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DRILLING STRING FLOAT VALVE

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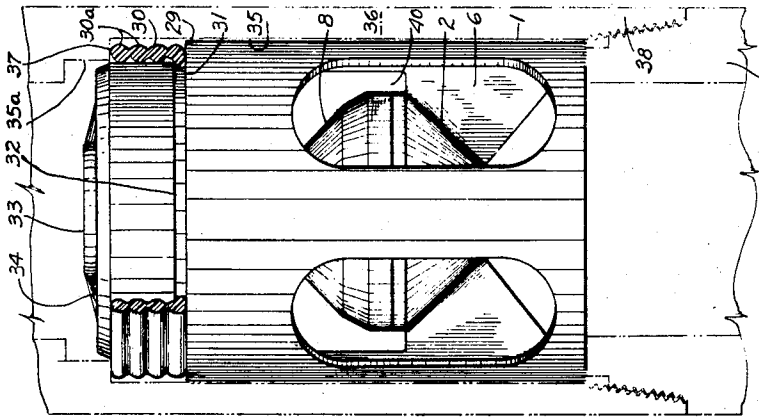


FIG. 3.

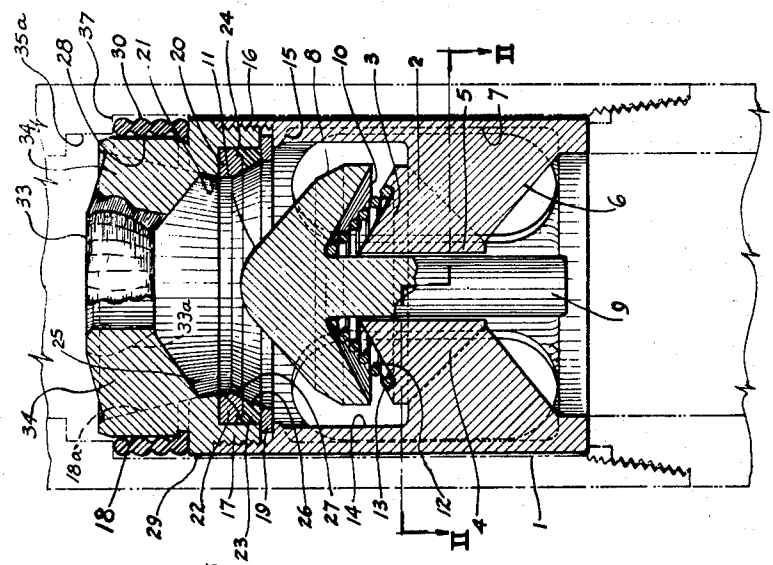


FIG. 1.

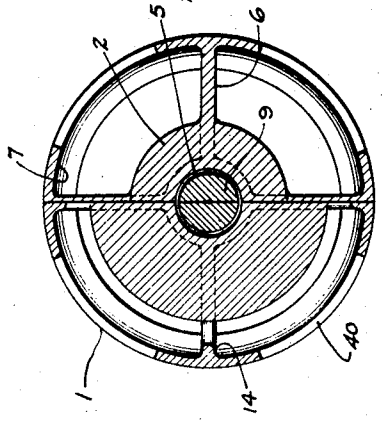


FIG. 2.

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DRILLING STRING FLOAT VALVE

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This invention relates to a new and improved float valve for use in oil-well drilling operations.

The purpose of a float valve is to prevent drilling mud pumped down a drilling string from backing up. A float valve may be inserted in a drilling string at any one of a number of points, i. e., in a drill collar immediately above the drilling bit, in a top drill collar or in a rotary substitute. For the purposes of simplicity, however, the simple term "drill collar" will be used throughout the following specification when describing the structure, use and insertion of the present float valve. Thus the term "drill collar" in the following specification and claims should be construed as being generic to any section of a drilling string in which a float valve might normally be inserted.

Drilling mud is pumped down a drilling string, when drilling is in progress, in order that it may cool the drilling bit and carry away the drill cuttings by circulating to the surface in the space between the drilling string and the side of the hole being drilled. It is undesirable that mud carrying drill cuttings re-enter and back up the drilling string thus causing plugging of the jet holes in the bit. Moreover, it is desirable to maintain an empty drilling string when running in the drill hole so that the weight thereof will be reduced.

Owing to the rapid flow of mud, under pressure, through a drilling string, there is the constant possibility of a wash-out between the drill collar and the float valve. When this occurs it is usually necessary to cut at least 12 inches off the drill collar in order that a new counterbore may be formed to eliminate the washed-out section.

It is, therefore, an object of the present invention to substantially reduce the length of a float valve and thus reduce the length of counterbore necessary to receive it.

It is also an object of the present invention to provide an improved seal between a float valve and a drill collar thus reducing the occurrence of wash-outs.

A further object of the present invention is to provide a float valve in which the valve spring is shielded from the washing action of the fluid passing through the valve.

Another object of the present invention is to provide a float valve having as large an opening as possible and presenting a minimum resistance to the flow of fluid, i. e., in which the smallest internal diameter is no less than the smallest internal diameter of the drill collar in which it is inserted, thus reducing the washing action of the fluid on the valve casing and the drill collar.

Yet another object of the present invention is to provide a survey instrument catcher integral with the valve casing.

According to the present invention a drilling string float valve comprises a hollow, substantially cylindrical valve casing open at both ends thereof, a valve head having a valve stem, a valve seat, a spring, and a valve stem guide, said valve stem guide being rigidly held within said casing co-axial therewith, said valve stem extending downwardly from the underside of said valve head through said valve stem guide, the underside of said

valve head being recessed to receive the upper portion of said valve stem guide, means for retaining said valve spring between the upper portion of said valve stem guide and the underside of said valve head, said valve seat being rigidly held within said casing at the end thereof towards which the upperside of said valve head faces, and said spring being adapted to urge said valve head against said valve seat.

In the accompanying drawings which illustrate the preferred embodiment of the present invention:

Figure 1 shows a longitudinal section of a float valve;

Figure 2 shows a cross-section along the line II—II of Figure 1, and

Figure 3 shows a float valve in position in a drill collar counterbore.

To facilitate description of the present invention, a drill pipe float valve will be considered to be in its normal, operating position, i. e., substantially vertical, co-axial with the drilling string in which it is placed. Relative terms such as "above," "below," "upper portion" and "underside" should be construed in the light of the foregoing statement whenever appearing in either the following description or the appended claims.

A hollow, substantially cylindrical valve casing 1, open at both ends thereof, has an outside diameter greater than the inside diameter of a drill collar. Rigidly supported with the casing 1 and co-axially therewith is a valve stem guide 2. The stem guide 2 has an upper portion 3 and a lower portion 4, the configuration of the stem guide 2 being substantially that of a truncated right circular cone superimposed co-axially upon the base of an inverted truncated right circular cone of similar base diameter but of greater height. The hole 5 of the stem guide 2 extends therethrough co-axially therewith, the diameter of the hole 5 substantially corresponding with the smaller diameters of the truncated cones. The plane of abutment of the portions 3 and 4 (i. e., the two truncated cones) is substantially co-planar with the plane transversely bisecting the casing 1.

Supporting webs 6 extend radially from the lower portion 4 of the stem guide 2 to the inner surface 7 of the casing 1. There are, preferably, two such webs spaced about the stem guide 2 at intervals of 180 degrees.

A substantially conical valve head 8 has a valve stem 9 extending, from the centre of the underside 10 thereof, downwardly through the hole 5.

The dimensions of the valve stem 9 and the hole 5 are such that the stem 9 is slidable in the direction of its longitudinal axis but that it is restrained from lateral movement. The underside 10 of the valve head 8 is recessed to receive the upper portion 3 of the valve stem guide 2 therein while the conical configuration of upperside 11 of the valve head 8 substantially corresponds in dimensions to the conical configuration of the lower portion 4 of the stem guide 2.

A wide, spring-retaining recess 12 is formed in the upper portion 3 of the stem guide 2 about the hole 5 and a conical valve spring 13, of the compression type, is retained therein between the upper portion 3 and the underside 10 of the valve head 8.

Extending upwardly along the inner surface 7 of the casing 1 from the supporting web 5 are reinforcing members 14 which terminate at a supporting ridge 15. In the preferred form of the present invention both the supporting webs 6 and the reinforcing members 14 are moulded integrally with the casing 1.

Between the supporting ridge 15 and the upper end of the casing 1 is an internally threaded portion 16, the threading of which extends from the upper end of the casing 1 to the supporting ridge 15.

Engaging the internally threaded portion 16 of the casing 1 is an externally threaded portion 17 of an annu-

lar valve seat housing **18**. The housing **18** has an outside diameter at its widest point similar to that of the casing **1**, the externally threaded portion **17** of the housing **18** being somewhat less in diameter to allow for the wall thickness of the internally threaded portion **16** of the casing **1**.

A metal retaining ring **19**, having an inside diameter greater than the maximum diameter of the valve head **8**, is rigidly held between the lower end of the externally threaded portion **17** of the housing **18** and the supporting ridge **15**.

The minimum inside diameter of the housing **18**, at the lower end thereof, is less than the diameter of the valve head **8** and a valve seat retaining recess **20** is formed in the inner surface **21** of the housing **18**, at the lower end thereof, to receive an annular valve seat **22** and an annular valve seat cushion **23**.

The valve seat **22** is placed upon the valve seat cushion **23**, the latter being of rubber or other suitable resilient material, and they are both then inserted in the valve seat retaining recess **20**, being held in position by the retaining ring **19**. In order that a smooth surface may be presented to the flow of fluid through the valve, the inside diameter of the valve seat **22** and that of the valve seat cushion **23** are no smaller than the minimum inside diameter of the housing **18**. A projection **24** is formed on the upper face of the valve seat cushion **23** engageable with a groove **25** formed in the underside of the valve seat **22**; thus both the valve seat **22** and the valve seat cushion **23** are held in fixed relationship one to the other. The inner face **26** of the valve seat cushion **23** and the lower part of the inner face **27** of the valve seat **22** are bevelled to conform to the configuration of that portion of the upperside **11** of the valve head **8** with which they come into contact when the valve is closed. It is preferable that the valve seat cushion **23** be of slightly smaller inside diameter than the valve seat **22** so that the former may absorb the initial shock when the valve closes and so that a perfect seal may be obtained between the valve seat **22** and the valve head **8**.

A sealing ring receiving recess **28** is formed about the outer surface **29** of the housing **18** at the upper end thereof to accommodate a sealing ring **30** of rubber or other suitable resilient material. It will be noted from the drawings that the counterbore in the drill collar is stepped towards the inner end thereof. This step in the counterbore provides a surface against which the sealing ring **30** may act. The maximum outside diameter of the sealing ring **30** is substantially that of the casing **1** while the outside diameter of the housing **18**, where encircled by the sealing ring **30**, is less than the inside diameter of the smaller counterbore in the drill collar. The sealing ring **30** is retained in position by means of a propection **31** extending inwardly therefrom and engaging in a sealing ring retaining groove **32** formed about the housing **18** at the lower part of the recess **28**.

It is often necessary to run surveying instruments in a drilling string. In the past, when this has been done, it has been necessary to place an instrument catching ring on the top of the float valve in the drilling string to prevent the instruments from becoming fouled with the valve. Such an instrument catcher may be formed integrally with the present float valve in such a manner that it does not present significant resistance to the flow of fluid through the valve.

The inside diameter of the housing **18** increases towards the upper end thereof. An annular instrument catcher **33** is supported by at least two radial webs **34** within and substantially co-axially with the upper end of the housing **18**. The webs **34** are spaced about the instrument catcher **33** at intervals of 180 degrees.

The outside diameter of the instrument catcher **33** decreases towards the lower end thereof so that the outer surface **33***a* of the instrument catcher **33** is substantially parallel with the inner surface **18***a* of the housing **18**.

As shown in Figure 3 a float valve is placed in a counterbored section **35** of a drill collar **36** so that the sealing ring **30** abuts against a ridge **37** formed in the drill collar **36** at the commencement of the smaller counterbored section **35***a*. The outer end **38** of the counterbored section **35** is internally threaded to receive a drilling bit or other drilling string section **39** which, as it is screwed home, exerts a pressure against the valve casing **1** so forcing the sealing ring **30** against the ridge **37** and causing it to expand. It will thus be seen that a tight seal is effected between the float valve and the drill collar **36**.

The sealing ring **30** is, preferably, moulded so as to resemble a number of rings **30***a* of substantially circular cross-section superimposed co-axially one above the other. This configuration ensures relatively uniform lateral expansion when the ring **30** is subjected to longitudinal compression. This configuration also permits sufficient change in the distance between the end of the male threaded portion of the bit and the ridge **37** to allow for the tolerances permitted in the length of standard male threaded portion of drilling bits by the American Petroleum Institute. The allowable tolerance is ⅛" in length. If a solid rubber cylindrical ring were used instead of the configuration of this rubber seal, a long male thread would cause extrusion of the seal and a short thread would effect an imperfect seal between the valve and the drill collar or rotary substitute.

If a drill collar or other drilling string section into which a float valve according to the present invention is to be inserted is already counterbored to a depth greater than is required, a sleeve may be first inserted into the counterbore. The sleeve used should fit snugly into the counterbore, should have an inside diameter slightly greater than the outside diameter of the valve seat housing **18** and should be of a length necessary to permit the forming of a seal by compression of the sealing ring **30** against the sleeve due to the force exerted by the drill bit or other drilling string section **39** on the valve casing **1**.

Occasionally the present float valve may be inserted, at a point in a drilling string, in a female threaded member facing upwards instead of downwards. In such a case the counterbore **35** need not be stepped and a sleeve similar to that described in the foregoing paragraph may be used intermediate the sealing ring **30** and the co-operating male threaded connection.

In order to economize material, to reduce weight and to allow visual inspection of the valve head **8** without dismantling the valve, longitudinally extending apertures **40** may be formed in the wall of the casing **1** intermediate the reinforcing members **14**. These apertures **40** also have the important effect of increasing the cross-sectional area for the passage of fluid through the casing **1** where the outside diameters of the valve stem guide **2** and the valve head **8** are greatest.

In operation, the valve spring **13** urges the valve head **8** against the valve seat **22** so that the valve is normally closed. As mud is pumped down the drill pipe, it impinges upon the upper side **11** of the valve head **8** and forces the valve open. As soon as pumping ceases and the pressure against the upperside **11** of the valve head **8** eases, the valve spring **13** again urges the valve head **8** against the valve seat **22**. Thus a reversal in the flow of fluid in and around the drill pipe will merely tend to close the valve more tightly.

The principle cause of the reversal of flow of fluid, except when the pumps are operating, is that the drilling fluid in the annulus, between the drilling string and the wall of the hole, has a considerable specific gravity than the drilling fluid inside the drilling string. This condition is created by the suspension of considerable quantities of particles of the formation which is being ground up by the drilling bit. Under the condition where the drilling string is being run into the hole from the

surface, the hole is normally full or nearly full of drilling fluid. Since the valve remains closed under these conditions, it prevents entry of the fluid which is already in the hole into the drilling string. This floats the drilling string into the hole with a resulting sizeable reduction in the weight which must be carried by the surface equipment. It is from this floating action that the term "float valve" is derived.

I claim:

1. A drilling string float valve comprising a hollow valve casing having an accurately cylindrical outer surface and a substantially cylindrical inner surface, a valve stem, a conical valve head secured to said valve stem, a valve seat secured in said casing for co-operation with said valve head, a valve stem guide having a configuration substantially that of a truncated right circular cone superimposed co-axially upon the base of an inverted truncated right circular cone of similar base diameter but of greater height, a plurality of webs extending radially inwardly of said casing to support said valve stem guide centrally thereof whereby to mount said valve stem to extend along the longitudinal axis of said casing, said valve head and valve stem guide forming between them an annular conical cavity, a conical valve spring adapted to be compressible into a substantially flat spiral, said valve spring being mounted beneath said valve head in said cavity, the outer conical surface of the valve head and the outer conical surface of the valve stem guide co-operating with one another in the open position of the valve to form a substantially uninterrupted streamlined surface of smoothly varying cross-sectional diameter in the longitudinal direction of the casing.

2. A drilling string float valve as claimed in claim 1 wherein said casing is provided with a plurality of elongated apertures adjacent the outer periphery of said valve head.

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