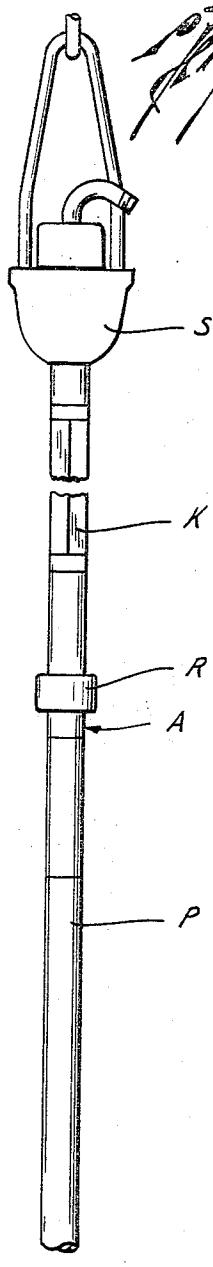
July 18, 1967 W. T. TAYLOR 3,331,385

CLOSURE APPARATUS WITH REMOVABLE PLUG

Filed Sept. 24, 1964 3 Sheets-Sheet 1

Fig. 1



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CLOSURE APPARATUS WITH REMOVABLE PLUG

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Fig. 2.

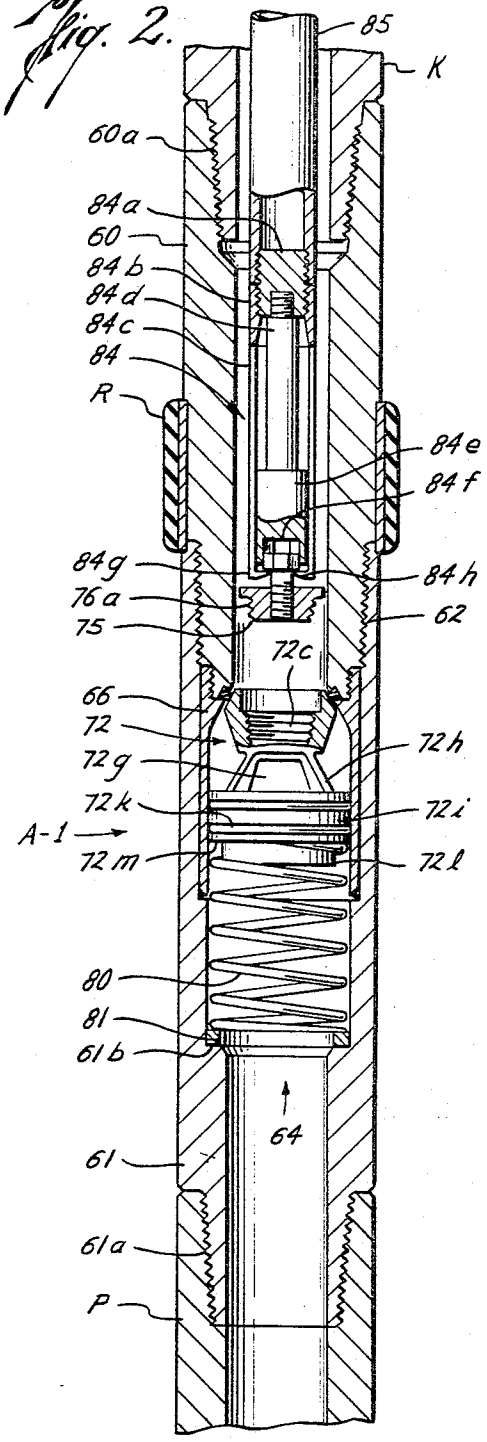


Fig. 3.

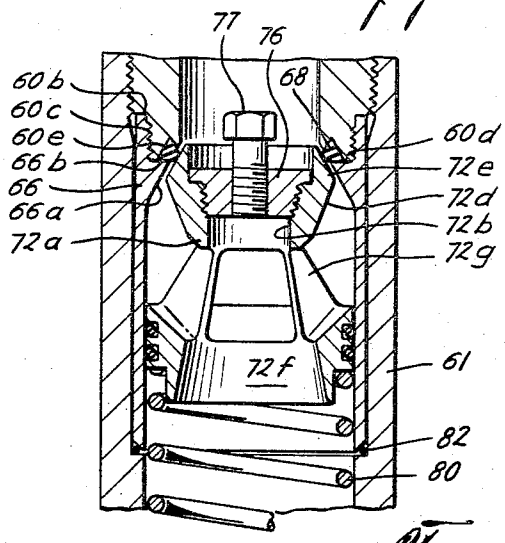
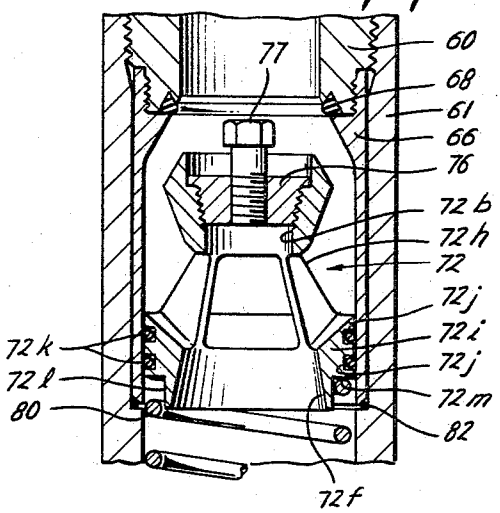


Fig. 4.



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CLOSURE APPARATUS WITH REMOVABLE PLUG

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Fig. 5.

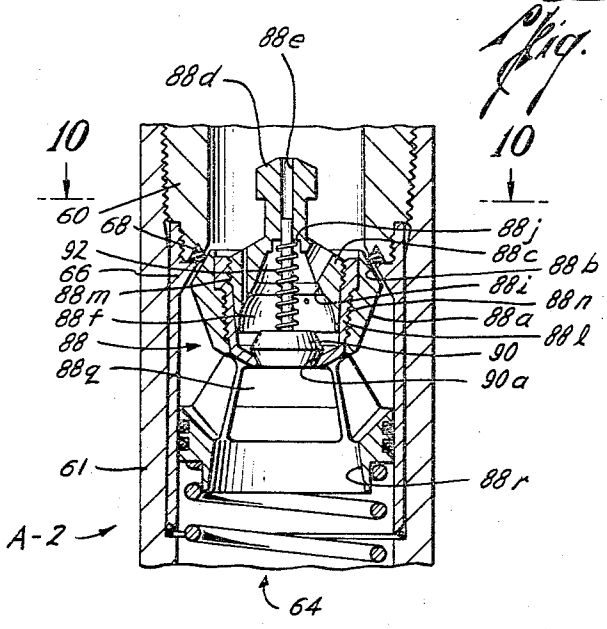


Fig. 6.

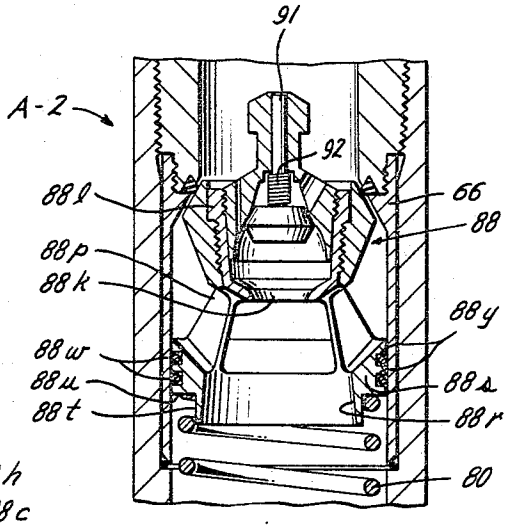
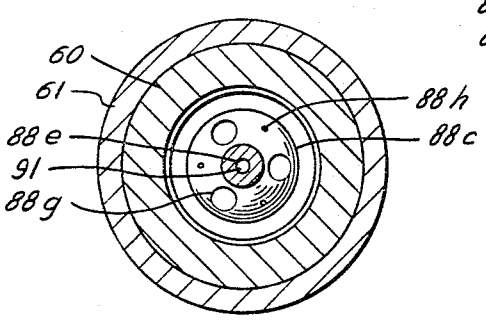


Fig. 7.



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3,331,385

CLOSURE APPARATUS WITH REMOVABLE PLUG

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Filed Sept. 24, 1964, Ser. No. 398,898
2 Claims. (Cl. 137—327)

ABSTRACT OF THE DISCLOSURE

A valve is connected between the kelly and the drill string to prevent drilling fluid from flowing out of the kelly when the drill string is disconnected therefrom. The valve also closes if the pressure in the drill string increases. A central plug in the valve body can be removed to allow tools to be run through the drill string.

The present invention relates to a new and improved closure apparatus for tubular members.

In drilling oil or gas wells or the like by the rotary drilling method, the drill bit is rotated by a string of drill pipe connected to a kelly suspended in a derrick at the earth's surface. Drilling mud or chemically laden drilling fluid is pumped through the kelly and string of drill pipe to the drilling bit in a manner well known in the art. Heretofore, during the drilling operations, whenever the drilling pipe was disconnected from the lower end of the kelly, the entire contents of drilling fluid in the kelly would immediately empty out onto the derrick floor. In drilling a well, it was not unusual for 100 to 150 barrels of drilling fluid to thus be lost, causing not only the waste of large quantities of expensive drilling fluid but also spraying mud all over the adjacent area and workmen and making the derrick floor dangerously wet and slippery and consequently hazardous for persons working on the derrick floor.

It is therefore an object of the present invention to provide a new and improved closure apparatus to retain drilling fluid in a kelly when it is disconnected from a string of drill pipe.

It is also an object of the present invention to provide a new and improved closure apparatus for use with a kelly which will open to allow fluid to be pumped therethrough under pressure in one direction and which will close when the back pressure on such fluid exceeds the pump pressure.

And yet another object of the present invention is to provide a new and improved closure apparatus for use with tubular members which will open to allow fluid to be pumped therethrough under pressure and which will automatically close when the pressure drops.

A further object of the present invention is to provide a new and improved closure apparatus for use in a tubular member which will open to allow fluid to flow therethrough in only one direction and which will automatically close to the flow of fluid therethrough in the opposite direction.

And still another object of the present invention is to provide a new and improved apparatus for connecting drill pipe to the lower end of a kelly including means for retaining a standing column of drilling fluid in the kelly.

And still another object of the present invention is to provide a new and improved device for use with tubular members to open upon the application of a predetermined fluid pressure to fluid flow therethrough in one direction and to automatically close to prevent fluid flow therethrough from the opposite direction.

Another object of the present invention is to provide a new and improved closure apparatus that can easily

and readily be positioned on a kelly by an ordinary drilling laborer without special tools, skills, or equipment.

And yet another object of the present invention is to provide a new and improved closure apparatus for positioning on a kelly which will open to substantially the full diameter of the bore of the drill pipe connected to the kelly.

An object of this invention is to provide a new and improved closure apparatus for connection to a kelly and drill string having means therewith for permitting wire lines to be run in the drill string.

One object of this invention is to provide a new and improved closure apparatus which prevents well blowout through the kelly.

Yet another object of this invention is to provide a new and improved closure apparatus which closes to prevent reverse flow and yet pressurizes the kelly to enable the operator to ascertain the pressure in the well string.

Another object of this invention is to provide a new and improved closure apparatus having means removable by a retriever to permit a wire-line to be run into the drill string.

Other objects and advantages of the present invention will become readily apparent from a consideration of the following description and drawings wherein:

FIG. 1 is an elevational view showing one use of the present invention wherein it is connected to a kelly and a string of drill pipe as they are positioned for rotary drilling;

FIG. 2 is a sectional view, partly in elevation, illustrating one preferred form of the invention connected to a kelly and drill string with a retriever extended through the kelly to the invention;

FIG. 3 is an enlarged view similar to FIG. 2 showing in greater detail the structure of the closure apparatus of this invention closed to the flow of drilling fluid;

FIG. 4 is a view similar to FIG. 3 showing the closure apparatus opened to the flow of drilling fluid through the kelly and into the drill string;

FIG. 5 is a sectional view of another preferred embodiment of this invention in the closed position;

FIG. 6 is a sectional view similar to FIG. 5 showing drilling fluid bleed means for pressurizing the kelly to enable the operator to read pressure in the drill string; and

FIG. 7 is a sectional view taken on line **10—10** of FIG. 5 showing passages for bleeding drilling fluid through closure apparatus.

An embodiment A–1 of this invention is illustrated in FIGS. 2–4 where the closure apparatus A–1 is shown connected to the kelly K and the drill string P is suspended therebelow. The closure apparatus A–1 is formed of an upper tubular housing **60** and a lower tubular housing **61** which housings are joined by means of threads indicated at **62** in defining a tubular member having passage means indicated generally at **64**. The protective wear sleeve R is placed about the closure apparatus A–1 to provide protection from wear and rough handling with tongs or the like. The upper hollow member **60** includes a set of threads **60***a* which is adapted to coact with the kelly K and threads **61***a* are carried on the member **61** for connection to the drill string P.

The upper tubular member **60** includes an annular shoulder **60***b* and an adjacent set of threads **60***c* which are engaged with an annular sleeve **66**. The sleeve **66** is tapered inwardly of the passage **64** at **66***a* to define a shoulder **66***b* which abuts the lower end **60***d* of the upper member **60**. The lower end **60***d* of the upper tubular member includes an annular groove **60***e* which is V-shaped for receiving a trapezoidal seal member **68** having an inwardlly facing shoulder extending into the passage **64**

and which is formed of a resilient material to provide sealing contact with other components of the closure apparatus A–1 of this invention.

A valve body indicated generally at **72** is positioned in the passage means **64** and serves as means for closing the passage **64** to the flow of pressure fluid in cooperation with coacting means in the form of the seal member **68**. The valve body indicated generally at **72** includes a narrow neck **72***a* with an axial passage **72***b* extending through the neck **72***a* to a threaded portion **72***c* opening to the passage **64** communicating the kelly K with the closure apparatus A–1 of this invention. The valve body **72** flares outwardly at **72***d* and extends inwardly at **72***e* to define a conforming surface adapted to cooperate with the valve seat member **68** clamped between the sleeve **66** and the upper tubular member **60**.

A removable member **75** in the form of a plug **76** has a bolt **77** axially mounted therein with the head of the bolt extending above the plug **76**. The removable member **75** includes a set of threads **76***a* for engaging the threads **72***c* in the valve body **72** for connecting the plug in the valve body and limiting fluid communication therethrough. The bolt **77** connected to the plug **76** is preferably a left-handed threaded bolt for reasons to be explained.

The axial opening **72***b* of the valve body indicated generally at **72** is enlarged at **72***f* immediately adjacent a plurality of fluid ports or openings **72***g*. Each of the ports **72***g* extends from the enlarged axial opening **72***f* through the valve body **72** in communication with the passage means indicated generally at **64**. The lateral openings **72***g* are defined by a group of metallic ribs **72***h* which are connected to a support member **72***i* which defines the enlarged opening **72***f*. The support member **72***i* is aligned with the passage means **64** and thereby guides the valve body **72** with respect to the valve seat member **68** for sealing engagement.

A support member **72***i* includes a pair of annular ring grooves **72***j* adapted to receive seal means such as the O-rings **72***k* shown positioned in the grooves. The enlarged axial opening **72***f* extends downwardly through the valve body **72** and is defined by a skirt **72***l* which terminates at an annular perpendicular shoulder **72***m*. The annular shoulder **72***m* provides a seat for resilient means such as the compressible coil spring **80** shown in the drawings. The spring **80** extends axially of the lower tubular housing **61** and is contacted against a support ring **81** resting on an annular shoulder **61***b* interiorly of the lower tubular member **61**. It may be appreciated that the resilient means **80** is restrained to provide a force axial of the closure apparatus A–1 of this invention for urging the valve body **72** against the valve seat for operation as will be described hereinafter.

The valve **72** is adapted to be moved within the chamber defined by the annular sleeve **66** and it may be appreciated that the valve **72** bears against the sleeve **66**. For wear purposes, the sleeve **66** may be made of a durable ceramic material for receiving the movable valve **72**. A rubber O-ring **82** is positioned adjacent the lower end of the sleeve **66** to prevent leakage of drilling fluids into the annular space between the sleeve **66** and the lower tubular member **61**.

Attention is directed to FIG. 2 wherein the removable member **75** is grasped by a retriever indicated generally at **84**. A tubular member **85** of a size appropriate to fit within the kelly K is threadedly engaged with a plug **84***a* and the plug **84***a* is connected to a bushing **84***b* on which axially extending fingers **84***c* are carried. A support bar **84***d* is threaded into the plug **84***a* and carries an enlargement **84***e* having a bolt socket **84***f* adapted to engage the bolt **77** carried in the removable member **75**. The socket **84***f* is centered between a plurality of detents **84***g* carried by the axially extending fingers **84***c* on the retriever. Each of the detents extends axially inwardly of the retriever **84** and has a chamfered face **84***h* for engaging the head of

the bolt **77** and deflecting to permit the head to pass between the detents into the socket opening **84***f* of the retriever. FIG. 2 illustrates the bolt head engaged in the socket with the detents clamping the nether side of the bolt head and restraining the bolt to move with the retriever **84**.

In operation, the apparatus A–1 of this invention is connected to the kelly K and the drill string P by the connecting means having the preferred form of the threads **60***a* and **61***a* and those skilled in the art will recognize that connection of the closure apparatus does not affect or alter drilling by the rotary method with the apparatus shown somewhat schematically in FIG. 1. Drilling fluids are pumped through the kelly K, the closure apparatus A–1, and the drill string P to the rotary bit utilizing conventional equipment. It may be appreciated that hydrostatic pressure is applied to the pressure fluid in the kelly K and the drilling mud acts on the valve **72** to move the valve **72** out of the valve seat **68**. The force pressure resulting from the drilling mud acts against the valve **72** to oppose the force of the resilient means **80** urging the valve **72** into the valve seat **68**.

On reaching a predetermined hydrostatic pressure in the upper tubular member **60**, the force of the resilient means **80** is overcome and the valve **72** is moved away from the conforming surface of the shoulder member **68** clearing the axial passage means **64** of the obstruction of the valve **72**. It may be appreciated from the foregoing that the resilient means operates as fluid pressure biasing means requiring the fluid pressure to achieve a predetermined level to open the valve.

The valve **72** is maintained in alignment with the valve seat by the support member **72***i* moving within the sleeve **66** as illustrated in FIG. 4 and the drilling fluid flows past the valve **72** through the port means **72***g*. The ports **72***g* cooperate with the enlarged axial opening **72***f* to reduce to a minimum the constriction of the valve body **72** so that drilling fluids flow through the closure apparatus A–1 of this invention to the drill string therebelow. When the drill string P is disconnected from the closure apparatus A–1 of this invention for any purpose, the operator reduces the pressure of the mud pumping apparatus and the resilient means **80** moves the valve **72** into contact with the seal member **68** and thereby seals the passage means **64** through the apparatus A–1, as illustrated in FIG. 3. The closing of the apparatus A–1 maintains a standing column of drilling fluid in the kelly K above the closure apparatus A–1 when the drill string P is disconnected at the threads **61***a*. The retention of the drilling fluids in the kelly K reduces waste of expensive drilling fluids and even more especially reduces the dangers inherent with a slippery and wet drilling platform to the operators and laborers.

On reconnection of the drill string P to the closure apparatus A–1 of this invention, drilling in the routine manner may be resumed by pumping drilling muds through the kelly K and forcing open the valve **72** as shown in FIG. 4. As will occasionally happen without forewarning, the drill bit may penetrate a reservoir under high pressure and gas or oil or a mixture of both will overcome the pressure of the column of drilling fluids standing in the drill string P. On such occurrence, reservoir pressure tends to force the drilling fluids back through the closure apparatus A–1 and through the kelly K into the mud pumping apparatus. Such reverse flow may occur rapidly and can cause far-reaching damages and blowouts are quite dangerous to personnel and equipment. The closure apparatus A–1 of this invention operates to hold the drilling muds under blowout pressure in the drill string P because the high pressure fluids acting on the valve **72** from the drill string P urge the valve **72** more firmly into contact with the yieldable shoulder means **68**. It may be appreciated from an understanding of the structure illustrated in FIG. 6 that the greater the pressure in the drill string, the more firmly seated is the valve **72**

safely retaining the highly pressurized and dangerous blowout surging upward through the drill string P.

On occasion, it is necessary to run various items into the drill string P on a wire line to perform various functions in the well bore. For instance, a backoff shot may be run in the drill string P for jarring the drill string when it is stuck and will not rotate. This can be accomplished by using the retriever indicated generally at 84 to open the closure apparatus A–1 as shown at FIG. 2 where the retriever is connected to the pipe 85. The retriever 84 is run into the kelly K on the pipe 85 and is engaged with the removable member 75. The member 75 is grasped by forcing the detents 84*g* aside the head of the bolt 77 on contact with the sloping faces 84*h* of the detents and the head is received in the socket hole 84*f* and the detents 84*g* are snapped by the springlike fingers 84*c* to the illustrated position of FIG. 2 so that the retriever is thereby engaged with the removable member 75. It may be appreciated that the bolt head shown in the drawings is hexagonal in shape and the socket 84 conforms to the head so that rotation of the pipe 85 rotates the retriever 84 and the attached removable member 75.

The threads of the bolt 77 in the member 75 are of left-hand configuration as opposed to the threads 76*a* on the plug 76 which are right-handed. It is not desirable to remove the bolt from the plug on rotation so that rotation of the bolt 77 in the customary direction tightens the bolt 77 in the plug 76 but disconnects the plug 76 from the threads 72*c* of the valve 72.

Attention is directed to FIG. 5 which illustrates an additional embodiment A–2 of this invention featuring a valve body having bleed means therewith. There is shown in FIGS. 5–7 the upper and lower tubular members 60 and 61 joined together with the sleeve 66 positioned therein for clamping the seal member 68 which serves as a valve seat for a valve 88. The valve 88 includes a valve body 88*a* which, in the preferred embodiment, is assembled from a plurality of separate elements to define the valve 88 and a conforming surface 88*b* adapted to contact the seal member 68 positioned in the passage means indicated generally at 64. The valve body 88*a* includes an insert 88*c* which insert has an upwardly extending fishing neck 88*d* and an axial passage 88*e* extends through the fishing neck 88*d*. The insert 88*c* has a valve chamber 88*f* communicating with the passage 88*e* and a plurality of ports 88*g* communicate the valve chamber 88*f* in the insert 88*c* with the passage means indicated generally at 64 extending through the apparatus A–2. The preferred embodiment includes three such ports 88*g* spaced equidistantly about the centrally located axial openings 88*e* as shown in FIG. 7 and spaced between the large ports are small weep holes 88*h* which will be described in greater detail hereinafter.

The valve chamber 88*f* includes an annular shoulder 88*i* immediately below the large ports 88*g* which serves as a valve seat for a valve member 90 mounted on a valve shaft 91 which extends upwardly of the valve chamber 88*f* into the axial opening 88*e*. A coil spring 92 is loosely fitted about the guide rod 91 and bears against the upper surface of the valve 90 and is confined within the valve chamber by an annular shoulder 88*j* formed on the valve insert 88*c*. The valve 90 includes an encircling chamfered surface 90*a* adapted to conform with a lower valve seat 88*k* at the bottom of the valve chamber 88*f* in the valve 88. The valve seat 88*k* is preferably formed on an inner sleeve 88*l* which is threadedly engaged with the insert 88*c* at a set of threads identified at 88*m*. The threads 88*m* are similar to a set of threads 88*n* for joining the inner sleeve 88*l* to the valve body 88*a* as shown in the drawings. A plurality of evenly spaced web-like members 88*p* are connected to the lower end of the valve body 88*a* to define a plurality of ports 88*q* opening from just beneath the valve body 88*a* into an enlarged axial opening indicated at 88*r*. The enlarged axial opening 88*r* extends downwardly as shown in the drawings in a support member 88*s* connected to the web-like members 88*p*. A downwardly extending encircling lip 88*t* is terminated at one end in an outwardly extending, perpendicular shoulder 88*u* which extends to the sleeve 66 and the shoulder provides a bearing surface for receiving the resilient means indicated generally at 80. O-ring slots are provided at 88*y* and O-rings 88*w* are placed in the slots to limit the axial flow of drilling fluids along the exterior surface of the valve support member 88*s*.

The valve support means 88*s* is urged axially of the closure apparatus A–2 by the spring 80 which is supported in the lower tubular member 61 in the same manner as is the embodiment A–1 shown in FIGS. 2–4.

In order to expand and further amplify understanding of the embodiment A–2 shown in FIGS. 5–7, operation of the closure apparatus of this invention will be described and referred to the closure apparatus A–1. The embodiment A–2 is connected to the kelly K and the drill string P in the same way as the closure apparatus A and A–1. The handling of the drill string P by manipulations directed to the kelly K such as rotating, raising, and lowering the drill string P is done in a conventional manner. Drilling mud under pressure is applied to the kelly K and is communicated therethrough to the apparatus A–2 with the pressurized fluid maintaining a standing column on the exposed surfaces of the valve 88 which is seated against the valve seat 68 as shown in FIG. 5. The pressure of the drilling fluid bears on the valve 88 and on overcoming the fluid pressure biasing means 80, the valve 88 is moved from the conforming contact of the resilient member 68 into the chamber below the shoulder of the rubber member and pressure fluid passes about the valve body 88*a*. The drilling mud then flows through the ports 88*q* of the support structure 88*s* and passes through the axial opening 88*r* and thence into the lower tubular member 61. The lower tubular member 61 is connected to the drill string P and the fluid flows into the drill string P and onto the rotary drill bit connected thereto for lubrication in the customary manner. The flow as described above occurs on a pressure drop acting across the valve 88 sufficient to open the valve of the embodiment A–2 and is similar in operation to the closure apparatus A–1. The drilling mud passes through the ports 88*g* extending into the valve chamber 88*f* to fill the chamber and the weep holes 88*h*.

The flow of pressure fluid is dependent on the biasing force exerted by the resilient means 80 positioned in the lower tubular member 61. Because of this, the drilling fluid pumping apparatus may be operated to reduce the pressure of the drilling mud in the kelly K and the valve 88 is returned to conforming contact with the valve seat and fluid flow is prevented. This step is customarily associated with the addition or removal of a joint of pipe from the drill string P which requires a disconnection of the drill string P from the lower end of the closure apparatus A–2. As is well known to those familiar with the art, the drill string P is usually disconnected from the kelly K and additional joints of pipe are connected therebetween or the top joint of pipe in the drill string P is removed in accordance with the desires of the operator.

As mentioned previously, blowouts may occur, tending to lift drilling mud through through the drill string P and the closure apparatus under the reverse pressure acting upwardly from the drill string P. Such pressure below the closure apparatus A–2 returns the valve 88 to the valve seat 68 and the kelly and fluid handling apparatus are protected from reverse flow of the drilling mud into the pumping apparatus, and the likelihood of damage resulting from the blowout is thereby avoided. Of course, the pressure in the well bore may rise or increase for other reasons and the closure apparatus A–2 will prevent the pressure fluid in the well bore from

acting on the fluid handling apparatus connected upstream of the invention.

On the occurrence of increased pressure in the well bore above the pressure of the drilling fluid acting on the valve **88**, the valve **88** is closed as described above and the bleed means operates to enable the operator to have knowledge of the pressure in the drill string P. The valve **90** is lifted from the valve seat **88***k* and moved to contact the valve seat **88***i* at the upper end of the valve chamber **88***f* which movement compresses the coil spring **92** positioned about the guide rod **91** as shown in FIG. 6 and the guide **91** moves upwardly into the axial opening **88***e* of the central insert **88***c*. When the valve **90** is seated in the position shown in FIG. 6, the larger ports **88***g* connected to the upper end of the valve chamber **88***f* are sealed to prevent the flow of any drilling mud in the reverse direction. However, a small quantity of drilling fluid is bled through the weep holes **88***h* into the passage means **64** to bring the drilling fluid in the passage **64** slowly up to the pressure level of the drilling fluids below the closure apparatus A–**2** of this invention. It may be appreciated that the weep holes **88***h* are small in cross-sectional area and the drilling fluids are slowly transferred by the pressure of the drilling mud in the well bore so that the operator has sufficient time to shut down expensive equipment susceptible of damage from reversed flow of drilling muds and is able to connect pressure gauges or the like with the kelly K to thereby obtain a measurement of the pressure within the well bore itself. Accurate information about the pressure of the drilling muds within the well bore is of benefit to the operator in planning safe, precautionary operations for dealing with the sudden increase and to also provide information for deciding whether or not such increase is in fact a dangerous blowout or merely results from some other cause. Whatever the cause, knowledge of the pressure enables precautionary moves to be adapted on the drilling platform for the protection of equipment and preservation of life.

Certain alterations may be included with the present invention and one such alternation involves the elimination of the weep holes **88***h* shown in the embodiment A–**2**. A route for bleeding pressure fluids past the valve **90** when seated against the seat **88***i* may be obtained by machining or otherwise forming a bleed capillary at the surface of the valve chamber **88***f* through the valve seat **88***i*. Alternatively, the vertical travel of the valve **90** may be limited to a position short of sealing contact with the valve seat **88***i* so that leakage past the seat **88***i* and through the large ports **88***g* is possible. This may be achieved by positioning a spacer sleeve about the coil spring **92** sufficiently long to contact the shoulder **88***j* to hold the valve **90** below the seat **88***i* on compression of the spring **92**. In other words, such means would provide an annular space between the valve **90** and the valve seat **88***i* to permit the bleeding of pressure fluid past the the valve and into the upper tubular member **60**. Such bleeding would likewise enable the operator to obtain pressure measurements of the pressure fluid below the closure apparatus A–**2**.

Broadly, the present invention relates to a device which automatically closes off a tubular member.

I claim:

1. A closure apparatus for controlling fluid flow through a kelly into a drill string and including an arrangement whereby tools may be lowered through the closure apparatus, comprising:

(a) a member having a passage therethrough,
(b) means for connecting the member in fluid communication with the drill string and kelly,
(c) an annular shoulder located in said passage,
(d) a body having a conforming surface adapted to contact said shoulder to shut off fluid flow through said passage,
(e) guide means in said passage for aligning said body with said shoulder,
(f) resilient means for urging said body into contact with said shoulder to maintain a standing column of fluid in the kelly,
(g) said resilient means yielding on predetermined fluid pressure acting through the kelly whereby fluid may flow through said passage,
(h) a plug threadedly engaged in the upper end of said body, and
(i) a projection extending upwardly from said plug so that said plug may be threadedly disengaged and lifted upwardly out of said body whereby tools may be lowered through said body and into the drill string.

2. The invention of claim **1** wherein said plug includes port means in the upper end thereof and a spring loaded check valve mounted within said plug and normally preventing flow from said drill string through said port means, but which check valve may be actuated to open said port means to bleed fluid pressure from the drill string through said plug and which check valve acts upon the occurrence of a pressure surge from the drill string to close off said port means in said plug.

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