

March 13, 1945.

J. J. McNAMARA

2,371,248

WELL DRILLING TOOL

Filed April 22, 1942

8 Sheets-Sheet 1

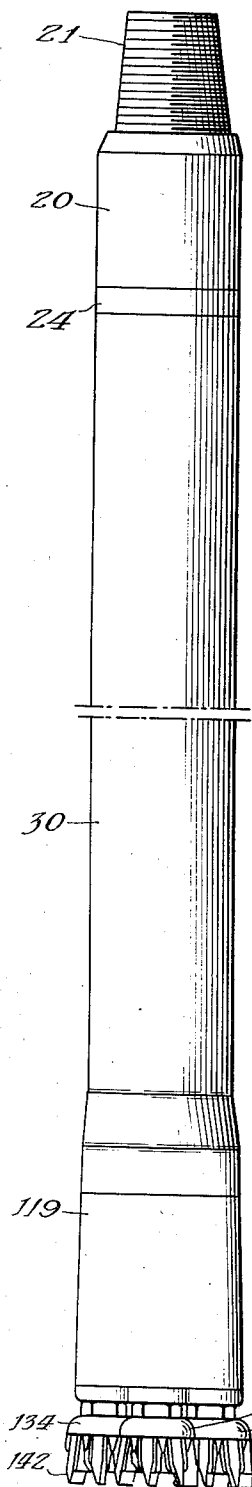


Fig. 1.

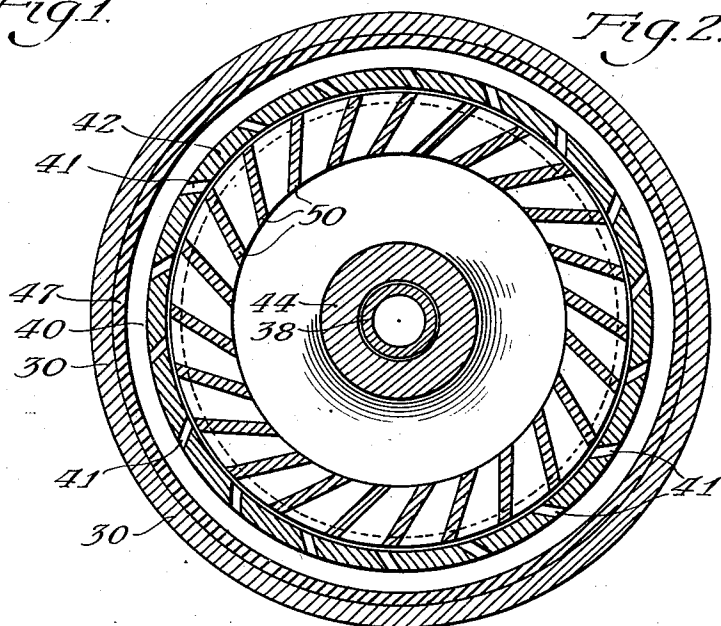


Fig. 2.

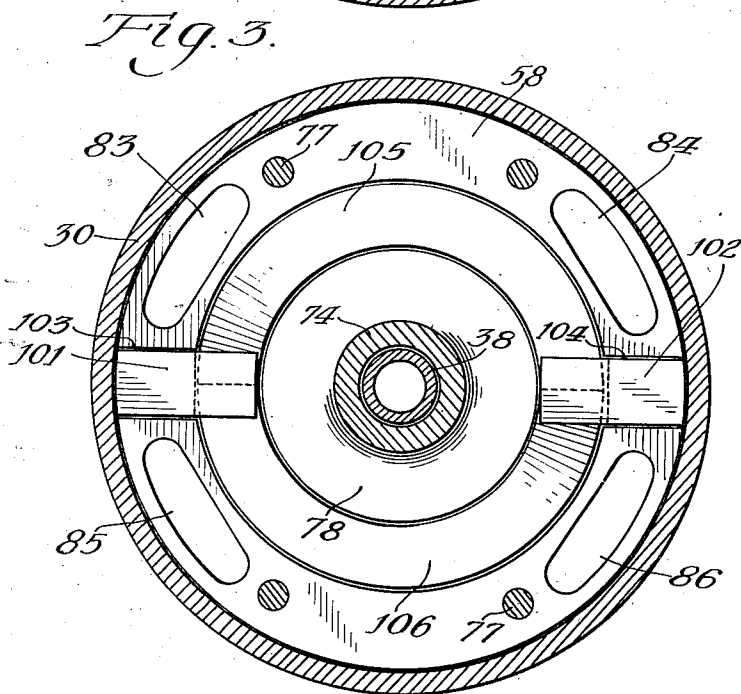


Fig. 3.

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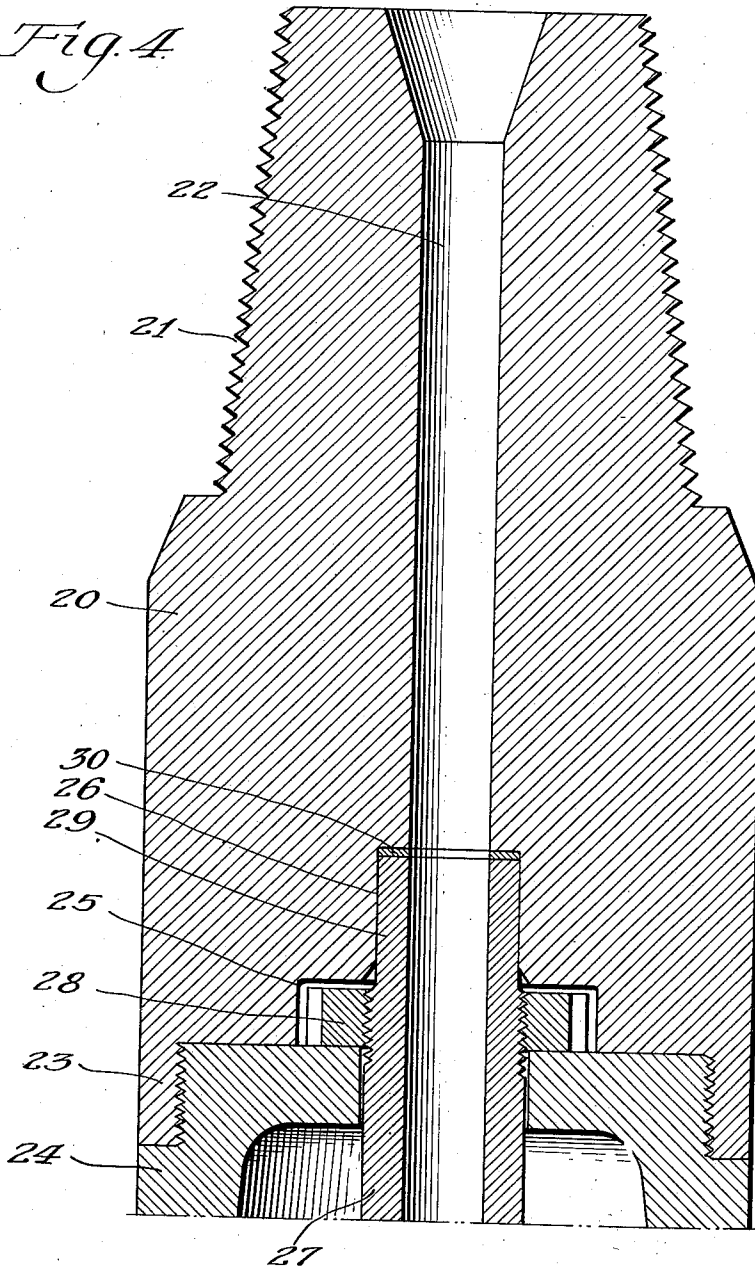
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Fig. 4



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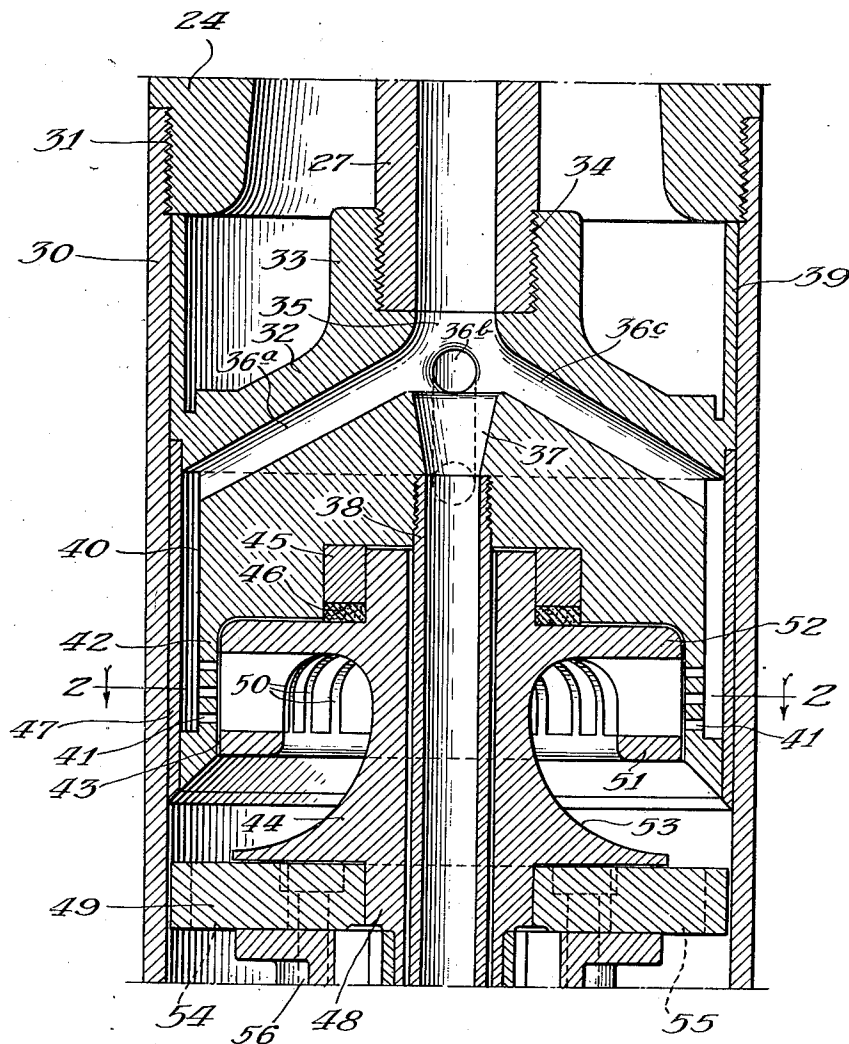
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*Fig. 5.*



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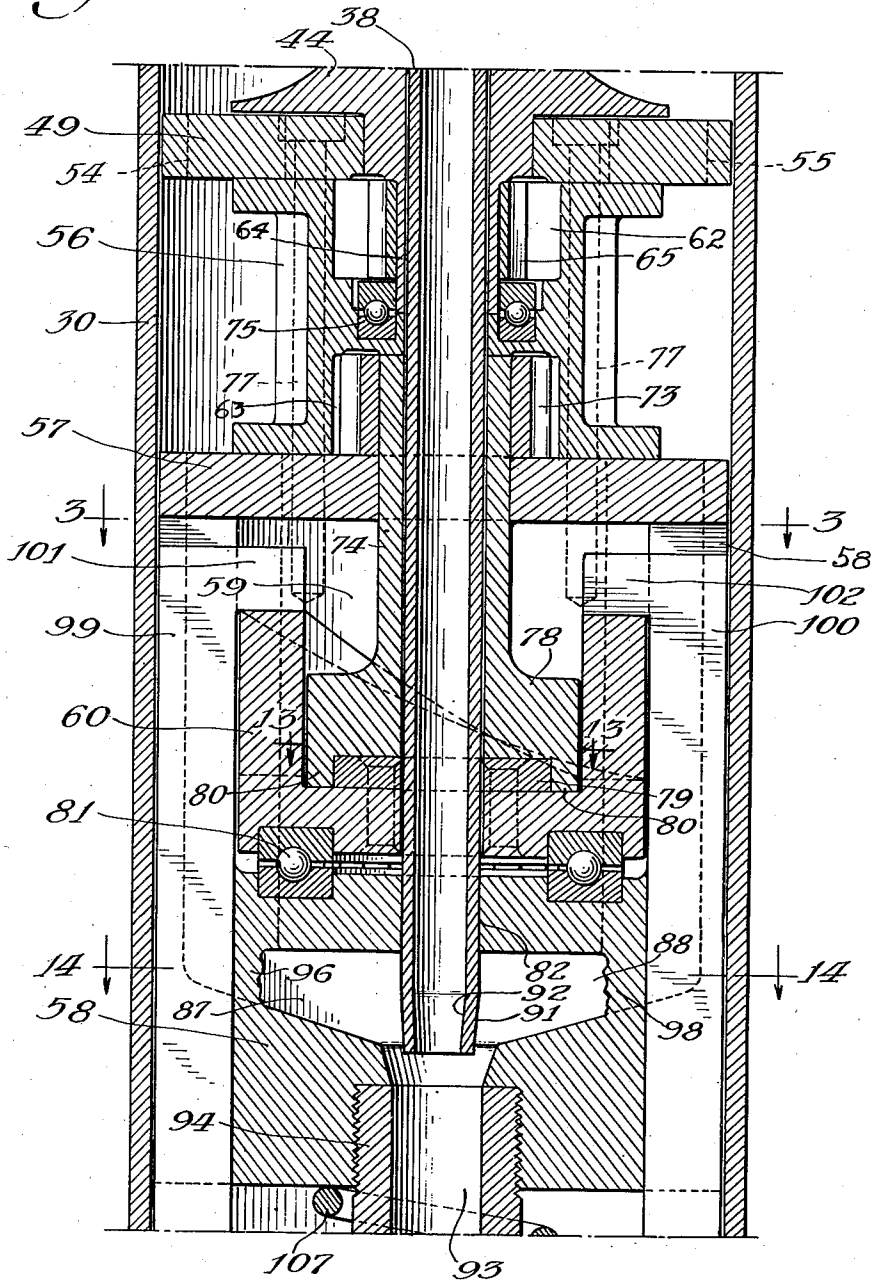
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Fig. 6.



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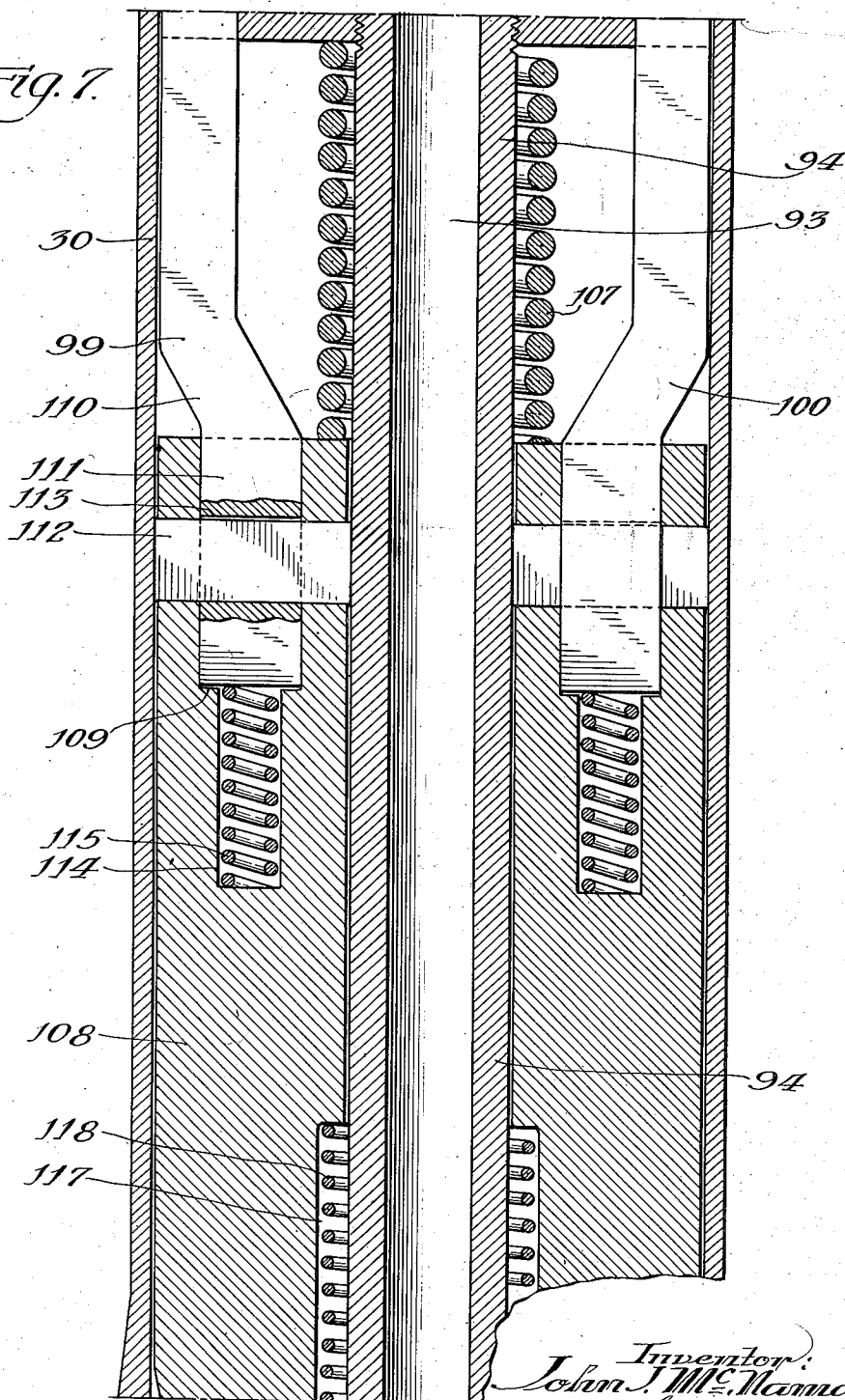
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Fig. 7.



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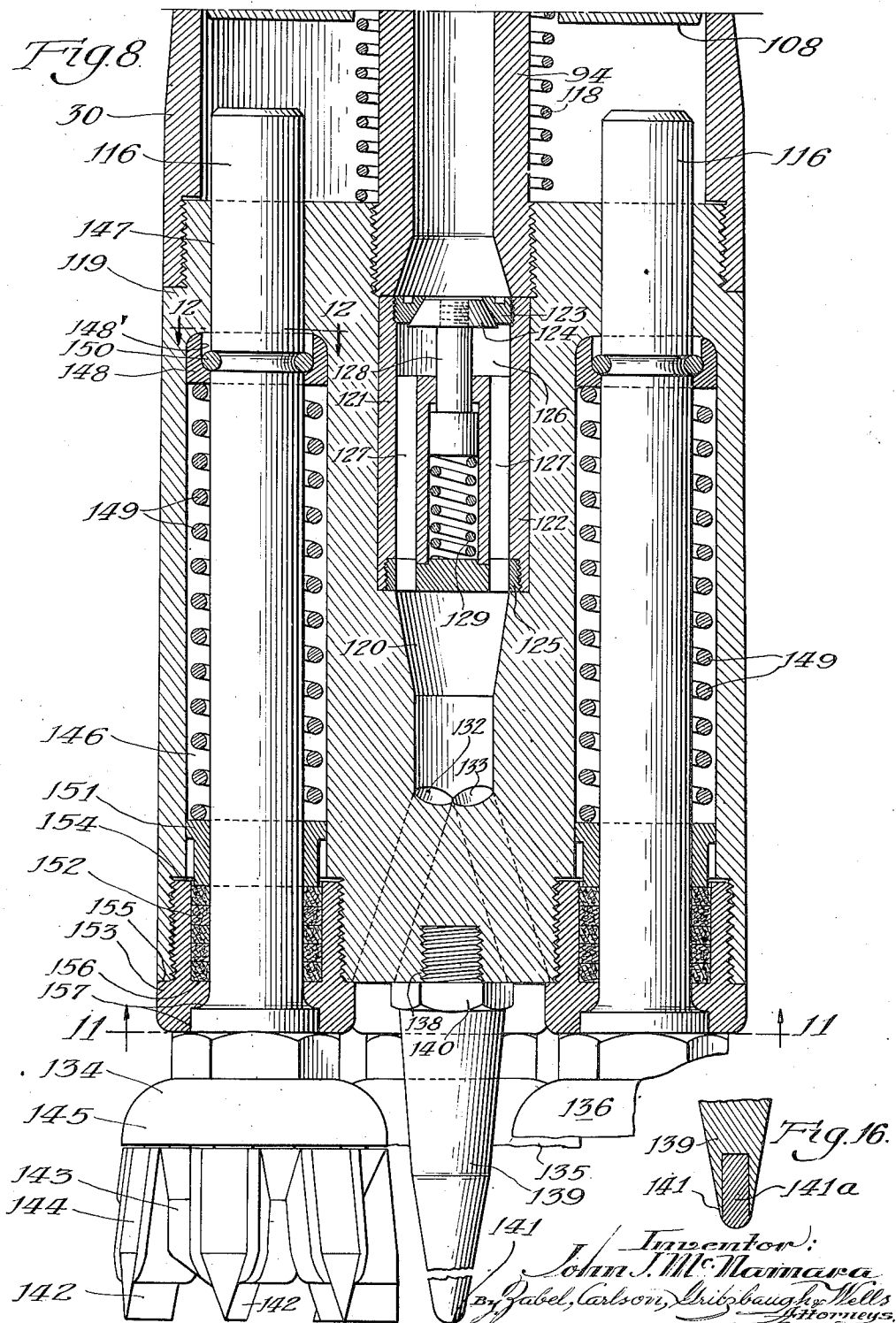
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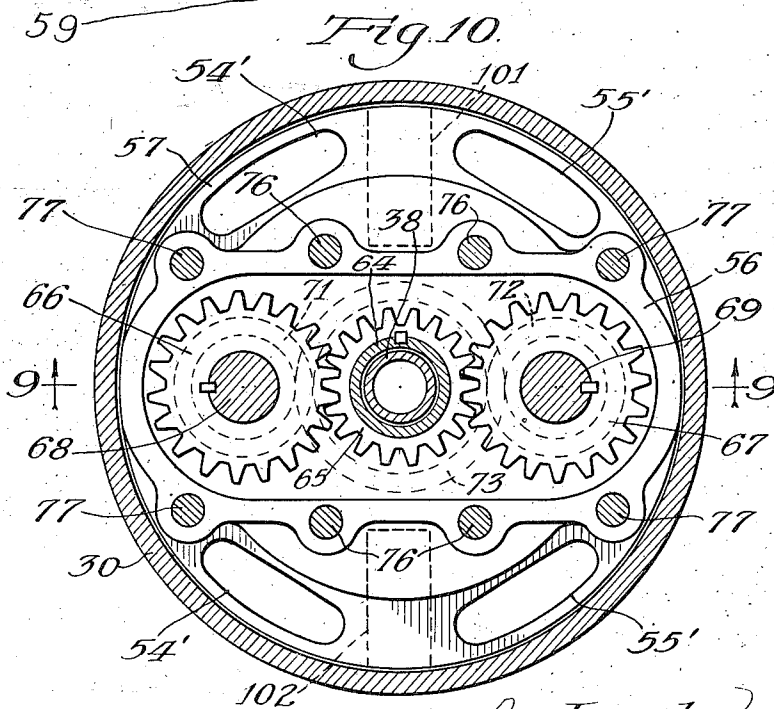
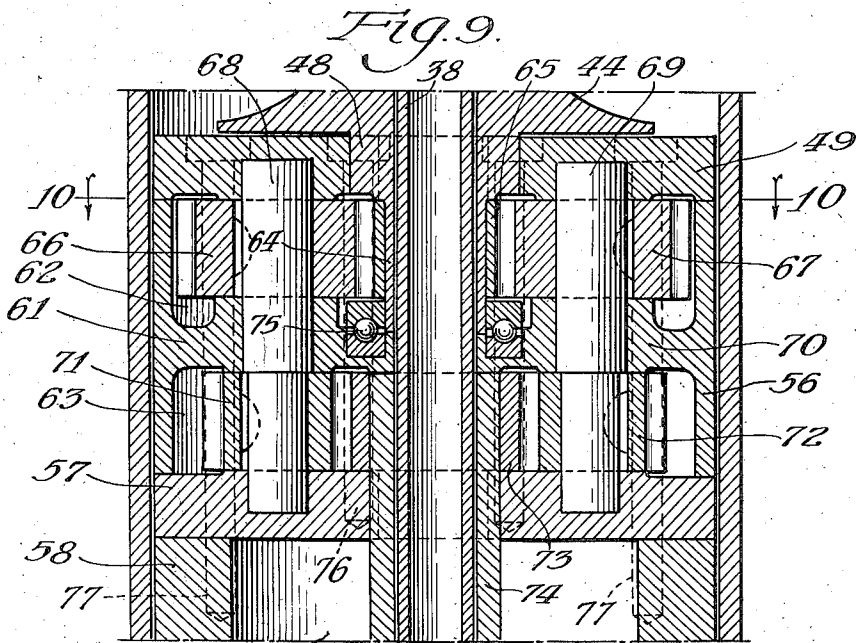
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WELL DRILLING TOOL

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## UNITED STATES PATENT OFFICE

2,371,248

## WELL DRILLING TOOL

John J. McNamara, Chicago, Ill.

Application April 22, 1942, Serial No. 439,986

2 Claims. (Cl. 255—4.4)

The present invention relates to well drills such as are used in drilling for oil and is particularly directed to the provision of novel means for actuating cutting tools for well drilling. The instrumentality provided is particularly directed to the type of well drill wherein the cutting tools or bits are pounded repeatedly and rapidly so as to chip the formations encountered by the drill, and the material thus broken away is flushed out by means of a fluid that is forced down into the well by a pump. In well drills of this character it is customary to gradually turn the drill at a relatively low rate of speed so as to bring the cutting tools into new positions.

In apparatus of this character it has been previously proposed to use the flushing liquid as a means of furnishing motive power to actuate the cutting tools. Devices of this character however have not to date received general acceptance for various reasons.

The present invention has for its principal object the provision of apparatus of the character described wherein the necessary power to actuate the cutting tools is taken from the power that is stored in the flushing fluid in such a manner as to enable the operator to maintain adequate pressure and speed of the flushing fluid while taking enough power from a portion of the flushing fluid for the reciprocation of the cutting tools. The fluid generally used in drilling an oil well is a fairly thick "mud" which is capable of picking up the cuttings in the bottom of the hole and carrying them to the surface.

My invention contemplates a well drilling apparatus wherein the power unit above referred to is so mounted and arranged that it may be coupled onto the end of a fluid delivery pipe as a complete unit, the parts of which are all assembled in an outer shell or casing that is divided by connecting members into separable sections. The upper section of the device comprises merely a connector whereby a fluid pipe and a turbine housing are secured to the head or attaching end of the casing. The turbine wheel itself is mounted within the turbine housing and a certain portion of the fluid is tapped off from the main fluid supply while the remainder of the fluid is directed into a second pipe of reduced cross section and forced down through the center of the turbine by the pressure upon the liquid being fed downward so as to give the liquid not used by the turbine a considerably higher velocity than the velocity of the liquid entering the branch connection where the liquid to the turbine is tapped from the main supply.

The turbine wheel is driven by the tapped off liquid and it in turn drives a cam through a speed reduction gear unit, the cam acting to lift a hammer and let it drop twice for each rotation thereof. The hammer and its cooperating spring means for imparting downward acceleration thereto, together with the lifting arms that lift the hammer as the cam is rotated, constitute a section of the device immediately below the turbine, speed reducing gear and cam assembly.

In order to draw off the spent liquid from the discharge side of the tube means is provided whereby the liquid that does not enter the turbine is increased in velocity and discharged into a larger conduit so as to draw off the spent liquid, or in other words, eject it from the discharge side of the turbine. In this manner I am able to obtain a relatively high efficiency in the operation of the turbine while at the same time insuring delivery of the liquid below the turbine at a speed and pressure sufficient for flushing purposes. The last and lower unit of the drill operating assembly comprises a shell which has sockets for the mounting of the stems of a plurality of drill units, each having a number of cutting bits on its lower face. This bottom shell contains also a check valve for preventing reverse flow of the heavy fluid in the bottom of a well into the drill operating parts as the drill is being lowered in the hole.

The details of the several units will be taken up separately and described, after which the operation of the device as a whole will be more clearly understood.

It will appear from the following description that certain objects and advantages of the present invention are found in the relative arrangement of the several parts to obtain an efficient, compact organization thereof.

Other objects of the invention are the improvement in delivery of the cutting or chipping blow to the stems of the drill units, while still other objects lie in providing a novel mechanism whereby the rotation of the turbine is communicated to the cam without interfering with the discharge of the liquid to the faces of the cutting tools.

Other objects and advantages will appear from the following description and the accompanying drawings wherein a preferred form of the invention is disclosed. It is to be understood however that the drawings and description are illustrative only and that they should not be taken as limiting the invention except insofar as it is limited by the claims.

In the drawings:

Fig. 1 is a view on a much reduced scale showing the well drilling apparatus in side elevation;

Fig. 2 is a horizontal sectional view taken through the turbine substantially at the level 2—2 which is indicated in Fig. 5;

Fig. 3 is a horizontal sectional view taken at the top of the cam element substantially on the line 3—3 indicated in Fig. 6;

Fig. 4 is a vertical sectional view taken through the upper or attaching portion of the apparatus;

Fig. 5 is a sectional view like Fig. 4 taken through the turbine unit and showing the next portion of the apparatus below that shown in Fig. 4;

Fig. 6 is a vertical sectional view taken on the same line as Fig. 5 and showing the speed reduction gear unit and the cam unit of the apparatus;

Fig. 7 is a vertical sectional view taken on the same line as Fig. 6 and illustrating the upper portion of the hammer unit and its connection to the hammer lifting arms which are actuated by the cam;

Fig. 8 is a vertical sectional view taken on the same line as Fig. 7 and illustrating the bottom unit by which the several cutting drills are held in position to be engaged by the hammer;

Fig. 9 is a vertical sectional view through the gear reduction unit, this view being taken at right angles to Fig. 6 and substantially on the line 9—9 of Fig. 10;

Fig. 10 is a horizontal sectional view taken on the line 10—10 of Fig. 9;

Fig. 11 is a horizontal sectional view looking upward and taken on the line 11—11 of Fig. 8;

Fig. 12 is a fragmentary sectional view taken on the line 12—12 of Fig. 8;

Fig. 13 is a fragmentary sectional view taken on the line 13—13 of Fig. 6;

Fig. 14 is a horizontal sectional view taken on the line 14—14 of Fig. 6;

Fig. 15 is a view in side elevation of the cam base separate and apart from its connecting structures; and

Fig. 16 is a fragmentary sectional view taken through the center pin of the drill.

It will be noted that Figs. 4 to 8, inclusive, constitute in effect a single vertical section through the well drilling apparatus. In certain instances there is a small vertical overlap between the showings of the different figures, in order that a complete illustration of the various parts may be had.

Referring now to Figs. 4 and 5 in particular, the upper connecting unit of the drill apparatus comprises a block 20, preferably a casting, which is threaded with substantially heavy threads 21 along its tapered upper end for connection to the lower end of the drill supporting and turning mechanism. This block has a passage 22 extending vertically through it for the passage of the flushing liquid, as will be readily understood. At its lower end the block 20 has a depending flange 23 that is screw threaded interiorly to receive a connecting shell 24 which may also be a casting. The block 20 also has a large recess 25 which is relatively shallow, and a smaller recess 26 extending upwardly into the block from the base of the recess 25. A pipe 27 passes through the shell 24 from below and is supported on the shell by means of a nut 28 threaded on the pipe, the nut 28 being seated in the recess 25. A reduced end 29 is provided on the pipe 27

to extend up into the recess 26. It will be evident that the pipe 27 can be mounted on and suspended from the shell 24 and drawn up to the proper height with respect to the shell before applying the block 20 to the shell. Then when the block 20 is screwed down on the shell the reduced end 29 of the pipe can be forced up into the recess 26 in which it makes a tight fit. A packing 30 may be provided at the top of the reduced portion 29.

Referring now to Figs. 5 and 2, it will be noted that in Fig. 5 the shell 24 and the pipe 27 extend downwardly from their connection with the block 20. The shell is screw threaded as indicated at 31 to receive a casing 30 and support the same. A turbine body 32 fits inside the casing 30 and has a neck portion 33 that is threaded onto the pipe 27 by threads 34. The turbine body 32 is provided with an inlet opening 35 communicating with the interior of the pipe 27 so as to receive fluid under pressure. From the inlet opening 35 there are four diverging fluid conduits 36a, 36b, 36c and 36d (not shown). There is also a downwardly directed conduit 37 which extends axially through the turbine body 32. As shown, this conduit gradually reduces in diameter until it meets with the upper end of a pipe 38 that is threaded into the turbine body 32. The turbine body has an annular flange 39 at the top thereof and is cut away to provide an annular recess 40 which begins at the outer ends of the conduits 36a, 36b, 36c and 36d and extends downwardly to and below a series of angularly disposed annularly spaced openings 41 which are directed inwardly through a relatively thin wall portion 42 of the turbine body to a rotor-receiving space 43 provided in the turbine body. A rotor 44 is journaled in the body 32 by a bearing 45, a suitable packing gasket 46 being provided immediately beneath the bearing ring 45.

The recess 40 is closed by an outer sleeve 47 which is placed on the rotor body 32 and secured in place by welding or otherwise after the body is formed.

The rotor 44 has an extension 48 which is seated in and guided by a plate 49. The rotor 44 has a multiplicity of blades 50 so arranged as to receive the fluid from the nozzles 41 at an effective angle as illustrated in Fig. 2. The blades 50 are joined to each other at their lower ends by a ring 51 which is integral with the blades. The upper ends of the blades are joined together by a web 52 which forms a part of the body portion of the rotor. It will be noted that the rotor is so mounted in the turbine body as to be spaced from and unsupported by the pipe 38. It will also be noted that the spent fluid leaving the rotor flows downwardly and outwardly along a curved surface 53 provided in the body of the rotor. The spent fluid directed outwardly and downwardly by the body of the rotor is carried downwardly through the plate 49 through apertures indicated in dotted lines at 54 and 55 (Fig. 5). The relative position of these apertures with respect to the mechanism below the plate 49 will appear more fully from the description hereinafter made in connection with Figs. 3, 6, 9 and 10.

Referring now to Figs. 3, 6, 9 and 10, and particularly to Fig. 6, the construction immediately below the turbine will be described. It will be noted that the pipe 38 continues downwardly through the center of the rotor 44. A speed reduction gear unit 56 is placed directly below the plate 48 and rests on a second plate 57 which in turn rests on a cam mounting block 58. The

block 58 has a recess 59 in which a cam 60 is rotatably mounted. The cam 60 is drivingly connected through the gear unit 56 to the rotor 44.

The gear unit 56 comprises a body 61 having a central aperture to receive the pipe 38 and having upper and lower recesses 62 and 63 to receive the gears of the unit. The part 48 on the rotor has a reduced extension 64 which extends down into the recess 62. A pinion 65 is fixed on the extension 64 by a key or other means so as to rotate with the extension. The gear 65 meshes with two gears 66 and 67 which are keyed to a pair of shafts 68 and 69. The shafts 68 and 69 are larger at their upper ends and extend down through a partition wall 70 between the recesses 62 and 63 where they have keyed to them gears 71 and 72, respectively. That is, the shaft 69 has the gears 67 and 72 keyed thereto. The shaft 68 has the gears 66 and 71 keyed thereto. The gears 71 and 72 mesh with a gear 73 which is fixed by a key or otherwise to a depending hollow shaft 74, the hollow shaft 74 being extended down into the cam 60 and connected thereto in a manner which will be presently described. It will be noted that the plates 49 and 57 are recessed to receive the opposite ends of the shafts 68 and 69. Speed reduction is obtained by making the pinion 65 relatively small with respect to the gears 66 and 67 and by making the gears 71 and 72 relatively small with respect to the gear 73. The particular speed ratio thus obtained between the rotor 44 and the shaft 74 is determined by the relation of the several gears in the speed reduction unit 56.

The body 61 provides ball bearings 75 for the lower end of the extension 64, these bearings being mounted in the partition 70 as shown clearly in Figs. 6 and 9. The body 61 and its associated gears are fastened between the plates 49 and 57 by four screw bolts 76. These screw bolts have their heads countersunk in the plate 49 and are threaded into the plate 57. The entire assembly comprising the plates 49 and 57 and the speed reduction unit 56 is held in place on the block 58 by four screw bolts 77 placed at the four corners of the unit 56. These screw bolts have their heads countersunk in the plate 49 and are threaded into the body 58. The plate 57 is provided with apertures 54' and 55' corresponding to the apertures 54 and 55 in the upper plate 49.

The block 58 has already been described as having a recess 59 to receive the cam 60. The driven shaft 74 has a head 78 thereon, which head interlocks with a plate 79 that is riveted to the cam 60. The details of this construction are shown more fully in Fig. 13. The head 78 is cut out so as to provide four depending lugs 80 spaced 90° apart around the periphery of the head 78. The plate 79 is notched on its periphery to receive the lugs 80. It is considerably easier to cut the plate 79 to the shape to receive the lugs 80 and then rivet it to the cam than it would be to cut the necessary recesses in the cam material itself for the lugs 80. The cam 60 is supported in the block 58 by a ball bearing 81.

It is understood of course that the pipe 38 continues down through the head 78 and through the cam 60 and that the actual bearings which keep the parts aligned prevent them from wearing upon the pipe 38 which, as shown in the drawings, is slightly smaller in diameter than the diameters of the apertures provided through the cam 60, the drive shaft 74 and the rotor 44.

The pipe 38 however fits tightly in the web portion 82 of the block 58 which supports the bearing 81. The block 58 has vertically running chan-

nels 83, 84, 85 and 86 which are so arranged as to match up with the apertures in the plate 57 in order to direct the fluid downwardly into the block 58. Immediately below the web 82 the block 58 is cored out to provide inwardly extending passageways 87, 88, 89 and 90 (see Fig. 14). These passageways are arranged so that the channels 83, 84, 85 and 86 open into them and they extend inwardly to a chamber 91 which surrounds the lower end 92 of the pipe 38. This lower end 92 is reduced to form a nozzle which is adapted to discharge the fluid which has been by-passed around the turbine straight down at a high velocity. The chamber 91 opens into the interior 93 of a conduit 94 which is threaded into the bottom of the block 58. There are four webs 95, 96, 97 and 98 separating the passageways 87, 88, 89 and 90, but these webs extend only to the chamber 91.

The function of the nozzle or reduced end 92 of the pipe 38 is to restrict the cross section of the pipe so as to cause the fluid flowing down the pipe to be increased in velocity so that it will entrain and carry away the spent fluid that is discharged from the turbine and passes downwardly through the apertures 54', 55' and the channels and passageways in the block 58. This relieves the pressure on the discharge side of the turbine and enables it to function more efficiently. Also, since a comparatively high velocity is required for the fluid as it passes on down to the drill bits it is essential that the by-passed fluid be capable of imparting enough energy to the total mass of fluid flowing down the passage 93 to enable the fluid to carry away the material that is loosened or chipped off by the drill bits.

The block 58 serves also as a guide for two hammer operating arms 99 and 100. As shown best by Figs. 3, 6 and 14, these arms ride upon the top surface of the cam 60. They have lateral projections 101 and 102 extending over the cam. The block 58 is grooved at 103 and 104 to receive the arms 99 and 100 and guide them in their vertical movement. The rotation of the cam 60 is such that the arms are lifted as the extensions 101 and 102 ride upwardly on the inclined surfaces 105 and 106 of the cam (see Fig. 15). The weight of the hammer and the force of a spring 107 which presses down on the hammer move the hammer downwardly when the extensions 101 and 102 pass off the high ends of the surfaces 105 and 106. It will be noted that for each complete revolution of the cam the arms are lifted twice.

The connection between the arms 99 and 100 and the hammer 108 is illustrated in Fig. 7 of the drawings. The hammer comprises a cylindrical metallic body with a central opening through which the pipe 94 passes. The spring 107 is interposed between the top of the hammer and the bottom of the body 58 and is of sufficient size and strength to give the desired downward impetus to the hammer for actuating the drills. The two arms 99 and 100 are connected to the hammer in the same fashion so a description of one connection will suffice for both. The hammer is provided with a recess 109 extending down from the top thereof and the arm is provided with an offset at 110 and a depending mounting portion 111 that extends down into the recess 109. The hammer and the mounting portion 111 are drilled to provide openings to receive a locking key 112. The key 112 fits snugly in the hammer and is slightly longer than the thickness of the hammer from the pipe 94 out to the shell 30 so that the key 112 may ride upon the shell and pipe. There is

of course enough clearance to avoid any appreciable friction or binding of the key against either the shell or the pipe. The aperture in the mounting portion 110 is slightly greater in vertical depth than the vertical depth of the key 112 so as to provide a small space 113 as shown in Fig. 7. Beneath the mounting portion 111 the hammer is provided with a spring receiving recess 114 in which a spring 115 is mounted. This spring is of sufficient strength to press the hammer mounting portion 111 upwardly to the position shown in Fig. 7.

In operation, when the arms 99 and 100 move off the top portions of the cam surfaces that lift them the hammer is of course forced downwardly at a rapid rate by its own weight and by the pressure of the spring 107. When the hammer strikes the tops of the drill shanks to be herein-after described it stops suddenly. The springs 115 tend to cushion the downward movement of the arms 99 and 100 at this point and the clearance provided at 113 and in the bottom of the recess 109 permits a slight vertical movement of the arms 99 and 100 with respect to the hammer to, in a measure, overcome the effect of the rebound of the hammer.

Referring now to Figs. 7 and 8, it will be noted that the lower end of the hammer 108 is spaced slightly above the top ends of the drill shanks 116 of which, in the present device, there are four. The hammer is also provided at its lower end with a recess 117 in which the upper coils of a spring 118 are housed. This spring 118 encircles the pipe 94 and rests upon the top of a drill shank mounting head 119. The drill shank mounting head is provided with a central opening 120, the upper portion of which is enlarged and threaded to receive the lower end of the pipe 94. The enlarged portion of the opening or passage 120 also receives a check valve 121 which is actually held in place by the lower end of the pipe 94. It will be observed that the casing 30 is slightly enlarged or thickened at its lower end and is threaded onto the head 119. The head 119 increases slightly in diameter from the top to the bottom as shown by Figs. 1 and 8. It is a solid block, preferably a casting, which is bored to receive the drill shanks 116 and to provide a passageway for the fluid that is fed down through the pipe 94.

The check valve 121 is provided to prevent backflow of the fluid through the pipe 94 which might cause the device to get clogged up with the fluid and the cuttings of stone that are entrained thereby. This valve comprises a block 122, an upper end plug 123 which provides a seat for a valve 124, and a lower end plug 125. The block 122 is hollowed out to provide a chamber 126 immediately below the valve 124 and a multiplicity of passages 127 are spaced circumferentially about the block 122 to pass the fluid through the block. The block 122 is also centrally bored to receive a valve stem 128 for the valve 124 and to receive a spring 129 which normally urges the valve 124 to closed position and which is held in place by the plug 125. Below the valve block 122 the passage 120 is restricted for a short distance and then divided into four passageways 130, 131, 132 and 133 that open downwardly on the lower face of the head 119. The position of the passageways just mentioned is such that they diverge downwardly and discharge between the four drills 134, 135, 136 and 137 which are carried by the head 119.

On the bottom face of the head 119, at the center thereof, a screw threaded recess 138 is pro-

vided for the reception of a center pin 139. The center pin is provided with a polygonal head 140 by which it may be turned to thread it into the recess 138. This center pin tapers slightly through a little more than one-half of its length and then tapers more sharply as shown in Fig. 8, terminating in a rounded tip 141 which is adapted to rest on the material at the bottom of the well. The tip 141 preferably is made by inserting a hardened plug 141a in the end of the pin 139.

The several drill units 134, 135, 136 and 137 are alike in construction and in their mounting in the head 119 so a description of one of the units and its mounting will suffice for all. Each drill unit comprises a plurality of cutting tools 142 which are mounted in a block 143 in such a way as to be readily replaceable, each cutting tool being backed up by a removable plug 144 that is held in place by a cap 145. The particular details of this construction form no part of the present invention. They are claimed in a separate application filed by the applicant and therefore will not be described further here.

The drill shank 116 is fixed to the cap 145. The shank extends upwardly through an aperture 146 that is provided in the head 119. This aperture, at its upper end, is of just such diameter as to make a snug sliding fit with the drill shank 116 as shown at 147. A short distance from the top of the head 119 the aperture 146 is enlarged to provide room for a cup washer 148 and a spring 149 which together with a split ring 150 serve to support the shank and the cutting tools carried thereby in the head 119. The spring 149 is in turn supported at its lower end by a packing washer 151 that rests upon rings of packing 152, the rings of packing being held in a threaded and shouldered sleeve 153. The sleeve 153 has external screw threads that thread into an enlarged portion 154 of the aperture 146. The sleeve has a shoulder 155 to engage the bottom surface of the head 119 around the aperture 146. The sleeve is also provided with a shoulder 156 on which the packing rings 152 rest, and the sleeve is shaped as indicated at 157 to receive the lower end of the shank 116, which end is somewhat enlarged.

When the hammer 108 strikes the upper ends of the drill shanks 116 these drills are given a sudden downward movement which causes the cutting tools 142 to strike the stone or other formation in the bottom of the well a sharp blow. At the same time the springs 149 are being compressed so as soon as the downward movement of the drills is stopped they are immediately forced upward by the recoil of the springs 149. Since it is possible to get quite rapid action of the hammer 108 from the cam 60 the cutting tools can be made to strike a multiplicity of blows in rapid succession so as to accomplish high speed drilling however remote the drilling apparatus may be from the surface of the ground. Means are provided whereby the entire drill unit is given a slow rotational movement so as to continually bring the cutting tools into engagement with new surfaces in the bottom of the well, the liquid being discharged from the passage 120 serving to wash away the material and carry it up outside of the casing 30 as the drilling operation proceeds. The means to rotate the drill unit are well known and therefore no showing of such means has been made in the drawings.

It is believed that the operation of the apparatus hereinbefore described will be readily apparent from the detailed description. Briefly,

this operation may be stated as follows: the washing fluid by which the material to be drilled is brought to the surface of the ground is directed into the drill unit shown in full in Fig. 1 at the top thereof. Naturally the pressure imparted to the fluid will depend upon the force necessary to carry the liquid and the removed material from the bottom of the well to the surface of the ground. Pumps now in use, however, develop sufficient pressure and fluid flow to serve this purpose. The present drill functions to divide the flow of fluid near the top of the drill unit. One portion of the fluid, and in fact the main portion thereof, is directed downwardly through the pipe 38 in a restricted passage so that it is given an increased velocity in order to effect the required volume of flow. The remainder of the liquid is fed to the turbine blades 50 of the turbine so as to cause the rotor 44 to turn at a relatively high speed. As the rotor 44 turns it drives the cam 60 through the speed reduction unit 56. The cam in turn repeatedly lifts the hammer 108 and lets it fall so that the hammer may strike the drill stems and give the cutting tools the proper sudden sharp impact that they need to cut away the formation at the bottom of the well. Advantage is taken of the velocity of the fluid in the pipe 38 to draw off the spent fluid from the back side of the turbine thus preventing back pressure from cutting down the efficiency of the turbine. The spent fluid from the turbine and the by-passed liquid are combined and flow down through the pipe 94 and the passage 120 to finally reach the lower face of the drill head 119 at a velocity sufficient to pick up the cuttings and carry them upwardly around the drilling apparatus.

The assembly is such that several parts can readily be put together before putting them in the casing 30. It will be noted that the entire drill head 119 and its drill assembly are completely independent of the rest of the apparatus except for the screw threaded connection. Once the drill head is removed and the connecting head 20 is removed the rest of the apparatus can be taken out by disconnecting the casing from the shell 24.

The particular means of mounting the drill shanks in the head 119 makes it easy to assemble any particular drill shank. The washer 148 serves both as a means of holding the spring 149 under compression and as a means of holding the split ring 150 in place. This split ring may be in two sections, each a semi-circle. In order to apply the split ring it is necessary to compress the spring 149 enough to bring the top edge of the cup washer 148 below the level of the annular depression provided in each of the drill shanks; then the split ring can be dropped in the depression after which the washer 148 by virtue of its peculiar cup-shaped portion 148' (see Figs. 8 and 12) serves to lock the split ring in position and to stop the upward movement of the washer at the ring.

The check valve 121 readily opens under downward pressure of fluid in the pipe 94 but immediately upon failure of the downward pressure this valve closes under the influence of its enclosed

spring 129 to eliminate danger of fluid and cuttings, mud and the like, getting back inside of the pipe 94 and the block 58 where it might clog the entire system. The check valve is simple in its construction and its mounting does not in any way interfere with the connection of the head 119 to the rest of the drilling apparatus.

I have found that in connection with the packing rings 152, these rings have to take a great deal of punishment and if I use a coiled packing and cut the rings separately, staggering the joints, they will last much longer.

In connection with the speed reduction gear unit, I have found the particular assembly shown herein to be quite effective and practical both from the standpoint of simplicity in putting it together and into the assembly of the entire apparatus. However, it is obvious that any suitable speed reduction unit may be interposed between the rotor 44 and the shaft 74. In fact, where the speed of the rotor is not excessive with respect to the desired speed of operating the cutting tools the speed reduction gearing may be dispensed with entirely.

From the foregoing description it is believed that the nature and operation of the present apparatus will be readily apparent to those skilled in this art. Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A well drill comprising in combination, a supporting body having a passageway extending downwardly from the top thereof, whereby a fluid under pressure may be supplied to the drill, a water turbine supported by said body, a by-pass conduit having its inlet end in said passageway and adapted to direct a portion of the supplied fluid past the turbine, other conduit means connected to said passageway to direct the remainder of the fluid to the turbine whereby to effect rotation thereof, discharge conduit means extending down from the turbine for the spent fluid from the turbine, said by-pass conduit including a nozzle directing the by-passed fluid downwardly at an increased velocity into the discharge conduit for the spent fluid, a cutting tool carried by said supporting body, means connected to the turbine to actuate the cutting tool, and means to direct the combined spent fluid and by-passed fluid to the vicinity of the cutting tool for washing away the cuttings, said last named means including means to prevent flow of fluid and cuttings into the apparatus from the cutting tool end.

2. In a well drill, a supporting body having a water inlet conduit entering it at the top, a water turbine in said body and having a rotor, means to direct part of the water from the inlet conduit to the turbine rotor, means comprising a conduit extending through the turbine rotor to direct the remainder of the water axially through the turbine rotor, and means below the turbine directing the spent water from the turbine inwardly to the axially directed stream for distributing the energy of the said remainder of the water to the water discharged from the turbine.

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