April 11, 1967 T. M. FRISBY 3,313,360

HYDRAULICALLY ACTUATED ORIENTING DEVICE

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Fig. 1

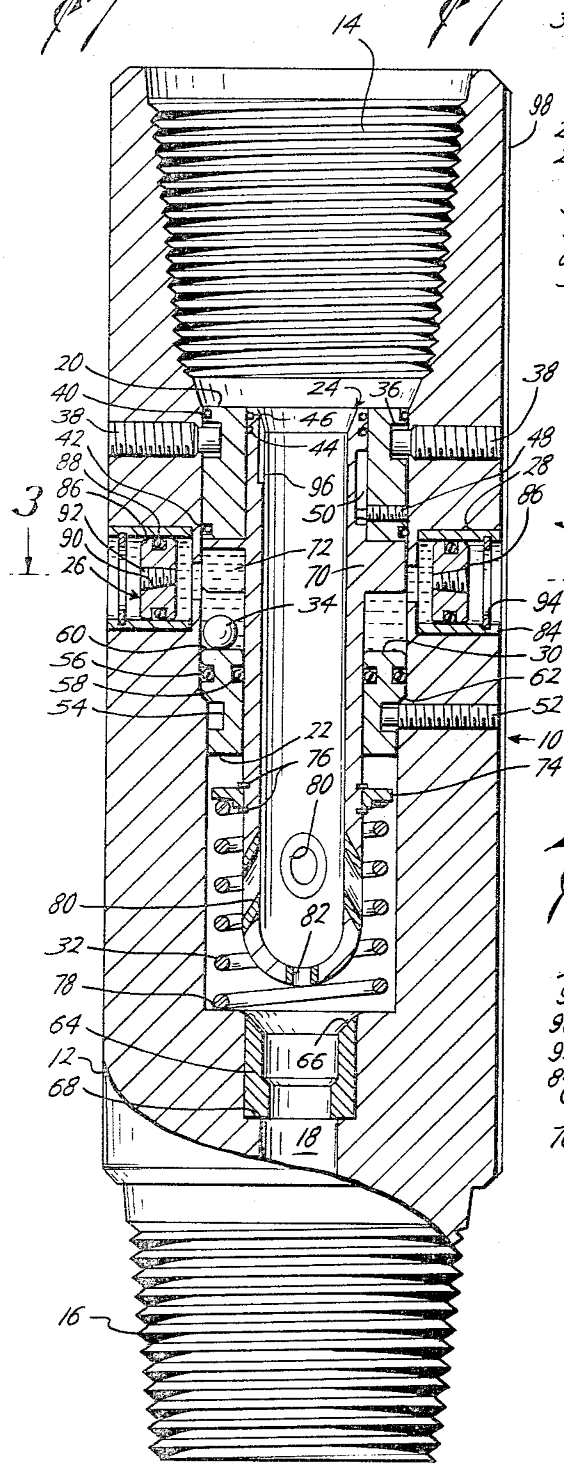



Fig. 2

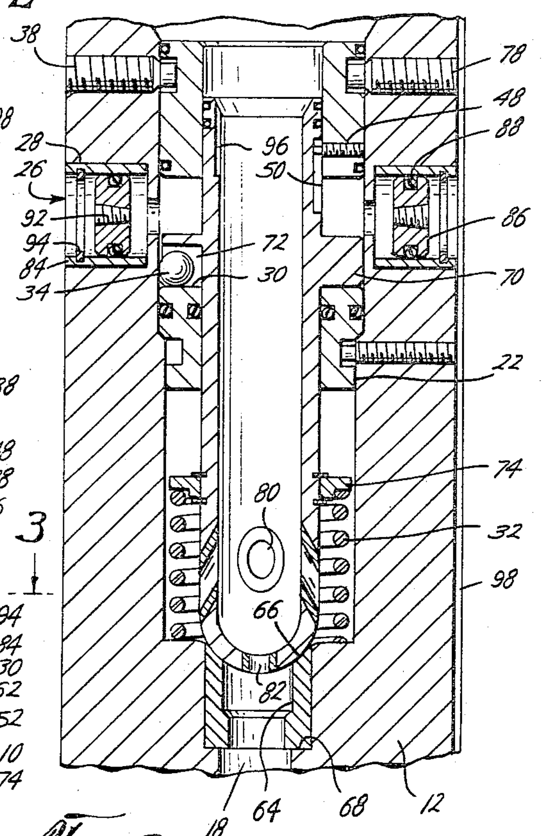
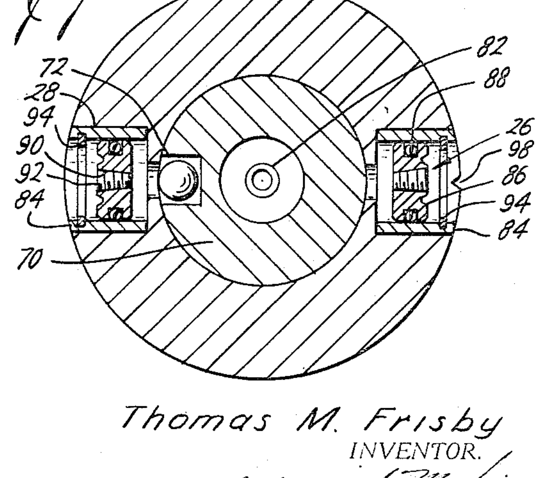



Fig. 3

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# HYDRAULICALLY ACTUATED ORIENTING DEVICE

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This invention relates to new and useful improvements in a hydraulically actuated orienting device. Such devices are employed in earth boring for determining and establishing orientation of deflecting tools with respect to the low side of the bore. More particularly, the invention relates to an orienting device which is operative under the influence of fluid pressure to enable surface indication of orientation of a deflecting tool, for example, to carry on directional well drilling operations.

Various prior devices have been used for such orientation of tools in the drilling of subsurface wells and a typical example of such devices is my prior Patent No. 3,095,924, issued July 2, 1963. The present invention is an improvement upon the structure of said prior patent.

In my prior patent, the orientation is accomplished by a member which seeks the low side of the well bore and which co-acts with a movable piston. When oriented position is reached, movement of the piston is permitted. Such movement of the piston, in turn, actuates a valve to effect a change in volume of flow of circulating fluid through the device to thereby change the pressure of the circulating fluid at the surface. The pressure change thus provides an indication at the surface that proper oriented position has been attained. My prior patent broadly discloses a device utilizing pressure change at the surface as the indicating means; its specific embodiment illustrates a structure in which a valve assembly is operated to cause a pressure decrease in the circulating fluid. Although this has been found to be satisfactory in most instances, there are circumstances which make it more desirable to effect a pressure increase to act as the indicating means. For example, where a tool is used below the orienting device and has more restriction to the flow of fluids than the fully opened valve assembly, a pressure decrease will not be suitable as the indicating means.

It is, therefore, one object of this invention to provide a device having all of the advantages of the device of my prior patent but which utilizes an increase in pressure of the circulating fluid as the indication of proper oriented position, whereby the presence of undue restrictions in tools below the device will not interfere with accurate indication.

Another object of the invention is to provide an orienting device which is hydraulically actuated and which, when properly oriented, provides a surface indication of orientation as a distinct and readable increase in the pressure of the fluid being circulated.

Another object of the present invention is to provide a hydraulically actuated orienting device incorporating a movable piston which is biased in one direction by spring means, which, when positioned responsive to such biasing, provide a substantially unrestricted flow of circulating fluids through the device and, when positioned in a direction opposite such biasing, provides a greater restriction to the flow of circulating fluid than occurs at any other part of the fluid circulating system which includes said device and all tools connected in the pipe string.

A still further object of the present invention is to provide a hydraulically actuated orienting device of the character described in which the valve assembly and spring means are so arranged that the spring means is located out of the line of flow of the circulating drilling fluid to thereby protect the same from being damaged, due to cutting out by reason of the abrasive character of the fluid.



Still another object of the present invention is to provide a hydraulically actuated orienting device having a movable piston assembly in a sub which cooperates with a valve seat in the sub to substantially restrict the flow of circulating fluids through the device when said piston is in oriented position.

These and other objects and advantages of the present invention will be more readily understood from the following detail description with reference to the accompanying drawings wherein:

FIGURE 1 is a detail vertical sectional view of a preferred embodiment of the orienting device of the present invention illustrating the relative position of the parts prior to orientation.

FIGURE 2 is a fragmentary sectional view of the device of the present invention illustrating the relative position of the parts after the device has been oriented.

FIGURE 3 is a sectional view taken along lines 3—3 of FIGURE 1.

Referring more particularly to the drawings, the orienting device **10** illustrated in the figures has its component parts embodied within the sub **12**. The sub **12** is merely representative of various form of generally cylindrical sections which may be employed for interconnection in a drill string, and, accordingly, one end of the sub may be internally threaded, as at **14**, for example, for connection to the lower end of a drill pipe section (not shown) and may further include a lower threaded stem end **16** for connection with a deflecting tool, also not shown. It will be evident, though, that other than to serve as a housing for various parts forming the device of the present invention, the particular form of construction of the sub **12** over cylindrical section itself is of no importance and may be connected in various ways and at any desired location in the drill string, keeping in mind that the primary function of the device is to serve as a way of orienting the deflecting tool to resume drilling in the desired direction.

A central, continuous passage, generally indicated at **18**, extends through the sub **12** for disposition of the various elements comprising the orienting device, and these elements are comprised broadly of upper seal ring **20**, lower seal ring **22**, a slidable piston assembly **24** and free floating pistons **26** which are positioned in lateral bores **28** communicating with the race **30** just beneath the upper seal ring **20**. In addition, a compression spring **32** is shown positioned at the lower end of the piston assembly **24**, and a rolling member in the form of a ball **34** is shown positioned on the top surface of the lower seal ring **22**.

The seal rings **20** and **22** serve generally to form a complete seal between the inner wall of the sub **12** and the exterior of the piston assembly **24**, so that in a manner to be described, drilling fluid forced under pressure through the sub will be constrained to pass completely through the interior of the piston assembly **24** and will not leak around the exterior thereof. Accordingly, the upper seal ring **20** may include a circumferential groove **36** to receive diametrically opposed set screws **38** which extend laterally through the wall of the sub and in this way to hold the upper seal ring **20** securely in place at the top of the main passage **18**. O-ring seals **40** and **42** are positioned in grooves near the upper and lower ends of upper seal ring **20** to provide seals between the exterior of the upper seal ring **20** and the interior of the sub **12**. O-ring **44** and scraper ring **46** are positioned in grooves on the exterior of the piston assembly **24** and will provide a seal between the exterior of the piston assembly **24** and the interior of the upper seal ring **20**. The set screw **48** extends through upper seal ring **20** and is provided with a pin end engaging within the groove **50** on the exterior of the piston assembly **24** allowing longitudinal movement of the piston assembly **24** with respect to the upper seal ring **20** but maintaining the rotational orientation of the two components.

The lower seal ring **22** is positioned within the passage **18** in surrounding relation to piston assembly **24** and is secured in such position by set screw **52** which extends laterally through the wall of sub **12** into the circumferential groove **54**. O-ring **56**, positioned in a groove on the exterior of lower seal ring **22**, will seal ring **22**, will seal against the exterior of piston assembly **24**. The upper or top surface **60** of lower seal ring **22** is made perfectly level and smooth so as to define essentially within the confined space between the piston assembly **24** and the inner wall of the sub **12** a race or ball support surface for the rolling member **34** With this construction, the ball **34** will be highly sensitive to even slight inclinations of the orienting device **10** as a whole so as to tend to roll toward the lower side of the race **30**. It may be desirable to provide the shoulder **60** on the interior of the passage **18** to serve as the main support for lower seal ring **22**, and this shoulder will cooperate with a corresponding shoulder portion **62** on lower seal ring **22** and with set screw **52** in the groove **54** to secure lower seal ring **22** in the desired position within the sub **12**.

Valve seat insert **64** is positioned in the passageway **18** through the sub **12** and is provided with the upwardly facing seat **66** which cooperates with the slidable piston assembly **24**, as hereinafter more fully explained. Valve seat insert **64** should be suitably secured within the passage **18** against the internal shoulder **68** by any suitable method, for example, by a press fit.

The piston assembly **24** is generally tubular in configuration and cooperates with the other components of the orienting device in carrying out the principles of the present invention. Spaced downwardly from the upper end of the piston assembly **24** is a relatively thick external shoulder **70** which extends outwardly in annular fashion just beneath the lower end of upper ring **20** and into contiguous relation with the inner surface of the sub **12** opposite the lateral bores **28**. It will be noted that the external shoulder actually extends in spaced relation above the race **30** so as to form a completely confined area for movement of the ball **34** between the bottom surface of the shoulder **70** and the top surface **60** of the lower ring **22**. Additionally, the external shoulder **70** includes a downwardly facing notch or recess **72** which is of a size, when aligned, to receive the ball or rolling member **34** therein and actually to permit the piston assembly **24** to slide downwardly until the bottom surface of shoulder **70** comes into contact with the race surface **60**, as best seen from FIGURE 2.

An annular flange **74** is secured to the exterior of the lower portion of the piston assembly **24** at a position below the lower end of seal ring **22** by the snap rings **76** or any other suitable securing means which may be released for assembly and disassembly of the piston assembly **24** and the lower seal ring **22**. The annular flange **74** provides the upper abutment for the spring **32** which is positioned in surrounding relation to the lower end of the piston assembly **24** and by engagement with the internal shoulder **78** in the passage **18** will bias the piston assembly **24** upwardly into the position illustrated in FIGURE 1.

A plurality of ports **80** extend through the cylindrical wall of the piston assembly **24** at a position below the installed position of the annular flange **74**. These ports **80** extend outwardly and downwardly through the cylindrical wall and provide communication from the interior of the piston assembly to the passage **18** above the upwardly facing valve seat **66**. The lower end of piston assembly **24** is closed in a generally hemispherical shape to provide an external portion which is adapted to engage with the upwardly facing valve seat **66**. Further, the central portion of the closed end of piston assembly **24** is provided with restricted orifice **82** which will provide communication from the interior of piston assembly **24** to the portion of passage **18** below the seat **66** when the piston assembly **24** is seated on the seat **66**, as best illustrated in FIGURE 2. With the piston assembly **24** positioned as illustrated in FIGURE 1, the ports **80** and the restricted orifice **82** will provide communication for the flow of circulating fluid downwardly through the interior of the piston assembly **24** and out through the ports **80** and the restricted orifice **82** into the portion of passage **18** in the lower end of sub **12**. When the piston assembly **24** moves to its lower position, as illustrated in FIGURE 2, the seating of the lower end of the piston assembly **24** on the upwardly facing valve seat **66** will close the flow of circulating fluid through the ports **80**, and thereafter the flow of circulating fluid will flow only from the interior piston assembly **24** through the restricted orifice **82** into the lower portion of the passage **18**. This flow through restricted orifice will therefore provide the increased pressure indication at the surface providing positive indication that the device has been oriented, as hereinafter more fully explained.



The confined space formed between the shoulder **70** and the surface **60** for movement of the ball **34** is preferably filled with fluid to damp the action of the ball and also to allow for pressure equalization between the confined space in the hydrostatic head of the well bore itself. In this way, the pressure developed by the fluid in the confined space will prevent the shoulder **70** normally from moving downwardly against the top surface of the ball **34** to prevent its free rolling movement around the race **30** when the piston assembly is under pressure. Moreover, it is desirable to maintain a substantially constant pressure equalization between this confined space and the well bore notwithstanding changes in volume which take place when the piston assembly travels downwardly, for example, to the position shown in FIGURE 2, or which result from temperature changes. To this end, the floating pistons **26** are positioned in the lateral bores **28**, as mentioned, and serve as the principal means of equalizing the pressure between the space of the race **30** and the well bore. In order to seat the floating pistons within the lateral bores **28**, each bore is provided with an outer sleeve **84** secured within the bore, and a generally circular piston member **26** is positioned in the sleeve for free sliding movement therealong in response to differences in pressure on opposing sides of the piston. The piston member **26** is generally in the form of a circular plug **86** having a circular seal **88** positioned on its circumference to engage the inner wall of the sleeve **84** and having a tapered threaded opening **90** formed in the center of the plug to receive a correspondingly shaped core **92**. For removal of the plug **86**, it is only necessary to remove the core **92** and to substitute a tool having a similarly formed threaded end for engagement within the opening **90**. Additionally, in order to limit the outward movement of the plug **86**, for example, when a high internal pressure is developed in the confined space, a snap ring **94** is positioned adjacent the outer end of the sleeve **84**. In filling the cavity, any suitable motor oil, such as an SAE 10–20 all-weather motor oil, may be employed. The cavity may be filled by first inserting a floating piston in one lateral bore and then laying the sub on its side with the open bore up and depositing the oil in the confined space through the open bore. The inserted piston may then be reciprocated manually within the sleeve to work the air gradually out the upper part of the confined space in order to permit complete filling of the confined space, followed by the insertion of the second piston.

Before connecting the orienting device into the drill string, it is desirable to align the notch or recess **72** in a position such that when the notch moves into alignment with the ball on the low side of the hole, the whipstock or the deflecting tool will be facing in the desired direction. Through this expedient, there is eliminated the necessity for additional rotation of the drill string after orientation has been established. Since the orienting notch 72 is effectively hidden within the sub upon installation, a special notch 96 may be formed in the top of piston assembly 24, and this may be aligned with a facing line 98 scribed on the surface of the sub 12 at 180° or diametrically opposed to the desired position of the orienting notch 96. Once properly aligned, it being understood that the notch 96 is aligned 180° on the opposite side from the scribe line 98, the upper seal ring 20 may then be evenly secured in place by tightening the set screws 38. The inner set screw 48, as stated, serves to retain the piston assembly 24 against rotation relative to the upper seal ring 20, and in turn, the upper seal ring 20 is securely held in place by the set screws 38.

Once aligned, the entire assembly may be made up with a deflecting tool connected so that it faces in the direction of the scribe line 98. The entire drill string assembly may then be lowered to the bottom of the hole in conventional manner following which pumps at the well surface may be started and operated for a few minutes at a speed and volume that can be repeated at each step of the orientation. Pressure at this initial volume may be checked and recorded. At this point, the pump may be shut down and the drill string rotated 15 or 20 degrees and worked up and down several times to work out the torque. As the pipe is rotated and, assuming that there will be at least some inclination of the sub and connected deflecting tool away from vertical, the ball 34 will be gravity responsive to seek and remain at the low side of the hole. The pumps may then be operated between each rotative step and at the same volume, and the pressure again noted and recorded. These steps may be repeated until an increase in pump pressure is noted which will indicate that the notch 72 in the piston assembly 24 is in line with the ball 34 at the low side. The reason for this is best seen from FIGURE 2 where it will be noted once the piston is free to move downwardly relative to the seal rings and sub assembly, the lower portion of the piston assembly will move downwardly to engage the upwardly facing seat 66 thereby effectively closing communication for the flow of circulating fluids through the ports 80 into the lower portion of the passage 18. The size of the ports 80 should be sufficient so that restriction to flow will occur in the deflecting tool when the piston assembly is positioned as shown in FIGURE 1. The size of restricted orifice 82 must be sufficiently small so that it creates a restriction in the flow of circulating fluid therethrough when the piston assembly is positioned as shown in FIGURE 2 which is much greater than the restriction normally in the circulating fluid flow. With this restriction thus limiting the flow of circulating fluid, an increase in the pressure at the surface will be readily noticeable. It should be noted that the piston assembly 24 will be moved downwardly by the pressure from the circulating fluid but will not move downwardly to a position at which the lower end of the piston assembly will engage the upwardly facing valve seat 66 unless the rolling member 34 and the notch 72 are properly positioned so that on downward movement of the piston assembly 24, the rolling member 34 will be contained within the recess 72, as shown in FIGURE 2.

To align the notch, it will be noted that the pumps must be shut down when the pipe or drill string is being rotated so as to eliminate the differential pressure between the top and bottom of the piston assembly thereby permitting the piston assembly 24 to be urged upwardly in response to the bias of the spring 32 so that the ball 34 will be free to roll along the race 30 to the low side of the hole. In addition, by maintaining pressure-equalized conditions within the confined space for the ball 34 and isolating such space from the flow through passage 18, the piston assembly 24 is made responsive solely to the urging of the spring 32 and the pressure of the drilling fluid and thus may be closely regulated in orienting the deflecting tool.

Once initial orientation has been established, it can easily be checked by moving 20 or 25° on either side of the point at which a pressure increase is noted, checking pump pressure at these positions and then returning to the point where the orientation was first made. Assuming, for example, that a whipstock is being employed, once orientation has been established, the whipstock may be set down to shear its pin following which drilling may proceed in a conventional manner.

By isolating the orienting parts, and especially the rolling member 34, greatly increased reliability, accuracy and operation are obtained since the flow of fluid through the interior of the orienting device will have no effect whatsoever upon the movement of parts and particularly upon the rolling member 34. Of course, the pressure of the circulating or drilling fluid may be utilized effectively to establish at desired intervals a differential pressure causing the piston assembly 24 to move downwardly but other than this, the drilling fluid will not influence the operation of the aligning elements of the device. It will further be evident that the ports 80, the lower end of the piston assembly 24 and the upperwardly facing valve seat 66 cooperate to form a valve assembly which is normally open when the piston assembly 24 is in the "up" position and which is responsive to downward movement of the piston assembly 24, once alignment of the notch and ball have been established, to substantially decrease the flow area through the assembly whereby a surface indication that orientation has been established may be noted by the corresponding pressure increase. By providing the restricted orifice 82 of a small enough size to provide a greater restriction than any other portion of the flow path of the circulating fluid, it should be clear that when the valve assembly 24 is moved to the lower position illustrated in FIGURE 2 that a distinct pressure increase will be readily ascertainable at the surface because of the substantial restriction of the closing of the valve assembly, thereby providing definite indication that the tool is properly oriented. Further, it should be noted that the spring 32 is not exposed to the flow of fluids when the piston assembly has moved to its lower position, illustrated in FIGURE 2, and therefore will be protected from being dislodged or from any distortion which might be caused by the wash of circulating fluids over the spring 32.

From the foregoing it can be seen that the present invention provides an orienting device in which a positive indication will be provided at the surface whenever the device is properly oriented, which indication is not dependent upon slight changes in pressure resulting from the high pressure drop through the drilling tools associated with the orienting device. The surface indication provided by the orienting device of the present invention is a distinct and readable increase in the pressure of the circulating fluid and further does not provide any restriction to the flow of circulating fluids except when the piston assembly is in oriented position and is moved to its lowermost position closing the valve assembly.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. An orienting sub for insertion in a drill string for earth boring operations comprising,

an outer tubular member having a bore therethrough,

a tubular piston in said bore,

an external shoulder on said piston having a recess therein,

sealing means between said piston and the walls of said bore above and below said external shoulder,

said piston being movable axially in said bore,

means securing said piston against rotational movement,

spring biasing means between said piston and said outer tubular member biasing said piston against the inlet pressure of circulating fluid in said bore,

valve means,

a restricted outlet from said piston,

an unrestricted outlet from said piston,

said external shoulder defining a race, and

a movable weighted member co-acting with said race to hold said piston in its spring biased position when said weighted member is not in a predetermined position with respect to said recess,

said piston moving to a position opposite said spring biased position when said weighted member is in a predetermined position with respect to said recess to close said valve means thereby closing flow of circulating fluid through said unrestricted outlet from said piston to produce a noticeable increase in circulating fluid pressure to indicate said weighted member is in said predetermined position with respect to said recess.

2. An orienting sub according to claim 1 wherein said movable weighted member is a weighted ball positioned in said race which will position itself in response to inclination of said sub at the low side of said race whereby when said ball and said recess coincide said piston will move to close said valve means and provide an increase in the pressure of said circulation system indicating that said recess is positioned on the low side of said sub.

3. An orienting sub according to claim 1 wherein said restricted outlet provides a greater restriction to the flow of circulating fluid than any other restriction through which said circulating fluid flows, whereby when flow of said circulating fluid is through only said restricted outlet, said circulating fluid pressure noticeably increases.

4. An orienting sub according to claim 1 wherein said valve means comprises,

an upwardly facing seat in said outer tubular member, and

a plug adapted to engage said seat,

said plug being formed on the lower end of said piston whereby when said piston moves to its lower position said plug engages said seat closing said valve means.

5. An orienting sub according to claim 4 wherein,

said restricted outlet from said piston extends through said plug to be in registry with the interior of said valve seat when said valve means closes,

said unrestricted outlet from said piston extending outwardly through said piston above said plug whereby closing of said valve means shuts off flow of circulating fluid through said unrestricted outlet.



6. An orienting sub according to claim 1 wherein,

said spring biasing means is spaced radially outward and in surrounding relation to said piston, and

said unrestricted outlet from said piston is inclined downwardly whereby flow of circulating fluid from said unrestricted outlet passes downwardly in the space between the exterior of said piston and said spring biasing means.

7. An orienting sub for insertion in a drill string for earth boring operations comprising,

an outer tubular member having a bore therethrough,

a tubular piston in said bore axially movable therein and having a bore and at least one port in its wall near its lower end,

an external annular shoulder having a downwardly facing notch therein,

a restricted opening at its lower end defining a first outlet passage constituting an outlet area for the passage of circulating fluid from said sub,

the bore of said piston and said restricted opening forming a passageway for circulating fluid through said sub,

a tubular seal between said piston and said bore located above said external shoulder,

an annular seal between said piston and the walls of said bore located below said external shoulder and above said port,

the upper end of said lower seal and the lower surface of said external shoulder defining an annular race,

means for indicating the orientation of said piston and said notch rotationally with respect to said outer tubular member,

means for securing said piston in oriented position against rotational movement,

spring biasing means between said piston and said bore biasing said piston upwardly against the inlet pressure of circulating fluid in said passageway,

a ball in said race holding said piston in its upper position when the ball is not in said notch,

a valve seat in said bore and cooperating with the lower end of said piston and adapted to receive said piston when said piston is in its lower position, whereby when said ball is in said notch the piston will move to its lower position to close said valve seat thereby closing flow through said port and decreasing the outlet area from said passageway resulting in a noticeable increase in circulating fluid pressure to indicate that the ball is in said notch.


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