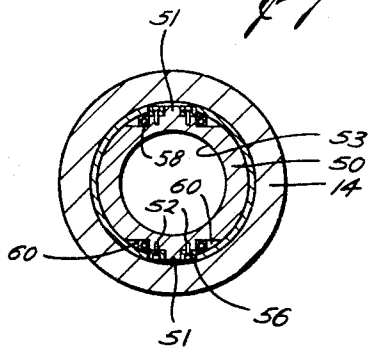
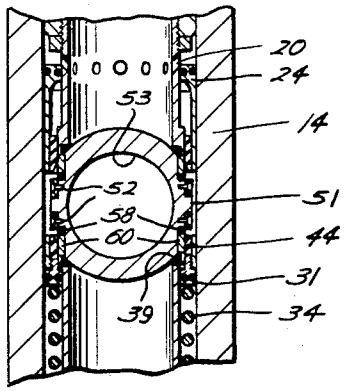


Fig. 2



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Filed Dec. 5, 1966 Sheet 2 of 2

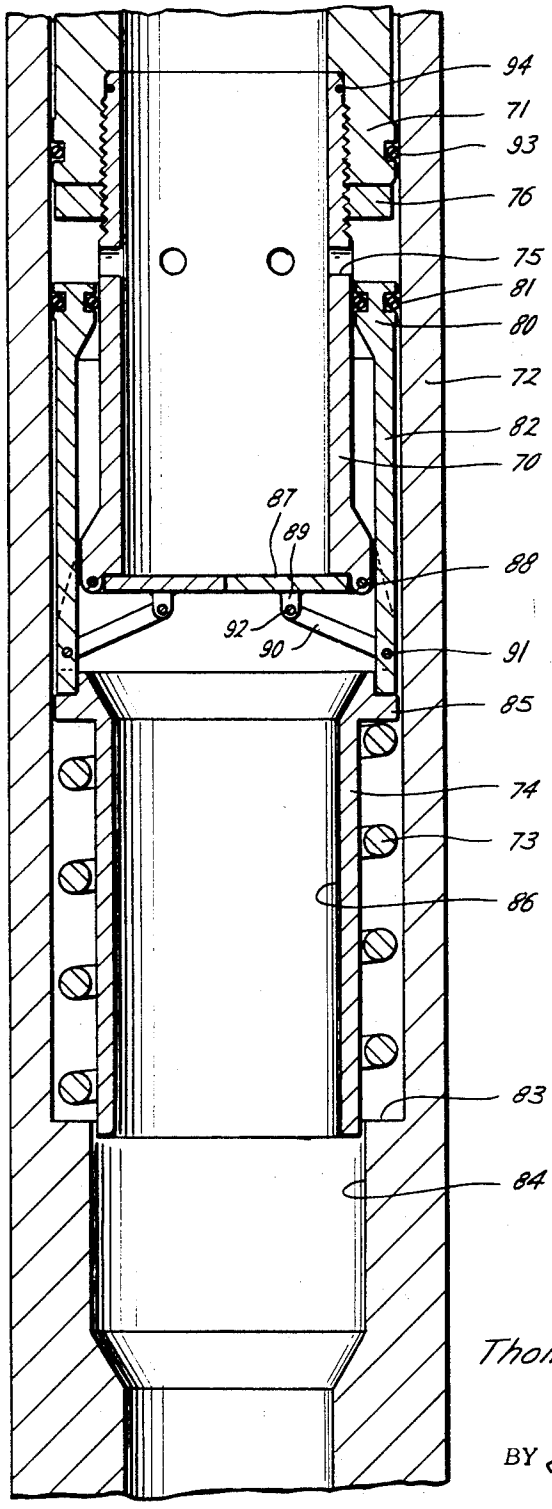


Fig. 4

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United States Patent Office 3,433,252
Patented Mar. 18, 1969

3,433,252

FLUID CONDUIT VALVE

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Continuation-in-part of application Ser. No. 409,648, Nov. 9, 1964. This application Dec. 5, 1966, Ser. No. 605,119
U.S. Cl. 137—496 7 Claims
Int. Cl. F16k 3/02

ABSTRACT OF THE DISCLOSURE

A valve for inclusion in a fluid conduit for controlling fluids flow therethrough. The valve is responsive to changes of fluid pressure in the conduit for moving to and from the closed position. The valve is particularly useful for inclusion in a drill string below the kelly to prevent loss of drilling fluid while making connections during make-up and break-out while performing downhole drilling operations. In such use, the valve is designed to close upon termination of the pumping of fluid through the kelly, and in the closed position supports a column of drilling fluid thereabove to prevent its being lost onto the drilling platform.

This application is a continuation-in-part of co-pending application SN 409,648 filed Nov. 9, 1964, entitled, "Valve Sub," now Patent No. 3,289,691.

This invention relates to a valve for inclusion in a fluid conduit for controlling fluid flow therethrough. More particularly, it relates to a valve which is responsive to fluid pressure to thereby open or close in response to changes in the pressure above or below a predetermined level. The valve of this invention has particular utility for inclusion in a drill string below the kelly to prevent loss of drilling fluid while making connections during make-up and break-out operations in downhole drilling.

One of the problems encountered during make-up and break-out of drill string during downhole drilling operations is that drilling fluid contained in the kelly will be lost onto the drilling platform whenever the kelly and the kelly saver sub is broken from the balance of the drill string. The result is that the lost mud creates dangerous working conditions on the drilling platform. Moreover, many muds or drilling fluids are extremely expensive thereby causing great economic loss.

Certain prior art valves had been developed for the purpose of preventing this loss. However, they have for the most part been hand operated such that it was difficult to open and close the valves at the desired times because of the inexcessability of the valve at a point high in a derrick during certain phases of the operation. Moreover, they required the use of a separate wrench which created the hazard of the wrench being dropped into the bore hole.

Other prior art devices have been developed which are responsive to fluid pressure applied by the pumps pumping the drilling fluid, but certain of these valves have not been full opening or have otherwise diverted the drilling fluid such that the sub which contained the valve was subjected to erosion caused by the abrasive action of the drilling fluid witht he result that quite often the valve sub would quickly break and thereby drop the drill string into the bore hole necessitating a fishing operation.

It is therefore an object of this invention to provide an improved conduit closure valve which is particularly useful for inclusion in a drilling string to overcome the aforesaid problems.

Briefly stated, the invention herein comprises a body member having means for attaching in the fluid conduit

and having an axial bore therethrough. Piston means are mounted for axial movement in the body member, with the piston means including a generally tubular member having an axial bore therethrough of a diameter substantially as large as the diameter of the bore through the drill string. Resilient biasing means are provided for urging the piston means generally upwardly. Full opening bore closing means are provided which are connected to the piston means and adapted to be placed in the closed position by movement of the piston means upwardly. Means are also provided for applying a pressurized fluid to the piston means to thereby drive the piston means downwardly and to move the bore closing means to the open position. In certain embodiments of the invention the bore closure means may be in the form of a pair of flap gates.

In another embodiment of this invention, and which is the presently preferred embodiment, the bore closure means is in the form of a generally annular rotatable bore closure member mounted for rotation to and from the closed position in the body member by movement of the piston means. It is to be understood that the term "annular rotatable bore closure means" is intended to include not only ball type valve closure members, but plug type valve closure members which may be cylindrical in shape, conical in shape or the like. In this embodiment, rotation means are provided and connected between the closure member and the piston means for rotating the closure member to and from the closed position in response to relative movement of the piston means.

Further reference to the drawings will further explain the invention wherein like numerals refer to like parts and in which:

FIG. 1 is a central vertical section of the presently preferred embodiment of the invention showing the closure member in the closed position.

FIG. 2 is a partial central sectional view of the valve closure member shown in FIG. 1 and taken at an angle transverse to that shown in FIG. 1.

FIG. 3 is a view of the valve closure member taken generally along line 3—3 of FIG. 1, but showing the valve closure member in the open position.

FIG. 4 is a central vertical sectional view of another embodiment of the invention.

Referring now to the FIGS. 1, 2 and 3 generally, the presently preferred embodiment of the invention will be described in detail. The valve is comprised of a body member generally indicated by the numeral **11** which is comprised of a top connector **12** having an axial bore therethrough and upper box thread end for connection to the pin end of an adjacent section of the drilling string, as for example, the lower end of a kelly. Top connector **12** has supported thereabout a sub protector **13** for protecting wear thereon. The lower end of top connector **12** is provided with a reduced end portion **17** having external threads which are connected to and support tubular portion **14** of body member **11** which deep ends therebelow. The lower end of tubular portion **14** is provided with pin end **15** for connection to an adjacent section of the conduit, for example, a section of drill pipe. Tubular portion **14** likewise has an axial bore therethrough which is generally of the same diameter as the bore through the drill string and is additionally provided with an enlarged bore thereby forming shoulder **35** in the lower portion thereof for supporting compression spring **34** therein.

Reduced end portion **17** of top connector **12** is provided with internal threads which engage and support upper inner sleeve **18** in a fixed relationship. Sleeve **18** has a conduit means therethrough which provide fluid communication between the bore of top connector **12** and

the annular space between sleeve **18** and tubular portion **14**, which space may sometimes be referred to as the piston chamber. Inner sleeve **18** is locked in position by means of lock ring **19** which is threaded thereabout into abutting engagement with the lower end of reduced end portion **17**. Sleeve **18** has an externally enlarged lower portion which supports upper Teflon seal **40**, which abuts against the valve closure means in the form of ball valve **50**.

The piston chamber formed between inner sleeve **18** and tubular portion **14** has mounted therein piston means including an annular piston head **24** having internal and external O-ring seals **25** thereabouts and is connected to a tubular member in the form of piston sleeve **28**, which is adapted for relative axial movement up and down in the piston chamber.

The lower end of piston sleeve **28** has connected thereto, as by threads, lower annular piston head **31** which likewise is provided with internal and external annular O-ring seals **32** for sealing engagement with the adjacent walls.

The lower side of ball valve **50** is additionally supported by a fixed lower sleeve **37**, which abuts against the lower end of tubular portion **14** and is provided with O-ring seal **38** thereabout for sealing engagement therewith. The upper end of internal sleeve **37** is provided with an externally enlarged portion which supports lower Teflon seal **39** which abuts in sealing engagement with the lower side of ball valve **50**. There is also supported between ball valve **50** and piston sleeve **28** an annular upper Teflon filler seal **43** and a lower Teflon filler seal **44** for sealing engagement therebetween.

Ball valve **50** is provided with an opening **53** therethrough which is generally the same inside diameter as the bore through body member **11**, such that the closure member may be described as being full opening.

Ball valve **50** is adapted for rotation to and from the closed position on a pair of spindles **51** spaced on opposite sides thereof for rotation thereabout.

Each of the spindles **51** has supported thereabout a ball bearing **58** and also attached thereto a pinion gear **56**, which gears are attached thereto by means of mounting screws **52**. Ball valve **50** is further supported by a pair of polished metal thrust plates **60** which support the outside race of bearings **58**. Thrust plates **60** are supported inside of piston sleeve **28**, which thereby positions ball valve **50** in the tool and secures it from axial movement therein.

Means are provided for rotating ball valve **50** to and from the closed position, which means conveniently take the form of rack and pinion gear means including rack gears **55** connected to or attached to sleeve **28** for engagement with and rotation of pinion gears **56**. Hence, during relative axial movement of piston sleeve **28** ball valve **50** is rotated to and from the closed position. In the embodiments shown in FIGS. 1, 2 and 3, ball valve **50** is adapted for rotation to the closed position by relative axial movement of piston sleeve **28** upwardly.

In operation, the valve is installed in a conduit such as being attached in a drill string below the kelly in the manner shown in FIG. 1. Ball valve **50** would be in the closed position by virtue of the fact that compression spring **34** is urging piston sleeve **28** in a first direction, i.e., upwardly, which thereby causes rack gears **55** to rotate pinion gears **56** such that ball valve **50** is rotated to the closed position. In this position, ball valve **50** is adapted to support a column of drilling fluid thereabove. When the pump associated with supplying drilling fluid down through the kelly starts up, the pressure of the fluid is applied through ports **20** to the upper end of the piston chamber and to the upper end of piston head **24**. When this pressure exceeds the predetermined pressure exerted by compression spring **34**, piston sleeve **28** is driven downwardly, thereby rotating ball valve **50** to the open position as shown in FIG. 3, whereby ball valve

50 is moved to the full open position to permit the passage of the drilling fluid downwardly through bore **53** of valve **50**. When it becomes necessary to disconnect the lower end of body member **11** from the drill string in preparation for either adding or removing another section of drill pipe, pressure on the drilling fluid above valve **50** is terminated at which point spring **34** biases or urges piston sleeve **28** upwardly thereby rotating ball valve **50** to the closed position again, thereby supporting the column of drilling fluid thereabove.

The foregoing description described the presently preferred embodiment of the invention. Because of its particular construction, the working parts are substantially isolated from the corrosive effects of the drilling fluid. Moreover, a valve constructed in accordance with the embodiments shown in FIGS. 1, 2 and 3 can withstand great tensional forces. For example, a valve sub made in accordance with the invention shown therein and provided with a 6¼" O.D. and a 3" I.D. has been shown to have a yield strength of 653 tons, which is adequate to support most drill strings without danger of dropping the drill string. Moreover, because of the full opening nature of the tool, there is very little likelihood of the drilling fluid abrading away or weakening the structure to thereby cause breaking of the tool, which might result in dropping of the drill string. The device is also able to withstand a differential pressure of 10,000 lbs. in the closed position from the bottom direction and therefore acts as a blow-out preventor in the closed position. In the preferred embodiment, spring **34** might be provided with a predetermined force of 200 p.s.i. for example. The externally enlarged lower portion of upper sleeve **18** also acts as a stop point for the downward movement of piston head **24** and lock ring **19** acts as a stop for upward movement thereof in the piston chamber.

Not only may the foregoing tool be used as a valve closure means, but it also substitutes for the normal kelly saver sub which is usually attached immediately below the kelly. It is to be understood that the various metal parts of the tool may be chrome plated to further reduce the corrosive effects of any drilling fluid passed therethrough.

Referring now to FIG. 4 an alternate embodiment of the invention is shown. The tool is comprised of tubular portion **72** which corresponds with tubular portion **14** shown in FIG. 1 and has means (not shown) for connecting the lower end thereof to an adjacent section of drill pipe. Tubular portion **72** is connected to a top connector (not shown) such as top connector **12** shown in FIG. 1, which has a reduced end portion **71** which corresponds with reduced end portion **17** shown in FIG. 1 with seal ring **93** therebetween.

Reduced end portion **71** has internal threads which threadedly engage and support upper inner sleeve **70** with a seal ring **94** therebetween and which has a plurality of ports **75** which communicate with the annular piston chamber formed between inner sleeve **70** and tubular portion **72**. Inner sleeve **70** is locked in position by means of lock ring **76** which abuts against the lower end of reduced end portion **71** in the same manner as lock ring **19** shown in FIG. 1.

In this embodiment the lower end of inner sleeve **70** has pivotally connected thereto a pair of flapper gates **87** which are generally semicircular in plan view and adapted to seal off flow of drilling fluid downwardly through the bore of the tool in the closed position. It is to be understood that flapper gates **87** are pivotally connected by means of hinge pins **88**, as shown. The lower side of flap gates **87** are provided with lugs **89** which are pivotally connected by hinge pins **92** to arms **90**, the lower ends of which are connected for pivotal movement with the lower end of piston sleeve **82** by means of hinge pins **91**.

Piston sleeve **82** is generally tubular in shape and is adapted for up and down movement in the piston chamber described above. In addition, piston sleeve **82** has

connected to the upper end thereof piston head **80** which is provided with internal and external O-ring seals **81** for sealing engagement with adjacent walls.

The lower end of piston sleeve **82** is adapted to abut against and engage the upper end of sleeve head **85**, which is in the form of an external flange attached to the upper end of moveable lower internal sleeve **74**. Internal sleeve **74** is provided with a sleeve bore **86** which is generally of the same size as the bore through the tool and permits fluid flow therethrough. Internal sleeve **74** is adapted for up and down movement in intermediate bore **84** provided in tubular portion **72** as shown. Biasing means in the form of compression spring **73** is provided in the annular space between sleeve **74** and tubular portion **72** and is arranged to abut at its lower end on shoulder **83** and at its upper end to the lower side of sleeve head **85**.

As with the compression spring **34** shown in FIG. 1, compression spring **73** is selected to provide a predetermined upper biasing force to sleeve head **85**, which thereby forces piston sleeve **82** and piston head **80** upwardly, thereby carrying flapper gates **87** to the closed position. In the closed position flapper gates **87** are arranged to support a column of drilling fluid thereabove. When the drilling fluid pressure is applied downwardly through the tool, the drilling fluid pressure is applied through ports **75** to the piston chamber to thereby drive piston head **80** and hence piston sleeve **82** downwardly when the pressure exceeds the force exerted by compression spring **73**.

The operation of this embodiment of the tool is similar to that described with respect to FIGS. 1, 2 and 3. The closure means are full opening and are adapted to be placed in a closed position by movement of the piston means upwardly as described. The closure means are adapted for movement to the open position by downward movement of the piston means. It is to be understood that spring **73** is provided with a predetermined force sufficient to move flapper gates **87** to the closed position and support a column of fluid thereabove which can be overcome by the application of pressure to the drilling fluid in excess of hydrostatic pressure, whereby the flapper gates **87** may be moved to the open position by the application of pressure to the drilling fliud.

Modifications may be made in the invention as particularly described without departing from the scope of the invention. Accordingly, the foregoing description is to be construed as illustratively only and is not to be construed as a limitation upon the invention as defined in the following claims.

What is claimed is:

1. A valve sub for including in a drill string below the kelly to prevent loss of drilling fluid while making connections during down hole drilling comprising:

a body member having means for attaching in said drill string and having an axial bore therethrough and a piston chamber therein;

piston means mounted for axial movement in said piston chamber in said body member, said piston means including a generally tubular member having an axial bore therethrough of a diameter substantially as large as the diameter of the bore through the drill string;

resilient biasing means for urging said piston means upwardly when pressure on said drilling fluid is below a predetermined level;

full opening bore closing means connected to said piston means and adapted to be placed in the closed position by movement of said piston means upwardly and to support a column of drilling fluid thereabove in the closed position;

and means for applying a pressurized fluid to said piston means including a plurality of ports communicating said piston chamber and the bore of said body member for applying drilling fluid under pressure to said chamber to thereby drive said piston means downwardly and to move said bore closing means to the open position.

2. The apparatus as claimed in claim **1** wherein:

said bore closing means includes a pair of flapper gates which are cammed to the closed position when said piston means moves upwardly, and are adapted to move to the open position when said piston means moves downwardly in response to drilling fluid pressure above said predetermined amount.

3. A valve sub for including in a drill string below the kelly to prevent loss of drilling fluid while making connections during down hole drilling comprising:

a body member having means for attaching in said drill string and having an axial bore therethrough;

piston means mounted for axial movement in said body member, said piston means including a generally tubular member having an axial bore therethrough of a diameter substantially as large as the diameter of the bore through the drill string;

resilient biasing means for urging said piston means upwardly;

full opening bore closing means connected to said piston means and adapted to be placed in the closed position by movement of said piston means upwardly, said bore closing means including; a pair of flapper gates pivotally attached to said body member for movement to and from the closed position, and connection means connecting said flapper gates to said tubular member, whereby said flapper gates are pivoted to and from the closed position by axial movement of said tubular member;

and means for applying a pressurized fluid to said piston means to thereby drive said piston means downwardly and to move said bore closing means to the open position.

4. A valve sub for including in a drill string below the kelly to prevent loss of drilling fluid while making connections during down hole drilling comprising:

a body member having means for attaching in said drill string and having an axial bore therethrough;

piston means mounted for axial movement in said body member, said piston means including a generally tubular member having an axial bore therethrough of a diameter substantially as large as the diameter of the bore through the drill string;

resilient biasing means for urging said piston means upwardly;

full opening bore closing means connected to said piston means and adapted to be placed in the closed position by movement of said piston means upwardly;

means for applying a pressurized fluid to said piston means to thereby drive said piston means downwardly and to move said bore closing means to the open position;

and a lower internal sleeve about which said biasing means is supported and having an external flange near the upper end thereof which is adapted for contact on the lower side thereof by said bias means and on the upper side thereof by the lower end of said tubular member, whereby said bias means urges said internal sleeve upwardly, and said internal sleeve urges said tubular member upwardly, to thereby provide an enclosed chamber for the operation of said biasing means.

5. A valve for inclusion in a fluid conduit for controlling fluid flow therethrough, said valve comprising in combination:

a body member having means for attaching in said conduit and a bore therethrough communicating with said conduit;

piston means mounted for relative movement in said body member;

biasing means for urging said piston means in a first direction;

a generally annular rotatable bore closure member mounted for rotation to and from the closed position in said body member about an axis which is generally transverse to the central axis of said bore;

rotation means connected between said closure member and said piston means for rotating said closure member to and from the closed position in response to relative movement of said piston means;

and conduit means communicating the upstream side of said conduit and one end of said piston means for applying a pressurized fluid to said piston means to thereby drive said piston means in a direction counter to said biasing means;

whereby said closure member is rotated to and from the closed position by relative movement of said piston means.

6. A valve sub for including in a drill string to prevent loss of drilling fluid while making connections during down hole drilling, comprising in combination:

a body member adapted for attaching in said drill string and having an axial bore therethrough for passage of drilling fluid downwardly therethrough, said body member having an annular piston chamber surrounding and being generally co-axial with said bore;

piston means including a tubular member mounted for axial movement in said chamber in said body member and having an axial bore therethrough which is generaly co-axial with said bore through said body member;

resilient biasing means for urging said turbular member in a first axial direction;

a generally annular rotatable bore closure member mounted for rotation to and from the closed position in said body member about an axis which is generally transverse to the central axis of said bore

through said body member, and for supporting a column of drilling fluid thereabove in the closed position;

rotation means connected between said closure member and said tubular member for rotating said closure member to and from the closed position in response to relative axial movement of said tubular member;

and conduit means communicating between said piston chamber and the bore of said body member above said closure member for applying said drilling fluid under pressure to said piston means to drive said piston means in a direction counter to said biasing means;

whereby said closure member is rotated to and from the closed position by relative movement of said piston means.

7. The apparatus as claimed in claim 6 wherein:

said biasing means includes a compression spring selected to apply a predetermined direction in an axial upward force to said piston means.

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U.S. Cl. X.R.

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