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R. C. BAKER ET AL
DRILL PIPE FLOAT VALVE

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Fig. 1.

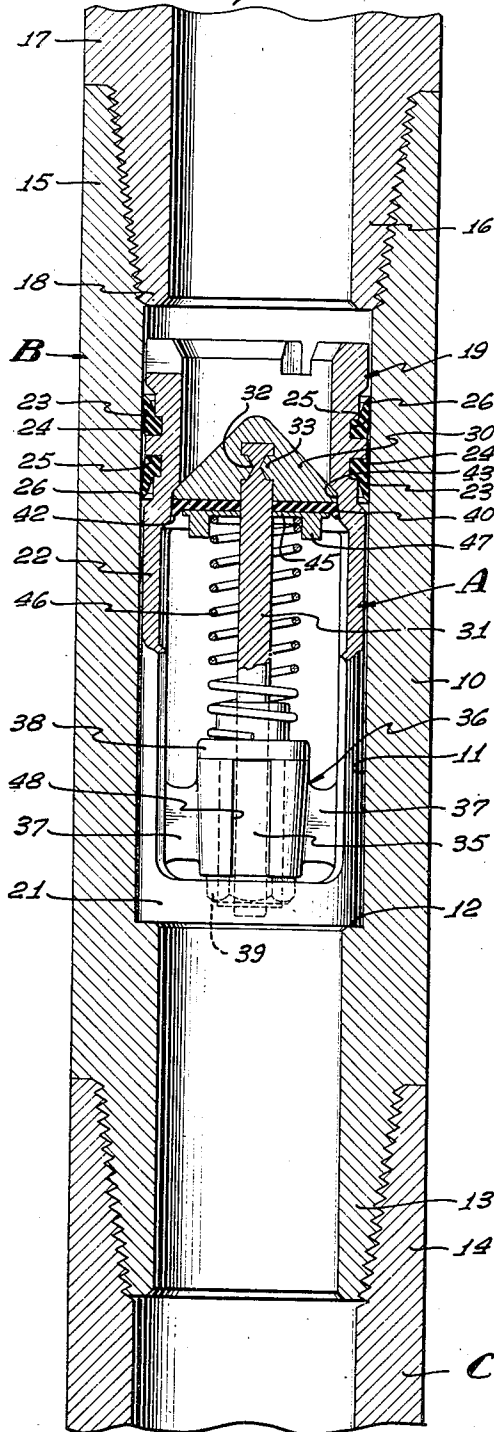


Fig. 2.

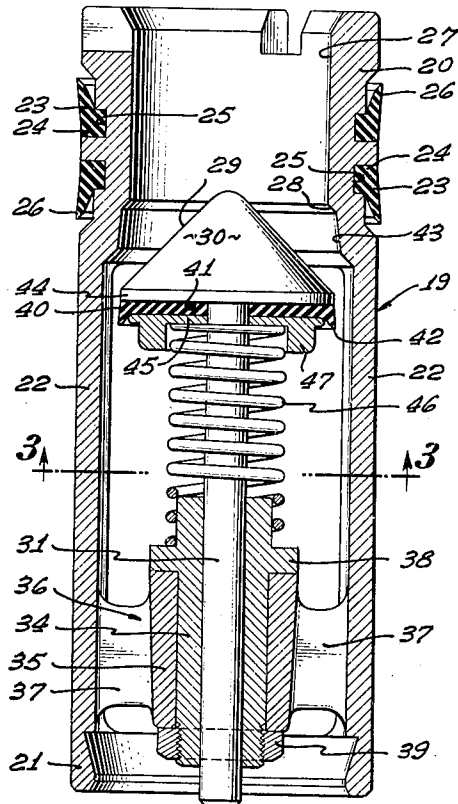
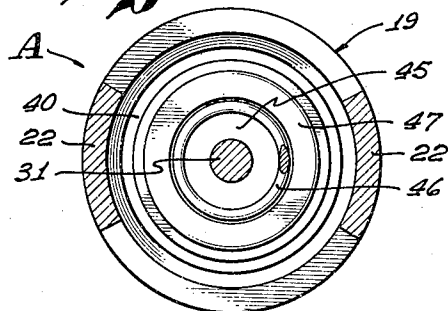


Fig. 3.



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DRILL PIPE FLOAT VALVE

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7 Claims. (Cl. 137—542)

The present invention relates to subsurface well apparatus, and more particularly to valve devices which are to be incorporated in strings of drill pipe for the purpose of preventing upward flow of fluid therethrough.

Drill pipe float valves are incorporated in strings of drill pipe that are to be disposed in well bores, to accomplish several desirable objectives. Inasmuch as this type of valve closes in an upward direction and opens to permit downward flow of fluid therethrough, it is instrumental in floating the drill pipe string in the hole as the string is being lowered therewithin. As a result of this floating action, the derrick and rig equipment is relieved of a substantial portion of the weight of the drill pipe string. In addition, the drill pipe float valve reduces the danger of the drill bit at the lower end of the string of pipe plugging, and also eliminates the annoyance of fluid rapidly filling the drill pipe and overflowing at the top of the hole, wetting the surface equipment, the working area, and the personnel. By preventing upward flow of fluid through the drill pipe, blowouts or other damage is minimized or prevented entirely in the event the drilling string should part.

Since the valve normally opens fully in a downward direction, it allows full and unimpeded pumping of drilling mud and similar drilling fluid down through the drill pipe and out of the drill bit, carrying the cuttings upwardly around the drill pipe to the top of the hole. Such downward pumping of fluid through the drill pipe float valve has heretofore been attended with erosive wear on the parts, which reduces the effectiveness of the valve and its life.

An object of the present invention is to provide a drill pipe float valve possessing a greatly increased life.

Another object of the invention is to provide a drill pipe float valve embodying a non-metallic sealing element which is easier to install, is less likely to be damaged during installation, and which provides a more positive seal holding the valve closed while the drill pipe is being lowered through the fluid in the well bore, or in the event fluid tends to flow upwardly through the drill pipe.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a longitudinal section through a string of drill pipe, with a float valve mechanism embodied therein, the valve being shown in closed position;

Fig. 2 is an enlarged longitudinal section through the valve mechanism, removed from the string of drill pipe, with the valve shown in an open position;

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Fig. 3 is a cross-section taken along the line 3—3 on Fig. 2.

As disclosed, a valve mechanism A is incorporated within a string of drill pipe B extending to the top of the hole, and through which drilling fluid is pumped in a downward direction as the drill pipe is rotated, to rotate a drill bit C on its lower end. The valve device can be incorporated at any convenient point along the length of the drill pipe. As shown, it is mounted within a relatively short drill collar or sub 10 ordinarily placed at the lower end of the drill pipe string B and immediately above the drill bit C. The drill collar may have an enlarged bore 11 providing a cylindrical wall and a lower transverse shoulder 12. It may also have a lower threaded pin 13 threadedly secured within the upper threaded box 14 of the drill bit C, or of a sub, which is, in turn, attached to the drill bit. The upper end of the drill collar or pipe 10 is constituted as a threaded box 15 threadedly secured to the lower pin end 16 of an adjoining drill pipe or drill collar section 17.

The lower transverse shoulder 12 and the lower end 18 of the pin 16 of the upper drill pipe section form a pair of opposed longitudinally spaced stops for confining the valve body or cage 19 of the valve mechanism A. This body or cage has an outside diameter slightly less than the diameter of the cylindrical wall of the enlarged drill pipe bore 11, whereas the length of the valve body 19 may be slightly less than the longitudinal distance between the lower transverse shoulder 12 and the lower pin end 18 of the upper drill pipe section 17.

The valve body or cage 19 may consist of an upper cylindrical portion 20 and a lower cylindrical portion 21 interconnected by a plurality, such as a pair, of circumferentially spaced, longitudinal bars or ribs 22. The upper cage portion 20 is provided with a pair of oppositely directed side seals 23 which may be in the form of cup-shaped packings whose base portions 24 are received within circumferential grooves 25 in the valve body, the lip portions 26 of the packing or sealing members being engageable with the cylindrical wall of the enlarged bore portion 11 of the drill pipe and facing away from each other. It is evident that the upper seal ring member 23 precludes downward flow of fluid between the valve body 19 and the drill pipe section 10, whereas the lower packing member 23 precludes upward flow of fluid between the valve body 19 and the drill collar or pipe section 10.

The valve cage 19 has a comparatively large bore or passage 27 therethrough for the flow of fluid. The upper portion of this passage is cylindrical, having a generally frusto-conical stop or valve seat portion 28 which converges in an upward direction, this frusto-conical portion being engageable by a correspondingly tapered surface 29 of a valve head or stop 30. This head member is suitably secured to a valve stem 31 depending therefrom, as by casting the head 30 on the upper end of the valve stem 31, the latter being provided with a peripheral groove 32 into which the cast metal can flow, to form a circumferential flange or rib 33 within the stem groove. The stem 31 extends downwardly from the head or stop 30, being freely slidable through an elongate valve guide 34 which extends through the hub portion 35 of a spider 36, the latter being secured to the longitudinal ribs 22 of the valve cage or body 19 by a plurality, such as a pair, of diametrically opposed ribs 37. The arcuate spaces between the radial ribs 37 provide passages through which the fluid moving down through the string of drill pipe can flow when the valve head 30 and stem 31 are moved in a downward direction substantially away from the companion stop 28, or well below the lower portion of the upper cylindrical section 20 of the valve body or cage 19.

It is to be noted that the upper and lower cylindrical portions 20, 21 of the body 19, its longitudinal ribs or bars 22, the radial ribs 37 and the hub 35 are all integral with one another. The valve guide 34 is a separate member that is, nevertheless, firmly secured to the valve body 19. As shown, the guide 34 has an upper flange 38 resting upon the upper portion of the hub 35, this flange being held firmly against the upper portion of the hub by threading a nut 39 on the lower end of the guide which is tightened to snugly engage the lower end of the hub 35. It is apparent that the upper guide flange 38 prevents downward movement of the guide 34 with respect to the valve cage 19, whereas the nut 39 prevents upward movement of the guide with respect to the hub 35 and valve cage 19.

The head 30 can engage the companion seat or stop 28 on the valve cage and prevent upward flow of fluid through the valve device. However, reliance is not placed upon this sealing engagement of the valve head with its companion seat to prevent upward leakage of fluid through the device. Actually, such upward leakage of fluid is prevented by a non-metallic valve element or disc 40 which surrounds the valve stem 31 and bears against the underside 41 of the valve head 30. This non-metallic valve element has an outer downwardly facing lip portion 42 adapted to sealingly engage a generally cylindrical seat 43 which extends downwardly from the tapered stop portion 28 of the valve cage. This last-mentioned seat 43 has a diameter which is slightly greater than the periphery 44 of the valve head, and, if desired, may actually be formed with a slight taper inclined in an upward and inward direction toward the axis of the valve device. The non-metallic valve disc 40 may be made of rubber or rubber-like material, fluid pressure from below the element urging the depending lip 42 radially outward into firm sealing engagement with the companion generally cylindrical seat 43.

The rubber valve disc 40 is held against the valve head 30 by a suitable metallic retainer disc 45 surrounding the valve stem 31 and having a diameter that is substantially smaller than the diameter of the valve head periphery 44, to allow fluid to be directed outwardly against the lip 42 of the sealing element. This separate retainer disc 45 is urged in an upward direction to hold the rubber valve element 40 against the head 30 by a helical spring 46 encompassing the valve stem 31, the lower end of the spring bearing against the upper guide flange 38, and the upper end of the spring bearing against the retainer disc 45. The upper end of the spring is prevented from moving laterally of the disc by virtue of an encompassing depending skirt 47 forming part of the retainer disc 45.

The spring 46 not only holds the non-metallic sealing element 40 in proper relation against the valve head 30, but it also urges the valve head 30, stem 31, rubber sealing element 40, and retainer disc 45 in an upward direction as a unit, to place the head 30 in contact with its companion stop 28 and the sealing disc 40 in sealing engagement with its seat 43.

For the purpose of facilitating assembly of the valve mechanism, the hub 35 has a longitudinal slot 48 there-through slightly wider than the diameter of the stem 31. In assembling the parts, the sealing element 40 is first slipped over the stem 31, followed by the retainer disc 45. The spring 46 is then placed over the stem, with its upper end disposed within the disc skirt 47. The guide 34 is then placed over the stem 31 with its upper portion within the lower portion of the spring 46. The spring exerts a comparatively light force, which enables the guide 34 to be moved upwardly along the stem 31 to fully compress the spring. Thereafter, the parts are placed laterally in the cage 19 between the longitudinal ribs 22, with the valve head 30 adjacent its companion stop 28 and with the lower end of the guide 34 above the upper end of the hub 35. The portion of the valve stem 31 projecting from the lower end of the guide can then be

inserted laterally through the hub slot 48, the guide 34 then being shifted down into the hub 35, with its upper flange 38 engaging the upper end of the hub. The nut 39 is then threaded on the lower end of the guide and tightened against the lower end of the hub 35. With the parts in this position, the spring 46 is effective to urge the valve head 30, stem 31, sealing element 40, and retainer disc 45 in an upward direction, to engage the valve head 30 with its companion stop 28 and place the non-metallic element 40 in sealing relation to the generally cylindrical seat 43.

The assembled valve mechanism A, with the seals 23 in place, is then slipped into the cylindrical bore 11 in the drill pipe member 10 and the latter threaded into the string of drill pipe at the desired location, the side seals 23 preventing leakage in both longitudinal directions between the valve body 19 and the inner wall of the drill pipe member or collar 10. During lowering of the string of drill pipe through the fluid in the well bore, such fluid is capable of passing upwardly through the valve body 19, since the valve head 30 is engaging its companion stop 28 and the lip 42 of the valve sealing element 40 is disposed fully within its companion substantially cylindrical seat 43. The fluid under pressure urges the seal outwardly into firm sealing engagement with the cylindrical wall, the upper portion of this seal being prevented from being moved upwardly beyond the head 30 by the head itself, whose periphery 44 makes a fairly close fit with the generally cylindrical seat 43.

In the event fluid is to be pumped down through the string of drill pipe, the valve device does not interfere with this action, since the spring 46 is preferably comparatively light, exerting just sufficient force to insure the upward engagement of the head 30 and valve seal element 40 with the stop 28 and seat 43, respectively. A comparatively low volumetric rate of flow in a downward direction will shift the valve elements downwardly to a fully open position, the valve element 40 being disposed downwardly away from its companion seat 43, which is also true of the larger portion 44 of the valve head 30. Fluid can pass downwardly around the valve head 30 and the seal 40, flowing through the arcuate spaces between the longitudinal ribs 22, as well as the radial ribs 37, down into the drill pipe and drill bit passages therebelow. The flow of fluid may urge the lip 42 of the sealing element 40 inwardly to some extent, but such inward deflection can occur readily in view of the reduced diameter of the retainer disc 45 as compared to the diameter of the valve disc 40 and of the valve head periphery 44.

In the event downward pumping of fluid is discontinued, the valve spring 46 reshifts the valve head 30, valve sealing element 40, and retainer disc 45 back into the position disclosed in Fig. 1, in which the valve is again closed.

Should upward flow of fluid tend to occur, the lip 42 of the sealing element 40 engages the cylindrical seat 43, to prevent such flow of fluid around the periphery of the valve element 40 and the valve head 30. Similarly, the pressure is also acting upon the main body portion of the valve element 40, urging it firmly against the lower surface 41 of the valve head 30 to prevent leakage between the valve stem 31 and the valve element 40, and between the upper surface of the valve element 40 and the lower surface 41 of the valve head 30.

The valve mechanism disclosed and described has been found to have a longer effective life than similar devices heretofore employed in drill pipe strings. The valve seal 40 is very simple to install in place in the manner described above, such installation occurring without the necessity for deforming or stretching the rubber or similar material from which the valve seal is made. Accordingly, there is a lessened likelihood of damaging this seal during installation, so that it remains effective for positively preventing fluid passage in an upward direction through the string of drill pipe. In addition, the seal element 40 engages a generally cylindrical seat 43 to positively pre-

vent leakage therearound, the seal element being reinforced by the head 30, this head being backed up by its engagement with the tapered stop surface 28 formed on the valve cage 19.

The inventors claim:

1. In a drill pipe float valve: a valve body having a transverse stop portion and a substantially cylindrical valve seat below said stop portion, said body also having an inner hub below said cylindrical seat; a guide in said hub and having a flange engaging the upper end of said hub; a member threaded on said guide and engaging the lower end of said hub; a valve stem slidable in said guide: a valve head on said stem movable upwardly into engagement with said stop portion, said head having a peripheral portion within and closely adjacent said seat when said head engages said stop portion; a non-metallic sealing disc bearing against a downwardly facing surface of said valve head and having a downwardly facing lip portion to sealingly engage said seat; a retainer member engaging the underside of said disc; said disc and retainer member being movable downwardly relative to said valve head away from said surface; and a spring encircling said stem and bearing against said guide and retainer member to engage said disc with said head surface and urge said head and disc upwardly to engage said head with said stop portion and said lip with said seat.

2. In a drill pipe float valve: a valve body having a valve seat and an inner hub below said valve seat; a guide in said hub and having a flange engaging the upper end of said hub; a member threaded on said guide and engaging the lower end of said hub; a valve stem slidable in said guide; valve means on said stem movable upwardly into engagement with said seat; and a spring engaging said flange and said valve means to urge the latter upwardly into engagement with said seat.

3. In a drill pipe float valve: a hollow valve body having an axis, a transverse stop portion sloping longitudinally and inwardly towards said axis, and a valve seat below said stop portion having a longitudinally extending internal seating surface; a guide on said body below said seat; a valve stem slidable in said guide; a valve head complementing said stop portion carried on said stem movable upwardly within said seat into engagement with said stop portion, said head having a peripheral portion within and closely adjacent said seating surface when said head engages said stop portion; a non-metallic sealing disc bearing against a downwardly facing surface of said valve head and having a downwardly facing lip portion adapted to be disposed within said seating surface to sealingly engage said seating surface; a retainer member engaging the underside of said disc; said disc and retainer member being slidably mounted and movable downwardly along said valve stem and relative to said valve head away from said downwardly facing surface; and a spring encircling said stem and bearing against said guide and retainer member to urge and hold said retainer member yieldably against said disc, said disc against said head surface, and to urge said head and disc upwardly to engage said head with said stop portion and said lip with said seating surface.

4. In a drill pipe float valve: a hollow valve body having a transverse substantially frusto-conical stop portion and a valve seat below said stop portion having a longitudinally extending internal seating surface; a valve member having a substantially conical surface movable upwardly into engagement with said stop portion and having a peripheral portion disposed within and closely adjacent said seating surface when engaged with said stop portion; a non-metallic sealing disc bearing against a downwardly facing surface of said valve member and having a downwardly facing lip portion adapted to be disposed within said seating surface to sealingly engage said seating surface, said disc being movable downwardly relative to said member away from said downwardly facing surface; and means engaging said disc to urge and

hold it upwardly against said valve member surface and to urge said valve member and disc toward said stop portion and seat.

5. In a drill pipe float valve: a hollow valve body having an axis, a transverse stop portion and a valve seat below said stop portion having a longitudinally extending internal seating surface; a valve member movable upwardly into engagement with said stop portion and having a peripheral portion disposed within and closely adjacent said seating surface when engaged with said stop portion; said stop portion and valve member having complementary mutually engagable surfaces sloping longitudinally and inwardly towards said axis; a non-metallic sealing disc bearing against a downwardly facing surface of said valve member and having a downwardly facing lip portion adapted to be disposed within said seating surface to sealingly engage said seating surface, said disc being movable downwardly relative to said member away from said downwardly facing surface; and spring means bearing upon said disc and acting between said disc and body to engage said disc with said valve member surface and urge said valve member and disc yieldably upwardly to engage said member with said stop portion and said lip with said seating surface.

6. In a drill pipe float valve: a hollow valve body having an axis, a transverse stop portion sloping longitudinally and inwardly towards said axis and a valve seat below said stop portion having a longitudinally extending internal seating surface; a guide on said body below said seat; a valve stem slidable in said guide; a valve head on said stem having a surface complementing that of said stop portion movable upwardly within said seat into engagement with said stop portion, said head having a peripheral portion within and closely adjacent said seating surface when said head engages said stop portion; a non-metallic sealing disc bearing against a downwardly facing surface of said valve head and having a downwardly facing lip portion adapted to be disposed within said seating surface to sealingly engage said seating surface; a retainer member engaging the underside of said disc; said disc and retainer member being biased and movable downwardly by gravity relative to said valve head away from said downwardly facing surface; and a spring encircling said stem and bearing against said guide and retainer member to engage said disc with said head surface and urge said head and disc yieldably upwardly against the force of gravity to engage said head with said stop portion and said lip with said seating surface.

7. In a drill pipe float valve: a hollow valve body having an axis, a stop portion inclined in a longitudinal and inward direction and a valve seat below said stop portion having a longitudinally extending internal seating surface; a guide on said body below said seat; a valve stem slidable in said guide; a valve head on said stem having an upper frusto-conical surface conforming to the inclination of said stop portion and movable upwardly into engagement with said stop portion, said head having a peripheral portion within and closely adjacent said seating surface when said head engages said stop portion; a non-metallic sealing disc slidably embracing said stem and bearing against a downwardly facing surface of said valve head and having a downwardly facing lip portion adapted to be disposed within said seating surface to sealingly engage said seating surface; a retainer member slidably embracing said stem and engaging the underside of said disc; said disc and retainer member being movable downwardly relative to said valve head away from said downwardly facing surface; and a spring encircling said stem and bearing against said guide and retainer member to engage said disc with said head surface and urge said head and disc upwardly to engage said head with said stop portion and said lip with said seating surface.

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