United States Patent

[11] 3,598,189

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[21] Appl. No. **838,903**
[22] Filed **July 3, 1969**
[45] Patented **Aug. 10, 1971**

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[54] RAISE DRILLING MACHINE

9 Claims, 4 Drawing Figs.

[52] U.S. Cl. 175/53, 173/44, 173/163
[51] Int. Cl. E21b 3/02
[50] Field of Search 173/57, 147, 43, 44; 175/53, 85, 122, 170

[56] **References Cited**

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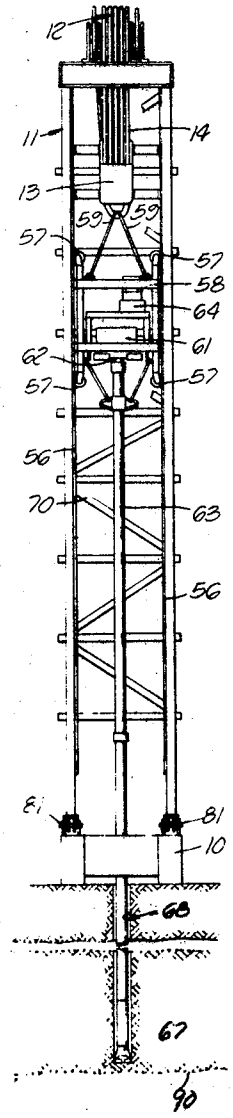
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Primary Examiner—Ernest R. Purser
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ABSTRACT: A rotary drilling rig employs a drill string suspended and rotated by a power head guided for longitudinal movement within a mast mounted on a base. A power-driven spooling drum receives a cable which passes between a crown block on the mast and a travelling block supporting the power head. The mast is proportioned to absorb the reaction torque of the power head and to transmit it to the base. A first bit on the lower end of the rotary drill string forms a pilot hole in the earth as the drill string descends by gravity under control of a brake on the spooling drum as it unspools the cable. The pilot hole intersects a shaft in the earth, where a larger bit is installed on the lower of the drill string, to cut upwardly. Torque is then applied to the drum to turn it at a speed between a stalled condition and very low r.p.m. to keep a tension on the cable, thereby applying a lifting force to the rotary drill string and larger bit to enlarge the pilot hole from the bottom up.



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SHEET 1 OF 2

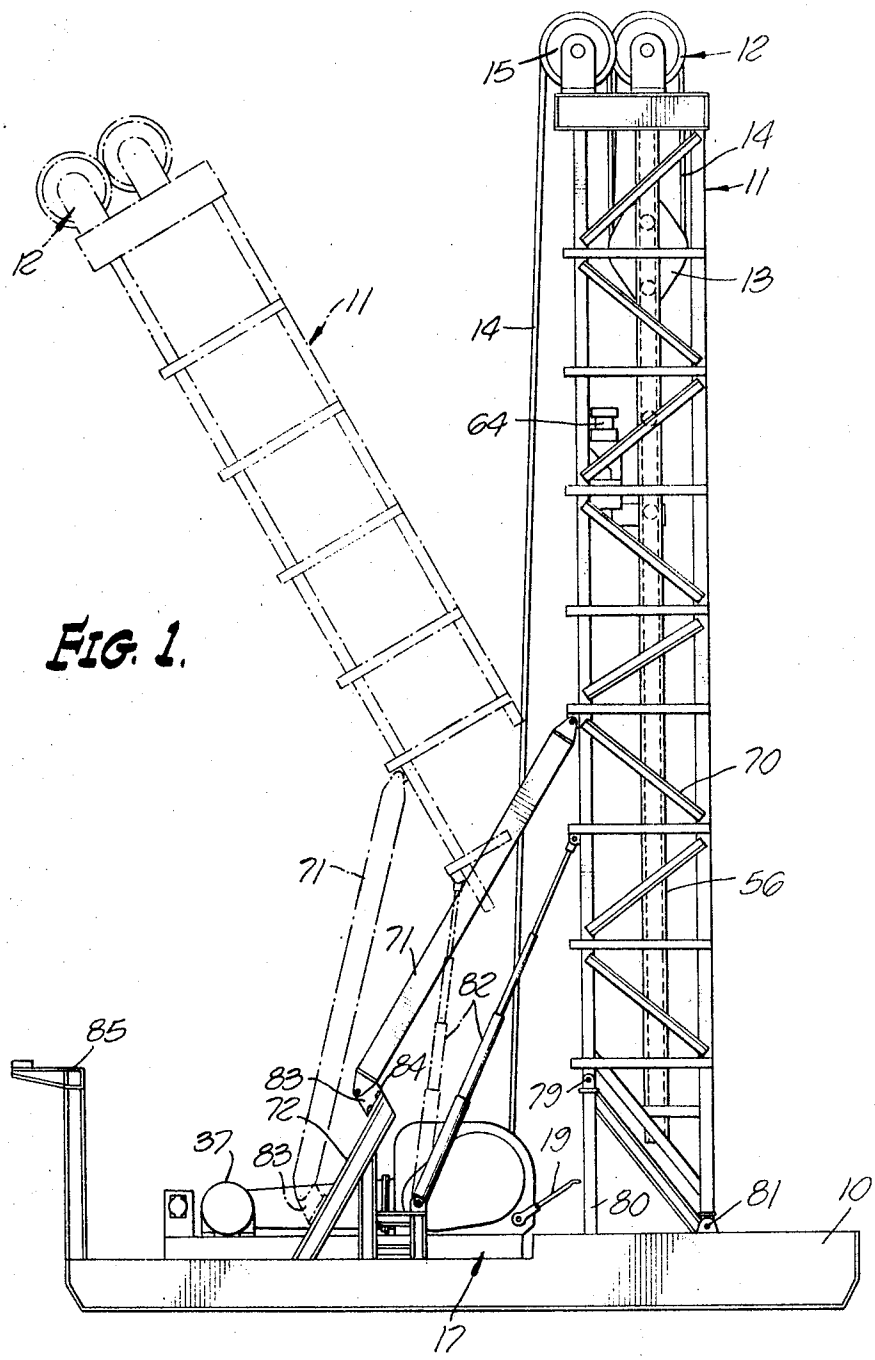
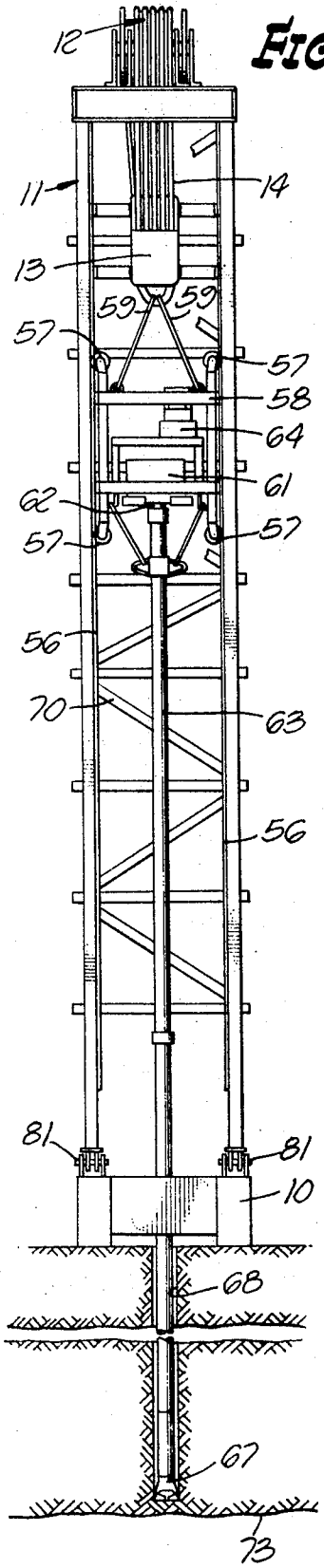


FIG. 1.

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FIG. 2.



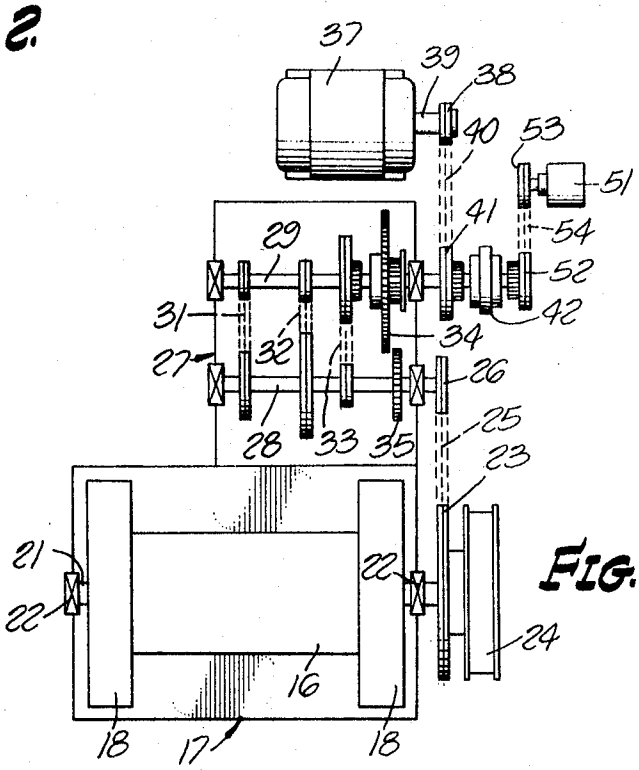


FIG. 4.

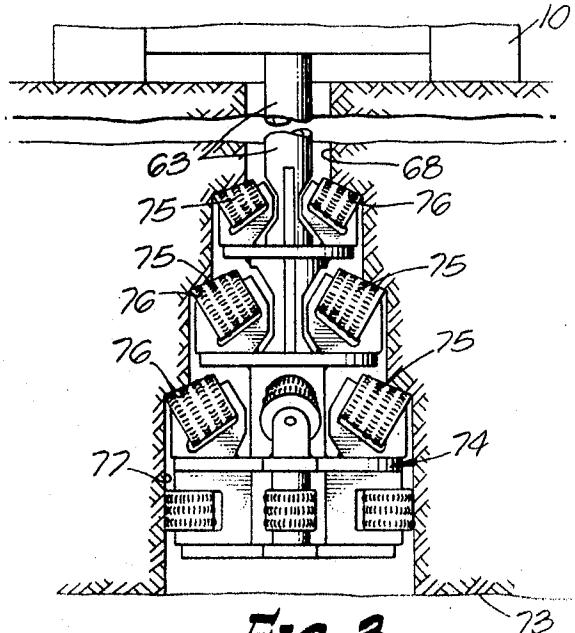


FIG. 3.

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RAISE DRILLING MACHINE

This invention relates to raise drilling and is particularly directed to improved apparatus for drilling a pilot hole in the earth into an existing mine shaft or the like and then using the same apparatus to enlarge the pilot hole from the bottom up. Raise drilling apparatus of this general type is disclosed in the Cannon et al. U.S. Pat. No. 3,220,494 494 and in the Winberg U.S. Pat. No. 3,231, 029. However, the devices disclosed in these patents apply hydraulically operated rams for raising and lowering the rotary drill string, with the result that the length of the operating stroke is limited by the effective length of the rams. It is an object of this invention to employ apparatus of the general type used in the drilling of wells by the rotary method, wherein a derrick or mast supports the drill string by means of a crown block and travelling block having a cable rove between them, the cable being spooled on a power-driven drum. A much longer stroke, as determined by the height of the mast, is thus obtained, and much greater drilling depths are made possible.

Other and more detailed objects and advantages will appear hereinafter.

In the Drawings:

FIG. 1 is a side elevation showing a preferred form of this invention.

FIG. 2 is an end elevation of the device shown in FIG. 1.

FIG. 3 is a sectional view on an enlarged scale, showing the upward-acting bit in place on the lower end of the drill string for enlarging the previously formed pilot hole.

FIG. 4 is a plan view in diagrammatic form, showing the spooling drum and the power means for turning it.

Referring to the drawings, the base 10 supports a mast 11 having a crown block 12 at its upper end. A travelling block 13 within the mast 11 is suspended from the crown block 12 by means of a cable 14 rove between the blocks and extending downward from the sheave 15 to the spooling drum 16, forming a part of the hoist assembly 17. Friction brake rims 18 of conventional form are contacted by conventional brake bands, not shown, operated by the manual brake lever 19. The drum shaft 21 is supported on axially spaced bearings 22. Power to rotate the drum shaft and spooling drum is supplied through sprocket 23 and air-operated clutch 24. An endless chain 25 drives the sprocket 23 from the driving sprocket 26.

A change speed transmission, generally designated 27 and of conventional form, includes a driven shaft 28 to which the sprocket 26 is affixed, and a driving shaft 29. Each shaft is supported in spaced bearings. Chain and sprocket drives 31, 32 and 33, each provided with a clutch, provide means for driving the shaft 28 at any one of three different speeds and for a given speed of the driving shaft 29. In addition, gears 34 and 35 afford a means of driving the shaft 28 in a reverse direction, by lateral shifting of the gear 34 to bring it into mesh with the gear 35.

A prime mover 37 has a sprocket 38 fixed to its power shaft 39 and arranged to drive by a chain 40 a sprocket 41 loose on the shaft 29. A clutch 42 is shiftable laterally in one direction to connect the sprocket 41 in driving relation with the shaft 29. The sprockets 38 and 41 are used for turning the spooling drum 16 at substantial speeds for hoisting operations. The prime mover 37 may take the form of a direct current motor of about 350 horsepower and variable speed. A much smaller motor 51 may comprise an alternating current slip clutch motor of 30 horsepower. This variable speed motor 51 drives the sprocket 52 through sprocket 53 and chain 54. The sprocket 52 is clutch connected to the shaft 29 by lateral shifting of the clutch 42.

From this description, it will be understood that there are two power paths to the transmission shaft 29: (a) From large motor 37 through sprocket 38, chain 40 and sprocket 41, and (b) From small motor 51 through sprocket 53, chain 54 and sprocket 52. The first of these power paths through chain 40 is a high-speed drive for hoisting operations, and the second power path through chain 54 is a low speed drive for supplying torque to the spooling drum 16 at speeds varying from a stalled position to very low r.p.m. to tension the cable 14 for a continuous upward drilling process.

Parallel tracks 56 are fixed to the upright elements of the mast 11. These are engaged by rollers 57 mounted on a carriage 58 suspended by members 59 from the travelling block 13. A power head 61 is mounted on the carriage 58 and is connected in supporting and driving relationship at 62 to the upper end of the sectional drill string 63. The drill string 63 is thus suspended and rotated by means of the power head 61. A variable speed electric motor 64 is connected to drive the power head 61. This motor 64 may be an alternating current slip clutch motor or a direct current motor.

In operation, a first bit 67 of conventional design is installed in the lower end of the section drill string 63. The drill string 63 is rotated by means of the power head 61 as it is lowered by gravity. The brake lever 19 is manipulated to allow the spooling drum 16 to turn under tension in the cable 14. Drilling mud or air may be circulated downward through the interior of the hollow drill string 63 to emerge through holes in the bit 67 and return upward through the pilot hole 68 being drilled in the earth. The rotary swivel for introducing the mud or air into the drill stream, and the apparatus for receiving the mud and cuttings from the pilot hole 68, are both conventional and are omitted from the drawings. The torque reaction from the power head 61 is applied to the carriage 58 and then through the rollers 57 and track 56 to the mast 11. The mast is of heavy construction, closed on three sides and open on one side, and capable of withstanding a reaction torque of 200,000 foot-pounds when the travelling block is in its highest operating position. The mast includes diagonal braces 70 to absorb the torque transmitted to the base 10. The external braces 71 connected to the A-frame 72 on the base 10 also serve to transfer the twisting moment on the mast 11 to the base 10.

The downward drilling operation proceeds, adding sections to the drill string 63 as required, until the bit 67 breaks into a subterranean shaft such as the mine shaft 73. If the pilot hole 68 is a deep one, or if very hard earth formation material is encountered, it may be necessary to change the bit 67 a number of times before the mine shaft 73 is reached. During the operation of hoisting the drill string 63 section by section, in order to replace the bit 67 at the surface, the hoisting drives through chain 40 from the prime mover 37 are employed.

After the bit 67 has broken through into the mine shaft 73, it is removed from the lower end of the drill string and a larger bit 74 is installed on the lower end of the drill string 63 by workmen in the mine shaft 73. This bit 74 employs cutting rollers 75 which engage all of the frustoconical surfaces 76 formed between the pilot hole 68 and the enlarged hole 77. As the drill string 63 is rotated by the power head 61 to turn the upward acting bit 74, the cable 14 is tensioned by applying a torque to the spooling drum 16 through the variable speed electric motor 51, chain 54, shaft 29 and through the low-speed drive 31 to the shaft 28. The air clutch 24 is closed so that the sprocket 23 drives the drum shaft 21 and spooling drum 16. This power path applies torque to the drum 16 to tension the cable but turns the drum at speeds varying from a stalled position to very low r.p.m. and under close speed control. The pilot hole 68 is thus enlarged from the bottom up.

The raise drilling device may also be used for drilling a hole at an angle. Thus, as shown by the phantom lines in FIG. 1, the mast 11 may be tilted around the pivot pins 79 (see FIG. 1) positioned at the upper ends of the parallel posts 80 fixed to the base 10, after removal of the connecting pins 81. This tilting movement of the mast may be accomplished by means of the pair of extensible hydraulic rams 82. The shoes 83 at the lower end of each of the angular external braces or struts 71 slide to a new position on the A-frame 72 and are fixed in such new position by means of bolts 84.

For purposes of transport, the mast 11 may be lowered about the pivot pins 79 to engage the headrest 85 fixed on the base 10. The rams 82 are employed for lowering the mast 11 into engagement with the headrest 85, as well as for returning it to drilling position, either vertical or inclined.

We claim:

1. In a raise drilling rig for enlarging a hole in the earth by means of an upward cutting bit, the combination of: a base, a mast mounted on the base, a crown block on the mast, a travelling block within the mast, a cable rove between the blocks, a carriage suspended from the travelling block, means on the mast guiding the carriage for movement longitudinally of the mast, a drill string extending into the hole and carrying the upward cutting bit at its lower end, means including a power head on the carriage for suspending the drill string and for rotating it, the mast being proportioned to absorb the reaction torque of the power head as applied to the carriage and to transmit it to said base, a spooling drum on the base for winding said cable, and variable speed power means on the base for applying torque to the spooling drum at zero to very low r.p.m. to tension the cable, whereby the drill string may be simultaneously rotated and pulled upward to enlarge the hole.

2. The combination set forth in claim 1 in which the mast is mounted for angular adjustment on the base, for inclined drilling.

3. The combination set forth in claim 1 in which said guide means comprises a track within the mast engaged by rollers on the carriage.

4. The combination set forth in claim 1 in which the variable speed power means includes an alternating current slip clutch motor.

5. The combination set forth in claim 4 in which the power head also includes an alternating current slip clutch motor.

6. In a rotary rig for raise drilling, the combination of: a base, a mast mounted on the base, a crown block on the mast, a travelling block within the mast, a cable rove between the blocks, a carriage suspended from the travelling block, means on the mast guiding the carriage for movement longitudinally of the mast, a drill string extending below the base, means including a power head on the carriage for suspending the drill string and for rotating it, the mast being proportioned to absorb the reaction torque of the power head as applied to the carriage and to transmit it to said base, a spooling drum on the base for winding said cable, power means on the base for driving the drum, said power means including a prime mover and high-capacity transmission connections operatively connecting the prime mover to drive the drum for hoisting the drill string, said power means also including means for applying torque to the drum from a stalled position to a very low r.p.m. for raise drilling, and brake means for impeding rotation of the drum, whereby the drill string may be rotated and permitted to descend by gravity to form a hole in the earth when the drill string is supplied with downward cutting bit, and whereby the drill string may be rotated and pulled upward to enlarge the hole when the drill string is supplied with an upward cutting bit larger than the first.

7. The combination set forth in claim 6 in which the mast is mounted for angular adjustment on the base, for inclined drilling.

8. The combination set forth in claim 6 in which said guide means comprises a track within the mast engaged by rollers on the carriage.

9. The combination set forth in claim 6 in which the means for applying torque to the drum from a stalled position to a very low r.p.m. comprises an electric motor.