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DEFLECTING TOOL

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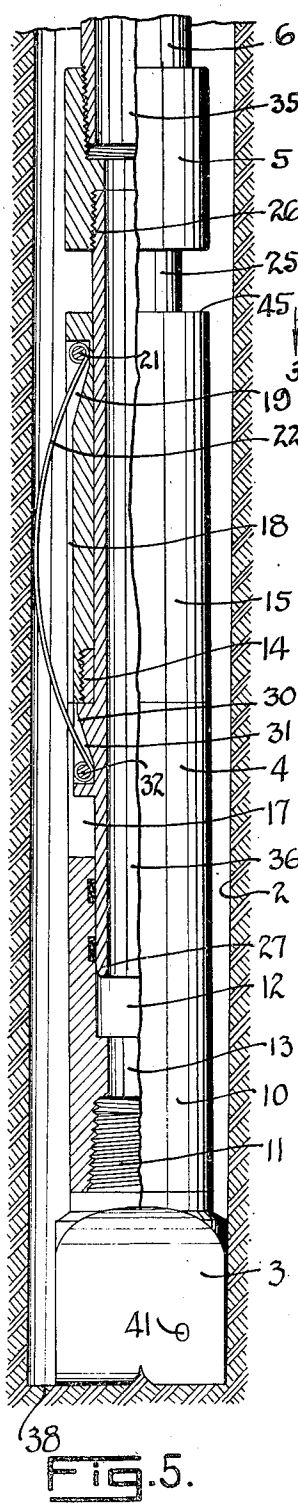


Fig. 5.

Fig. 1.

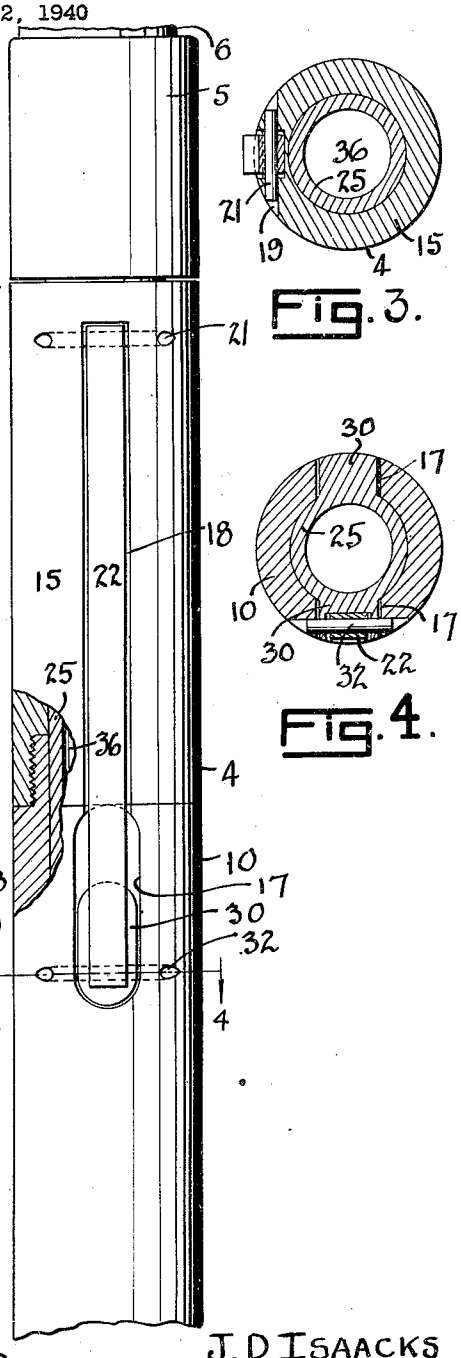


Fig. 2.

Fig. 3.

Fig. 4.

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DEFLECTING TOOL

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The invention relates to an improvement in tools used in the deflecting of well bores.

In the drilling of wells by the rotary method a drill bit is rotated by means of a string of pipe known as the drill stem, and as the bit penetrates the earth additional sections of pipe are added.

In many instances the rotating of the bit causes the well bore to veer off at an angle from the vertical and this is particularly true if too much of the weight of the drill stem is allowed to rest on the bit as it is drilling. In other instances boulders, fissures in the formation being drilled, and other factors contribute in making the well bore crooked.

In the past when a well bore was to be straightened, the practice was to insert an inclined wedge-like member known as a whipstock, so that the drilling of the well could be continued when the bit moved along this inclined surface so as to correct the deflection if the well were crooked, or to deflect the well if it were desired to incline the well in some other direction. More recent deflecting tools have been devised wherein an inclinable member acted as the drilling bit and could be tilted so as to cause the well to be drilled in a different direction. Various methods of orienting both the whipstock and the deflecting tools have been devised so that both the direction and the angle of deflection can be controlled.

In still other instances where some obstruction was present in the well bore it has been desirable to deflect the well at an angle with respect to its path so as to avoid such obstruction and the whipstock and deflecting tools have also been used for this purpose. Other deflecting operations are employed when the well bore is to be directed in a pre-determined direction as in the instance where a number of wells are drilled from the same footing and fan out in the earth in different directions.

The present invention contemplates a tool and the method of utilizing it, wherein the drilling operation can be carried on with the same tool which is utilized in effecting the deflection or in correcting an inclination as the case may be.

It is one of the objects of the invention to provide a device wherein the hydraulic pressure on the drilling mud circulated in the rotary method of drilling will be used to move the drill bit to its deflecting position.

Another object of the invention is to move a drill bit off center in the well bore by hydraulic pressure.

Still another object of the invention is to provide a drill bit assembly which can be deflected by hydraulic pressure while it is suspended off bottom.

It is also an object of the invention to provide a mechanically operated deflecting member which can be controlled by the application of hydraulic pressure.

Another object of the invention is to provide a deflecting member for drill bit assemblies which will remain contracted during the drilling operation and when the bit is being lowered into and removed from the well bore, but which can be moved to active position by the application of hydraulic pressure.

Still another object of the invention is to provide a telescopic joint in a drill bit assembly which will effect the actuation of a deflecting member.

Another object of the invention is to provide a deflecting member which can be operated by hydraulic pressure applied to the drill bit.

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

Fig. 1 is a vertical sectional view of a drill collar to which the invention has been applied, and illustrating the deflecting member in contracted position.

Fig. 2 is a side elevation taken at right angles to the section of Fig. 1.

Fig. 3 is a transverse section taken on the line 3—3 of Fig. 1.

Fig. 4 is a transverse section taken on the line 4—4 of Fig. 2.

Fig. 5 illustrates the assembly in position in the well bore with the deflecting device in operating position and the drill bit about to penetrate the bottom of the well bore after having been deflected and moved off center.

In Fig. 5 the well bore 2 has been illustrated, which well bore is to be deflected from its path and this well bore may be a well bore which has been inclined and is to be straightened, or any other well bore the drilling of which is to be continued at an angle with respect to itself.

The well bore 2 may be of any desired size but it is intended that with the present invention the drill bit such as 3 will be of lesser diameter than the bore which has been theretofore drilled. A common instance is that if the well bore 2 were of a standard diameter, say 9⅞ inches, then the drill bit such as 3 would probably be 5⅝ inches so that the bit would have considerable clearance in the well bore which would permit its being moved off center as is illustrated in Fig. 5.

The drill bit 3 is shown as having been at-

tached to a drill collar 4 which is in turn connected to the tool joint 5 of the drill stem 6. The principal part of the invention lies in the construction of the drill collar 4 which may be made up in the form of a sub to be placed adjacent the bit 3 as illustrated, or above the conventional types of drill collar which are ordinarily used, it being understood that the drill collar usually employed is a rigid, heavy section of pipe to lend stability to the drilling operation and avoid sharp deflections if the bit should encounter obstructions. The present collar is of a particular construction, however, in that it embodies an outer collar 10 which has the shank 11 of the drill bit threaded into the lower end. This barrel has a passage 12 therethrough which is restricted adjacent its lower end 13 where the passage discharges into the lower part. The outer collar 10 may be of any desired length and has a reduced upper end 14 thereon which has a nipple 15 threaded thereto. The outer barrel 10 is provided with a pair of elongated slots 17 in opposite sides thereof, as will be best seen in Fig. 4.

The nipple 15 has a longitudinal groove 18 therein which joins a recess 19 at its upper end. This recess carries a cross-pin 21 to which the upper end of a spring 22 is affixed. This spring 22 is a relatively long, flat bow spring which is shown at a somewhat larger scale in Figs. 1 and 2. In view of the fact that the upper end is affixed to the nipple 15, it seems obvious that the spring will be caused to move with the outer barrel 10 and the drill bit 3.

The outer collar of the drill bit assembly are connected to and carried by an inner barrel 25 whose upper end is threaded at 26 into the tool joint 5. This inner barrel 25 is of the size to fit snugly into the passage 12 and has its lower end 27 projecting downwardly inside of the collar 10 to almost the bottom of the passage 12 where it is reduced at 13. In this manner a sliding telescope connection is provided between the collar 10 and the barrel 25.

In order to limit the sliding movement of the collar and barrel, a pair of spaced lugs 30 project from the barrel 25 into the slots 17 as best seen in Fig. 4. One of these lugs has a recess 31 therein which carries a cross-pin 32 similar to the pin 21, and to which the lower end of the bow spring 22 is affixed.

From the foregoing, it seems obvious that there can be relative vertical sliding movement between the barrel and collar, and the spring 22 is of such size and strength that it will normally support the weight of the drill bit 3 and the collar 10 while remaining in contracted position as seen in Fig. 1, so that it substantially lies in the groove 18. The normal weight of the bit and collar will not cause the spring to move to expanded position so that when the assembly is lowered into the well bore it will be in the position shown in Figs. 1 and 2 with the spring contracted. This spring, however, is of such strength that it may be expanded by an additional pressure which tends to move the drill bit and collar 10 downwardly relative to the barrel 25. It seems obvious that the pin 32, being rigidly affixed through the barrel 25 to the drill stem 6, can be held stationary as seen in Fig. 1.

When it is desired to expand the bow spring 22 which is the deflecting member of the tool, it is only necessary to apply pump pressure to the stream of liquid, usually drilling mud, which is being circulated downwardly through the passage 35 in the drill stem into the passage 36 in the inner barrel and thence through the passage 13 in the bottom of the collar.

The assembly may be so constructed that the passage 40 in the drill bit leading to the ports 41 where it discharges from the drill bit, may be of any desired size which is less than the area of the passage 35 or 36, or even 13. In this manner when the pressure is increased on the drilling mud there will be a tendency to force the drill bit down relative to the drill stem which will be held suspended. This tendency will cause a sliding movement of the outer collar of the inner barrel. This sliding movement moves the pin 21 toward the pin 32 causing the bow spring and deflecting member to expand as seen in Fig. 5. When the spring thus expands, the drill bit 3 will be held just off bottom in the well bore so that as the spring 22 engages the side of the well bore 2, the bit will be moved to an off center position. The bit will thus be positioned at one side of the well bore as seen at the bottom of Fig. 5, and while the pressure is still applied the entire assembly can be lowered so that the bit will engage the bottom 38 of the well bore. Sufficient weight can now be placed on the drill stem to force the bit into the earth formation as it is rotated. This weight may be sufficient to cause the outer barrel 25 to again telescope into the collar 10 and in this manner contract the spring 22 so as to return it to the position of Fig. 1 irrespective of the fact that the pressure is still applied through the drill stem.

On the other hand, however, the pressure applied to the drilling mud may be an excessive pressure greater than that ordinarily used during the drilling operation, and after the drill bit has been landed in a deflecting position, the pressure may be reduced, allowing the spring to contract as the drill stem is lowered. In either event, it should be particularly noted that as the drilling is started and the bit assembly rotated by the drill stem, that the spring 22 is contracted so that it does not scrape around on the wall of the well bore but returns to an inoperative position where it does not interfere in any manner with the drilling of the well bore.

It may be that the entire lower portion of the drill stem will be flexed by the deflecting member 22, or it may be that it is merely moved off to one side by the deflecting member, depending upon the circumstances in the particular well.

It seems obvious that the upper end 45 of the nipple 15 on the collar 10 may abut the tool joint 5, as seen in Fig. 1, to limit the sliding movement, or the lower ends 46 of the lugs 30 may abut the lower end of 47 of the slots 17.

The downward sliding movement of the collar 10 relative to the barrel 25 will be limited when the upper end 48 of the lugs 30 abut the upper end 49 of the slots 17 as seen in Fig. 5. With this construction the sliding movement is limited in each direction but the spring 22 is normally of a strength to hold the parts in a telescoped or collapsed position as seen in Fig. 1.

In operation the assembly will be arranged as seen in Figs. 1 and 2 and lowered into the well bore. If the well is to be deflected in any desired direction of the compass, the drill stem can be oriented so that the spring 22, or deflecting member, will be on the opposite side from the direction from which the bit is to be deflected. Various methods of orienting a drill stem in the well bore are well known. It is to be understood that the device may be used without orientation, however,

if it is merely desired to deflect the well irrespective of direction. When the bit is lowered to a position closely adjacent the bottom of the well bore the pump pressure can be either initially applied or increased as the case may be, so as to force the drill bit and the drill collar downwardly relative to the barrel **25** to expand the deflecting member **22**.

Thus the bowing of the spring causes the suspended drill bit to move to an off center or deflecting position and the bit can now be lowered against the bottom of the hole to assume the position as seen in Fig. 5. The rotation of the bit may now be started and as the weight is applied to the drill stem the spring will be collapsed as the barrel **25** slides down into the collar **10**, or as pointed out heretofore, the pressure may be reduced to allow the spring to collapse. In either event, however, the bit having been moved to an off center position, the drilling may now begin and the well bore continued in a deflecting position by virtue of the drill stem being inclined and the fact that the bit has been positioned off center.

Broadly the invention contemplates a method or apparatus for deflecting bores which operates independently of the weight applied to the drill stem, and which can be controlled by hydraulic pressure from the surface.

What is claimed is:

1. A deflecting drill bit assembly including a drill stem, a barrel thereon, a collar over said barrel and slidably mounted thereon, interfitting lugs and slots on said collar and barrel, a bow spring arranged longitudinally of the assembly and having one end affixed to said collar and one end to one of said lugs on said barrel so that when said barrel and collar are contracted the spring will be contracted, a drill bit on said sleeve, said barrel and collar having a continuous passage therethru, a plurality of discharge ports in said bit whose total area is less than that of said passage to form a restriction for a flow of liquid through the assembly so that the pressure on the liquid will exert a down thrust on said bit and collar to expand said spring and move the assembly off center of the bore while the bit is suspended off bottom.

2. In a deflecting tool for well bore a pair of relatively movable parts, a bow spring normally holding said parts retracted, and means to apply liquid pressure to the tool to extend said parts and bow said spring so as to contact the wall of the well bore to move the tool to deflecting position.

3. In a deflecting tool for well bore a pair of relatively movable parts, a bow spring normally holding said parts retracted, means to apply liquid pressure to the tool to extend said parts and bow said spring so as to contact the wall of the well bore to move the tool to deflecting position, and interengaging shoulders on said parts to transmit the weight of the upper part to the lower part to overcome the force of said means and retract said spring when the lower part contacts the well bottom.

4. In a deflecting tool for well bore a pair of relatively movable parts, a bow spring normally holding said parts retracted and means to apply pressure to the tool to extend said parts and bow said spring so as to contact the wall of the well bore to move the tool to deflecting position.

5. Directional drilling apparatus for use in combination with a hollow drill stem comprising a member arranged to be secured to a lower portion of a drill stem, a second member slidable relatively to said first-mentioned member, wall-engaging means secured to said members and arranged to be projected against the wall of a bore hole when said members occupy one relative position and arranged to occupy a retracted position when said members occupy another relative position, and means restricting flow of liquid through the drill stem to effect relative movements of said members depending upon rate of liquid flow through the drill stem.

6. Directional drilling apparatus for use in combination with a hollow drill stem comprising a member arranged to be secured to a lower portion of a drill stem, a second member slidable relatively to said first-mentioned member, a spring element secured to said members and normally occupying a retracted position and serving to maintain said members in one relative position, and means restricting flow of liquid through the drill stem to effect relative movements of said members to another relative position depending upon rate of liquid flow through the drill stem, said spring element being projected against the wall of a bore hole when the members are in the last-mentioned position.

7. Directional drilling apparatus for use in combination with a hollow drill stem comprising a pair of relatively slidable members forming an expansible chamber having a restricted outlet and arranged to communicate with the passage through a drill stem, and wall engaging means secured to said members and arranged to be projected against the walls of a bore hole when said members occupy one relative position and arranged to occupy a retracted position when said members occupy another relative position, said members moving between said relative positions depending upon liquid pressure in the chamber provided thereby.

8. Directional drilling apparatus for use in combination with a hollow drill stem comprising an expansible chamber securable to a drill stem in communication with the liquid passage therethrough, and wall engaging means connected to said chamber to be projected against the walls of a bore hole and withdrawn therefrom as said chamber responds to variations in pressure of liquid passing through said drill stem.

9. A deflecting drill collar and bit assembly wherein the bit is to be moved off center of the well bore in the direction of deflection while suspended off bottom of the well bore comprising a rigid drill stem, a drill collar thereon, a bit on said collar, inner and outer parts forming said collar which parts are telescopically arranged, and bow spring means normally supporting the lower part on the upper part in retracted position, and a restriction for the flow of liquid through said lower part so that liquid under pressure tends to extend said parts, bow said spring means, and move the assembly laterally in the well bore.

10. A deflecting drill bit and drill stem assembly of less diameter than the well bore which is to be deflected thereby, including an extensible connection between the bit and stem, a wall engaging means connected to said extensible connection, means normally holding said connection retracted, said means providing a chamber extensible in response to liquid pressure applied thereto so as to project said wall engaging means laterally to engage the side of the well bore to move the bit in the bore to a deflecting position.

11. A deflecting drill bit and drill stem assembly

of less diameter than the well bore which is to be deflected thereby including an extensible connection between the bit and stem, a wall engaging means connected to said extensible connection, means normally holding said connection retracted, said means providing a chamber extensible in response to liquid pressure applied thereto so as to project said wall engaging means laterally to engage the side of the well bore to move the bit in the bore to a deflecting position, said connection being collapsed by a pressure forcing said bit against the bottom of the bore to return said wall engaging means to an inoperative position as the deflected drilling proceeds.

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