

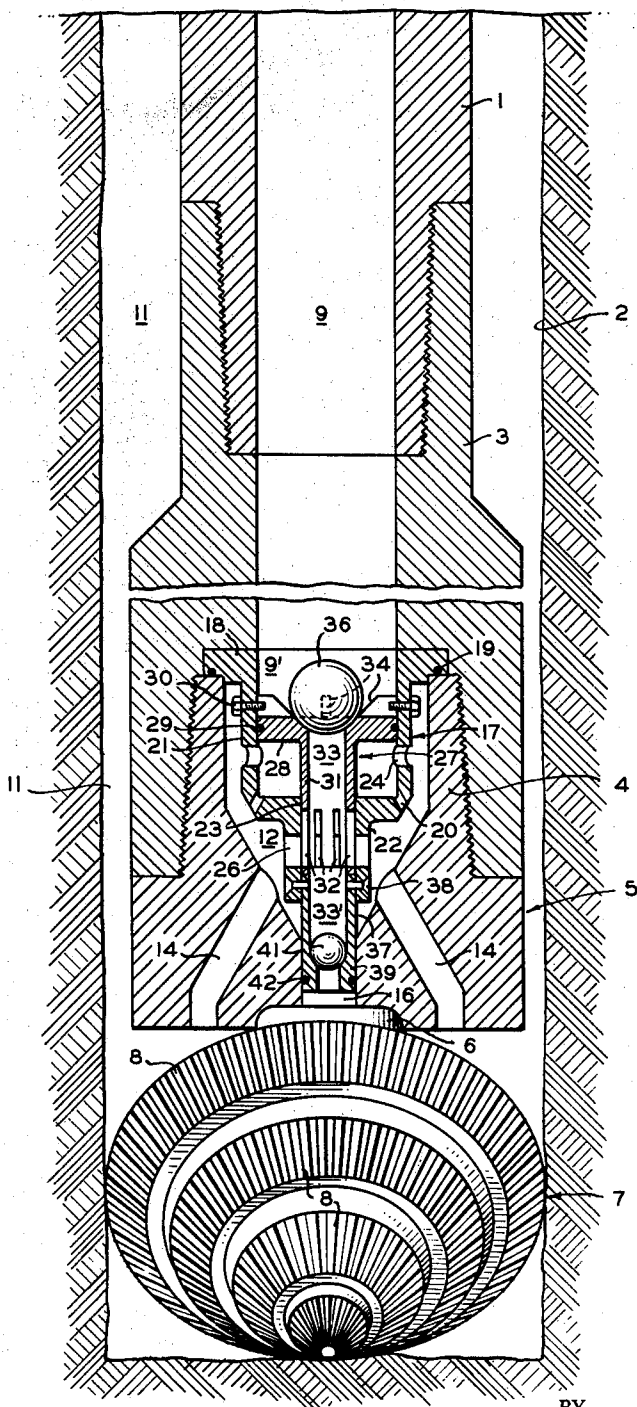
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G. S. BOUDREAUX ET AL

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BOTTOM HOLE DRILLING FLUID CONTROL VALVE

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INVENTORS  
G. S. BOUDREAUX  
R. A. BOBO

BY

Hudson & Young

ATTORNEYS

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2,945,678

## BOTTOM HOLE DRILLING FLUID CONTROL VALVE

George S. Boudreaux and Roy A. Bobo, Houston, Tex.,  
assignors to Phillips Petroleum Company, a corporation  
of Delaware

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This invention relates to a bottom hole drilling fluid control valve. More particularly, this invention relates to a bottom hole drilling fluid control valve used in a drilling process wherein a bore hole is drilled with an aerated drilling fluid.

In drilling wells for oil or gas, it is sometimes desirable to lighten a column of drilling fluid to prevent loss of circulation, to increase the drilling rate, and/or to allow small amounts of oil and gas from the formation being drilled to enter the drilling fluid so that they may be detected. This lightening of the drilling fluid is done by injecting a gas (generally air but sometimes hydrocarbon gas, or gases resulting from combustion) into the liquid used as the drilling fluid before it is pumped into the well. One difficulty encountered in this type of operation occurs when initiating the gas flow, or when resuming circulation, as, for example, after making a round-trip to change the bit. When the fluid containing compressed gas first leaves the lower end of the drill string, the gas rises and expands in the annular space between the casing and the drill string. Since this annular space is full of drilling fluid, the gas can cause a violent discharge or "blow out" of this fluid at the surface of the bore hole, resulting in a loss of fluid before the flow becomes stabilized.

In order to circumvent the above-mentioned difficulty, it is often desirable to circulate non-aerated drilling fluid to fill up the drill string and the annulus surrounding the same, for example, before pulling the string to replace a worn bit, so that the mud in the bore hole does not "blowout" or "unload" as pressure is released and expansion of the gas in the drilling fluid takes place. Then, when the string is rerun, for example, with a new bit, aerated drilling fluid is once again circulated to displace the non-aerated heavier drilling fluid. However, while using aerated drilling fluid it is desirable to provide a relatively small opening or openings through the drill bit as compared with the size of the opening used when circulating non-aerated drilling fluid. The provision of smaller openings is so that sufficient pressure differential can be carried across each small opening to project the necessary impact energy to effectively clean the hole beneath the bit. Moreover, when displacing the aerated drilling fluid with non-aerated drilling fluid before pulling the drill string from the bore hole or when displacing the non-aerated drilling fluid with aerated drilling fluid after running the drill string in the bore hole, it is desirable to provide a relatively large opening through the drill bit to permit rapid circulation in order to save time during the displacing operation.

Accordingly, an object of this invention is to provide a bottom hole drilling fluid control valve. A further object is to provide a bottom hole drilling fluid control valve for use in drilling a bore hole with an aerated drilling fluid. A further object is to provide a bottom hole drilling fluid control valve which will insure efficient jetting of the aerated fluid against the bottom of the bore hole. A still further object is to provide a

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bottom hole drilling fluid control valve which will permit rapid circulation of drilling fluid when displacing non-aerated drilling fluid with aerated drilling fluid, or vice versa. Other objects and advantages of our invention will become apparent, to those skilled in the art, from the following discussion, appended claims, and the single drawing which is an elevation view in partial section of a drilling tool inserted in a well bore embodying features of our invention.

The term "aerated drilling fluid" or "aerated mud" as used in the description of this invention and in the appended claims is to be understood to mean a drilling fluid which contains air or other gas in compressed condition so as to render the fluid substantially less dense. The term includes all of the conventional drilling fluids, such as oil, water, mud, lime, etc., which have been aerated with air or other gas. Conversely, the term "non-aerated drilling fluid" or "non-aerated mud" is to be understood to mean any conventional drilling fluid which has not been aerated with air or other gas.

Although our invention is equally applicable to any flow system where it is desired to conduct fluids having different densities from a common alternatively used conduit to different flow passages, it is particularly applicable in combination with a drill bit used during those drilling operations wherein a bore hole is traversed while circulating aerated drilling fluid.

Referring now to the single drawing, a conventional drill string 1 is shown depending within a well bore 2. The lower end of drill string 1 is threadedly secured to a collar 3, the latter being threadedly connected at its lower end to a tapered portion or shank 4 of a drill bit body generally designated 5. The body 5 has suitable depending extensions or legs 6 which support one or more conical drilling cones generally designated 7 having a plurality of cutting faces 8 comprising a plurality of cutting elements. In order to avoid a prolix showing, only one cone is shown in the drawing, and it is to be understood that our invention is applicable to any drilling bit wherein the number of cones may vary, for example, from one to four. The drill string 1 and the drill collar 3 have a common flow passageway 9 which supplies drilling fluid under pressure from a source of supply at the surface to the drilling bit body 5. The drill string 1 may be rotated by conventional drilling equipment, such as a rotary drilling rig, and the rotary motion is transmitted to the drill bit body 5 which in turn rotates the cone 7 whereby the drilling of the bore hole is accomplished. The drilling fluid flows from the drill string, in a manner subsequently to be described, and serves to carry the resulting cuttings up through the annulus 11 of the bore hole 2 to the surface.

The body 5 can be provided with an interior chamber 12, the bottom portion of which may be conical as shown. The lower portion of body 5 is provided with one or more jet passageways 14 the upper ends of which communicate with the lower tapered or conical portion of the internal chamber 12. These jet passageways 14 can be adapted to conduct a jet of drilling fluid in a direction generally tangential to the cutting faces 8 of the cone 7 or at any other desired angle. The body 5 is also provided with a central discharge passageway 16 which is adapted to conduct a stream of drilling fluid in a direction generally between a plurality of cones. The diameter of central discharge passageway 16 is preferably larger than the diameter of jet passageway 14.

Depending in internal chamber 12 is a hollow valve body generally designated 17. The latter is provided with an upper annular flange 18 which is supported by the upper end of shank 4 and locked in that position by collar 3. A suitable O ring seal 19 may be provided between the adjacent faces of annular flange 18 and shank

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4. The valve 17 has a first reduced portion 21 and a second smaller reduced portion 22. The former defines a flow passageway 9' which is in communication with flow passageway 9 and has generally the same cross-sectional area. The bottom of reduced portion 21 can be provided with one or more ports 20 to permit egress of fluid. The reduced portion 22 defines a passageway 23. The side wall of reduced portion 21 is provided intermediate its ends with one or more ports 24 and the side wall of reduced portion 22 is provided with one or more ports 26. A displaceable sleeve, generally designated 27, is inserted in flow passageway 9' and passageway 23. Sleeve 27 is provided at its upper end with an annular head portion 28, the periphery of which snugly fits the inner walls of the reduced portion 21; the adjacent faces of annular head 28 and reduced portion 21 may be provided with a suitable O ring seal 29. The upward displacement of the annular head 28 is prevented by reason of one or more stops, such as set screws 30. Sleeve 27 is also provided with a stem portion 31, the lower end of which depends in passage 23. Stem portion 31 is provided with one or more ports 32 which are preferably longer than ports 26 and register therewith. Sleeve 27 is provided with an axial flow passageway 33 which communicates at its upper end with flow passageway 9' and at its lower end with central discharge passageway 16. The upper face of annular head 28 is provided with a beveled valve seat 34 adapted to seat a ball 36, the latter having a diameter substantially greater than that of flow passage 33. A second ejectable sleeve 37 is snugly fit in the lower portion of the passage 23 of reduced portion 22 and is held therein by suitable releasable holding means, such as shear pins 38. Sleeve 37, defining passageway 33', has a reduced inner portion 39 adapted to serve as a valve seat for ball 41, the diameter of the latter being slightly smaller than the cross sectional area of flow passage 33. The lower portion of sleeve 37 snugly fits in central discharge passageway 16. The adjacent portions of sleeve 37 and the walls of the drill bit body 5 defining the passage 16 can be provided with a suitable O ring seal 42.

In operation, with the bore hole filled with non-aerated drilling fluid, the drill string 1 is run into the bore hole and the bottom hole drilling fluid control valve elements are in the position shown in the drawing, except that the balls 36, 41 are subsequently dropped into the drill string, as described hereinafter. When the drill bit reaches the bottom of the bore hole, aerated drilling fluid is pumped into the drill string 1 at the surface and the drilling fluid flows downward therethrough displacing the non-aerated drilling fluid in the drill string. The aerated drilling fluid is circulated from the drill string 1 into the annulus 11 via passageways 9', 33, 33' slots 32, ports 26 and passageways 14, 16. When the non-aerated drilling fluid has been displaced, ball 41 is dropped into the drill string 1 at the surface and pumped downward through the drill string 1 with aerated drilling fluid and it comes to seat in the lower sleeve 37. The ball 41 when it reaches the position shown in the drawing cuts off further flow of the aerated drilling fluid through central discharge passageway 16 and the bore hole is drilled with aerated drilling fluid being jetted through jet passageways 14. During the drilling operation the upper sleeve 27 remains in a first position shown in the drawing, the sleeve 27 covering the ports 24. The pressure differential across the drill bit, acting on the annular head 28 of the upper sleeve 27, is too small to shear pins 38. When it is desired to remove the drill string from the bore hole, for example, in order to change a drill bit, ball 36 is dropped into the upper end of drill string 1 and is pumped to the bottom where it seats on the valve seat 34 at the upper end of the sleeve 27. At this time the rotation of the drill string is discontinued and the resulting pressure differential across the drill bit is allowed to act on the upper face of the annular head 28, thus exerting sufficient force to

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shear pins 38. In so doing, the upper sleeve 27 is pushed downwardly to a second position where the upper face of the annular head 28 moves to a position below the ports 24. Lower sleeve 37 and ball 41, made preferably from drillable material, are thus pushed through the central discharge passageway 16 into the bottom of the bore hole where it can be subsequently drilled and removed from the bore hole by circulating it along with drilling fluid up the annulus 11. The lower end of the upper sleeve 27 will now occupy its second position at a point below the lower reduced portion 22. The slots 32 can be so sized that they will register with the ports 26 in the lower reduced portion 22 when the sleeve 27 is in its second position. Fluid trapped in reduced portion 21 below ports 24 by annular head 28 is vented through ports 20 to permit annular head 28 to reach its second position below ports 24. With the sleeve 27 in its lower or second position, non-aerated drilling fluid is pumped down the drill string 1 into the annulus 11 via passageway 9', ports 24, jet passageways 14, ports 26, slots 32 and the central discharge passageway 16.

When the aerated drilling fluid in the annulus 11 has been completely displaced with non-aerated drilling fluid, the drill string 1 can be pulled from the bore hole and the bit changed, etc. With a new lower sleeve in place and the replacement of shear pins 38, the drill string with its bottom hole drilling fluid control valve can again be inserted into the bore hole.

Various modifications and alterations of our invention will become apparent, to those skilled in the art, from the foregoing discussion and accompanying drawing, and it is to be understood that they are merely preferred embodiments of our invention and the latter is not to be unduly limited thereto.

We claim:

1. A valve structure comprising, in combination, a body having a first fluid-conducting passageway therethrough, the latter having a first inlet and a first outlet, a displaceable sleeve disposed in said first passageway and movable within said first passageway from a first position to a second position, releasable holding means holding said sleeve in its first position, at least one second fluid-conducting passageway in said body having a second inlet and a second outlet, said second passageway adapted to communicate through said second inlet with said first passageway through a first set of ports in said body when said sleeve is in its first and second positions and through a second set of ports in said body when said sleeve is in its second position, first displaceable obturating means associated with one end of said sleeve and adapted to initially divert flow of fluid through said body through said second outlet of said second passageway when said sleeve is in its first position, and second obturating means associated with the other end of said sleeve and adapted to obstruct flow of fluid through said sleeve, said second means adapted to release said holding means when a predetermined pressure differential acts upon the former, whereby said sleeve moves to its second position and fluid is permitted to flow through said first and second outlets.

2. A valve structure comprising, in combination, a body having a first fluid-conducting passageway therethrough, the latter having a first inlet and a first outlet, a displaceable sleeve disposed in said first passageway and moveable from a first position to a second position, releasable holding means holding said sleeve in its first position, said body having first ports registerable with corresponding ports in said sleeve when the latter is in its first position and second ports which are covered by said sleeve member when the latter is in its first position, a plurality of second fluid-conducting passageways in said body having second inlets and second outlets, said second passageways adapted to communicate through said second inlets with said first passageway through said first and second ports, first manually controlled means as-

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sociated with one end of said sleeve adapted to initially obstruct the flow of fluid through said first outlet and divert the same through said second outlets of said second passageways, and second manually controlled means associated with the other end of said sleeve and adapted to obstruct the flow of fluid through said sleeve passageway, said second means adapted to cause the release of said holding means when a predetermined pressure differential acts upon the former, whereby said sleeve moves to its second position and fluid is permitted to flow through said first and second outlets.

3. Valve structure according to claim 2, wherein said first means comprises a first ball valve adapted to seat in said first passageway at a point adjacent said first outlet to obstruct the flow of fluid therethrough, and wherein said second means comprises a second ball valve adapted to seat on the other end of said sleeve adjacent said first inlet to obstruct flow of fluid therethrough.

4. A valve structure comprising, in combination, a body having an internal chamber provided with a first outlet at its lower end, a tubular member depending in said chamber from its first inlet, a displaceable sleeve disposed in said tubular member and moveable from a first position to a second position, an ejectable sleeve having an upper end disposed in said tubular member adjacent the lower end of said displaceable sleeve and a lower end disposed in said first outlet, said ejectable sleeve held in said tubular member by releasable holding means, said tubular member having first ports registerable with corresponding ports in said displaceable sleeve when the latter is in its first position and second ports which are covered by the upper portion of said displaceable sleeve when the latter is in its first position, a plurality of passageways in said body having second inlets and outlets, said second inlets communicating with said chamber, first manually controlled means associated with said ejectable sleeve and adapted to initially obstruct the flow of fluid through said first outlet and divert the same through said second outlets of said passageways, and second manually controlled means associated with the upper end of said displaceable sleeve and adapted to obstruct the flow of fluid through the latter, said second means adapted to cause said holding means to release when a predetermined pressure differential acts upon the former, whereby said displaceable sleeve moves to its second position and ejects said ejectable sleeve from said body through said first outlet, and whereby fluid is permitted to flow through said first and second outlets.

5. A valve structure comprising, in combination, a body having an internal chamber provided with a first outlet opening at its lower end communicating with a first fluid-conducting passageway, a tubular member depending in said chamber from its first inlet, said member having an upper enlarged portion providing an inwardly-projecting shoulder, a displaceable sleeve slidably disposed in said tubular member and moveable downward from a first position to a second position, the upper end of said sleeve having an enlarged annular head the lower face of which engages said shoulder to limit downward movement, an ejectable sleeve having an upper end disposed in the lower portion of said tubular member adjacent the lower end of said displaceable sleeve and a lower end disposed in said first passageway, said ejectable sleeve member held in said tubular member by the shear pins, said tubular member having first ports in its lower portion registerable with corresponding ports in said displaceable sleeve when the latter is in its first position and second ports in its upper enlarged portion through which communication can be had when said annular head is seated on said shoulder, a plurality of second passageways in said body having second inlets and second outlets, said second inlets communicating with said chamber, first manually controlled means adapted to initially construct the flow of fluid through said first outlet and divert the same through said second outlets of said second pas-

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sageways, said first means comprising a first ball valve adapted to seat in said ejectable sleeve, and second manually controlled means adapted to obstruct the flow of fluid through said displaceable sleeve, said second means comprising a second ball valve adapted to seat on the upper face of said annular head, said second means adapted to cause said pins to shear when a predetermined pressure differential acts upon the former, whereby said displaceable sleeve moves to its second position and ejects said ejectable sleeve from said body through said first outlet, and whereby fluid is permitted to flow through said first and second outlets.

6. In combination with a drill bit having a cutting head providing with cutting elements, a valve structure associated with said drill bit, said valve structure comprising, in combination, a body having a first fluid-conducting passageway therethrough, the latter having first inlet and a first outlet adjacent said cutting head, a displaceable sleeve disposed in said first passageway and moveable within said first passageway from a first position to a second position, releasable holding means holding said sleeve in its first position, at least one second fluid-conducting jet passageway in said body having a second inlet and a second outlet, said second passageway adapted to communicate through said second inlet with said first passageway through a first set of ports in said body when said sleeve is in its first and second positions and through a second set of ports in said body when said sleeve is in its second position, said second passageway adapted to discharge a jet of fluid through said second outlet adjacent said cutting head, first displaceable obturating means associated with one end of said sleeve and adapted to initially divert flow of fluid through said body through said second outlet of said second passageway when said sleeve is in its first position, and second obturating means associated with the other end of said sleeve and adapted to obstruct flow of fluid through said sleeve, said second means adapted to release said holding means when a predetermined pressure differential acts upon the former, whereby said sleeve moves to its second position and fluid is permitted to flow through said first and second outlets.

7. In combination with a drill bit having a cutting head providing with cutting elements, a valve structure comprising, in combination a body having a first fluid-conducting passageway therethrough, the latter having a first inlet and a first outlet adjacent said cutting head, a displaceable sleeve disposed in said first passageway and moveable from a first position to a second position, releasable holding means holding said sleeve in its first position, said body having first ports registerable with corresponding ports in said sleeve when the latter is in its first position and second ports which are covered by said sleeve member when the latter is in its first position, a plurality of second fluid-conducting jet passageways in said body having second inlets and second outlets, said second passageways adapted to communicate through said second inlets with said first passageway through said first and second ports, said second passageways adapted to discharge jets of fluid through said second outlets adjacent said cutting head, first manually controlled means associated with one end of said sleeve adapted to initially obstruct the flow of fluid through said first outlet and divert the same through said second outlets of said second passageways, and second manually controlled means associated with the other end of said sleeve and adapted to obstruct the flow of fluid through said sleeve, said second means adapted to cause the release of said holding means when a predetermined pressure differential acts upon the former, whereby said sleeve moves to its second position and fluid is permitted to flow through said first and second outlets.

8. The combination according to claim 7, wherein said first means comprises a first ball valve adapted to fall by gravity and seat in said first passageway at a point adjacent said first outlet to obstruct the flow of fluid there-

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through, and wherein said second means comprises a second ball valve adapted to fall by gravity and seat on the other end of said sleeve adjacent said first inlet to obstruct flow of fluid therethrough.

9. In combination with a drill bit having a cutting head providing with cutting elements, a valve structure associated with said drill bit, said valve structure comprising, in combination, a body having an internal chamber provided with a first outlet as its lower end adjacent said cutting head, a tubular member depending in said chamber from its first inlet, a displaceable sleeve disposed in said tubular member and moveable from a first position to a second position, an ejectable sleeve having an upper end disposed in said tubular member adjacent the lower end of said displaceable sleeve and a lower end disposed in said first outlet, said ejectable sleeve held in said tubular member by releaseable holding means, said tubular member having first ports registerable with corresponding ports in said displaceable sleeve when the latter is in its first position and second ports which are covered by the upper portion of said displaceable sleeve when the latter is in its first position, a plurality of jet passageways in said body having second inlets and out-

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lets, said second inlets communicating with said chamber, said jet passageways adapted to discharge jets of fluid through said second outlets against the bottom of said bore hole, first manually controlled means associated with said ejectable sleeve and adapted to initially obstruct the flow of fluid through said first outlet and divert the same through said second outlets of said passageways, and second manually controlled means associated with the upper end of said displaceable sleeve and adapted to obstruct the flow of fluid through the latter, said second means adapted to cause said holding means to release when a predetermined pressure differential acts upon the former, whereby said displaceable sleeve moves to its second position and ejects said ejectable sleeve from said body through said first outlet, and whereby fluid is permitted to flow through said first and second outlets.

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