July 29, 1941. T. B. HUDSON ET AL 2,250,912

WELL DRILLING SYSTEM

Filed Oct. 9, 1939 2 Sheets-Sheet 1

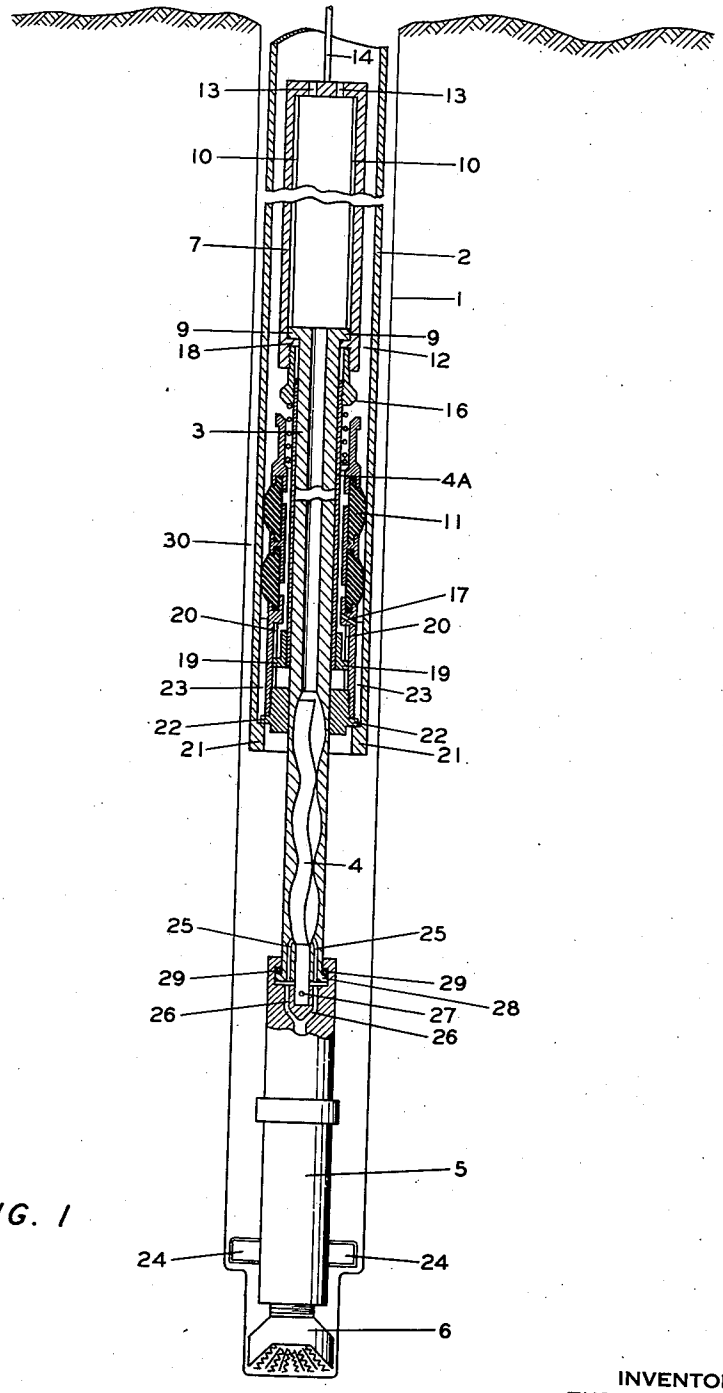


FIG. 1

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WELL DRILLING SYSTEM

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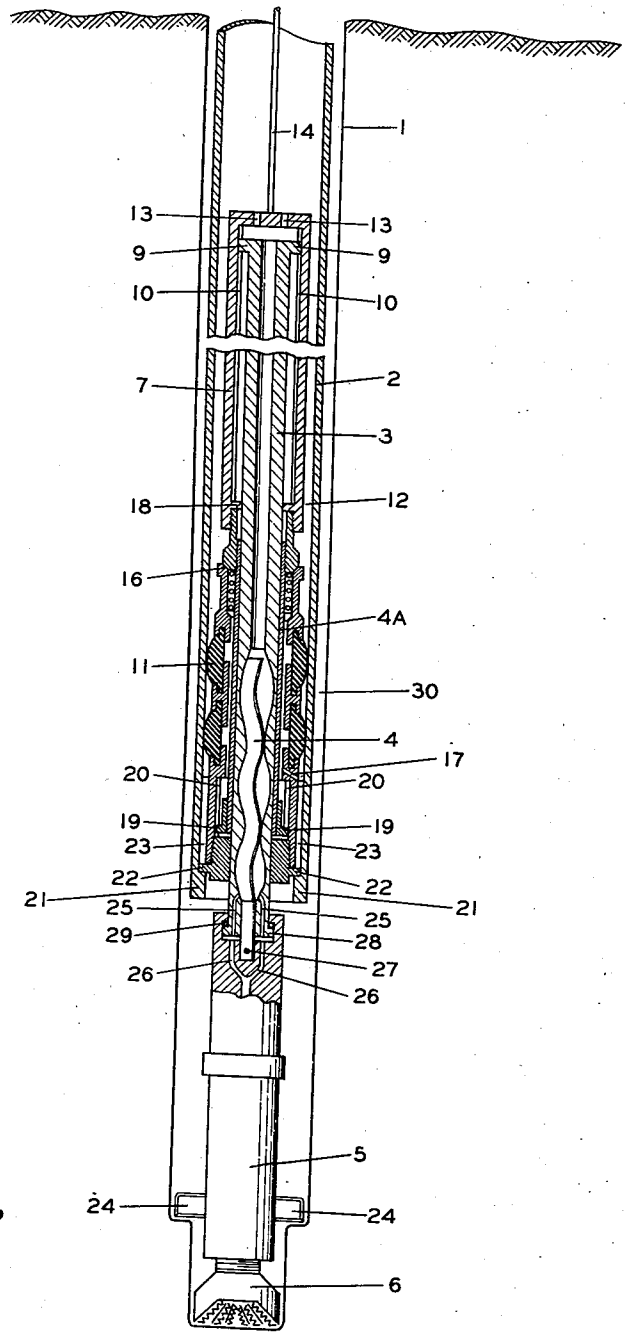


FIG. 2

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WELL DRILLING SYSTEM

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Application October 9, 1939, Serial No. 298,700

7 Claims. (Cl. 255—4)

The present invention relates to improvements in deep-boring apparatus and more particularly to improvements in a hydraulically operated well drilling system.

One of the objects of the present invention is to provide well drilling apparatus wherein the cutting bit or tool is operated by the fluid that is utilized to carry the cuttings away from the bit.

A further object of the present invention is to provide means for utilizing the well casing as a conductor pipe for the motor operating fluid as the drilling advances.

A further object of the present invention is to provide the motor with means whereby to eliminate several disadvantages encountered in using a drilling system in which the motive power for drilling is transmitted either through a rigid torque tube or a flexible conduit.

Briefly described, the present invention comprises a hydraulically operated rotary motor having a hollow weight member slidably associated with it in such a manner as to permit vertical movement only of the motor as the drilling advances; and packing means sealing the space between the motor and the well casing whereby fluid entering the casing will be directed into the motor through the hollow weight member.

Several important advantages are obtained with this system, chiefly, all cumbersome hose handling, or making and breaking of drill pipe joints is eliminated, and the circulation of fluid may be continuously maintained. An appreciable amount of time in the drilling operations is thus saved and a more efficient application of power is obtained, since it is applied directly to the bit where the work is to be accomplished. A greater safety factor is also ensured through continuous circulation of the mud fluid. By using the casing as a conductor pipe, the casing is advanced as the drilling proceeds and protects the well bore from caving.

Other objects and advantages of the invention will appear as the description of the drawings proceeds. We desire to have it understood, however, that we do not intend to limit ourselves to the particular details shown and described, but that we intend to include as part of our invention, all such obvious changes and modifications as would occur to persons skilled in the art.

Our invention will be understood from the following detailed description taken in connection with the accompanying drawings wherein like reference characters denote corresponding parts throughout.

With reference to the drawings:

Figure 1 is a vertical sectional view of the drilling apparatus at the bottom of a bore hole.

Figure 2 is a similar view showing the casing advanced with respect to the drill bit.

Referring more particularly to the drawings, numeral 1 indicates the well bore and 2 the well casing mounted within the well bore in the customary manner. The drilling apparatus, generally designated by numeral 3, comprises the hydraulic rotary motor 4, a hydraulic expansion wall scraper or rotary underreamer 5, and a standard rotary drilling bit 6.

The motor 4 is shown as a helical gear mechanism which serves as a fluid turbine and is of conventional construction such as the device disclosed in detail in the U. S. patent to Moineau No. 2,028,407. The motor is directly connected to and rotates the wall scraper 5 and drilling bit 6. A weight member 7 is provided at the upper end of the motor and is slidably connected to the motor. The slidable connection comprises a key and slot arrangement in which the keys 9, 9 are carried by the upper end of the motor and are slidable in vertical slots 10, 10 formed in the weight member 7. This arrangement permits the body of motor 4 to move up or down in a vertical direction and prevents it from rotating in a horizontal plane.

Located between the weight member 7 and the motor 4 is a packing member, generally designated by numeral 11, adapted to seal off the space between the housing 4A of the motor and the inside of well casing 2. The packing member serves to close the annular space 12 between the drilling apparatus and the well casing when the weight of weight member 7 is applied to the packing member as illustrated in Figure 2. When packing member 11 is set by weight member 7 as shown in Figure 2 and fluid under pressure is pumped into casing 2, the packer will divert the fluid from the casing into the hydraulic motor 4 through openings 13 in the weight member 7.

The weight member 7 comprises a hollow cylinder which serves to set the packing member 11 and to prevent motor 4 from spinning when the torque developed is applied to the rotary bit and the underreamer which are directly connected to the motor. A steel cable 14 is attached to the upper end of the weight member for the purpose of removing the drilling apparatus from the well bore when the underreamer 5 or bit 6 must be replaced.

The packing member 11 is of standard construction and is provided with a valve 16 at its upper end and ports 17 at its lower end. When the drilling apparatus is being run into or pulled from the well casing by cable 14, valve 16 is in an open position as illustrated in Figure 1 allowing fluid to by-pass packing member 11 through valve 16 and ports 17.

A flanged portion 18 is provided at the lower end of the weight member and coacts with members 9, 9 to prevent complete separation of the weight member and the motor. This construction together with the sliding arrangement previously described affords a jarring action which can be utilized in freeing the bit or drilling apparatus in the event of its sticking in the well bore, the jarring action being obtained by reciprocation of the steel cable 14.

The lower end of the motor housing 4A is slidably connected to packing member 11 by a key and slot arrangement in which the keys 19, 19 are carried by the lower portion of the body member and are slidable in vertical slots 20, 20 formed in the packing member 11. The lower end of the casing is provided with a stop 21 with which keys 22, 22 on the packing member cooperate to prevent the packing member from passing through the lower end of the casing. Keys 22, 22 engage vertical slots 23, 23 in the casing to prevent rotation of the packing member 11 relative to the casing. It will be noted that keys 22, 22, 19, 19, and 9, 9 together with their corresponding slots allow vertical movement of the drilling apparatus relative to the casing, but effectively prevent rotary motion of the motor, motor body member, and packing member relative to the casing.

Suitably attached to the rotor of motor 4 is the hydraulic expansion wall scraper or rotary underreamer 5. Any standard type having blades 24, 24 which are extended into cutting position, as shown, when hydraulic pressure is applied, is satisfactory. The purpose of this underreamer is to enlarge the bore hole made by the bit 6 so the well casing may be lowered. Operating fluid discharged from motor 4 through ports 25, 25 enters the underreamer through ports 26, 26 to expand the blades of the underreamer and wash away cuttings from the underreamer and from bit 6. When the drilling apparatus is to be withdrawn from the well by cable 14, fluid is bypassed through packing member 11 as previously described. Interruption of fluid supply to scraper 5 allows the blades 24 to retract into the body of the underreamer 5. The bit 6 and the underreamer, in the closed position, easily pass within the well casing and may be withdrawn to the surface. Underreamer 5 is connected to the rotor of motor 4 by a pin 27 or equivalent coupling means and is provided with a bearing 28 having a suitable sealing means 29 to prevent loss of fluid through the bearing.

The bit 6 is a standard rotary type suitable for any type of formation that is to be drilled and is attached to the lower end of the underreamer by a screw threaded connection or equivalent means. The diameter of the bit is slightly less than that of well casing 2 so it will easily pass through the interior of the casing when the drilling apparatus is withdrawn from the well bore for inspection or to change bits.

In operation, fluid under pressure is pumped into the well casing 2 and is diverted into the upper end of the motor 4 through openings 13 by reason of packing member 11. The fluid in passing through the motor causes rotation of the rotor which in turn drives bit 6 and underreamer 5 causing them to penetrate the strata to be drilled. The fluid, discharged under lower pressure at the lower end of the motor through ports 25, 25 forces the blades 24, 24 into an extended and cutting position and also washes the cuttings from the blades and from the bit 6. This fluid, after washing the bit 6, is forced back through the annular space 30, outside of the well casing, to the surface and may be recirculated as described. Drilling is carried on in this manner until the keys 9, 9 reach the lower end of slots 10, 10 as illustrated in Figure 1. The well casing is then advanced to the position illustrated in Figure 2 and the drilling continues.

Thus it will be seen that the construction herein shown and described is well adapted to accomplish the objects of the present invention. It will be understood, however, that the invention may be embodied otherwise than here shown, and that in the form illustrated certain obvious changes in construction may be made. Therefore, we do not wish to be limited precisely to the construction herein shown except as may be required by the appended claims considered with reference to the prior art.

Having thus described the invention, what is claimed is:

1. In combination with a well casing, a drilling apparatus comprising a drilling bit, a rotary fluid motor for operating the bit, a slidable connection between the motor and the well casing permitting vertical movement only of the motor with respect to the well casing, a weight member mounted at the upper end of the motor, a slidable connection between the weight member and the motor permitting vertical movement only of the motor with respect to the weight member, and fluid conducting means for supplying fluid under pressure to the motor.

2. In combination with a well casing, a drilling apparatus comprising a drilling bit, a rotary fluid motor for operating the bit, a slidable connection between the motor and the well casing permitting vertical movement only of the motor with respect to the well casing, a weight member mounted at the upper end of the motor, a slidable connection between the weight member and the motor permitting vertical movement only of the motor with respect to the weight member, and means for supplying fluid under pressure to the motor through the well casing.

3. In combination with a well casing, a drilling apparatus comprising a drill, a rotary hydraulic motor for operating the drill, a hollow weight member mounted at the upper end of the motor, a slidable connection between the weight member and the motor permitting vertical movement only of the motor with respect to the weight member, and means for introducing fluid under pressure into the motor.

4. In combination with a well casing, a drilling apparatus comprising a drill, a rotary hydraulic motor for operating the drill, a hollow weight member mounted at the upper end of the motor, a slidable connection between the weight member and the motor permitting vertical movement only of the motor with respect to the weight member, and means for sealing off the space between the well casing and the motor whereby fluid pressure introduced into the well casing will be diverted into the motor through the hollow weight member.

5. In combination with a well casing, a drilling

apparatus comprising a rotary bit, a rotary underreamer attached to the bit, a rotary hydraulic motor for operating the bit and underreamer, a hollow weight member mounted at the upper end of the motor, a slidable connection between the weight member and the motor permitting vertical movement only of the motor with respect to the weight member, and means for sealing off the space between the well casing and the motor whereby fluid pressure introduced into the well casing will be diverted into the motor through the hollow weight member.

6. In combination with a well casing, a drilling apparatus comprising a rotary bit, a rotary hydraulic expansion underreamer, a rotary hydraulic motor for operating the bit and underreamer, a hollow weight member mounted at the upper end of the motor, a slidable connection between the weight member and the motor permitting vertical movement only of the motor with respect to the weight member, and means for sealing off the space between the well casing and the motor whereby fluid pressure introduced into the well casing will be diverted into the motor through the hollow weight member.

7. In combination with a well casing, a drilling apparatus comprising a rotary bit, a rotary hydraulic motor for operating the bit, a packing member for sealing off the space between the well casing and the motor, a weight member mounted on the packing member, a slidable connection between the motor and the weight member permitting vertical movement only of the motor with respect to the weight member, and a slidable connection between the packing member and the well casing to prevent rotation of the well casing with respect to the packing member.

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