# United States Patent

[11] 3,587,757



[72] Inventor **Bobby R. Herring**
**1327 Clyde Drive, Marrero, La. 70072**



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[54] **HYDRAULIC DRILLING TOOL**
**1 Claim, 5 Drawing Figs.**


[52] **U.S. Cl.** ..... **175/94,** 175/321
[51] **Int. Cl.** ..... **E21b 3/08**
[50] **Field of Search** ..... 175/94, 321, 230, 101, 107



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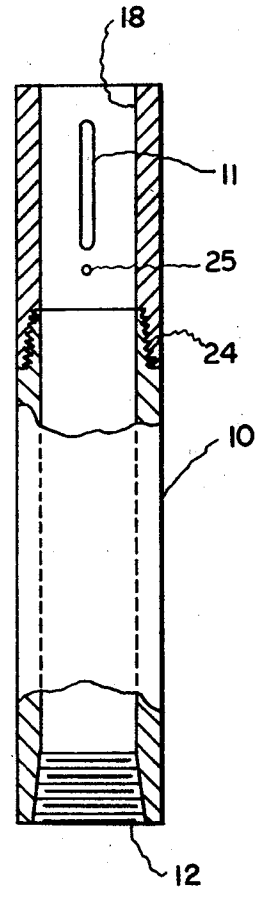
*Primary Examiner*—Marvin A. Champion
*Assistant Examiner*—Richard E. Favreau
*Attorney*—Calvin J. Laiche



**ABSTRACT:** The present invention pertains to an improved apparatus for use with positive displacement mud motors employed in present day directional drilling operations. Downhole deviations are usually accomplished today by the use of these drilling machines in combination with a bent sub placed above the machine which thereby forces the drill bit to drill in the desired direction. The instant invention provides a hydraulic sub which is preferably positioned above the drill motor and bent sub whereby jamming of the drill bit is eliminated. The present hydraulic feed sub basically comprises a piston-and-cylinder assembly which is actuated by the drilling fluid that operates the mud motor.

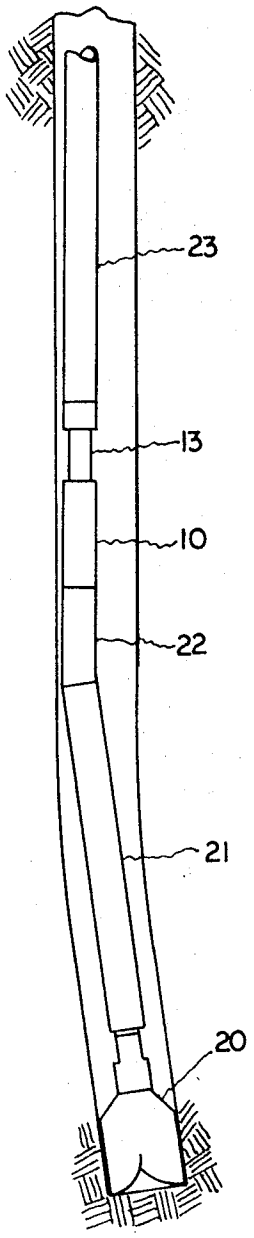



FIG. 5

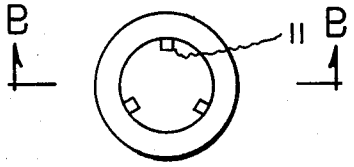



FIG. 2

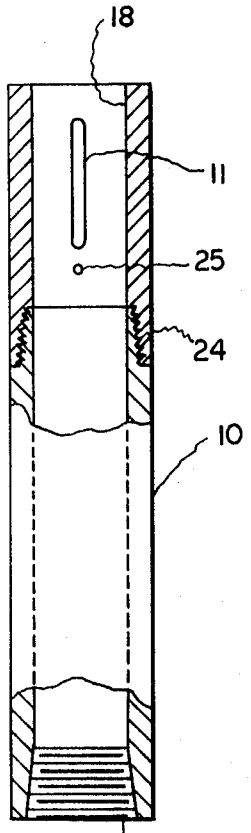



FIG. 1

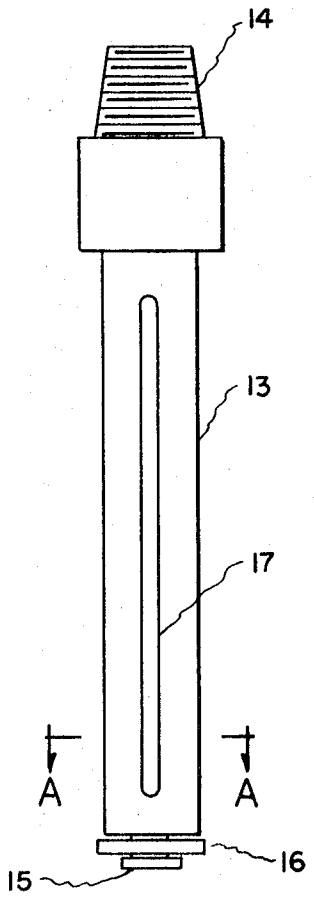



FIG. 3

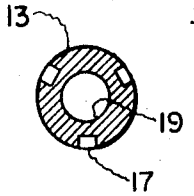



FIG. 4

INVENTOR:
BOBBY R. HERRING
BY: Calvin J. Laiche
ATTORNEY

# HYDRAULIC DRILLING TOOL

## BACKGROUND OF THE INVENTION

The present invention pertains to borehole directional drilling apparatus and techniques.

Quite often in the process of drilling oil wells or other boreholes, it becomes necessary to change the direction of the borehole. Prior to the use of mud motors for directional drilling, such operations as sidetracking, hole straightening, controlled directional drilling, and the like, were realized by the use of conventional whipstocks. However, the use of whipstocks usually involves making separate runs in order to complete a significant directional change. Since it is necessary to pull the drill stem between each run, the resultant round trips are costly to say the least. Additionally, whipstocking generally results in a series of sharp and abrupt turns or doglegs which in turn results in frictional binding.

The above problems have been overcome in the art by the use of what is known as downhole directional drilling utilizing a positive displacement mud motor. The mud motor in turn drives the drilling but without drill pipe rotation. A bent sub is generally positioned above the mud motor whereby a continuous full gage deviated directional hole along a smooth curve is produced. While the use of mud motors has overcome most of the problems associated with whipstocking, it has been found that since the drill pipe does not rotate, the pipe and/or mud motor assembly does at times become hung up due to frictional contact with the sides of the borehole. This requires that the drill stem be worked up and down in order to move the drill bit into position. This practice quite often results in the drill bit being jammed or shoved too much into the drilling formation thereby requiring that the operator back off slightly. Consequently, the operator must maintain a suitable rate of feed or else he will not achieve a suitable drilling rate since if he moves the bit too fast, it will jam, or on the other hand, if it is not moved along at the proper speed, it will not perform efficiently. This and other problems are overcome by way of the present invention by providing a hydraulic drilling tool which moves the drill bit along under a force sufficient to maximize drilling efficiency, yet not so great as to jam the drill bit, without the operator having to continuously move the drill stem up and down.

## SUMMARY OF THE INVENTION

The present hydraulic feed sub, which is utilized in combination with a bottom hole rotary hydraulic mud motor, basically comprises an elongated outer tubular member having a threaded portion on one of its ends and its other end being provided with at least two elongated raised portions spaced essentially equidistance round its inner peripheral surface. The longitudinal axis of the raised portions are essentially parallel to that of the tubular member. Positioned within the outer member is an elongated inner tubular member which also has a threaded portion on its external end. The inner member is provided with elongated grooves which correspond in number to the raised portions within the outer member. The grooves are of a depth and width sufficient to accommodate the raised portions which are positioned therein in a sliding relationship. The longitudinal axis of the grooves are essentially parallel to that of the inner tubular member. In this manner, the inner tubular member is allowed to telescope within the outer member thereby forming a cylinder and piston assembly. The length of travel of the inner member is determined and fixed by the length of the grooves therein relative to the length of the raised portions within the outer member. The inner member is provided with resilient seal means positioned on its end inserted within the outer member whereby a fluid under pressure when forced into either end of the present tool causes the inner member to slide outwards of the outer member. This operation is realized as hereinafter discussed in detail.



## DESCRIPTION OF THE DRAWING

FIG. 1 in the drawing depicts a side elevation view, partly in section, taken along the line B–B of FIG. 2 showing the outer tubular member.

FIG. 2 represents a top end view of the outer member as depicted in FIG. 1.

FIG. 3 depicts a side elevation view of the inner tubular member.

FIG. 4 depicts a cross section view of the inner tubular member taken along the line A–A of FIG. 3.

FIG. 5 shows the present hydraulic drilling tool as utilized in combination with a conventional positive displacement downhole mud motor.

## PREFERRED EMBODIMENT

Referring to FIG. 1 in the drawing, the present hydraulic drilling motor comprises the elongated outer tubular member **10** which is generally provided with the female threaded portion **12** on one of its ends. The raised portions or keys **11** are provided at its other end, positioned along the inner peripheral surface of the member **10** and are essentially parallel to its longitudinal axis. Of course, the members **11** can be made integral with the member **10** or separately and attached thereto in a suitable fashion, e.g. by welding.

The elongated inner tubular member **13**, which actually serves as a piston and the member **10** as a cylinder, is generally provided with the male threaded portion **14** at one of its ends. The threaded portion **14**, like that of the member **10**, is preferably adapted for connection in a standard manner to a conventional drill pipe or stem and related appurtenances. The other end of the member **13** is provided with the flanged portion **15** which is adapted to receive the resilient seal means **16**. The member **13** is further defined in that it is provided with the elongated grooves **17** which extend lengthwise to the member **13** such that the longitudinal axis of the grooves **17** are essentially parallel to that of the member **13**.

The diameter of the resilient seal means **16** is sufficient such that when the member **13** is inserted within the member **10**, it contacts the inner peripheral surface **18** of the member **10** thereby forming a sealed piston-and-cylinder assembly. The member **13** is bored to provide the aperture **19** whereby fluid under pressure ejected into the member **13** flows into the outer member **10** such that when the threaded end **12** of the member **10** is closed, the fluid acting against the seal **16** causes the member **13** to be shoved or pushed outwards.

The present hydraulic feed sub is provided with at least one of the keys **11** so as to either prevent rotation or insure rotation depending upon its location. In the arrangement depicted in FIG. **5**, the objective is to prevent rotation. However, where the present tool is installed between the mud motor **21** and the drilling bit **20**, the purpose of the raised portions or keys **11** is to insure rotation between the members **10** and **13**. Generally, it is preferred to provide the present device with three of the keys **11**. Correspondingly, the member **11** would be provided with three grooves corresponding in position to that of the keys **11**. This preferred arrangement is readily shown in FIG. **2** and **4**. Of course, the keys **11** are of a width sufficient to slidably fit within the grooves **17** such that the member **13** slidably telescopes within the member **10**. The length of external travel of the member **13** out of the member **10** is determined by the length of the keys **11** relative to the grooves **17**. Thus, it can be seen that the shorter the length of the keys **11** relative to a fixed groove length, as well as the closer the keys are positioned to the top end of the member **10**, the greater will be the extent of travel of the member **13**. Generally, these members are proportioned such that the member **13** can telescope over a path of about 18 inches.

The present hydraulic feed sub is preferably positioned above the drill motor **11**, generally connected thereto by virtue of the bent sub **22** which in turn is connected to the drill stem **23** by virtue of the present tool, and thereby need not be designed to continuously rotate. In that case, the tongue-and-

groove assembly of the present tool need only be of sufficient strength so as to provide for rotating the mud motor **21** into a desired position when changing the direction of a borehole as shown in FIG. **5**.

The outer tubular member **10** is preferably contracted such that it can be screwed apart for replacement of the seal means **16**. This is preferably accomplished by making the member **10** in two pieces which are screwed together by virtue of the threads **24**. The member **10** is also preferably provided with the weephole **25** for preventing excess pressure buildup and caking between the members **10** and **13**.

As brought out above, mud motors will not operate unless the weight load on the motor is proper. Too light of a load will result in inefficiency and too great a load will cause excessive drill bit wear as well as jamming with its resultant lost time. Since the drill stem bangs up in the hole due to frictional contact with the sides of the borehole, it is difficult for an operator to continuously ease the drill stem into the hole, but rather, the drill stem will abruptly and sporadically slide downwards resulting in its jamming. In operation, the present device allows the operator to maintain a continuous and uniform pressure on the drill bit. Referring to FIG. **5**, the drill stem assembly is lowered in the borehole to a depth such that the member **13** telescopes essentially fully within the member **10**. As the drill bit **20** cuts a path, the member **10** slides downward and only the weight of the mud motor **21** and bent sub **22** is imposed upon the bit. Thus, the problem caused by frictional contact between the drill stem **23** and the borehole is eliminated.

When the member **10** is fully extended downwards, the operator can then lower the drill stem and as long as it is not lowered to a depth sufficient to jam the drill bit, e.g. not greater than the extent of travel between the members **10** and **13**, the same pressure is maintained on the drill bit **20**. The net result is increased bit life plus more efficient drilling.

The various components of the present tool are generally constructed of steel or some other suitable metal with the exception of the resilient seal means **16** which is generally composed of rubber or the like. It will be apparent to one skilled in the art that various modifications can be made in the present hydraulic feed sub without departing from the true scope and spirit of the present invention. For example, a series of packing and gland rings can be employed in lieu of the resilient seal means **16**. Further, the keys or tongues **11** can be located further within the member **10** as long as sufficient travel of the member **13** is realized.

I claim:

1. In combination with a bottom hole rotary hydraulic motor having a rotating bit sub for drilling a well borehole, the improvement comprising a hydraulic feed sub which is further defined as comprising:

a. an elongated outer tubular member having a threaded portion on one of its ends adapted to mate with the threaded end of a drill string, and its other end being provided with three elongated raised portions spaced apart at essentially 120° from each other, said outer tubular member being further defined in that it comprises a first portion wherein said three raised portions are located and a second portion which is threadably united to said first portion;

b. an elongated inner tubular member having a threaded portion on one of its ends adapted to mate with a rotary hydraulic motor and its other end being adapted for insertion in said outer tubular member, said inner member being provided with three elongated grooves of a depth and width sufficient to accommodate said respective raised portions in a sliding relationship, the longitudinal axis of the grooves being essentially parallel to that of said tubular member whereby said inner tubular member is allowed to telescope within said outer member, its length of travel being determined and fixed by the length of the grooves therein relative to the length of the raised portions within said outer member; and

c. resilient seal means operably positioned on the end of said inner member adapted for insertion within said outer member, said seal means being of a diameter sufficient to contact the inner peripheral surface of said outer member whereby said inner member is pushed out of said outer member upon injecting a fluid under pressure into said members.