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CUT-OFF VALVE FOR DRILL STEMS

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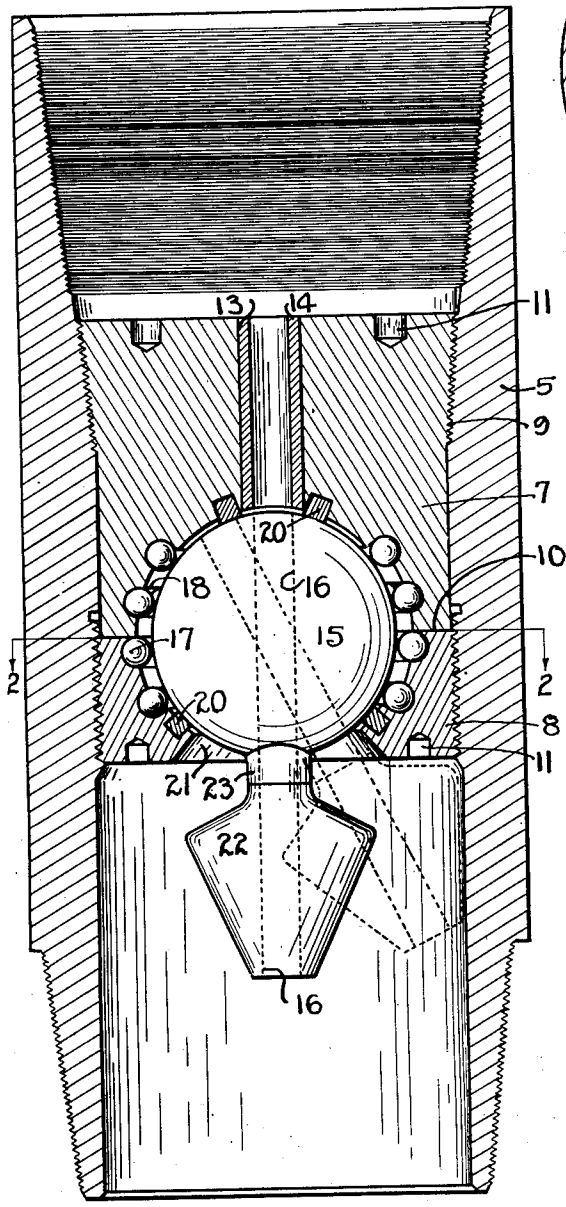

Fig 1

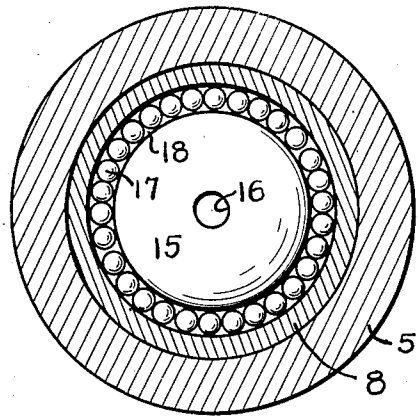

Fig 2

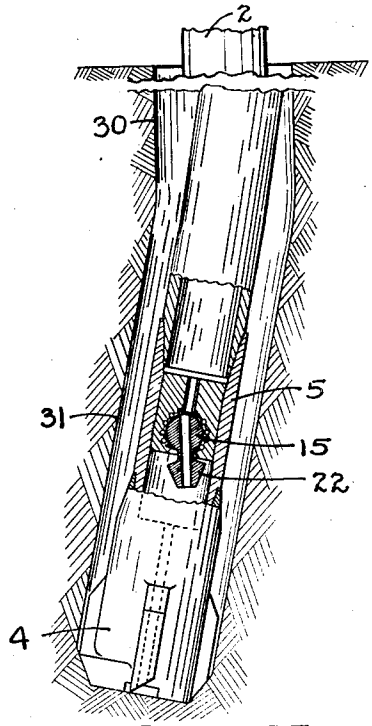

Fig 3

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UNITED STATES PATENT OFFICE

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CUT-OFF VALVE FOR DRILL STEMS

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The invention relates to an improvement in a means and method of detecting drill bit deviation during the well drilling operation.

In the drilling of wells by the rotary method, it is usual to maintain a circulation of drilling mud or slushing fluid while the bit is being rotated. This circulation is accomplished by pumping a supply of fluid down through the drill pipe so that it is discharged adjacent the cutting face of the bit. This mud then carries away the cuttings from the bit and flows upwardly around the outside of the drill stem. Another purpose of this circulation is to mud-in the walls of the formation and prevent caving, and it is usual to make this mud quite heavy so that the walls of the well bore will be maintained. The present invention contemplates the use of a device which will advise the driller almost instantly when the drill bit deviates from the vertical, and this device is of the type which will cut off the circulation of the fluid passing through the drill stem when the drill bit deviates from the vertical.

The circulation of mud is accomplished by means of slush pumps, and when the circulation is stopped for some reason, these pumps will stall because the pressure required to maintain the circulation is greater than the capacity of the pump. The driller realizes instantly when the pumps stall that circulation has been stopped, and the present invention uses a device to cut off the circulation when the drill bit deviates from the vertical so that the driller is advised by the stalling of his pumps that his bit has deviated from the vertical more than a predetermined angle.

One of the objects of the invention is to provide a means and method of instantly advising the driller when the drill bit deviates from the vertical.

Another object of the invention is to provide a means of detecting drill bit deviation by controlling the circulation of flushing fluid in the well in such a manner that the circulation will be restricted or cut off when the bit deviates beyond a predetermined angle with respect to the vertical.

A still further object of the invention is to provide a coupling for drill stems containing a gravity actuated valve, which is arranged to cut off the flow of fluid through the tool joint when the tool joint is inclined with respect to the vertical.

It is also an object of the invention to provide an oscillatable member in combination with a tool joint or drill collar so that the flow of fluid through the drill bit will be restricted when the bit assumes an inclination with respect to the vertical.

Other and further objects of the invention will be readily apparent to those skilled in the art, when the following description is considered in connection with the accompanying drawing, wherein:

Figure 1 is a central vertical section through the tool joint or drill stem cable, which has been equipped with the invention.

Figure 2 is a section taken on the line 2—2 of Figure 1, and looking in the direction of the arrows.

Figure 3 is a broken sectional view showing certain parts of the invention in elevation, and certain parts in section, and illustrating the invention as applied to a drill bit positioned in the well bore.

The drill stem used in drilling the well is indicated generally at 2, and extends to the surface of the earth. This drill stem is connected by tool joints or couplings, and carries the drill bit 4 on its lower end. In some instances a tool joint or drill collar is used to couple the drill stem and bit together, and it is contemplated that this invention may be incorporated in a tool joint or drill collar used adjacent the top of the drill bit. Such a drill collar or tool joint is indicated in Figure 3 at 5, and shows the relationship of the device to the remaining parts of the drilling equipment. It is understood that the drilling of the well is accomplished by the rotation of the stem 2, which in turn rotates the bit 4 and removes or cuts portions of the formation so that the bit may proceed.

Figure 1 shows a detailed sectional view of the invention wherein the tool joint or drill collar 5 is shown as being formed to receive an upper bushing 7 and a lower

bushing 8. These bushings are preferably threaded in the tool joint 5 from opposite directions and are retained in position by the threads 9 formed on the tool joints and the bushings. The bushings 7 and 8 are arranged to abut with each other at 10, and in this manner, serve as lock nuts for each other to insure that they will remain in position. Depressions 11 are provided in each of the bushings to receive a spanner wrench for inserting or removing the bushing.

The upper bushing 7 is provided with a passage 13, which is in turn fitted with a replaceable sleeve 14. It is through this passage that the flow of fluid to the drill bit must pass. Positioned between the upper bushing 7 and the lower bushing 8 is a ball valve 15. This valve has a passage 16 therethrough, which is arranged to normally serve as a continuance of the passage through the upper bushing 7. This ball valve 15 is mounted on antifriction bearings 17, which are positioned in grooves or openings 18 in the bushings 7 and 8. These openings 18 are preferably annular in form so that a series of ball bearings or roller bearings may be positioned in each groove so that the ball valve 15 will move with a minimum of friction. In order to maintain the bearings in operative condition, a packing ring 20 is provided in each of the bushings 7 and 8 adjacent the center thereof, and arranged to form a seal about the passage and to contact the ball valve.

A similar packing ring 20 is provided in the lower bushing 8. In assembling the device, one of the bushings may be placed in position and the ball valve seated therein. The device can then be inverted and the remaining bushing placed in locking position so that the ball valve 15 may be maintained in position such as shown in Figure 1.

The lower bushing 8 is provided with a cut-away area 21, which is arranged to permit passage of the weighted portion 22 of the ball valve. This weight is connected by means of the stem 23 to the ball valve, and is provided in order that the valve will remain in the position shown in Figure 1, with the passages 16 and 13 in alignment when the tool joint is in a vertical position. However, when the tool joint is inclined the weight 22 will seek a vertical position due to the force of gravity and will tend to tilt the ball 15 so that the passage 16 is no longer in alignment with the passage 13. In this manner the flow of fluid through the drill stem is either restricted or completely cut off, depending upon the degree of the inclination of the tool joint with respect to the vertical. The cut-away shoulder in the bushing 8 allows of a tilting movement of the ball valve 15 and the weight 22 so that it may assume a maximum inclination with respect to the tool joint, such as shown in the dotted line position in Figure 1.

It is intended that the ball valve 15, or other valve member used in practising the invention, may be mounted in any manner other than that shown in Figure 1, so long as the essence of the invention is practised, and this consists of restricting the flow of fluid through to the drill bit directly in proportion to the degree of inclination of the drill bit.

When the drill bit is provided with a device such as herein described, it seems readily apparent that so long as the bit is penetrating the formation in a vertical direction, such as well bore 30 of Figure 3, the valve 15 will remain in open position due to the force of gravity because of the weight 5. However, when the drill bit strikes some obstruction or is otherwise caused to deviate from the vertical its deviation will be quickly apparent to the driller because the force of gravity will cause the weight to maintain the passage 16 through the valve in a vertical position, and if the inclination is of a sufficient amount to cause the passage 16 to move out of alignment with the passage 13, it is then apparent that the flow of fluid through the passage 13 will be restricted. Its restriction will increase the pressure required to cause circulation and the driller will instantly notice that the slush pump is laboring to maintain the circulation, and when he knows that this invention has been incorporated in the tool joint, he is then aware that his drill bit has deviated from the vertical to a sufficient angle that the circulation is being restricted. He can then withdraw the drill bit and plug back the short distance 31 of the hole which has deviated from the vertical and then continue his drilling in a vertical direction.

With some types of modern equipment high speed rotation of the drill bit is possible. When this occurs the valve may be constructed without anti-friction bearings. It is also possible that when high speed rotation of the drill bit occurs that the weight 22 when once moved off center by inclination of the bit will then, due to centrifugal force, instantly move over to the maximum position such as shown in the dotted line position of Fig. 1.

Thus, in practising the invention, the driller is advised when his bit has inclined from the vertical but a few degrees, and can instantly remedy the difficulty; whereas, with the present practise the bit deviates, and, in many instances, several hundred feet of hole are drilled before the operator is advised that his well is crooked. It is then necessary to plug back this several hundred feet by filling the hole with cement, and he can then attempt to drill a vertical hole. The cost of this plugging back operation is

quite expensive and delays the drilling of the well. When the present invention is incorporated in the drill collar or tool joint adjacent the bit, the operator will be instantly advised of any deviation, and can then make his correction before any considerable crooked hole has been drilled.

It is contemplated that in the future development of the invention that various alterations and modifications may be resorted to, and that the structure shown herein and described is for purposes of illustration only, as the invention contemplates broadly the idea of indicating to the operator the deviation of his bit by restricting or cutting off the flow of fluid through the drill stem.

What we claim is:

1. In combination with a drill stem coupling, a valve seat having a passage therethrough, a valve for said seat having a passage therethrough which is adapted to be normally in alignment with said valve seat passage, a depending weight on said valve having a passage therethrough, said three passages being adapted for alignment when said coupling is disposed in a vertical position, and anti-friction bearings supporting said valve whereby said weight will cause movement of said valve and closing of said passage when said coupling is inclined.

2. A gravity operated cut-off valve for drill stems to close off the passage of fluid when said stem is inclined beyond a predetermined degree, including a seat construction, a ball valve disposed in said seat for swiveling movement, a weight connected to said ball valve and depending therefrom, a passage through said seat and a passage through said ball and weight which passages are adapted to be aligned but which will be moved out of alignment by swinging of said weight to swivel said valve.

3. A gravity operated cut-off valve for drill stems to close off the passage of fluid when said stem is inclined beyond a predetermined degree, including a seat construction, a ball valve disposed in said seat for swiveling movement, a weight connected to said ball valve and depending therefrom, a passage through said seat and a passage through said ball and weight which passages are adapted to be aligned but which will be moved out of alignment by swinging of said weight to swivel said valve, and a sealing ring between said valve and seat about said passage.

In testimony whereof, we hereunto affix our signatures this 22nd day of August, A. D. 1931.

EDGAR C. JOHNSTON.
JOHN F. FOWLER, JR.