This invention relates to drilling equipment, and has for its general object the provision of a means whereby the direction in which the hole is being drilled may be changed and controlled as drilling proceeds. In drilling deep wells or the like, particularly by the rotary drilling method, it is frequently desirable to change the direction in which the drilling is proceeding. This may be caused either by a desire that the drill hole be inclined or directed in a predetermined manner to reach a definite known goal, or by a desire to bring back to the vertical a hole in which the drilling has become deflected from the vertical.

Various means have been employed in the past for deflecting drilling tools so as to change or control the direction of drilled holes. Most of these have taken the form of so-called whipstocks or wedge-shaped blocks placed in the bottom of the well hole to deflect a drilling tool in one direction or another from the original well hole. These are objectionable for several reasons, the principal reason being that in order to set the whipstock in the well hole it is necessary not only to withdraw the drilling tool from the well hole, but to make an extra round trip into the well hole to set the whipstock. Also, the usual whipstock causes a sharp angular change in the direction of the well hole which is likely to cause trouble in subsequent operations. The operation of removing the drilling tool and setting the whipstock, then removing the setting string and reinserting the drilling tool is a time-consuming and highly expensive operation and it is desirable that it be reduced as much as possible.

It is an object of this invention to provide a device which will not require the use of a whipstock or the like in the well hole.

Another object of this invention is to provide a device for changing the direction of drilling in a well hole which will reduce the time required in changing the direction of the hole.

Another object of this invention is to provide a means for changing the direction of drilled holes which will reduce the number of necessary round trips of the drill stem into the hole.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein is set forth by way of illustration one embodiment of this invention.

In the drawings:

Fig. 1 is a longitudinal cross section through a well hole showing in elevation a device constructed in accordance with this invention at the time of the beginning of the deflection of the drilling tool.

Fig. 2 is a vertical cross section through the upper portion of the device illustrated in Fig. 1.

Fig. 3 is a vertical cross section through an intermediate portion of the device illustrated in Fig. 1 and forms a continuation of the lower portion of Fig. 2.

Fig. 4 is a vertical cross section through the lower portion of the device shown in Fig. 1 and forms a continuation of the lower portion of Fig. 3.

Fig. 5 is a horizontal cross section taken along the line 5—5 of Fig. 4.

Fig. 6 is a vertical cross section through the upper portion of the device after the deflection of the drilling tool has been completed.

Fig. 7 is a vertical cross section through the lower portion of the device under the same conditions, this view forming a continuation of the lower portion of Fig. 6.

In accordance with the present invention there is secured to the lower end of the drill stem by means of the usual tool joint and sub a drill collar. The lower end of the drill collar carries a reamer having roller cutters mounted in circumferentially spaced recesses in its outer surface. To the lower end of this reamer body there is threadedly secured a bit which is specially constructed in accordance with this invention and is provided with downwardly extending legs having roller cutters mounted on axles extending downwardly and inwardly with respect to the bit. The inner ends of these cutters terminate short of the center of the bit so as to leave room for a bar which extends downwardly and through and forms a part of a device for deflecting the bit to an eccentric position with respect to the bottom of the hole. On the lower end of this device there is carried a pilot bit head formed with a spoon shaped cutting part. The head is also formed with notches in its upper portion for a purpose presently to be described.

Referring now to Figs. 2, 3 and 4, it will be seen that the drill collar is provided with a liner which is preferably of relatively hard material and which has an inner passageway tapering from a larger dimension at its lower end to a smaller dimension at its upper end. The lower end of this liner is provided with external shoulders and which engage corresponding internal shoulders in the drill collar and prevent the liner from moving upwardly in the drill collar. The upper end of this liner having rather thick...
walls is provided with fluid passageways extending from the upper end of the liner to a position extending a considerable distance below the upper end of the liner where they open into the main passageway through the liner. The drill collar 4 and the sub 3 is still another member which is in the nature of a drill collar but which has a smooth internal bore adapted to receive a piston 20. The piston 20 has appropriate sealing cups 21 secured thereto so as to prevent leakage of fluid past the piston and is provided with an upwardly sealing valve member 22 spring pressed upwardly by means of a compression spring 23. The body of the piston is provided with an opening controlled by the valve 22, which opening communicates at its lower end through the passageways 24 with the space below the piston. The piston also carries a bearing member 25 adapted to support anti-friction bearings in which is rotatably mounted a pin 27. Pivoted to the lower end of this pin by means of a pivot 28, is a sleeve 38 which extends downwardly through the tapered sleeve or liner 14. The lower end of this bar is cut away on its opposite sides to receive the parts 30 of the bar member 31. The parts 30 are slotted as shown at 32 so to slidable receive a pin 33 which passes through the end of the bar 29 and permits sliding movement of the parts 31 with respect to the bar 29 but prevents these parts from being entirely separated. The parts 31 is provided with a pivot 34 at its lower end by which it is connected to a short spindle 35. A wear ring 36 is mounted around this spindle for rotation on the bearings 37. The spindle itself is threadedly engaged with the upper end of the bar 10 previously referred to.

Carried within the lower end of the reamer body is a sleeve 38 having an opening therein adapted to receive a shear pin 40. This shear pin has a head 41 on its outer end and is threaded at its inner end to receive the bolt 42 which passes through the bar 10. Below the head of the bolt 42 the bar 10 passes through a bearing member 43 having anti-friction bearings therein which permit the rotation of the bar within the bearing member. The bearing member also has an external ball shaped part 45 which engages the lower end so as to give it a substantially universal movement within the bit head 7. Pins 46 carried in this ball member engage with slots in the socket formed in the inner portion of the bit head to prevent rotation of the ball member. On its lower end the ball member is provided with circumferentially spaced downwardly extending lugs 47 adapted to engage the notches 13 on the upper end of the pilot bit head 9 as will be hereinafter referred to.

In operation, the device described is assembled as shown in Figs. 2, 3 and 4 before being lowered into the well. In the course of this assembling, the telescoping joint formed between the parts 29 and 31 permits the part 31 to be moved downwardly so that the bearing sleeve 43 and the other parts may be put in position after which the pin 40 is screwed in place and secured by the bolt 42 so as to hold the bar 10 in position such as shown in which it is inclined with respect to the bit head 7. Thus inclined and held the device is lowered into the well hole with the bar 10 projecting a very substantial distance beyond the lower end of the main bit with the pilot bit 11 positioned eccentrically with respect to the hole. When the bottom of the hole is reached care is taken to see that the drill is properly oriented so that the pilot bit will be offset from the center of the hole in the direction in which it is desired to deflect the drilling. The entire device is then spudded to enable the pilot bit to dig a small cavity sufficient to prevent it from sliding around on the bottom of the hole, and sufficient weight is placed on the bottom of the hole to shear the shear pin 40. Before the shear pin 40 is sheared, the usual pumps are started and fluid under pressure is forced in through the drill stem and against the upper end of the piston 20. If the pressure exerted by the fluid exceeds the strength of the spring 23, the valve 22 will open and permit fluid to pass through but the piston will still be held down with a force depending on the strength of the spring 23. When the pin 40 is sheared, it will be seen that the bar 20 and all associated parts are free to move upwardly within the drill bit but are held against doing so by the pressure of the fluid on the piston 20. Rotation of the drill is then started and the drill is allowed to slowly descend in this descent it is guided toward one side of the hole by means of the bar 10. The bar 10 will not rotate during this operation but will remain substantially stationary and the piston, bar and associated parts will gradually move into the bit and assembly. During this movement the ring 36 will bear against and wear upon the inner wall of the reamer body and then upon the inner wall of the tapered liner 14 so that as it moves upwardly it will gradually come more and more into alignment with the drill stem until when it reaches the upper end of the liner it will be in substantially exact alignment with the drill stem. At the same time, the bearing member 43 will reach the lower end of the bar 10 and the lugs 47 will come into engagement with the notches 13. The parts will then occupy the position shown in Figs. 6 and 7 and it will be seen that the drill has been deflected so that it will now make a hole in a somewhat different direction from the original hole and that the pilot bit 41 will act as a center bit to cut the center bottom of the hole so that drilling may proceed without interruption. It is desirable however in the usual case that as soon as the hole has been definitely started in its new direction the deflecting apparatus be removed from the hole and the usual drilling apparatus inserted.

It will be seen from the foregoing that the objects and advantages sought by this invention will be attained by the structure described, that the direction of the drilling may be effectively changed, that the necessity for a large number of round trips in deflecting the direction of the drilling will be avoided, and that a relatively simple and effective apparatus has been provided.

Having described our invention, we claim:

1. In a device of the character described, a drill bit, a deflecting member telescope mounted in said drill bit, a piston connected to said deflecting member and slidable mounted in said drill bit, subject to the action of fluid flowing toward said drill bit, and means carried by said piston for permitting fluid to pass said piston only when the pressure above said piston exceeds a predetermined value.
2. In combination, a drill stem, a drill bit on the lower end thereof, a piston slidable mounted in said drill stem, a deflecting member hingedly attached to said drill bit, eccentrically mounted in said drill stem, and means for causing fluid to flow toward said drill bit only when said pressure exceeds a predetermined value.
connected to the lower end of said piston and adapted upon downward movement of the piston to be projected beyond said drill bit, means for releasably holding said deflecting member in projected and laterally deflected position, and means carried by said piston adapted to prevent the passage of fluid therethrough when the pressure of the fluid above said piston is less than a predetermined value and to permit such passage when the pressure above said piston exceeds such predetermined value.

GEORGE L. SCOTT.
JOHN F. SHAW.
WILEY B. NOBLE.