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R. R. ANGEL ET AL

3,025,919

REVERSE OPENING CIRCULATING SUB

Filed April 13, 1959

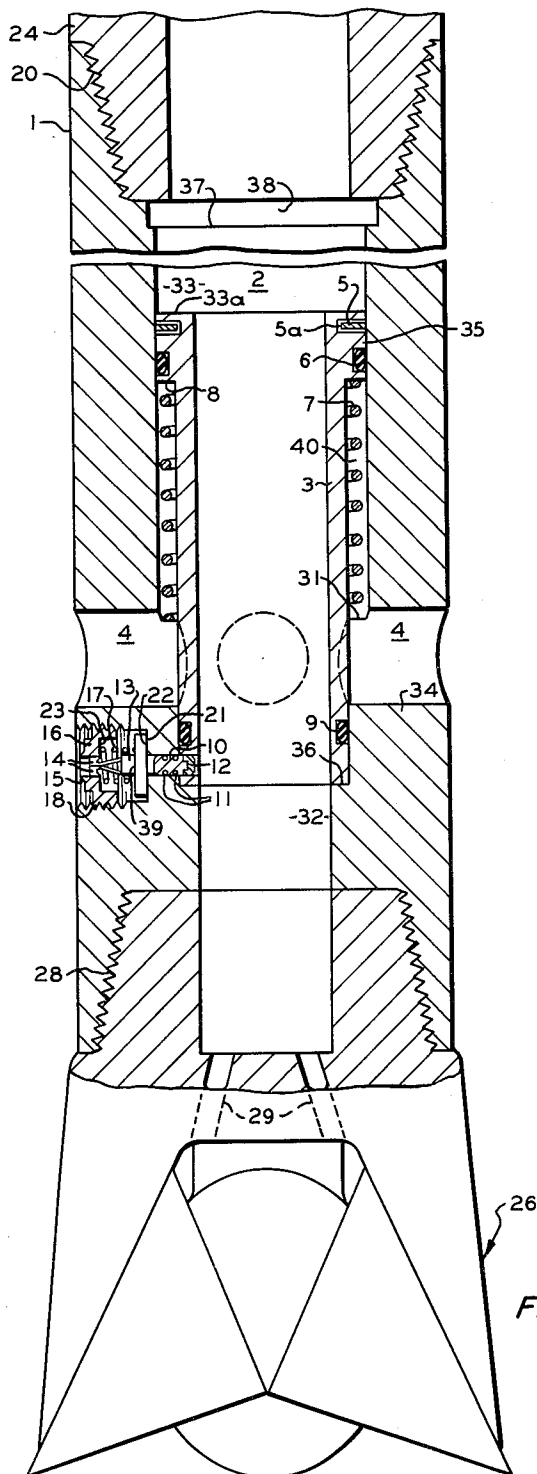


FIG. 1

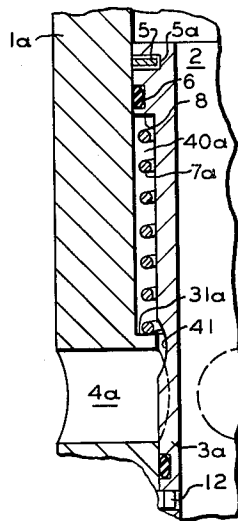


FIG. 2

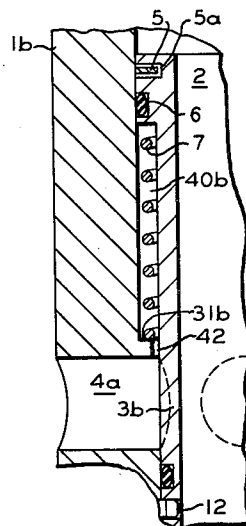


FIG. 3

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REVERSE OPENING CIRCULATING SUB

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18 Claims. (Cl. 175—317)

This invention relates to drilling deep wells with rotary drilling equipment. In one aspect it relates to regulation of drilling fluid circulation rates. In another aspect it relates to an apparatus adapted to permit reversed circulation as well as conventional circulation at greater than normal circulation rates.

In rotary drilling of deep wells the use of small bit jets for impinging drilling fluid at a high velocity against the surface being drilled increases drilling rates. Furthermore, the use of the jets restrict drilling fluid circulation rate which otherwise would be available for use in controlling a well in which a blowout is probable. The jets also hamper control of blowouts with reverse circulation which might, in some cases, be a distinct advantage.

According to this invention a valve apparatus as herein disclosed is installed in the drill string immediately above the jet bit. During normal drilling operations mud is pumped through the valve to the jet bit. In the event higher circulation rates are desired, either in the conventional direction of circulation or in reverse circulation, a shear pin is sheared and the valve opens thereby allowing large volume circulation through one or more openings or ports in the side of the valve. In this case the flow channels or jet openings through the bit are largely by-passed.

An object of this invention is to provide a deep well valve apparatus adapted for permitting reversed circulation of the drilling fluid. Another object of this invention is to provide an apparatus which is easily and definitely operable for permitting reversed circulation without need for dropping extraneous equipment down the drill tubing. Still another object of this invention is to provide an apparatus adapted to permit reversed circulation as well as conventional circulation at greater than normal circulation rates. Yet another object of this invention is to provide such an apparatus which is relatively simple, easy and relatively inexpensive to manufacture. Still another object of this invention is to provide such an apparatus which can be used over and over again, that is, one which is not destroyed upon a single use. Other objects and advantages of this invention will be realized upon reading the following description which, taken with the attached drawing, forms a part of this specification.

In the drawing:

FIGURE 1 is a longitudinal view, partly in section, of a preferred embodiment of this invention.

FIGURE 2 is a partial view, in section, of an alternate form of a portion of FIGURE 1.

FIGURE 3 is a partial view, in section, of another alternate form of a portion of FIGURE 1.

In some areas, for example along the Gulf coast areas of Texas and Louisiana, many deep wells pass through formations containing fluids under high pressure. The fluids are in some cases gas, and in other cases salt water. When the pressure in such a formation exceeds the pressure exerted by the column of drilling mud in the hole, there will be an inflow of fluid into the well bore. The possibility of a blowout then exists. Moderate inflows are usually controllable by surface manipulation of valves and by increasing the weight of the drilling mud pumped into the well. Stronger inflows of fluid may cause the well to blowout before remedial action can be taken.

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This possibility is increased markedly when the fluid entering the well bore is high pressure gas. In order to combat an imminent blowout, immediate action is necessary, and this action always requires an increase in the weight of the drilling mud so that the pressure of the fluid in the formation is overcome by the pressure exerted by the column of drilling mud. Strong inflows of salt water do not necessarily present as great a danger of a blowout as a strong inflow of gas, but even in the case of salt water remedial action must be taken.

In any case of inflow of fluid into the well bore, whether it be liquid or gas, displacement of the contaminated drilling mud with heavier mud is necessary. When sufficient heavy mud has been pumped into the well bore, the high pressure of the formation will be balanced or overcome by the column of heavier mud and fluid inflow will cease. Unless the heavy mud is added rapidly, the inflowing fluid will mix with the heavier mud as fast as it is added and the fluid may reduce the mud density or weight to such an extent that the weight of the column of mud cannot overcome the formation pressure.

Many modern rotary drilling bits are provided with small diameter jet nozzles for impinging drilling mud on the bottom of the hole. The small size of these nozzles restricts the flow of mud but the flow can be increased somewhat by increasing mud pump pressures. In combatting lost circulation this restriction of mud flow is undesirable, and if reversed circulation is desired to prevent a blowout after loss of mud it may prove so great as to make reversed circulation ineffective. High mud pressures in the annular space surrounding the drill pipe are undesirable because of the possibility of breaking down of uncased borehole wall. In case of rupture of a formation by mud pressure, mud is lost to the formation and such loss may greatly hamper the job of combatting a potential blowout.

This invention provides a flow passageway at a point near the drill bit and of sufficiently great diameter to permit unrestricted mud flow in either direction. Abnormally high mud circulation rates are thus possible in conventional or in reversed direction. This invention is especially well adapted for use with reversed circulation because it permits large volume mud flow at greatly reduced circulation pressures. Such large circulation flow is not possible with modern jet bits without use of our invention.

Adverse effects of strong salt water flows can be minimized by flushing out the salt water through the drill tubing by reversed circulation rather than allowing it to pass upward through the full length of the uncased borehole by conventional mud circulation. The rapid addition of heavy mud in reversed circulation quickly reduces or eliminates salt water inflow, thereby reducing danger of sticking the drill pipe.

In the drawing reference numeral 1 identifies an elongated, heavy-walled body member having about the same outer diameter as the outer diameter of the drill tubing. This apparatus is usually placed in the drill string immediately above the rotary drill bit. The body is provided with threads 20 or other means for attaching to the drill tubing 24, as illustrated. Reference numeral 28 identifies threads or other means for attaching the lower end of the body member to a drill bit 26.

The body member 1 has a conduit 2 extending throughout its length. The upper end section 33 of the conduit is somewhat larger in diameter than the inner diameter of the drill tubing. The lower end section 32 of the conduit has a diameter appreciably smaller than the diameter of the upper end section 33. An intermediate conduit section 34 has a diameter between the diameters of the end sections. Largely within the body member surrounding the intermediate conduit section are provided

one or more radial ports 4. As illustrated in FIGURE 1, four of these ports are provided. As will be noted, the upper sides of ports 4 extend a very short distance into the wall surrounding the upper end section 33. Reference numeral 31 identifies a generally annular shoulder which is the dividing surface between the upper and the intermediate diameter sections of the conduit. This generally annular shoulder is not necessarily a continuous annular surface because the several ports 4 remove small portions of the otherwise continuous surface. Thus with ports 4 positioned as illustrated, shoulder 31 comprises four equally spaced shoulder portions disposed around conduit 2. These several shoulder portions 31 are the seat for a compression spring 7. The upper seat for spring 7 is an annular surface 8 on the under side of a flange 35. This flange 35 is positioned at the top of a sleeve 3, as illustrated. The inner diameter of sleeve 3 is approximately the same as the diameter of the lower end section 32 of the conduit, while the outer diameter of the main portion of the sleeve has an outer diameter such as to fit operably the walls surrounding the intermediate diameter section 34 of the conduit. Reference numeral 36 identifies an annulus or upwardly facing shoulder against which the bottom end of sleeve 3 rests when the sleeve is in its inoperable position. Sleeve 3 is provided with an O-ring seal 9 and the flange 35 is provided with an O-ring seal 6, as illustrated. An expandable snap ring 5 is positioned in a groove 5a in flange 35. This snap ring is intended to snap expand into space 38 and against the annular land surface 37 to hold the sleeve 3 in its fully upward position as the sleeve is placed in its operable position.

The outer diameter of the flange 35 is larger than the inner diameter of the drill tubing 24 so that upon upward movement of the sleeve 3 the flange and the sleeve cannot enter the drill tubing. It is conceivable that the sleeve could move upward so rapidly that the snap ring 5 would not expand into space or groove 38 in time to prevent the sleeve from going up the drill pipe. Thus, by making the diameters of the conduit section 33 and the outer diameter of flange 35 of sleeve 3 larger than the inner diameter of the drill tubing, danger of passage of the sleeve into the tubing is eliminated.

At a level between the level of the O-ring 9 and annulus or shoulder 36 is disposed a locking piston 10, as illustrated. This locking piston comprises the piston proper which contains one or more O-ring seals 11.

A compression spring 17 is provided, as illustrated, for bearing against a large diameter end 39 of piston 10 to hold surface 21 against a matching surface 22 and the piston in an inoperable position. Threaded on the left-hand end of piston 10 is a snap catch member 13 which terminates at its left end as a pair of hook snaps 14. These hook snaps 14 are intended, upon movement to the left in the drawing, to catch or hook over a snap catch land 15 to hold the piston 10 in its operable position. The snap catch land 15 is a portion of a nut 16 which is threaded into body member 1 as illustrated. While one end of spring 17 bears against end surface 39 of the piston, the other end of the spring bears against an inner annular surface 23 of nut 16. As illustrated, nut 16 is held in position by threads 18. A shear member 12 is threaded or otherwise attached to the end of piston 10 adjacent conduit 2. The end of shear member 12 is intended to be exposed to fluid pressure within conduit 2 at all times prior to its being destroyed by the shearing action of sleeve 3, as subsequently described.

When this apparatus is assembled at the factory or machine shop, shear member 12 is threaded or otherwise attached to piston 10 and this assembly inserted into the apparatus from the exterior and held in its proper position by threaded nut 16. The length of this piston 10 which extends into the sleeve valve 3 is intended to be such that upon experiencing a predetermined pressure differential from conduit 2, the piston moves to the left and

hook snaps 14 seat against the snap catch land 15. In this position all of the piston proper will be removed from the sleeve valve 3 and only the shear member 12 will extend from the sleeve valve 3 into the body member 1. The shear member 12 is made of a shearable material such as brass, bronze, copper, or a suitable plastic material or such other material as will be sheared by upward movement of sleeve valve 3 with respect to the body member 1.

The shearing action exerted between sleeve valve 3 and body member 1 is occasioned by reversing drilling mud circulation and exerting a greater pressure outside the body member than inside. Pressure from outside the body member, that is, from the annulus between the drill string and the walls of the well, is transmitted through port or ports 4 into an annular space 40 containing the compression spring 7. This pressure is transmitted against annular shoulder 8, and since the area enclosed by O-ring 6 is greater than that enclosed by O-ring 9 the sleeve valve tends to move upward. Upon exertion of a predetermined reverse circulation pressure differential, sleeve valve 3 moves upward thereby shearing shear member 12. After this shearing is complete the sleeve valve 3, by the combined action of this pressure differential and compression spring 7, moves upward and the snap ring 5a expands into space 38 thereby retaining the sleeve valve in its fully elevated position.

The shear member 12 is positioned at the aforementioned shearable position only upon exerting a predetermined pressure differential between conduit 2 and the annulus in the well with the pressure in conduit 2 being the larger. Thus, upon release of sleeve valve 3, the one or more ports 4 are fully opened and conventional circulation from conduit 2 to the annulus between the drill string and the well can be achieved at a greater rate than obtainable while drilling; or reverse circulation can be achieved at an equally rapid rate.

Reference numeral 29 identifies jet nozzles in the drill bit for directing jet sprays of drilling fluid from within the drill tubing to either the drilling members of the drill bit or to the rock face being drilled.

The area of surface 8 is sized so that only a predetermined relatively small pressure differential is required for shearing the shear member 12 for setting the sleeve valve 3 into operation.

In the embodiment illustrated in FIGURE 2, port or ports 4a are entirely within the wall of body member 1a surrounding the intermediate diameter section of conduit 2. Annular space 40a terminates in a shoulder 31a which extends around the inner wall between the upper end section and the intermediate diameter middle section of conduit 2. Reference numeral 1a refers to the tubular body member corresponding to body 1 of FIGURE 1. Reference numerals 5, 5a, 6, 7, and 8 refer to the same parts as in FIGURE 1. One or more slots 41 are made in the outer surface of sleeve valve 3a to provide communication between the exterior of the apparatus of FIGURE 2 and the annular space 40a for imposing pressure differential for opening the ports 4a.

In the embodiment illustrated in FIGURE 3, port or ports 4a are entirely within the wall of body member 1b surrounding the intermediate diameter portion of conduit 2. Slot or slots 42 provide communication from the borehole outside the apparatus to space 40b for lifting the sleeve by increasing pressure in the well annulus to a value greater than that in conduit 2. Shoulder 31b is continuous except for slot or slots 42.

Ordinarily, when fighting a potential blowout in a deep well, after the drilling mud therein has been stabilized as regards any tendency to be blown out of the well, ordinary procedure calls for withdrawal of the drilling string so as to inspect or to replace the drill bit. During such inspection, if desired, threaded nut 16 and piston 10 are removed and a new shear member 12 installed on the end of the piston, and the piston and nut reinserted into the

position illustrated in the drawing and with the sleeve valve 3 also in the position illustrated in the drawing. After resetting this sleeve valve and possibly installing a new drill bit, the drill string is then ready for running into the well and continuing the drilling operation.

While certain embodiments of the invention have been described for illustrative purposes, the invention obviously is not limited thereto.

We claim:

1. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit therethrough, said conduit comprising first and second end sections joined by an intermediate third section, said third section having a smaller diameter than the diameter of the first end section and a larger diameter than the diameter of the second end section, the juncture of said first end section and said third section forming a first shoulder facing said first end section, the juncture of said second end section and said third section forming a second shoulder facing said third section, the three conduit sections being disposed along a common axis, a first port through the wall of said third section, an axially movable sleeve disposed along said common axis in said conduit, one end of said sleeve slidably fitting within said third section and adjacent said second shoulder, the other end of said sleeve extending into said first end section and having a flange around its outer periphery slidably fitting the inner wall of said first end section, a pair of matching ports in the wall of said sleeve and in the wall of said third conduit section, a piston movable transversely with respect to said sleeve and tubular member and extending from one port into the other port of said pair of matching ports, a snap catch land attached to the wall of the port of said pair of ports in the wall of said third conduit section, hook means fixed to said piston in the last-mentioned port, said hook means being adapted to lock said piston to said snap catch land and against subsequent movement upon movement of said piston from the matching port in said sleeve into the other matching port, a shear member fixed to the end of said piston in the matching port of said sleeve, and upon said movement of said piston from the matching port in said sleeve said shear member is positioned in a shearing position in said pair of matching ports, said flange having a surface facing said first shoulder, means biasing said sleeve into said first end section, an expansible snap ring around said flange, a snap ring land surface around the inner wall of said first end section in such a position that upon axial movement of said sleeve into said first end section said snap ring expands and seats against said land surface whereby said sleeve clears said first port thereby providing communication between the exterior and interior of said assembly.

2. In the control valve assembly of claim 1, a slot in the outer wall of said sleeve providing communication from said first port to a space enclosed by the inner wall of said first end section, the outer wall of said sleeve, said first shoulder and said surface of said flange.

3. In the assembly of claim 1 wherein said shear member and said piston are spring biased by a compression spring in the port of said pair of ports in the wall of said intermediate section said piston is positioned in both ports of said pair of ports, and said piston and shear member being adapted to move against the bias of said compression spring upon exertion of a predetermined pressure differential between the interior and the exterior of the valve assembly in such a manner as to position said shear member in shearing position between the wall of said third conduit section and said sleeve.

4. In the assembly of claim 1 wherein said means biasing said sleeve into said first end section comprises a compression spring disposed intermediate said first shoulder and said flange.

5. In the assembly of claim 4 wherein said compression spring is disposed concentrically around said sleeve.

6. In the assembly of claim 4 upon exertion of a predetermined fluid pressure against said surface of said flange from the exterior of the assembly through said first port said sleeve moves upward and shears said shear member and moves upward further into locking position of said snap ring whereby fluid communication is provided from the exterior to the interior of said assembly by way of said first port.

7. In the assembly of claim 1, thread means on either end of said tubular member for attachment in a deep well drill string.

8. In the assembly of claim 7, a drill tubing threaded to said thread means on the end of said tubular member defined as said first end section of said conduit, the end of said drill tubing adjacent said first end section being an annular surface upon which said snap ring bears to prevent movement of said sleeve from said tubular member.

9. In the assembly of claim 8, a jet rotary drill bit attached to said means on the end of said tubular member adjacent said second end section of said conduit.

10. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit therethrough, said conduit comprising first and second end sections joined by an intermediate third section, said intermediate section having a smaller diameter than the diameter of the first end section thereby providing a first annular surface facing said first end section, said second end section having a smaller diameter than the diameter of said intermediate section, thereby providing a second annular surface facing said intermediate section, said first, second and third sections being disposed along a common axis, a first port through the walls of said first end section and said intermediate section, an axially movable sleeve fitting the intermediate conduit section and disposed along said common axis in said conduit, said sleeve extending from said second annular surface into said first end section, an exterior flange disposed around said sleeve in said first end section and slidably fitting the inner wall thereof, the surface of said flange facing said intermediate conduit section forming a third annular surface, a compression spring intermediate said first and third annular surfaces, a groove around the outer surface of said flange, an expansible snap ring in said groove, a pair of matching ports in the walls of said sleeve and said intermediate conduit section, a nonshear locking piston movable transversely with respect to said sleeve and tubular member in said matching ports extending from within the wall of said sleeve into the wall of said tubular member, said piston being adapted to move in a direction from said sleeve toward the exterior of said tubular member, means to lock said piston in its fully moved position, a shear member on the end of said piston in the wall of said sleeve, a snap ring land surface around the inner wall of said first end section in such a position that upon axial movement of said sleeve into said first end section said snap ring expands and seats against said land surface whereby said sleeve clears said first port thereby providing communication between the exterior and interior of the assembly.

11. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit therethrough, said conduit comprising first and second end sections joined by an intermediate third section, said third section having a smaller diameter than the diameter of the first end section and a larger diameter than the diameter of the second end section, the three conduit sections being disposed along a common axis, a first port through the wall of said third section, an axially movable sleeve disposed along said common axis in said third conduit section and extending into said first conduit section, the outer wall of said sleeve being spaced from the inner wall of said first end section, flange means around said sleeve in said first end section fitting the wall thereof, a pair of matching ports in the wall of said sleeve and in the wall of said third conduit section, a piston movable trans-

versely with respect to said sleeve extending from one port into the other port of said pair of matching ports, a shear member fixed to the end of said piston in the matching port of said sleeve, a latch at the other end of said piston and upon movement of said piston from the matching port in said sleeve said shear member is positioned in a shearing position in said pair of matching ports, and said latch becomes operative thereby retaining said piston against movement, and means intermediate said sleeve and the inner wall of said first end section biasing said flange and sleeve away from said third conduit section upon shearing of said shear member thereby opening said first port.

12. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit there-through, said conduit comprising first and second end sections joined by an intermediate third section, said third section having a smaller diameter than the diameter of the first end section and a larger diameter than the diameter of the second end section, the three conduit sections being disposed along a common axis, a first port through the wall of said third section, an axially movable sleeve disposed along said common axis in said third conduit section and extending into said first conduit section, the outer wall of said sleeve being spaced from the inner wall of said first end section, flange means around said sleeve in said first end section fitting the wall thereof, a pair of matching ports in the wall of said sleeve and in the wall of said third conduit section, a piston movable transversely with respect to said sleeve extending from one port into the other port of said pair of matching ports, a latch at the end of said piston in the port of said pair of matching ports in said third section and upon movement of said piston into the port of said pair of ports in said third section said latch is positioned in a latching position, means biasing said sleeve into said first end section an expansible means in said flange means, and means in the inner wall of the upper portion of said first conduit section for accommodation of said expansible means upon movement of said sleeve and flange means from said third conduit section.

13. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit there-through, said conduit comprising first and second end sections joined by an intermediate third section, said third section having a smaller diameter than the diameter of the first end section and a larger diameter than the diameter of the second end section, the three conduit sections being disposed along a common axis, a first port through the wall of said third section, an axially movable sleeve disposed along said common axis in said third conduit section and extending into said first conduit section, the outer wall of said sleeve being spaced from the inner wall of said first end section, flange means around said sleeve in said first end section fitting the wall thereof, a pair of matching ports in the wall of said sleeve and in the wall of said third conduit section, a piston movable transversely with respect to said sleeve extending from one port into the other port of said pair of matching ports, a latch at the end of said piston in the port of said pair of matching ports in said third section and upon movement of said piston into the port of said pair of ports in said third section said latch is positioned in a latching position, and means intermediate said sleeve and the inner wall of said first end section biasing said flange and sleeve away from said third conduit section upon movement of said piston from the port in said sleeve thereby opening said first port.

14. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit there-through, said conduit comprising first and second end sections joined by an intermediate third section, said third section having a smaller diameter than the diameter of said first end section and a larger diameter than the diameter of the second end section, the conduit sections being disposed along a common axis, a first port through the

wall of said third conduit section, an axially movable first means in said third and first conduit sections and closing said first port, second means biasing said first means from said third conduit section to open said first port, a movable third means retaining said first means against the bias of said second means in said third conduit section and said first port closed, shear means facing said conduit and adjacent said third means and movable therewith, said shear means being movable to a shearing position in the wall of said third section and in said first means, latch means retaining said shear means in this latter position, said first means being adapted upon exertion of fluid pressure from the exterior of the assembly on said first means to shear said shear means when in said shearing position thereby releasing said first means whereby said second means exerts its bias on said first means thereby moving said first means from said third conduit section and opening said first port.

15. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit there-through, said conduit comprising first and second end sections joined by an intermediate third section, said third section having a smaller diameter than the diameter of said first end section and a larger diameter than the diameter of the second end section, the conduit sections being disposed along a common axis, a first port through the wall of said third section, an axially movable sleeve disposed along said common axis in said third and first conduit sections and closing said first port, the inner wall of said first conduit section being spaced from the outer wall of said sleeve, first means around said sleeve slidably fitting the wall of said first end section, a pair of matching ports in the wall of said sleeve and in the wall of said third conduit section, a nonshear means in said pair of ports retaining said sleeve in said third conduit section and thereby said first port closed, a latch at the end of said nonshear means in the port of said pair of ports in said third conduit section, shear means in the port of said pair of ports in said sleeve, said shear means when in said shearing position and said nonshear means being movable by fluid pressure from said conduit in such a manner that said shear means is positioned in both ports of said pair of ports, third means intermediate said sleeve and the inner wall of said first conduit section biasing said sleeve from said third conduit section, said third means being adapted to move said sleeve from said third conduit section thereby opening said first port upon movement of said nonshear means from the port of said pair of ports in said sleeve and said shear means by fluid pressure from within said conduit to a position in both ports of said pair of ports whereby said latch operates to retain said nonshear means and said shear means in their last stated positions followed by exertion of sufficient fluid pressure on said first means from the exterior of the assembly shearing said shear member.

16. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit there-through, said conduit comprising first and second end sections joined by an intermediate third section, said third section having a smaller diameter than the diameter of said first end section and a larger diameter than the diameter of the second end section, the conduit sections being disposed along a common axis, a first port through the wall of said third section, an axially movable first means in said third and first conduit sections and closing said first port, second means biasing said first means from said third conduit section to open said first port, second and third ports in the walls of said third conduit section and in said first means respectively, third means in said second and third ports biasing these ports in alignment, a shear means in said third port adjacent said conduit, said shear means being adapted to move said third means from said third port upon exertion of fluid pressure on said shear means from said conduit, latch means in said second port on the side of said third means opposite

said conduit whereby upon exertion of fluid pressure from said conduit against said shear means, said third means moves from said third port into said second port thereby activating said latch means retaining said third means in said second port upon release of fluid pressure in said conduit, and said shear means moves to a shearing position in said second and third ports, and upon exertion of fluid pressure from outside said assembly against said first means said first means moves upwardly shearing said shear means and opening said first port thereby providing communication from said conduit through said first port to the exterior of the assembly.

17. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit there-through, said conduit comprising first and second end sections joined by an intermediate third section, said third section having a smaller diameter than the first end section and a larger diameter than the second end section, the three conduit sections being disposed along a common axis, a port through the wall of said third section, an axially movable valve means disposed along said common axis in said first and third conduit sections, separate portions of said valve means fitting the inner wall surfaces of said first and third conduit sections fluid-tight thereby providing an exterior annular surface facing said third conduit section, said valve means in its inoperative position closing said port, a shear means movable by fluid pressure within said conduit to a shearing position within the wall of said second end section and said valve means, whereby upon transmission of fluid pressure from the exterior of the assembly through said port to said annular surface, said valve means moves thereby shearing said shear means and opening said port to fluid communication

between the exterior of the valve assembly and said conduit.

18. A fluid flow control valve assembly comprising, in combination, a tubular member having a conduit there-through, said conduit comprising first and second end sections joined by an intermediate third section of diameter smaller than the diameter of said first end section and larger than the diameter of said second end section, the three conduit sections being positioned along a common axis, a port through the wall of said third conduit section, an axially movable fluid actuatable first valve means positioned operatively in said conduit for opening and closing said port, second means in said tubular member and in said first means releasably retaining said first means in closed position with respect to said port, said second means being adapted to be moved by pressure interior of the assembly in said tubular member and in said first means for positioning said second means in a first means releasing position whereby said first means is released by pressure exterior of the assembly thereby opening said port to fluid flow from said exterior of said assembly through said port into said conduit, and means for maintaining said first means operably open with respect to said port once the first means is opened from said port by the exterior fluid pressure.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,025,919

March 20, 1962

Richard R. Angel et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, lines 39 and 40, strike out "when in said shearing position".

Signed and sealed this 28th day of August 1962.

(SEAL)

Attest:

ESTON G. JOHNSON

Attesting Officer

DAVID L. LADD

Commissioner of Patents