

July 5, 1955

M. L. GILES ET AL
DIRECTIONAL DRILLING TOOL

2,712,434

Filed Nov. 23, 1953

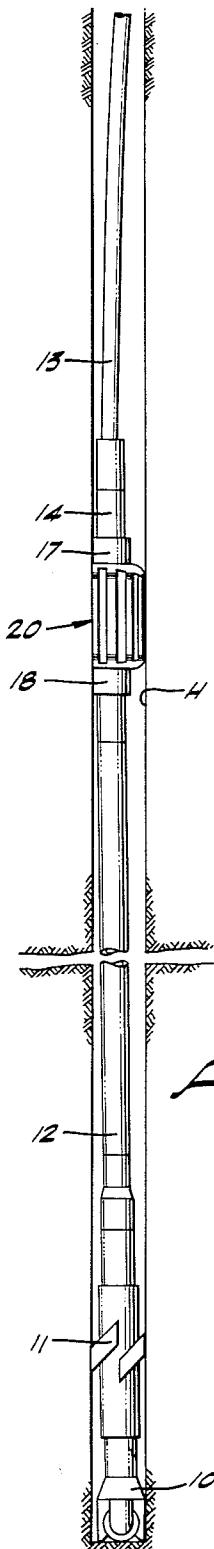


FIG. 1.

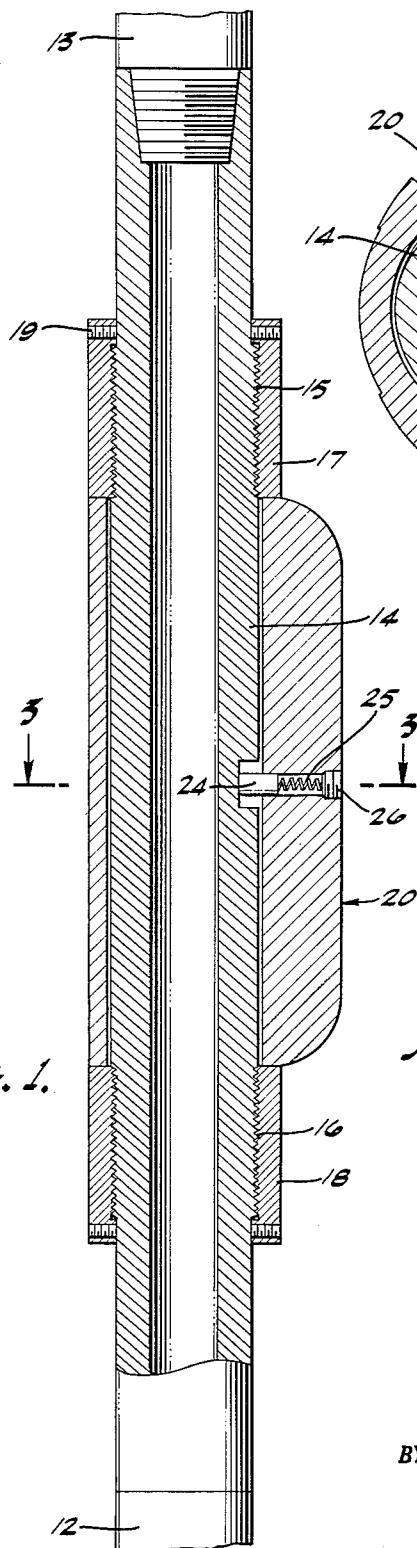


FIG. 2.

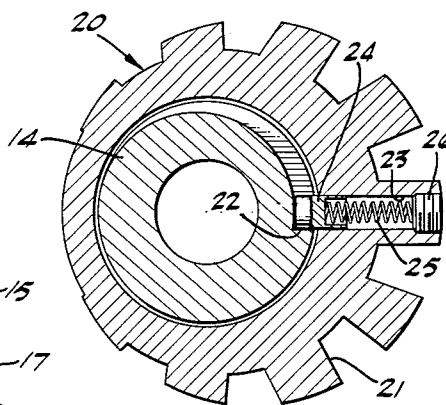


FIG. 3.

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DIRECTIONAL DRILLING TOOL

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Application November 23, 1953, Serial No. 393,758

3 Claims. (Cl. 255—1.6)

This invention relates to a directional drilling tool for use in conjunction with a rotary drill stem in drilling wells.

An object of the invention is to provide a relatively simple, sturdy directional drilling tool which may be incorporated in the drill stem between the drill collar and the bottom of the drill pipe that will cause the top of the drill collar to be laterally displaced with respect to the axis of the hole that is being drilled by the drilling bit. In this manner, as the drill collar is caused to assume a slightly inclined position with respect to the axis of the hole the bit will be laterally directed and thus cause the further drilling of the hole to return to vertical if the hole has been deviated from the vertical, or causing the further drilling of the hole to deviate from the vertical if directional drilling is desired.

Another object of the invention is to provide a directional drilling tool having the above-mentioned characteristics which consists essentially of a hollow mandrel that may be incorporated in the drill stem between the drill collar and the drill pipe and which has rotatably mounted thereon an eccentric bushing. This bushing is confined against vertical displacement with respect to the mandrel by opposed shoulders and has vertical passages on the exterior thereof for the upward flow of circulation fluid. The external diameter of the eccentric bushing is substantially equal to the diameter of the hole that is being drilled by the bit and a one-way clutch mechanism is arranged between the mandrel and the bushing so that the bushing can be properly oriented or positioned in the hole to cause the bit to be directed in the desired direction. After having been thus properly positioned the drill pipe and mandrel are normally rotated in the opposite direction wherein the mandrel may freely rotate relatively to the bushing without disturbing its position.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a partial view in vertical section through a well that is being drilled, illustrating the direction drilling tool embodying the present invention as having been incorporated in the drill stem;

Fig. 2 is a vertical section through the directional drilling tool; and

Fig. 3 is a horizontal section taken substantially upon the line 3—3 upon Fig. 2.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, we have illustrated in Fig. 1 a somewhat conventional rotary drill stem consisting of a well drilling bit 10 above which there is frequently a reamer or bit stabilizer indicated at 11. Above the bit stabilizer there is a conventional drill collar 12 which is normally connected to the drill pipe 13. The drill pipe 13 is rotated by the rotary table at the surface and causes the drill collar

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12 and the bit 11 to be rotated thereby in the course of drilling the well.

The directional drilling tool embodying the present invention consists of a hollow mandrel 14 threaded at its ends for attachment to the top of the drill collar 12 and the bottom of the drill pipe 13, respectively. This mandrel is externally threaded near its ends as indicated at 15 and 16 to receive shoulder-providing thrust collars 17 and 18, respectively. These thrust collars may be locked in position on the mandrel by set screws 19 or the equivalent. Between the thrust collars 17 and 18 there is disposed an eccentric bushing 20. This bushing is rotatable on the mandrel between the thrust collars and has an overall external diameter substantially equal to the gauge diameter of the bit 10 so that the bushing when positioned in the hole H will substantially fill the hole. On the exterior of the bushing there are vertical flutes or passages 21 which provide for the upward passage of circulation fluid that is discharged from the bit 10.

On the exterior of the mandrel there is formed a tooth or radial shoulder 22 which faces toward the left or in a counterclockwise direction as viewed in Fig. 3. This radial shoulder is arranged at one end of a cam-shaped groove on the mandrel. In the eccentric bushing 20 there is a radial bore 23 in which is slidable a spring-actuated detent 24. This detent is urged inwardly by a compression spring 25 that is confined in the bore by a plug 26.

When it is desired to change the direction in which the well hole H is being drilled by the bit 10, the mandrel, together with its thrust collars and bushing, is inserted in the drill stem between the drill collar 12 and the drill pipe 13. The drill stem is then lowered into the hole H until the bit 10 substantially reaches the bottom of the hole. During the lowering of the drill stem the eccentric bushing merely slides downwardly through the hole and circulation fluid may pass upwardly through the passage 21. In order to properly orient or position the bushing the drill pipe is then rotated to the left, causing the mandrel 14 to also rotate to the left. When the shoulder 22 engages the detent 24 rotation of the mandrel relatively to the bushing is arrested. Consequently, the bushing will thereafter be caused to rotate with the mandrel. The bushing is then rotated until it has been properly positioned to cause the bit 10 to be directed in the desired direction. Thereafter, the drill pipe is rotated to the right in the conventional manner and drilling proceeds. During this rotation to the right the mandrel merely rotates within the eccentric bushing without disturbing the position of the bushing inasmuch as the detent 24 is merely cammed out of the recess behind the shoulder 22 and as the shoulder passes beneath the detent, the detent snaps back into the recess under the action of the spring 25. In other words, the shoulder 22 and detent 24 form a type of one-way clutch which enables the sleeve to be properly positioned by the drill stem in the hole when the drill stem is rotated in one direction, but permits the drill stem to be freely rotated relative to the bushing when the drill stem is rotated in the opposite direction.

When the bushing has been properly positioned it will be noted from an inspection of Fig. 1 that the top of the drill collar has been displaced laterally in the hole so that the axis of the drill collar is slightly inclined relatively to the axis of the hole. If the bit 10 has a 10% gauge diameter the overall diameter of the bushing is also 10%". The eccentricity of the bushing is such that its geometrical center is spaced 1 3/8" from the center of the mandrel. With such dimensions when the tool is mounted on top of a 19' drill collar, the arrangement is such as to cause the bit 10 to start drilling with a 1° deviation from the direction of the hole previously drilled.

As drilling proceeds the bushing slides down the hole and this 1° deviation becomes cumulative. In this manner, the amount of deviation given the hole can be ascertained from the surface. In other words, the depth of hole drilled while the tool is in use will indicate the amount of deviation imparted to the hole. It will, of course, be appreciated that the eccentricity of the bushing may vary with different sizes and with the lengths of drill collars employed. The dimensions given are merely typical or representative.

The material of the bushing 20 and the plug 26 is preferably relatively soft so that if occasion should require a washover tool may be lowered into the well and the eccentric bushing can be drilled up. For this reason the inner end of the spring 25 is preferably recessed in the detent 24 so that this detent which is ordinarily formed of hard material, will not have any substantial mass thereof projecting outwardly beyond the diameters of the collars 17 and 18.

From the above-described construction it will be appreciated that an improved directional drilling tool is provided which is very simple in construction, very durable, and highly efficient in its operation.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

We claim:

1. In combination with a rotary drill stem having a drill pipe, a bit, and a drill collar between the bit and the drill pipe, an eccentric bushing having an external diameter substantially equal to the diameter of the hole drilled by the bit, means for rotatably mounting the bushing between the top of the drill collar and the drill pipe whereby the drill pipe and drill collar may rotate relatively to the bushing and the top of the drill collar will be held laterally displaced by the bushing relative to the axis of the hole drilled by the bit, and means for arresting

rotation of the bushing relative to the drill pipe and drill collar in one direction whereby the bushing may be properly oriented thereby in the hole.

2. A device for directional drilling comprising a hollow mandrel, means at the ends of the mandrel by which the ends may be connected to the top of a drill collar and the bottom of a drill pipe respectively, an eccentric bushing rotatably mounted on the mandrel, shoulder means for holding the bushing against vertical displacement on the mandrel, there being vertical fluid passages on the exterior of the bushing for the flow of circulation fluid therethrough, and one-way clutch means between the bushing and the mandrel enabling the bushing to be oriented by the mandrel in the hole but also enabling the mandrel to freely rotate relative to the bushing in the opposite direction.

3. A device for directional drilling comprising a hollow mandrel, means at the ends of the mandrel by which the ends may be connected to the top of a drill collar and the bottom of a drill pipe respectively, an eccentric bushing rotatably mounted on the mandrel, shoulder means for holding the bushing against vertical displacement on the mandrel, there being vertical fluid passages on the exterior of the bushing for the flow of circulation fluid therethrough, there being a radial shoulder on the mandrel facing in one direction, and a spring-actuated pawl in the bushing engageable with the shoulder to arrest rotation of the mandrel relative to the bushing in one direction but not in the other.

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