

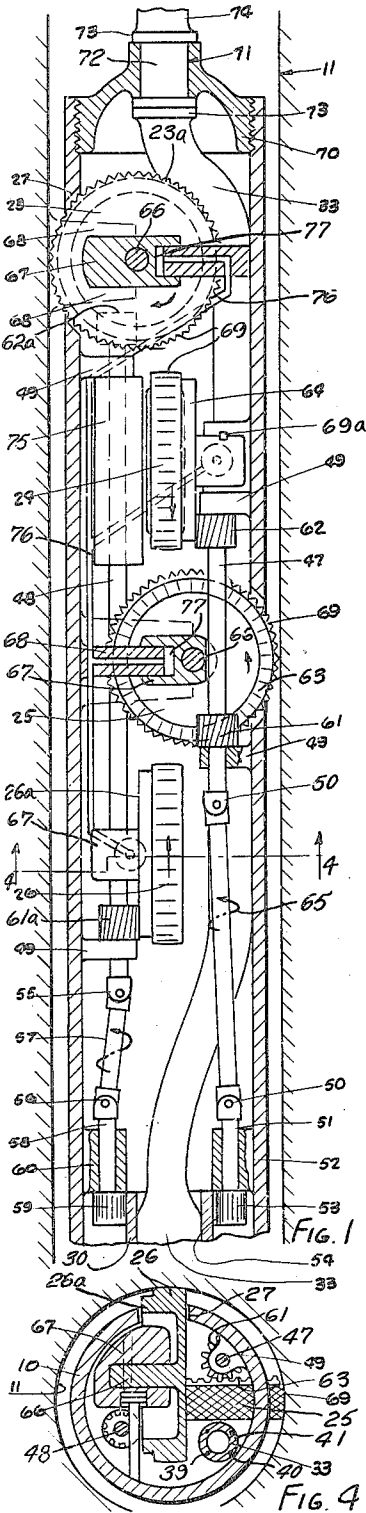
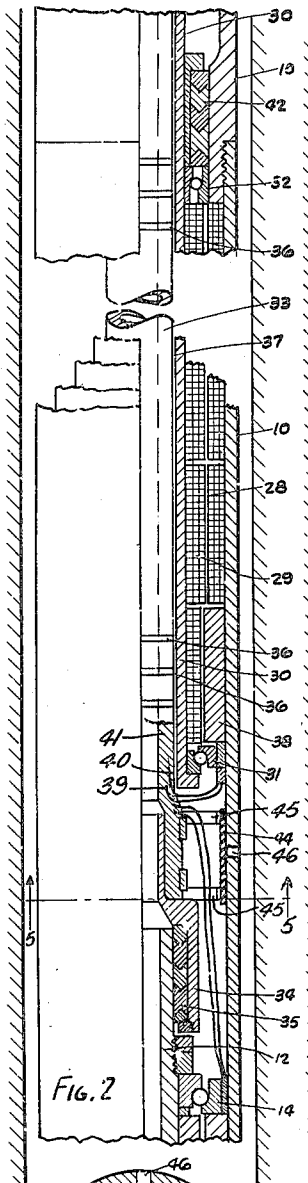
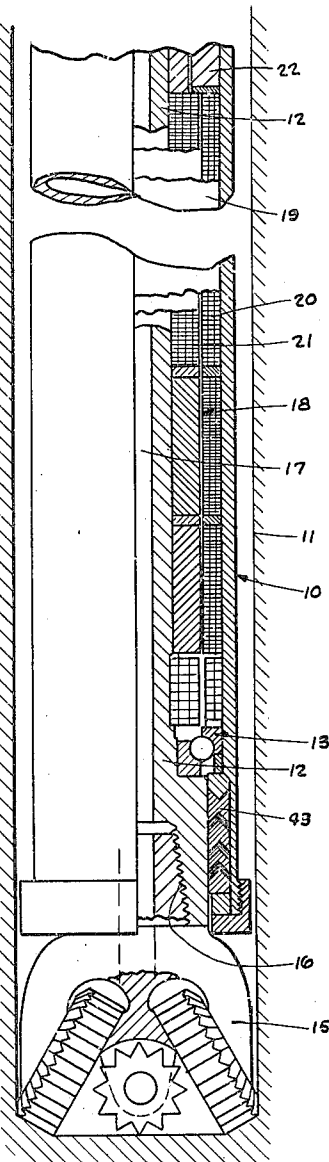
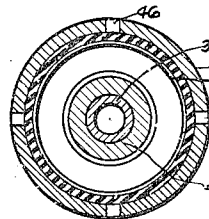
Sept. 6, 1949.

R. J. GILL

2,481,009

WELL DRILLING APPARATUS

Filed Jan. 14, 1946



ROBERT J. GILL Inventor

FIG. 5

By *Lyon & Lyon*

Attorney

UNITED STATES PATENT OFFICE

2,481,009

WELL-DRILLING APPARATUS

Robert J Gill, Los Angeles, Calif.

Application January 14, 1946, Serial No. 641,118

1 Claim. (Cl. 255-4.8)

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This invention relates to well drilling apparatus and is particularly directed to a rotary boring device adapted to be lowered into a well hole. In conventional rotary drilling equipment, it is the practice to employ a string of drill pipe for turning a bit at the bottom of the hole. Power for rotating the drill string and the bit is furnished by apparatus located at the top of the well. In the drilling of deep wells, much of the power imparted to the rotating equipment at the surface is lost before it reaches the bit since the friction between the rotating drill string and the well casing or between the rotating drill string and the well hole absorbs large amounts of power. Furthermore, the conventional drill string on a deep well requires high capacity surface equipment for hoisting the drill string out of the hole when it is necessary to change the bit. Indeed, on deep wells it has been found from experience that more time is consumed in hoisting the drill pipe out of the well and re-inserting it after replacement of the bit than is spent with the bit operating "on bottom."

It is, therefore, the principal object of my invention to remedy these difficulties inherent in the conventional rotary drilling system and to provide a device which may be lowered into a well hole as a unit and in which the power for rotating the bit is derived from a source near the bottom of the hole.

Another object of this invention is to provide well boring apparatus in which the power means for rotating the bit is located in the well bore adjacent to the bit and wherein additional means are provided for applying axial pressure to the bit.

Another object is to provide a device of this type which employs a feed down mechanism which is adapted to engage the side wall of the well hole.

Another object is to provide a well boring device which may be lowered into a well hole as a unit and which embodies independent power means for rotating the bit and for driving a feed down mechanism.

Other objects and advantages will appear hereinafter.

In the drawings:

Figures 1, 2, and 3 show longitudinal views, partly in section, of adjoining portions of a preferred embodiment of my invention. The views are separated into three figures for purpose of illustration.

Figure 4 is a transverse sectional view taken

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substantially on the line 4-4 as shown in Figure 1.

Figure 5 is a transverse sectional view taken substantially on the line 5-5 as shown in Figure 2.

Referring to the drawings, a housing generally designated 10 is adapted to be lowered into a well bore 11. In the lower end of the housing 10 and mounted co-axially thereof is a spindle 12 rotatably mounted upon bearings 13 and 14 which are adapted to absorb both radial and thrust loads. A conventional well drilling bit 15 is removably secured to the lower end of the spindle 12 by means of threads 16. The spindle 12 has an axial passage 17 for conveying a fluid to the bit 15. This fluid serves to cool the bit 15 as well as to carry the cuttings from the bit upwardly through the well hole 11 to the surface. Means within the housing 10 are provided for rotating the bit 15, and as shown in the drawings this means includes the high speed electric motor 18 mounted in the annulus 19 between the housing 10 and the spindle 12. The motor 18 is relatively long and relatively small in diameter but otherwise may be of conventional construction and may include the usual field windings 20, the armature 21, and the commutator assembly 22.

Means are provided for absorbing the torque reaction of the motor 18 for preventing rotation of the housing 10. As shown in the drawings, this means includes a plurality of feed wheels 23, 24, 25 and 26 which are adapted to project outwardly through openings 27 in the housing 10 to engage the side wall of the well hole 11.

A relatively slow speed electric motor 28 which is similar in many respects to the high speed motor 18 is mounted within the housing 10 above the motor 18. The armature 29 of this slow speed motor 28 is secured to a hollow shaft 30 which extends axially of the housing 10. Radial-thrust bearings 31 and 32 are provided for rotatably supporting the hollow shaft 30 within the housing 10. A conduit 33 extends axially through the hollow shaft 30 and is connected at its lower end to a coupling 34. The lower end of the coupling 34 encircles the upper end of the spindle 12 to define a packing annulus for the packing assembly 35. This packing assembly 35 forms a rotary seal between the rotatable spindle 12 and the non-rotatable conduit 33. Sealing means are also provided between the hollow shaft 30 and the conduit 33, and, as shown, this means includes a plurality of resilient collars 36 formed integrally with the conduit 33 and extending radially outwardly to

contact the bore 37 of the hollow shaft 30. The commutator assembly 22 for the high speed motor 18, as well as the commutator assembly 38 of the slow speed motor 28, are connected to electrical leads 39 and 40. These electrical leads 39 and 40 are embedded within the wall 41 of the conduit 33 and emerge from the conduit 33 at the lower end thereof for connection to the said commutator assemblies.

Positioned above the bearing 32 and mounted in the annulus between the housing 10 and the hollow shaft 30 is a packing assembly 42. Similarly a packing assembly 43 is positioned at the lower end of the housing 10 between the housing and spindle 12. It will be noted that the motors 18 and 28 are mounted between the packing assemblies 42 and 43 and, therefore, operate in an oil bath enclosure which is sealed against entrance of foreign matter. In order to equalize the pressure of the fluid within the well hole 11 with the oil within the enclosure occupied by the motors 18 and 28, a cylindrical membrane 44 is mounted within the housing 10 and is secured therein by means of axially spaced bands 45. Intermediate the length of this membrane 44 is located a series of ports 46 in the wall of the housing 10. Pressure from the well hole acts against the flexible membrane 44 to equalize the pressure on the interior and exterior of the housing 10, thereby minimizing the flow of well fluid inwards through the packing assemblies 42 and 43.

Means are provided for rotating the feed wheels 23, 24, 25, and 26 and for projecting them laterally into engagement with the side wall of the well hole 11. As shown in the drawings, this means includes a pair of drive shafts 47 and 48 which are rotatably mounted within the housing 10 by means of bearings 49. The shaft 47 is driven through universal joints 50 from a stub shaft 51 mounted in bearings 52. A gear 53 on the shaft 51 carried by the bearing 52 is adapted to mesh with a gear 54 fixed on the upper end of the hollow shaft 30. Similarly the drive shaft 48 is driven through universal joints 55 and 56 and the intermediate shaft 57. The gear 59 is secured on the stub shaft 58 which is carried in the bearing 60. Secured on the drive shaft 47 are pinions 61 and 62 adapted to mesh with the gear rings 63 and 64 formed on the feed wheels 25 and 24, respectively. The shape of the gear teeth provided on the pinions 61, 61a, 62 and 62a and the ring gears 63, 26a, 64 and 23a respectively is such that the meshing action between each pinion and its respective ring gear operates with best efficiency when the feed wheels are in the wall engaging position. Sufficient clearance is provided between the individual teeth of the pinion and the teeth of the ring gear to permit satisfactory operation regardless of the lateral position of the feed wheel. Thus, rotation of the drive shaft 47 in the direction indicated by the arrow 65 serves first to move the feed wheels 25 and 24 laterally outwardly into wall engaging position. Continued rotation of the shaft 47 and pinions 61 and 62 then serves to rotate the feed wheels 25 and 24 since further outward lateral movement is prevented by the contact between the periphery 69 of the feed wheels and the side wall of the well hole 11. Each of the feed wheels is provided with a central trunnion 66 rotatably mounted in a carrier 67. The carrier 67 is slidably mounted between the stationary projecting arms 68 fixed to the casing 10. A key 69a is provided between arm 68 and the carrier 67. Pump

75 driven by shaft 48 delivers fluid under pressure through piping 76 to a pressure chamber 77 in each of the carriers 67 to assist in advancing each of the feed wheels toward the wall of hole 11. The periphery 69 of the feed wheels may be notched, as shown, for development of maximum tractive effort against the side wall of the well hole 11. It will be noted from the consideration of Figure 1 that the feed wheels 23, 24, 25 and 26 extend radially outwardly in four directions, thereby maintaining the housing 10 co-axial of the well hole 11. It will be understood that a greater or lesser number of feed wheels may be employed if desired.

The conduit 33 emerges from the upper end of the hollow shaft 30 and is reduced in diameter for that portion of its length between the hollow shaft 30 and the supporting collar 70 at the upper end of the housing 10. The supporting collar 70 has a central cylindrical portion 71 encircling a portion 72 of the conduit 33. Collars 73 are provided on the conduit 33 both above and below the cylindrical section 71 to provide a securing means between the conduit 33 and the housing 10.

In operation, the device is lowered into the well hole 11 as a unit suspended on the lower end of a hose 74. This hose is attached integrally to the conduit 33 of the cylindrical section 72. The hose 74 carries a coolant to the bit 15 by way of the conduit 33 and the axial passageway 17 and the spindle 12. When the bit 15 comes to rest on bottom, fluid is delivered through the hose 74 and electrical energy is transmitted to the motors 18 and 28 through the electrical leads 39 and 40 embedded in the wall of the hose 74 and conduit 33. Control means (not shown) are provided at the surface for varying the speed of rotation of the motors. Rotation of the slow speed motor 28 serves to advance each of the feed wheels 23, 24, 25 and 26 outwardly into engagement with the side wall of the well hole 11 and to rotate the feed wheels for applying axial pressure to the bit 15. The speed of rotation of the motors 18 and 28 is independently variable so that the speed of the bit rotation and the speed of movement of the feed wheels are not inter-dependent but may be varied to meet changing drilling conditions.

When the bit 15 has become dull and it is necessary to replace it, the slow speed motor 28 is reversed in order to retract the feed wheels inwardly away from the side wall of the well hole 11. The device is then withdrawn from the well hole 11 as a unit by means of the hose 74. This hose may be sectional in character and provided with couplings, not shown, at intervals throughout its length. These couplings are disengaged at the surface as the hose 74 is withdrawn from the well hole. Since no drill pipe is employed, the total weight of the assembly being withdrawn from the well hole is relatively small and hence the withdrawal of the entire unit for bit replacement may be speedily accomplished without employing the conventional heavy duty hoisting machinery.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth, but my invention is of the full scope of the appended claim.

I claim:

In a well boring device, the combination of a housing adapted to be lowered into a well bore, the housing having a plurality of circumferentially spaced windows; a spindle rotatably mounted coaxially of the housing and extending through

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the lower end thereof; means preventing relative axial movement of the spindle and housing; a bit fixed on the lower end of the spindle; power means in the housing adapted to rotate the spindle and bit; means for preventing contra-rotation of the housing, said means including a plurality of rotatable feed wheels aligned with said housing windows; bearing means for said feed wheels slidably mounted within the housing; power means for moving the bearing means to advance the feed wheels outwardly through said windows into engagement with the side wall of the well bore; and means in the housing for turning the rotatable feed wheels in side wall contacting position to apply axial pressure to said bit.

ROBERT J. GILL.

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