

Jan. 11, 1938.

C. W. MacKAY

2,105,091

WELL DRILLING RIG

Filed April 4, 1936

3 Sheets-Sheet 1

Fig.1.

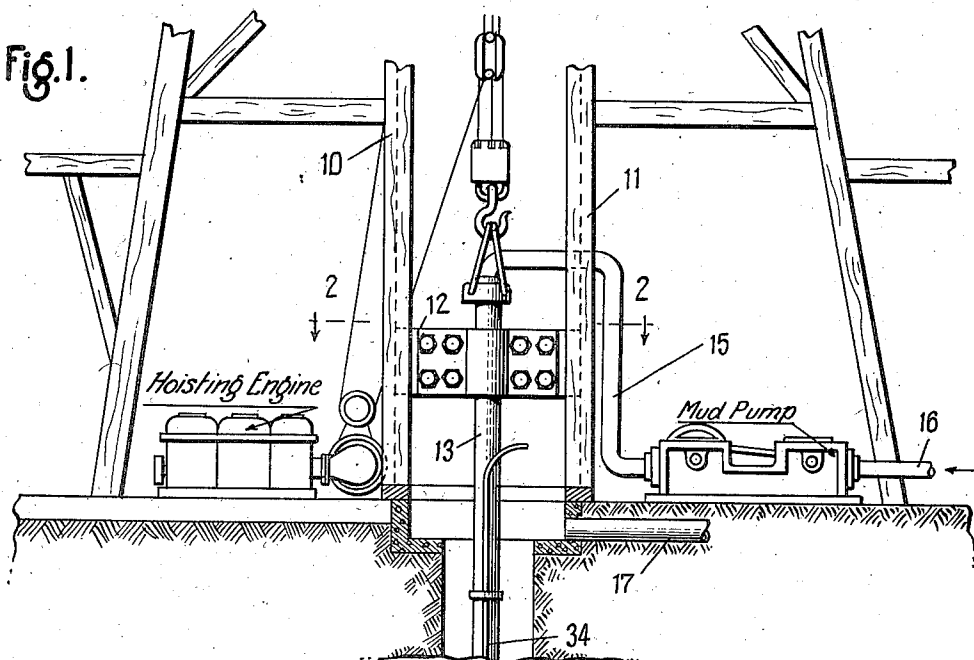
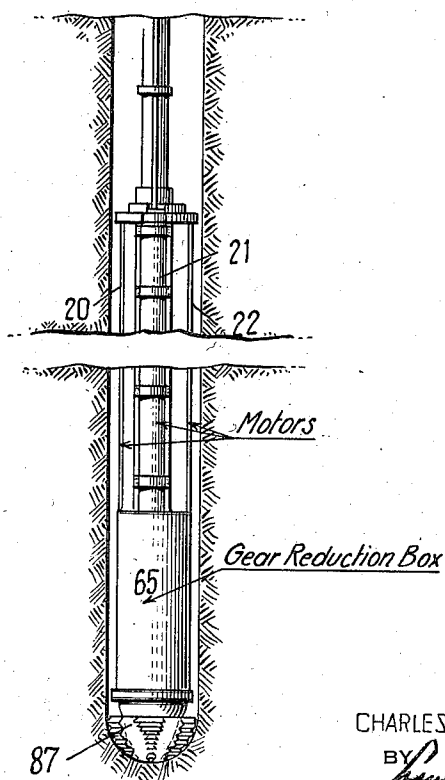
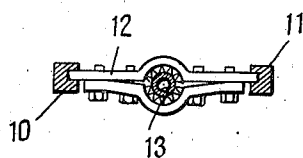


Fig. 2.



INVENTOR
CHARLES W. MACKAY

BY *Richard J. Farney*
ATTORNEY

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C. W. MacKAY

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Fig. 3.

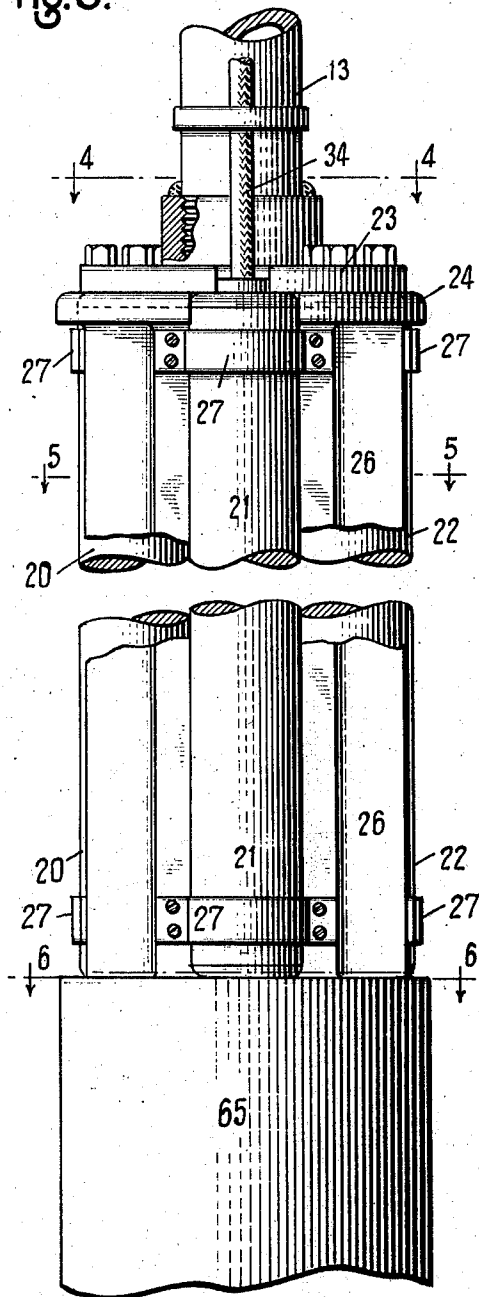


Fig. 4.

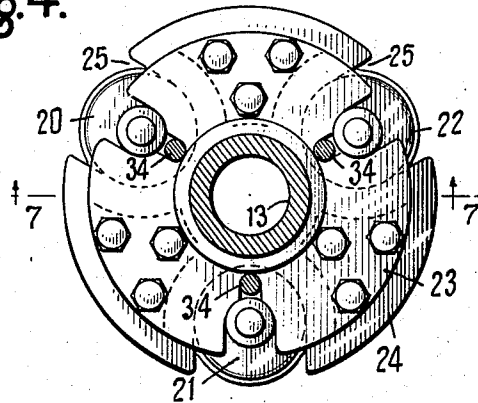


Fig. 5.

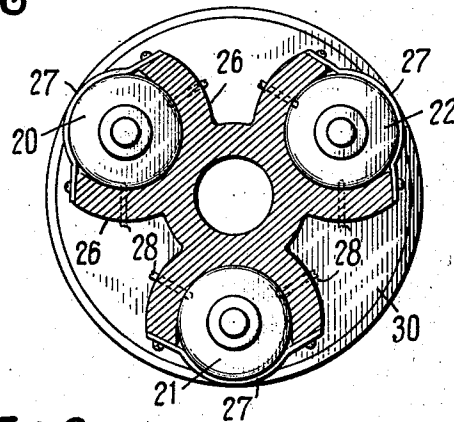
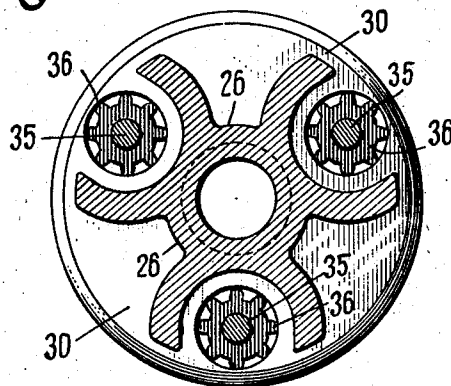


Fig. 6.



INVENTOR
CHARLES W. MACKAY
BY *Samuel A. Janney*
ATTORNEY

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C. W. MacKAY

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Fig. 7.

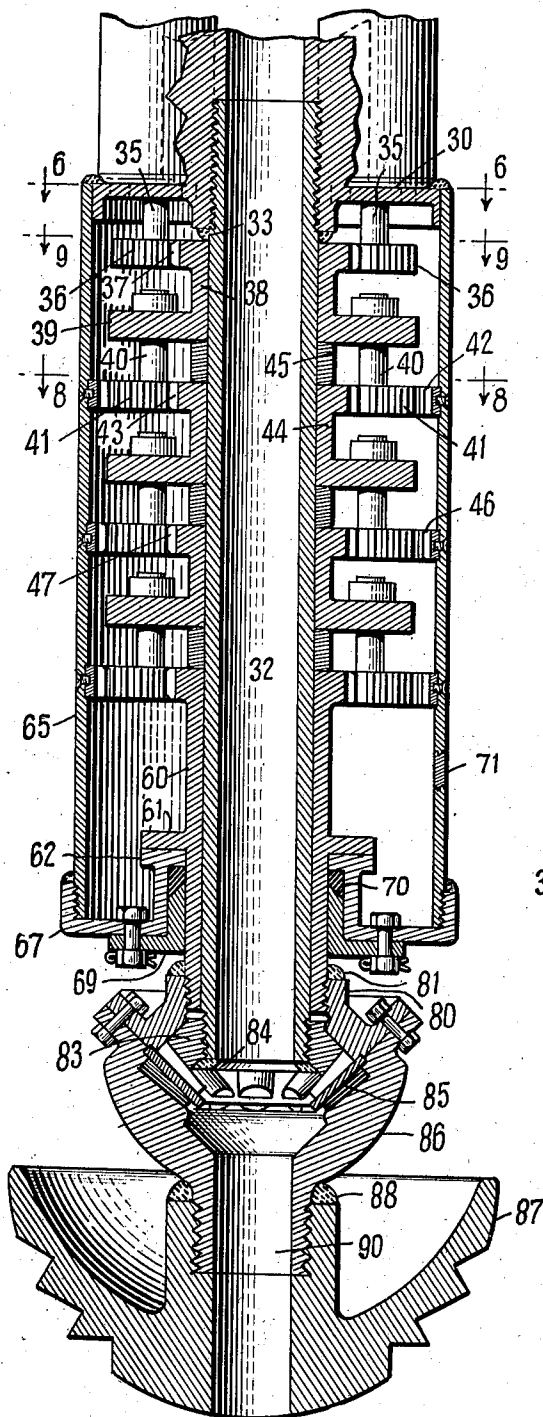


Fig. 8.

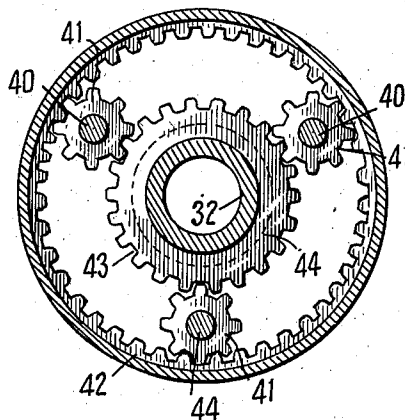
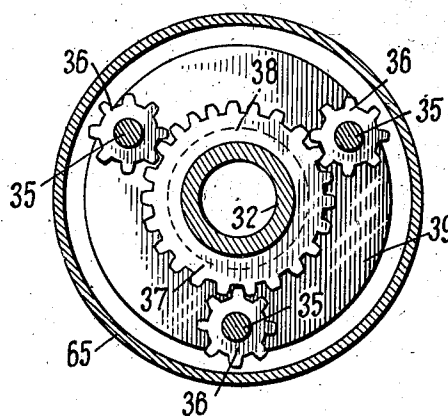


Fig. 9.



INVENTOR
CHARLES W. MACKAY
BY *Harmon A. Perry*
ATTORNEY

UNITED STATES PATENT OFFICE

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WELL DRILLING RIG

Charles W. MacKay, Tulsa, Okla.

Application April 4, 1936, Serial No. 72,766

5 Claims. (Cl. 255—4)

This invention relates to apparatus for drilling oil wells and the like, and more particularly to a mechanical arrangement for locating the power plant for the drilling closely adjacent to the drill itself so that the power plant and the drill progress together into the hole.

I purpose to discard the customary method of sinking a pipe into the hole, with the drilling tool fixed in relation to the bottom extremity of the pipe, and employing the pipe with the function of a shaft for rotating the tool by power applied at the top of the pipe. According to my invention, the pipe is held against rotation and supports the power plant at the bottom of the hole so that the latter may rotate the tool in relation to the non-rotating pipe.

As will appear to those skilled in the art, great advantages are derivable from the use of an embodiment of this invention.

In the drawings, Fig. 1 is a largely diagrammatic section on a vertical plane indicating the drilling apparatus during a boring operation, and some of the more or less conventional operating mechanism on the surface of the ground.

Fig. 2 is a detail section on a horizontal plane on the line 2—2 of Fig. 1.

Fig. 3 is a side elevation of a gang of electric motors mounted on a chassis near the bottom of the well pipe and constituting the power plant for rotating the drilling tool.

Figs. 4, 5, and 6 are horizontal sections on the respective lines 4—4, 5—5, and 6—6 of Fig. 3.

Fig. 7 is a vertical section on the line 7—7 of Fig. 4.

Figs. 8 and 9 are horizontal sections on respective lines 8—8 and 9—9 of Fig. 7.

Referring to Fig. 1, the apparatus at the surface of the ground comprises the vertical timbers 10 and 11 supplying vertical guideways (Fig. 2) for a horizontal crosshead 12, which embraces the top part of the well pipe 13 and holds it against rotation. This may be effected in any practical manner, as by having gripping jaws encircling the well pipe 13, as illustrated in Fig. 2, so that the crosshead 12 and the pipe 13 are held rigidly in fixed relation while vertical movement is permitted, and rotary movement is prohibited, by the engagement of the crosshead 12 in the guideways of the timbers 10 and 11. Hoisting gear 14 is attached to the upper end of the pipe 13 so that the latter is suspended and may be lifted and lowered by the illustrated hoisting engine. The indicated mud pump is connected by the piping 15 to the upper end of the well pipe 13. The intake pipe 16 of the pump communicates

with a sump (not shown) into which the mud overflow passes from the pipe 17, leading from the catch pit at the head of the hole.

The pipe 13, held against rotation as described, extends down into the hole, and near its lower end it supports a power plant which, in the illustrative organization, comprises a plurality of specially adapted electrical motors, each cylindrical in form and elongated on the axis of the rotor, and of small and compact diameter.

Three such motors 20, 21, and 22 are illustrated on an enlarged scale in Figs. 3, 4, and 5. The support for these motors comprises a flange 23 welded on the pipe 13 and bolted to an underlying cap piece 24 shaped as shown in Fig. 4 to provide recesses 25 to receive the upper ends of the respective motor housings. The cap plate 24 is welded to the upper extremity of a chassis 26, shown in horizontal section in Fig. 5, which is preferably a forging having a recessed pocket for each of the motors in which the motor is seated and held by straps 27 attached to the forging, the motor housings being held against rotation, as by set screws 28.

As shown in Fig. 7, the lower end of the chassis 26 is provided with an annular flange 30, upon which rests the lower end of each motor and through which the motor shafts project. Thus the motors are housed, and are confined at the top by the cap plate 24, at the bottom by the flange 30 on the chassis 26; and they are held laterally by the straps 27.

Secured to the lower end of the chassis 26 is a pipe 32 supplying in effect an extension of the bore through the center of the chassis. The upper end of this pipe 32 may be threaded into the chassis, as shown in Figure 7, and then provided with a welded bead 33 for securely integrating the pipe 32 to the chassis 26. The pipe 32 supplies not only a conduit for the down-flow of the drilling mud, as presently described, but also serves as a non-rotating shaft upon which are mounted successive elements of a reducing gear mechanism for reducing the speed from that of the motor shafts to such speed as is desired for the rotation of the drilling tool.

In varying applications of my invention to suit different purposes and conditions, I may select from a wide range of characteristics of current and motor design. As one illustration, under some conditions it would be preferable to employ a three-phase alternating current within the range of 500 to 1000 volts and having a frequency range of 5 to 20 cycles per second. Current of this type could be supplied at the site by

a motor generator set (not shown) receiving on its intake side such commercial current as is available, and delivering on its output side the alternating current of a voltage, phase and frequency appropriate to the particular motor design. One practicable type of motor design would deliver within the range of 300 to 1200 R. P. M., which would be reducible to a tool speed within the range 40 to 100 R. P. M. It is to be understood that the specifications just stated are merely illustrative and there is a considerable range of choice as to the particulars mentioned, within the skill of those experienced in this art. The controlling desideratum is that the selected current and motor design, and the reduction gearing, be determined for the economical consumption of electrical power and a minimum loss of power through reduction gears, eventuating in the application of adequate power to rotate the tool at practical working speeds.

The electrical power is preferably fed to each motor by a separate cable 34 secured by bands or straps to the pipe 13 as indicated in Fig. 1. Each motor shaft 35 has mounted on it a pinion 36 which meshes with a gear 37 formed upon a hub 38 having an annular flange 39. The hub 38 rotates on the non-rotating pipe 32. In the flange 39 are mounted three shafts 40, corresponding respectively to the three motors. Each shaft 40 carries at its lower end a pinion 41. These three pinions 41 have a planetary movement about the axis of the pipe 32. The pinions 41 all mesh with a ring gear 42 fixed upon the interior of the cylindrical shell of this gear mechanism. As presently described, this shell is fixed to the chassis 26 and is therefore non-rotatable. Hence, the ring gear 42 is non-rotatable. The pinions 41 engage not only the fixed ring gear 42 but also the gear 43 on a hub 44 which rotates on the pipes 32. The gear ratios are such that the planetary rotation of the pinions 41 drives the gear 43 at a speed less than the speed of rotation of the gear 37. A floating ring bearing 45 is interposed between the hubs 38 and 44. The hub 44 carries a flange which in turn carries shafts for additional pinions engaging an additional ring gear 46, and meshing with another gear 47 on still another hub and driving the latter at a further reduced speed. Similar units may be multiplied for reducing the speed through any desired range. Finally, the drive rotates a hub 60 having a flange 61, bearing upon a corresponding flange 62, upon a cap-piece 67 which closes the lower end of the shell for the gearing.

This shell consists of a cylinder 65, the upper end of which fits over the depending rim of the flange 30 and is welded thereto so that the shell 65 in effect is suspended from the chassis 26. The cap 67 is threaded on to the lower end of the shell 65 and is spot-welded thereto. Bolted to the cap 67 is a packing keeper 69 providing a packing gland 70. The interior of the shell 65 is to be supplied with grease preferably introduced under pressure through the aperture closed by the plug 71.

The hub 60, which is the final driven element of the described gearing, projects downwardly through the cap 67 and past the packing gland 70, and upon its lower end is threaded a tool-attaching head 80 secured in place by welded bead 81. This head 80 supplies the means of attachment to the driven hub 60 of whatever drilling tool is employed. At the lower end of the non-rotating pipe 32 is threaded a ferrule

83, which is also secured in place by a welded bead 84. The ferrule 83 has an annular oblique face, as indicated in Fig. 7, which bears against the roller thrust bearing 85, which is interposed between the ferrule 83 and the hub 86 which carries the tool. The hub 86 is bolted to the head 80 and rotates with the latter. The lower end of the hub 86 carries the drilling tool 87, which may be threaded onto the hub 86 and secured in place by a welded bead 88. The tool 87, of any desired rotary type, has a sufficient maximum diameter to drill a hole somewhat larger than the maximum diameter of the power plant and gear shell to allow for the upflow of mud and excavated material, around the exterior of the apparatus.

According to conventional practice in the art, the maximum cutting diameter of the drilling tool may be determined by reference to the intention to insert casings into the hole.

The hub 86 and the tool 87 have the axial bore 90 which communicates with the bore of the pipe 32 so that there is in effect a continuous hollow conduit from the top of the pipe 13 through that pipe, the chassis 26, the pipe 32 and thence downward to the lower extremity of the tool 87. As already stated, the mud pump indicated in Fig. 1 forces the mud downwardly through this continuous conduit and outwardly in the vicinity of the tool, whence the mud is forced upwardly, outside the drilling apparatus, and through the drilled hole to the surface of the ground. This forced flow of the mud may perform a particularly important function, in the application of this invention, in that it tends to act as a cooling medium, and to aid in keeping the motors and gearing from overheating. This result is enhanced by the combined downflow of the mud through the axial hollow conduit in direct contact with the metal piping which itself would take up a considerable portion of the heat generated by the motors, and then further by the upward flow of the mud surrounding the apparatus again in direct contact with the exterior of the gear shell and the motor housing.

According to conventional practice well known in the art, there will be provided at some points on the pipe 13, preferably where it is accessible above the surface of the ground, the elements of a measuring and indicating mechanism to show the vertical tensile stress on the pipe 13 to permit proper regulation of the upward pull on the pipe 13 through the hoisting engine, so as to enable the operator to avoid the application of excessive loads on the drilling tool. This subject matter, however, is no part of the present invention and is considered unnecessary to be shown in the drawings.

The illustrative form of the apparatus shown in the drawings may be readily assembled, and disassembled, for repair or replacement of parts. Where welded beads are employed for integrating the different parts, they may be removed by a suitable torch and replaced according to ordinary shop practice.

It is to be understood that the particular embodiment of the invention shown in the drawings and described above is only illustrative; and that the invention may be variously embodied in different forms employing wide variations of mechanical detail.

I claim:

1. A well-drilling apparatus comprising, in combination, a sectional well pipe constructed to extend from the surface of the ground con-

tinuously to the vicinity of the bottom of the hole, and to supply a substantially rigid unit throughout its length, to resist both torque and vertical thrust and to supply a heavy downward thrust to aid in the drilling operation; means at the surface of the ground for holding the well pipe against rotation; means also at the surface of the ground for raising, lowering and suspending the pipe and regulating its downward thrust and the effect thereof on the drilling operation; means also at the surface of the ground for forcing fluid downwardly through the pipe; a plurality of electric motors mounted upon the pipe near its lower extremity, with their rotor axes parallel with each other and with the axis of the pipe, said rotor axes being spaced from the axis of the pipe and disposed with geometric symmetry around the axis of the pipe; a drilling tool rotatably mounted at the lower extremity of the pipe; speed reducing mechanism driven by said motors collectively for rotating the tool at a speed substantially less than the driving speed of the motors; the mounting of the motors upon the pipe providing substantially continuous metal heat conduction from the vicinity of the motor fields to the interior of the well pipe, and the motor casings being at least partially exposed to the external upflow of fluid forced through the lower extremity of the well pipe; the non-rotating well pipe, the motors and their current supply cables, the reduction gearing and the drilling tool comprising an integrated organization extending throughout the length of the hole and movable upwardly and downwardly, through handling at the top of the hole, as a structural unit.

2. A well-drilling apparatus comprising, in combination, a sectional well pipe constructed to extend from the surface of the ground continuously to the vicinity of the bottom of the hole, and constructed to supply a substantially rigid unit throughout its length, to resist both torque and vertical thrust and to supply a heavy downward thrust to aid in the drilling operation; means at the surface of the ground for holding the well pipe against rotation; means also at the surface of the ground for raising, lowering and suspending the pipe and regulating its downward thrust and the effect thereof on the drilling operation; means also at the surface of the ground for forcing fluid downwardly through the pipe; a plurality of electric motors mounted upon the pipe near its lower extremity, with their rotor axes parallel with each other and with the axis of the pipe, said rotor axes being spaced from the axis of the pipe and disposed with geometric symmetry around the axis of the pipe; a drilling tool rotatably mounted at the lower extremity of the pipe; speed reducing mechanism driven by said motors collectively for rotating the tool at a speed substantially less than

the driving speed of the motors; the non-rotating well pipe, the motors and their cables, the reduction gearing and the drilling tool comprising an integrated organization extending throughout the length of the hole and movable upwardly and downwardly, through handling at the top of the hole, as a structural unit.

3. A well-drilling apparatus comprising, in combination, a sectional well pipe constructed to extend from the surface of the ground continuously to the vicinity of the bottom of the hole, and constructed to supply a substantially rigid unit throughout its length, to resist both torque and vertical thrust and to supply a heavy downward thrust to aid in the drilling operation; means at the surface of the ground for holding the well pipe against rotation; means also at the level of the ground for raising, lowering and suspending the pipe and regulating its downward thrust and the effect thereof on the drilling operation; means also at the surface of the ground for pumping fluid downwardly through the pipe; a plurality of electric motors mounted upon the pipe near its lower extremity, with their rotor axes spaced from the axis of the pipe and disposed with geometric symmetry around the axis of the pipe; a drilling tool rotatably mounted at the lower extremity of the pipe; and speed reducing mechanism driven by said motors collectively for rotating the tool at a speed substantially less than the driving speed of the motors.

4. A well-drilling apparatus comprising, in combination, a non-rotating well pipe; means for raising, lowering and suspending the pipe; means for pumping fluid downwardly through the pipe; a plurality of electric motors mounted upon the pipe near its lower extremity, with their rotor axes parallel with each other and with the axis of said pipe, said rotor axes being spaced from the axis of the pipe and disposed with geometric symmetry around the axis of the pipe; a drilling tool rotatably mounted at the lower extremity of the pipe; and speed-reducing mechanism driven by said motors collectively for rotating the tool at a speed substantially less than the driving speed of the motors.

5. A well-drilling apparatus comprising, in combination, a non-rotating well pipe; means for raising, lowering and suspending the pipe; means for pumping fluid downwardly through the pipe; a gang of three electric motors mounted upon the well pipe near its lower extremity with their rotor axes parallel and spaced 120° apart; a drilling tool rotatably mounted at the lower extremity of the pipe; and speed-reducing mechanism intermediate said motors and the tool for rotating the latter at a speed substantially less than the driving speed of the motors.

CHARLES W. MACKEY.