

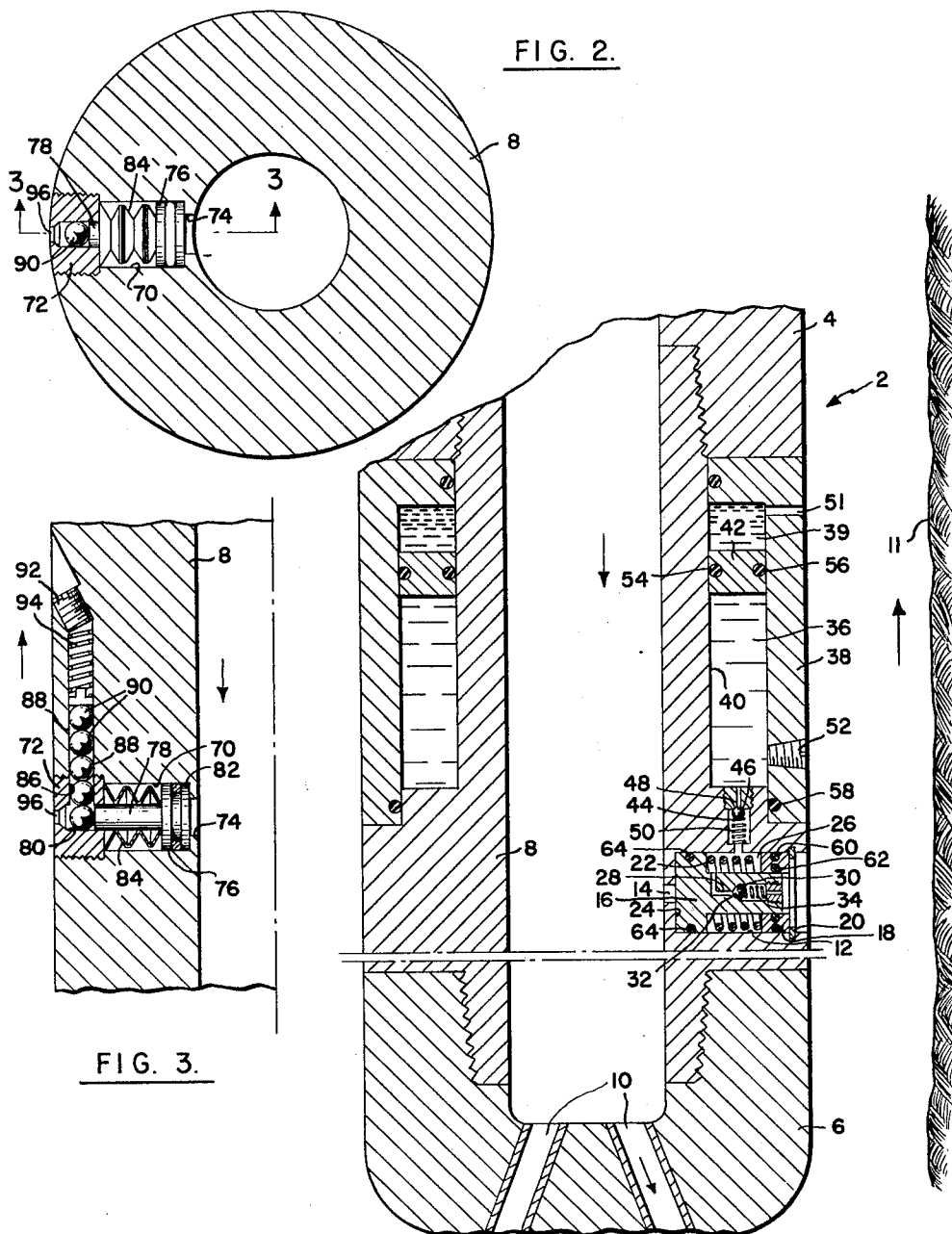
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BORE HOLE APPARATUS FOR MARKING DRILLING MUD

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3,155,176 BORE HOLE APPARATUS FOR MARKING DRILLING MUD

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This invention relates to bore hole drilling apparatus and more particularly to apparatus for marking the drilling mud.

In bore hole drilling it is desirable to be able to mark the drilling mud within the bore hole at a desired location and time in such a manner that when the mud at this location reaches the surface it can be identified. This permits checking of the drilling mud loss by measuring the time it takes for the mud to reach the surface from the marking location. Hence, in the case of lost mud circulation where treatment for stopping the mud loss is added, the effectiveness of this treatment may be checked by determining how long it takes the marked mud to reach the surface since the shorter this ascent time, the less the amount of mud circulation loss.

It is the general object of this invention to provide apparatus of the indicated type for the marking of drilling mud. Briefly stated, the apparatus in accordance with this invention comprises means responsive to a differential pressure between the interior and the exterior of the drill stem for injecting a fluid coloring means into the drilling mud in the bore hole. By this apparatus, the drilling mud becomes marked and can be detected when it reaches the surface.

The above and other objects and features of the invention will become apparent from a consideration of the following description read in conjunction with the accompanying drawing in which:

FIGURE 1 is an axial sectional view of the lower portion of a drill stem comprising the mud marking apparatus in accordance with this invention;

FIGURE 2 is a sectional view of a drill stem comprising a modified form of the mud marking apparatus in accordance with this invention; and

FIGURE 3 is a sectional view taken on a plane indicated at 3-3 of FIGURE 2.

Referring particularly to FIGURE 1, a conventional hollow drill stem is indicated at 2. This drill stem comprises at its lower end the usual drill collar 4 supporting a drill bit 6 by means of a sub 8 coupled between the drill collar 4 and the drill bit 6. Drill bit 6 has the usual mud flow openings 10 desirably lined with erosion-resistant liners. The drill stem 2 extends vertically within the bore hole indicated at 11.

A radially extending bore 12 is provided in the sub 8 and communicates at its inner end with a passageway 14 communicating with the interior of the drill stem. A piston 16 is mounted for reciprocable movement within bore 12. Piston 16 has an enlarged head at its inner end, i.e. the end adjacent the interior of drill stem 2, and is slidably supported at its outer end by an annular member 18 retained in bore 12 by a retaining ring 20. Piston 16 is guided for reciprocable movement within bore 12 by the wall of bore 12 which engages the outer wall of the head of piston 16 and by the inner wall of annular member 18 which engages the outer wall of the reduced diameter portion of piston 16, which portion extends outwardly from the piston head. A compression spring 22 is provided between the head of piston 16 and the annular member 18 to bias the piston 16 inwardly toward contact with a shoulder 24 at the inner end of bore 12.

Since the bore 12 has a larger diameter than the re-

duced diameter portion of piston 16, an annular chamber 26 is defined between piston 16 and the wall of bore 12. Chamber 26 communicates with the exterior of the drill stem 2 through a passageway 28 normally closed by a one-way valve means comprising a ball valve member 30 biased toward engagement with a seat 32 by a spring 34. Ball valve member 30 and seat 32 are arranged with the seat located adjacent the chamber 26 so that the ball valve member 30 permits flow from chamber 26 into the exterior of the drill stem and closes off flow from the exterior of the drill stem to the chamber 26.

Means are provided for supplying a dye fluid to the chamber 26. The dye fluid may be of any suitable type which will color the drilling mud upon mixture therewith. Such means comprises an annular reservoir 36 of dye fluid provided between a collar 38 positioned adjacent a reduced diameter portion 40 of sub 8. Collar 38 and portion 40 cooperate to define an annular chamber 39. An annular floating piston 42 is located within chamber 39 on the top of the dye fluid reservoir 36. A passageway 44 provides communication between reservoir 36 and chamber 26. A one-way valve means is provided in passageway 44 and comprises a ball valve member 46 biased toward contact with a valve seat 48 by a spring 50. Ball valve member 46 and seat 48 are arranged with the seat located closer to the reservoir 36 so that valve member 46 permits flow only in the direction from the reservoir 36 to the chamber 26.

The portion of chamber 39 above the floating piston 42 is connected to the exterior of the drill stem by a passageway 51. Hence, the pressure on the exterior of the drill stem urges the piston 42 downwardly. A plug 52 is provided in collar 38 to permit filling of the reservoir 36 with the dye fluid.

Suitable O-ring sealing means are provided to prevent leakage from the reservoir 36, such as sealing means 54 and 56 carried by piston 49 and sealing means 58 positioned between collar 38 and sub 8. The passageway 50 serves to equalize the pressure around the reservoir 36 so as to avoid undue pressure on the sealing means therefor.

Sealing means are also provided for the chamber 26. Such means comprises a pair of O-rings 60 and 62 mounted in the outer and inner walls of annular member 18 in contact with the wall of bore 12 and the reduced diameter portion of piston 16, respectively. The sealing means for chamber 26 also includes an O-ring 64 carried by the head of piston 16 for contact with the wall of bore 12.

During the drilling of a bore hole, the drilling mud is circulated down through the interior of the hollow drill stem 2, through the jet openings 10 and upwardly through the passageway between the exterior of the drill stem and the wall of the bore hole 11 as is indicated by the arrows in FIGURE 1. This circulation is provided by a suitable mud pump.

With the mud pump not operating, the drilling mud will settle within the bore hole and the pressure in the interior and the exterior of the drill stem will be equalized. In this condition, which is shown in FIGURE 1, spring 22 will hold piston 16 in its inner position with the head thereof contacting shoulder 24, chamber 26 will contain a supply of dye fluid and the valve members 30 and 46 will prevent flow through passageways 28 and 44, respectively.

When the marking of the drilling mud is desired, drilling mud is pumped down through the interior of the drill stem 2. This will create a pressure differential between the interior and the exterior of the drill stem since the jet openings 10 provide a restricted passageway and cause a pressure build-up within the interior of the drill stem.

The pressure of the interior of the drill stem is applied to the inner end of piston 16 through opening 14 to urge the same outwardly of the drill stem. This outward urging is opposed by the pressure on the exterior of the drill stem acting on the piston 16 and by the bias of spring 22. When the pressure differential is sufficient to overcome the bias of spring 22, the piston 16 is moved outwardly, i.e., to the right as viewed in FIGURE 1. This movement of piston 16 pumps the dye fluid from chamber 26 through the passageway 44 into the exterior of the drill stem. It will be apparent that during this movement of piston 16, the valve 32 in the passageway 28 will permit the flow of the dye fluid therethrough while the valve 46 in the passageway 44 will restrict any flow outwardly of the chamber 26.

The outward movement of piston 16 is stopped at the end of its permissible stroke or when the restricting force provided by the spring 22 and equals the force provided by the pressure differential on the piston 16. When the piston outward movement is stopped, no more dye fluid will be pumped through the passageway 28 and the ball valve member 30 will be retained in contact with valve seat 32 by the action of spring 34. This prevents any backflow of the drilling and mud into the chamber 26.

The piston 16 will remain in the position until the pressure on the interior of the drill stem is reduced by stopping the pumping of drilling mud down through the drill stem. When this occurs, the spring 22 will return the piston 16 to the inner position thereof as shown in FIGURE 1 to prepare the same for pumping another quantity of dye fluid into the bore hole. During this return movement, dye fluid is drawn from the reservoir 36 through the passageway 44 to replenish the chamber 26. The return movement of piston 16 creates a void in chamber 26 which must be filled. Since the drilling mud cannot enter chamber 26 through passageway 28, the dye fluid in reservoir 36 is the only source from which this void may be filled. The apparatus is now in position to pump or inject another quantity of dye into the bore hole.

It will be apparent that the apparatus in accordance with this invention is operable to mark the drilling mud as a result of the occurrence of a differential pressure between the interior and the exterior of the drill stem. This is conveniently provided by controlling the pumping of drilling mud down through the drill stem. Multiple marking may be effected by repeating the marking cycle which comprises the starting and stopping of the mud pump.

Since the mud pit may become colored with dye as a result of repeated marking operations, the color of the dye may be changed. This is desirably accomplished when the drill bit is being changed on the drill stem. Alternatively, there may be provided a system of interlocking pumps for injecting a different color of dye in each successive marking operation.

A modified form of this invention is shown in FIGURES 2 and 3 and comprises a radially extending bore 70 in the sub 8. A plug 72 is threaded into sub 8 at the outer end of bore 70. A passageway 74 provides communication between the inner end of bore 70 and the interior of the drill stem. A piston 78 is mounted for reciprocating movement within bore 70. Piston 76 has an enlarged head contacting the inner wall of bore 70 and a reduced diameter, cylindrical plunger 78 projecting outwardly from the head thereof. Plunger 78 projects into a bore 80 in plug 72 and is slidably movable therein.

Piston 76 is thus guided for reciprocating movement by the bearing surfaces provided by the walls of bore 70 and 80. Piston 76 is biased to an inner position wherein the head thereof contacts the shoulder 82 provided at the inner end of bore 70 by a spring means 84 positioned in compression between the head of piston 76 and plug 72. Spring means 84 is comprised of a plurality of flexible conical-shaped discs. However, any suitable compression spring could be used, such as the usual coil spring.

Plug 72 is provided with a bore 86 communicating at right angles with bore 80 and communicating axially with a bore 88 in sub 8. Bores 80, 86 and 88 are adapted to contain a plurality of dye vials 90 of a spherical shape. Bore 80 is constructed to contain only one vial 90 at a time and bores 86 and 88 cooperate to provide a supply of vials 90 in a stacked condition. A plug 92 is threadedly mounted in sub 8 to communicate with the outer end of bore 88. Plug 92 is removable from its mounting and serves to permit loading of the vials 90 into the bore 88. A spring 94 is positioned in compression between plug 92 and the upper vial 90 of the stack to urge the vials 90 toward bore 80. The dye within the vials 90 may be of any suitable type. However, a water soluble water dye is preferable.

When the piston 76 is in its inner position the outer end of plunger 78 clears the bore 86 to permit the entrance of a vial 90 into bore 80 from bore 86. A restricted opening 96 provides communication between the exterior of the drill stem and the bore 80. The circumference of opening 96 is smaller than the circumference of the spherical vials 90 for a purpose to be hereinafter described.

In the operation of the form of the invention shown in FIGURES 2 and 3, piston 76 is movable in response to the differential pressure between the interior and the exterior of the drill stem in the same manner as the piston of the FIGURE 1 form of the invention. When the differential pressure between the interior and the exterior of the drill stem is equalized, the spring means 84 will hold the piston 76 in its inner position with the head thereof contacting shoulder 82 as shown in the drawing. However, when the marking of the mud is desired, the drilling mud is pumped down through the interior of the drill stem to create a pressure differential between the interior and exterior of the drill stem. This pressure differential is applied to the piston 76 to urge the same outwardly from the position shown in FIGURE 1. When the pressure differential is sufficient to overcome the bias of the spring means 84, the piston 72 moves outwardly.

During this outward movement of piston 72, plunger 78 enters bore 80 to contact the vial 90 therein and forces this vial through the restricted opening 96. As the vial 90 is pushed through this opening 96 it will be ruptured so that the dye therein will mix with the drilling mud in the bore hole to color the same. The colored dye will be pumped to the surface of the bore hole where it can be identified as being that drilling mud in the vicinity of dye injecting apparatus at the time the mud pump was started.

The piston 72 will remain in its outward position until the pressure differential between the interior and the exterior of the drill stem is reduced in response to stopping of the pumping of drilling mud down through the drill stem. This will decrease the pressure differential across the piston 72 which will be actuated to its inward position by the action of the spring means 84. At the end of this return movement, the vial 90 which was held in the bore 86 by the plunger 78 will move into bore 80 by the action of spring 94. This replenishes the bore 80 to prepare the apparatus for the ejection of another vial 90 from sub 8 into the bore hole upon a subsequent reciprocating movement of the piston member 76 in response to the creation of a pressure differential as described above. It will be apparent that multiple marking of the drilling mud may be effected by repeating the cycle of starting and stopping the drilling mud pump.

With the apparatus shown in FIGURES 2 and 3, it is a simple matter to provide different colors. This is accomplished by providing different color dyes within the vials stacked within the bore 88. Thus, there will be no difficulty in observing the marked mud.

While the apparatus herein disclosed is directed to the injection of a coloring means into the drilling mud, it is to be understood that the invention can be practiced by the injection of other detectable means into the drilling

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mud. For example, chemicals which could be detected by their odor or by detecting instruments could be used. It is thus not desired to be limited except as required by the following claims.

What is claimed is:

1. Bore hole drilling apparatus comprising a hollow drill stem, means defining a chamber within said drill stem, a vial containing a liquid coloring dye positioned within said chamber in said drill stem, piston means movably mounted for movement into said chamber, said piston means having opposed pressure responsive sides, means applying the pressure at the interior of said drill stem to one of said sides to urge the piston in one direction, means applying the pressure at the exterior of the drill stem to the other of said sides to urge the piston in the opposite direction, passageway means providing communication between said chamber and said bore hole, said piston means being movable into said chamber to contact said vial to force the same from said chamber through said passageway means into the bore hole in response to the occurrence of a differential pressure between the interior and the exterior of said drill stem.

2. Apparatus as claimed in claim 1 comprising means biasing said piston means toward a first position, said piston means being movable from said first position against said bias to a second position during said movement thereof in response to said pressure differential occurrence, said biasing means returning said piston means from said second to said first position upon the termination of said differential pressure.

3. Apparatus as claimed in claim 2 comprising a plurality of said vials contained within said drill stem and means for positioning one of said vials in said chamber for contact by said piston means upon said piston means return movement to said first position.

4. Apparatus as claimed in claim 1 comprising means for rupturing said vials on movement thereof from said chamber into the bore hole.

5. Apparatus as claimed in claim 4 wherein said rupturing means comprises said passageway means providing communication between said chamber and the exterior of said drill stem, said passageway means being smaller than said vials.

6. Bore hole drilling apparatus comprising a drill stem having a longitudinal internal bore, a drill bit mounted at the bottom of said drill stem and having a restricted passageway between said internal bore and the exterior of said drill stem, fluid coloring means contained within said drill stem, and means mounted in said drill stem responsive to the predirected production of a pressure in said internal bore greater than the pressure on the exterior of said drill stem for injecting said fluid coloring means into the bore hole, said differential pressure being provided by drilling mud flowing down through said bore in drill stem and through said restricted passageway, whereby drilling mud passing along the drill stem exterior to the surface of the bore hole becomes colored.

7. Bore hole drilling apparatus comprising a drill stem having a longitudinal internal bore, fluid coloring means contained within said drill stem, piston means movably mounted in said drill stem, said piston means having opposed pressure responsive sides, means for applying pressure in said internal bore to one of said sides to urge the piston means in one direction, means for applying pressure at the exterior of the drill stem to the other of said sides to urge the piston means in an opposite direction, said piston means being movable through an injecting movement in response to the predirected production of a pressure in said internal bore greater than the pressure at the exterior of said drill stem, said fluid coloring means being positioned to be contacted and moved by said pis-

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ton means during said injecting movement thereof, and means guiding said fluid coloring means for movement from said drill stem to the exterior thereof upon contact and movement of said fluid by said piston means during said injecting movement.

8. Apparatus as claimed in claim 7 comprising means biasing said piston means toward a first position, said piston means being movable from said first position against said bias to a second position during said injecting movement thereof in response to said differential pressure occurrence, said biasing means returning said piston means from said second position to said first position upon the termination of said differential pressure.

9. Apparatus as claimed in claim 8 comprising means for replenishing said fluid coloring means upon said return movement of said piston means including a storage supply of fluid coloring means contained within said drill stem and means providing communication between said supply and the portion of said piston means engaging said fluid coloring means.

10. Bore hole drilling apparatus comprising a hollow drill stem having a longitudinal internal bore, means defining a chamber in said drill stem, a supply of fluid dye contained within said chamber in said drill stem, piston means movably mounted in said chamber, said piston means having opposed responsive sides, means for applying pressure in said internal bore of said drill stem to one of said sides to urge the piston means in one direction, means for applying pressure at the exterior of the drill stem to the other of said sides to urge the piston means in the opposite direction, passageway means providing communication between said chamber and the bore hole, said piston means being movable into said chamber to force the dye therefrom into the bore hole through said passageway means in response to the occurrence of a pressure in said internal bore greater than the pressure at the exterior of said drill stem.

11. Apparatus as claimed in claim 10 comprising means for biasing said piston means toward a first position, said piston means being movable from said first position against said bias to a second position during said movement thereof in response to said pressure differential occurrence, said biasing means returning said piston means from said second position to said first position upon the termination of said pressure differential.

12. Apparatus as claimed in claim 10 including means for replenishing said supply of fluid dye upon said return movement of said piston means, said replenishing means comprising a reservoir of fluid dye contained within said drill stem, and comprising a passageway means providing communication between said reservoir and said chamber and said passageway means providing communication between said chamber and said bore hole.

13. Apparatus as claimed in claim 12 including valve means in said passageway between said reservoir and said chamber permitting flow between said reservoir and said chamber and preventing flow in the reverse direction, and valve means in said passageway between said chamber and the bore hole permitting flow between said chamber and the bore hole and preventing flow in the reverse direction.

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