Jan. 21, 1936. L. R. SCHUESSLER 2,028,478

ROTARY DRILLING APPARATUS

Filed Aug. 8, 1934

Fig. 1.

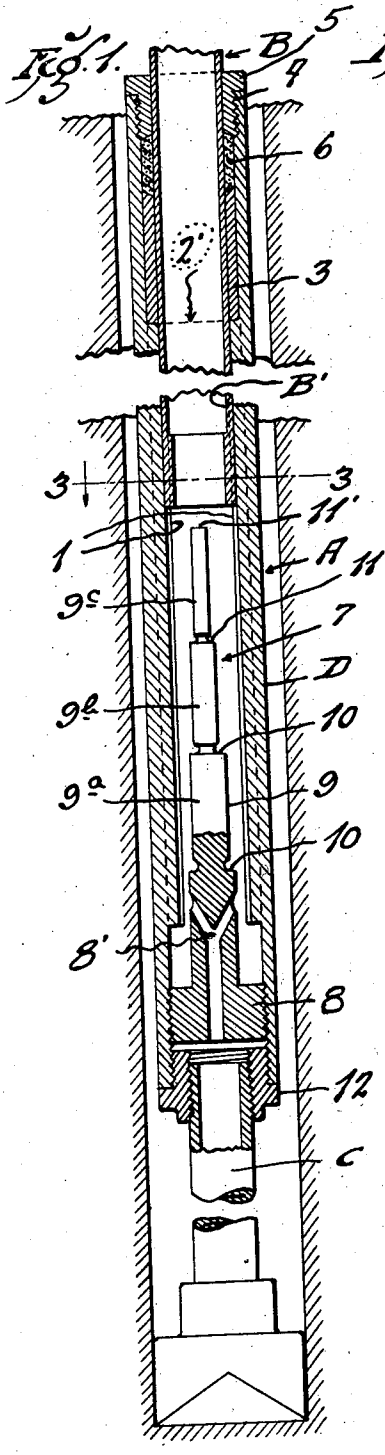


Fig. 2.

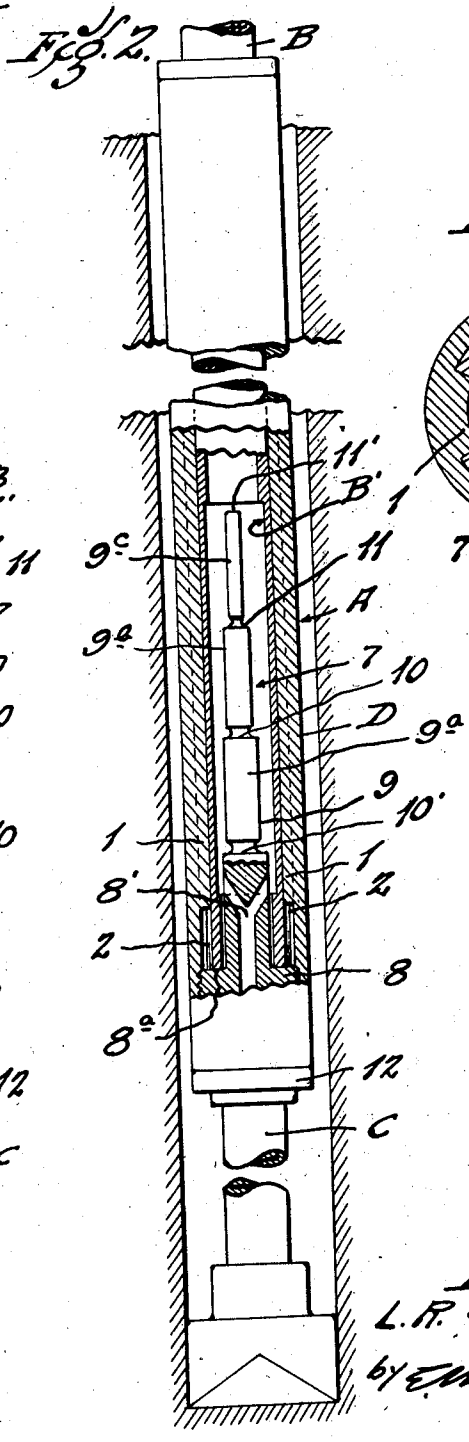
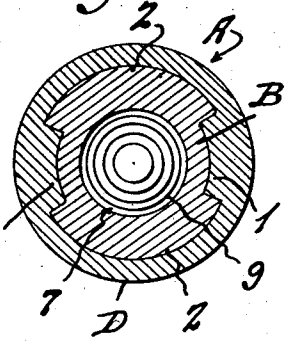


Fig. 3.



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ROTARY DRILLING APPARATUS

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6 Claims. (Cl. 255—28)

This invention relates generally to drilling apparatus, and more specifically to rotary drilling apparatus intended for use in drilling oil wells, gas wells, water wells, and other similar earth openings, the predominant object of the invention being to provide a rotary drilling apparatus of the telescopic type which is so constructed and arranged that different hydrostatic and physical pressures may be applied to the drill bit at the will of the operator of the drilling apparatus from the surface of the ground, when the drilling operation being performed requires that the downward pressure on the drill bit be varied.

Prior to this invention rotary drilling apparatus were produced which included telescopic sections in the drill stems which serve to limit the weight applied to the drill bits. In other words, in the use of a telescopic drill stem of the sort mentioned the drill bit was subjected to the weight of only the portion of the drill stem which was located below the telescopic section of the drill stem, hence in the case of very deep wells the drill bits were not subjected to the enormous weight of the entire drill stem which might cause the drill bits to be quickly dulled or even crushed.

The telescopic drilling apparatus referred to were capable of reasonably efficient use, but in such apparatus a serious deficiency was present that prevented the drilling apparatus from attaining the high efficiency desired for it. This deficiency resided in the fact that it was not possible to vary the pressure to which the drill bit was subjected during a drilling operation. In other words, in the use of the telescopic drill stems heretofore known the pressure on the drill bit was positively fixed by the weight of the portion of the drill stem below the telescopic section and this pressure could not be varied except by pulling the drill stem and adding length to the lower portion thereof, or by lowering the portion of the drill stem located above the telescopic section and imposing the additional weight thereof on the drill bit.

The main object of the present invention is to provide a telescopic rotary drilling apparatus which is so constructed and arranged that the downward pressure exerted against the drill bit may be varied within certain limits at all times at the will of the operator of the apparatus and from the surface of the ground. This regulation of the pressure on the drill bit is obtained by controlling the flow of fluid which passes through the improved rotary drilling apparatus in a manner to increase or decrease the pressure of the fluid at a certain point within the drilling apparatus. A portion of the drilling apparatus which is directly associated with the drill bit is subjected to the varying pressures of the fluid, with the result that the downward pressure on the drill bit is likewise varied.

Fig. 1 is a fragmentary vertical section of a drilling apparatus constructed in accordance with this invention.

Fig. 2 is a view similar to Fig. 1, but showing the parts of the apparatus in different positions.

Fig. 3 is an enlarged cross-section taken on line 3—3 of Fig. 1.

In the drawing, where is shown for the purpose of illustration, merely, one embodiment of the invention, A designates a portion of a drill stem made in accordance with this invention. The drill stem A includes an upper section B, a lower section C, and an intermediate section D which provides the drill stem with a telescopic joint, said sections B, C, and D being of tubular formation. The upper section B is of considerably less diameter than the intermediate section D, and said upper section is extended into said intermediate section as shown in Fig. 1, said sections B and D being capable of telescoping movement relative to each other.

At the inner face of the intermediate section D and at the outer face of the upper section B cooperating ribs 1 and 2 are formed, as shown in Fig. 2, which abut with each other in a manner to prevent relative rotary movement between said sections while permitting free longitudinal movement of said sections with respect to each other. The ribs may be formed integrally with said sections B and D, or, if desired, they may be in the form of separate elements secured to the section in any suitable manner. The ribs 1 formed at the inner face of the intermediate section D extend continuously from a point near the upper end of said intermediate section to a point near the lower end thereof, while the ribs 2 formed at the outer face of the upper section B extend upwardly from the lower end of said upper section a slight distance. The intermediate section D has fixed at its inner face a ring 3 which acts as a stop for limiting outward movement of the upper section B and the intermediate section D with respect to each other, the shoulders 2' at the upper ends of the ribs 2 contacting with the lower edge of the ring 3 when the limit of outward movement of the sections B and D has been reached. At its upper end the intermediate section D is provided with an internally screw-threaded portion 4 which receives an externally screw-threaded gland 5, and suitable packing 6 is interposed

between the lower end of the gland 5 and the upper end of the ring 3 to prevent a leakage of mud-laden fluid between the contacting walls of the sections B and D.

At the lower end of the intermediate sections A a fluid-controlling element 7 is located. This fluid-controlling element comprises a base portion 8 through which a fluid passageway 8' is formed, said fluid-controlling element being secured to the intermediate section A by having its externally screw-threaded base portion 8 screwed into the lower internally screw-threaded end portion of said intermediate section. The fluid-controlling element includes an upwardly extended shank 9 which is divided into portions of varying diameters, the shank portion 9^a which is located immediately adjacent to the base portion 8 being of greater diameter than the intermediate shank portion 9^b, and the outer shank portion 9^c being of less diameter than the intermediate shank portion 9^b. At the point where the shank portions 9^a and 9^b join each other a flat face 10 is provided, and at the point where the shank portions 9^b and 9^c join each other a similar flat face 11 is located. Also, the outer end of the shank portion 9^c is provided with a flat face 11'. The flat faces 10, 11, and 11' are disposed at substantial right angles with respect to the major axis of the shank 9 of the fluid-controlling element 7. The fluid passageway 8' formed through the base portion 8 of the fluid-controlling element is provided with openings at the point where the base portion joins the shank 9^a.

The particular structure shown in the drawing includes a coupler 12 which serves to connect the intermediate section D of the drill stem to the lower section C thereof. This coupler is provided with screw-threaded portions which engage screw-threaded portions of said intermediate and lower sections and thus connects said sections together.

In the use of a rotary drilling apparatus of the type disclosed herein mud-laden fluid is forced downwardly through the drill stem by a suitable pump (not shown) located at the surface of the ground, and this fluid passes through fluid discharge apertures formed in the drill bit for the purpose of lubricating the drill bit and washing away the cuttings while it is performing the drilling operation. The mud-laden fluid is returned to the pump by being forced thereby upwardly through the hole being drilled between the wall of said hole and the outer face of the drill stem.

When the improved drilling apparatus disclosed herein is being used only the weight of the lower section C of the drill stem is imposed on the drill bit because of the presence of the telescopic joint in said drill stem, and due to the fact that this weight plus the downward exertion produced by movement of the fluid against the faces 10, 11, and 11' provides sufficient downward pressure on the drill bit to cause it to cut through strata of ordinary hardness encountered by the drill bit, the drilling will progress in a uniform manner, the upper section of the drill stem being fed downwardly in accordance with the downward movement of the drill bit and the lower drill stem section, so as to maintain the telescopic sections of the drill stem in substantially the same relative positions during the drilling operation. During such drilling operation the lower end portion of the upper section B of the drill stem is maintained in an elevated position with respect to the shank 9 of the fluid-controlling element 7, as shown in Fig. 1, so that the mud-laden fluid may pass through the drill stem in an entirely unrestricted manner.

Assume, however, that instead of encountering strata of ordinary hardness the drill bit encounters a stratum which, because of unusual hardness or for some other reason, is not readily penetrated by the drill bit. In this event the operator will lower the upper drill stem section until the shank 9 of the fluid-controlling element 7 is extended into the lower end portion of said upper drill stem section. This will have the effect of choking the lower end portion of the upper drill stem section so as to restrict the passage of mud-laden fluid therethrough. Also, the degree of choking effect obtained may be regulated by positioning the lower end of the upper drill stem section adjacent to the different portions 9^a, 9^b, and 9^c of the shank of the fluid-controlling element due to the different diameter of said portions 9^a, 9^b, and 9^c. In other words, if the lower end of the upper drill stem section were located adjacent to the shank portion 9^c a certain choking effect would be obtained, while a greater choking effect would be obtained if the lower end of the upper drill stem section were located adjacent to the shank portion 9^b. Likewise, a still greater choking effect is obtained when the lower end of the upper drill stem section is located adjacent to the shank portion 9^a.

When the upper drill stem action is lowered as described to cause one of the portions 9^a, 9^b, or 9^c of the shank 9 to be located within the lower end of said upper drill stem section, the flow of mud-laden fluid is restricted at the lower end of the upper drill stem section, and because the pump continues to deliver fluid to the upper drill stem section the pressure of the fluid therein will be increased. This increased pressure acts against the flat faces of the shank 9 (the faces 10 and 11, and the face 11' at the outer end of the shank portion 9^c) in a manner to force the intermediate section D and the lower section C of the drill stem, together with the drill bit, downwardly whereby the required additional downward pressure on the drill bit is provided. It is important to note that various additional downwardly working pressures on the drill bit may be obtained by positioning the lower end of the upper drill stem section adjacent the different shank portions 9^a, 9^b, and 9^c, for it is plain that greater fluid pressure is built up in the upper drill stem section when the choking effect at the lower end thereof is increased by the use of a shank portion of increased diameter, while such additional fluid pressure is less when a shank portion of smaller diameter is used for choking purposes.

The flat faces 10, 11, and 11' of the shank 9 of the fluid-controlling element 7 serve also as impact faces against which the flowing mud-laden fluid moves. This movement of the mud-laden fluid against the flat faces mentioned tends to force the drill bit downwardly and thus apply additional downward pressure thereagainst.

It is important to note that when the drill stem is entirely telescoped the flow of mud-laden fluid is not entirely stopped. In other words, regardless of the relative positions of the telescoped elements of the drill stem, a flow of fluid through the drill stem is maintained at all times.

In this connection attention is directed to Fig. 2, wherein the upper drill stem section B is shown as supported by the shoulder 8^a at the

top of the base of the fluid-controlling element 7. When so positioned it is plain that the entire weight of the upper drill stem section is imposed on the drill bit and the drill stem may be used in the manner of an ordinary non-telescopic drill stem. When the drill stem is so used the mud-laden fluid may flow freely through the drill stem, due to the fact that the inner face of the lower portion of the upper drill stem section is cut away, as indicated at B', to provide space for such free passage of fluid through the drill stem when the telescopic drill stem is entirely collapsed. This cutaway portion B' does not extend to the lower end of the upper drill stem section, hence the choking effect heretofore described is obtained.

Also additional downward pressure may be applied to the drill bit of my improved apparatus by maintaining the telescopic members of the drill stem in the approximate positions in which they are shown in Fig. 1 and increasing the pressure produced in the fluid by the pump by stepping up the pump. In this event the increased pressure acting against the faces 10, 11, and 11' will exert downward pressure on the drill bit.

It is obvious, therefore, that the improved apparatus may be operated so that only the weight of the lower drill stem section plus the downward pressure produced by the mud-laden fluid moving against the faces 10, 11, and 11' is imposed upon the drill bit, and if desired the weight of the lower drill stem section may be partially supported from the derrick to lessen its weight on the drill bit. Also this downward exertion against the drill bit may be increased by choking the flow of fluid at the lower end of the upper drill stem section as already explained herein, so as to exert additional fluid pressure against the faces 10, 11, and 11'. Additionally, the upper drill stem section may be lowered so that its weight is imposed on the drill bit, and if desired this additional weight may be balanced from above the ground so that the entire weight of the upper drill stem section or a portion thereof may be imposed on the drill bit. Finally, additional fluid pressure may be applied to the drill bit by increasing the fluid pressure produced by the pump and causing this additional pressure to act against the faces of 10, 11, and 11'.

Thus it is plain that my improved apparatus is capable of very flexible use and practically any desired downward pressure may be applied to the drill bit.

In addition to the flat faces 10, 11, and 11' on the shank of the fluid-controlling element 7 I provide a similar flat face 10' which is located between the base portion 8 and the shank portion 9^a.

I claim:

1. A drill stem comprising a pair of tubular members arranged in telescopic relation, means to restrict rotary movement of said tubular members with respect to each other, communicating passageways for fluid formed through said tubular members, a fluid-controlling element, said fluid-controlling element being supported by one of said tubular members and having a shank portion relative to which an open end of the other of said tubular members moves in a manner to cause said shank portion to be extended into said open end of said other tubular member and partially choke same, whereby passage of fluid through the open end of said other tubular member is restricted and the pressure of fluid adjacent to the open end of said other tubular member is increased, a pressure-receiving face formed on said shank portion and movable into and out of said open end of said other tubular member against which said increased fluid pressure acts to move said fluid-controlling element downwardly, and a drill bit to which is transmitted downward movement imparted by said increased fluid pressure to said fluid-controlling element.

2. A drill stem comprising a pair of tubular members arranged in telescopic relation, means to restrict rotary movement of said tubular members with respect to each other, communicating passageways for fluid formed through said tubular members, a fluid-controlling element, said fluid-controlling element being supported by one of said tubular members and having a shank portion relative to which an open end of the other of said tubular members moves in a manner to cause said shank portion to be extended into said open end of said other tubular member and partially choke same, whereby passage of fluid through the open end of said other tubular member is restricted and the pressure of fluid adjacent to the open end of said other tubular member is increased, a pressure-receiving face formed on said shank portion and movable into and out of said open end of said other tubular member against which said increased fluid pressure acts to move said fluid-controlling element downwardly, said pressure-receiving face being disposed at an approximate right angle relative to the major axis of said shank portion, and a drill bit to which is transmitted downward movement imparted by said increased fluid pressure to said fluid-controlling element.

3. A drill stem comprising a pair of tubular members arranged in telescopic relation, means to restrict rotary movement of said tubular members with respect to each other, communicating passageways for fluid formed through said tubular members, a fluid-controlling element, said fluid-controlling element being supported by one of said tubular members and having a shank portion of varying diameters relative to which an open end of the other of said tubular members moves in a manner to cause said shank portion to be extended into said open end of said other tubular member and partially choke same, whereby passage of fluid through the open end of said other tubular member is restricted and the pressure of fluid adjacent to the open end of said other tubular member is increased, pressure-receiving faces formed on said shank portion and movable into and out of said open end of said other tubular member against which said increased fluid pressure acts to move said fluid-controlling element downwardly, and a drill bit to which is transmitted downward movement imparted by said increased fluid pressure to said fluid-controlling element.

4. A drill stem comprising a pair of tubular members arranged in telescopic relation, means to restrict rotary movement of said tubular members with respect to each other, communicating passageways for fluid formed through said tubular members, a fluid-controlling element, said fluid-controlling element being supported by one of said tubular members and having a shank portion relative to which an open end of the other of said tubular members moves in a manner to cause said shank portion to be extended into said open end of said other tubular member and par-

tially choke same, whereby passage of fluid through the open end of said other tubular member is restricted and the pressure of fluid adjacent to the open end of said other tubular member is increased, said shank portion being provided with a plurality of portions of different diameters, pressure-receiving faces formed on said shank portion and movable into and out of said open end of said other tubular member against which said increased fluid pressure acts to move said fluid-controlling element downwardly, and a drill bit to which is transmitted downward movement imparted by said increased fluid pressure to said fluid-controlling element.

5. A drill stem comprising a pair of tubular members arranged in telescopic relation, means to restrict rotary movement of said tubular members with respect to each other, communicating passageways for fluid formed through said tubular members, a fluid-controlling element, said fluid-controlling element being supported by one of said tubular members and having a shank portion relative to which an open end of the other of said tubular members moves in a manner to cause said shank portion to be extended into said open end of said other tubular member and partially choke same, whereby passage of fluid through the open end of said other tubular member is restricted and the pressure of fluid adjacent to the open end of said other tubular member is increased, said shank portion being provided with a plurality of portions of different diameters, and flat pressure-receiving faces arranged at the junctions of said plurality of portions and at the outer end of said shank portion and movable into and out of said open end of said other tubular member against which said increased fluid pressure acts to move said fluid-controlling element downwardly, and a drill bit to which is transmitted downward movement imparted by said increased fluid pressure to said fluid-controlling element.

6. A drill stem comprising a pair of tubular members arranged in telescopic relation, means to restrict rotary movement of said tubular members with respect to each other, communicating passageways for fluid formed through said tubular members, a fluid-controlling element, said fluid-controlling element being supported by one of said tubular members and having a shank portion relative to which an open end of the other of said tubular members moves in a manner to cause said shank portion to be extended into said open end of said other tubular member and partially choke same, whereby passage of fluid through the open end of said other tubular member is restricted and the pressure of fluid adjacent to the open end of said other tubular member is increased, said shank portion being provided with a plurality of portions of different diameters, and flat pressure-receiving faces arranged at the junctions of said plurality of portions and at the outer end of said shank portion and movable into and out of said open end of said other tubular member against which said increased fluid pressure acts to move said fluid-controlling element downwardly, said fluid-controlling element having a fluid passageway formed through a portion thereof, and a drill bit to which is transmitted downward movement imparted by said increased fluid pressure to said fluid-controlling element.

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