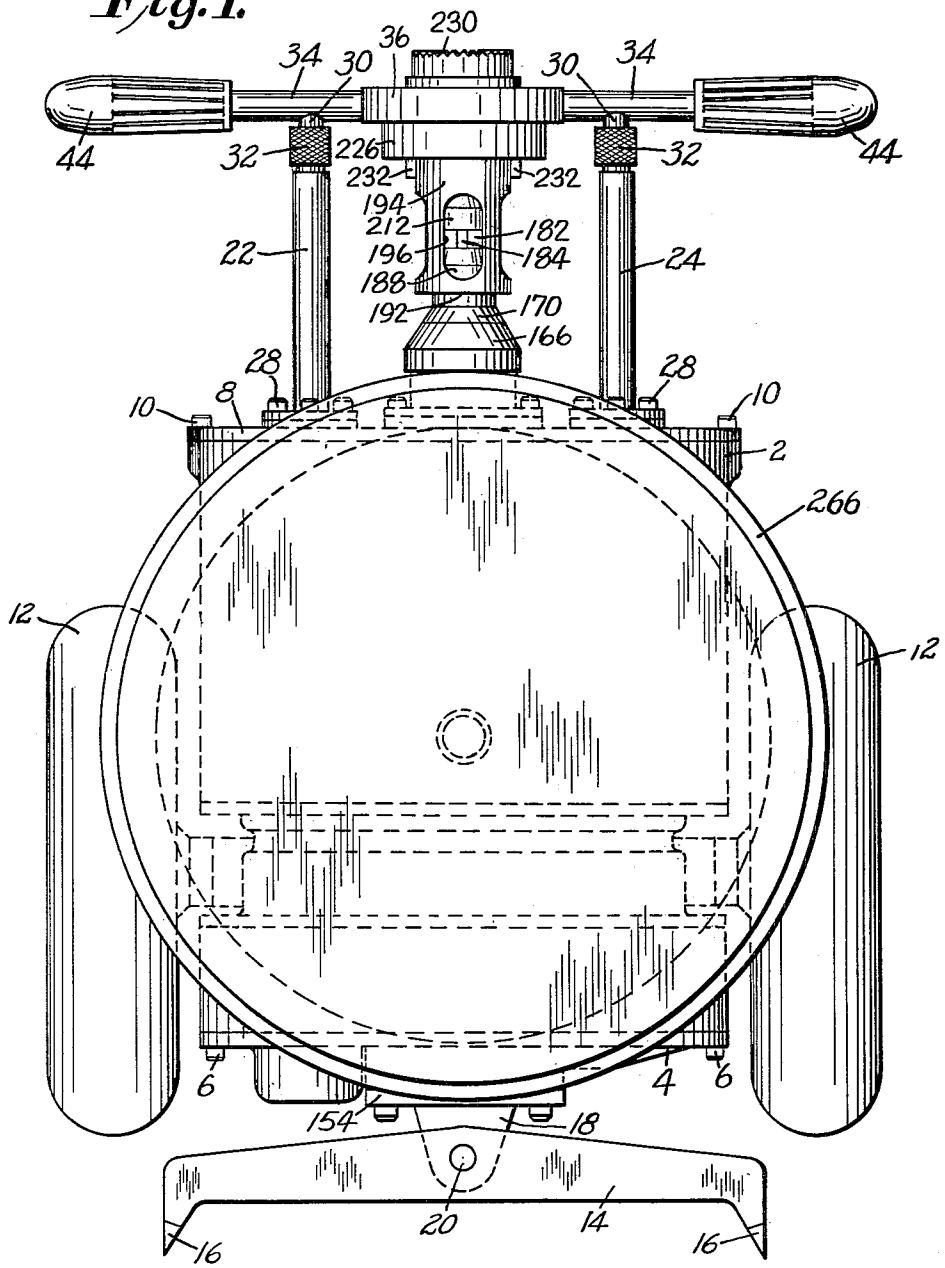
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DRILL

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Fig. 1.



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Fig. 2.

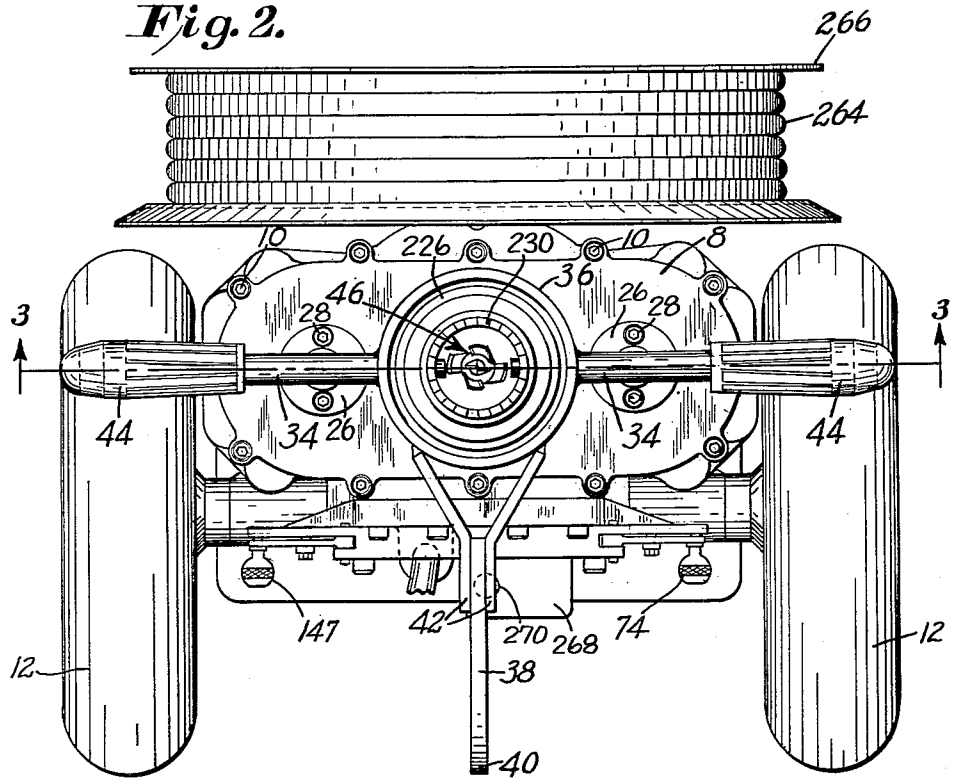


Fig. 5.

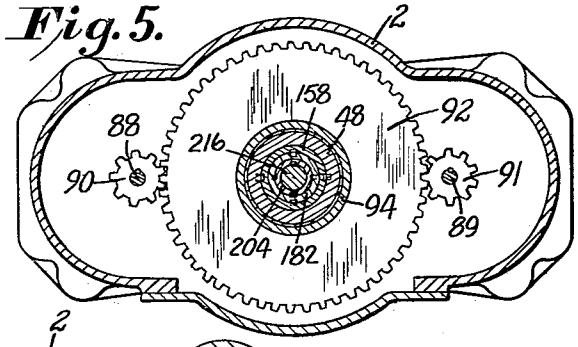
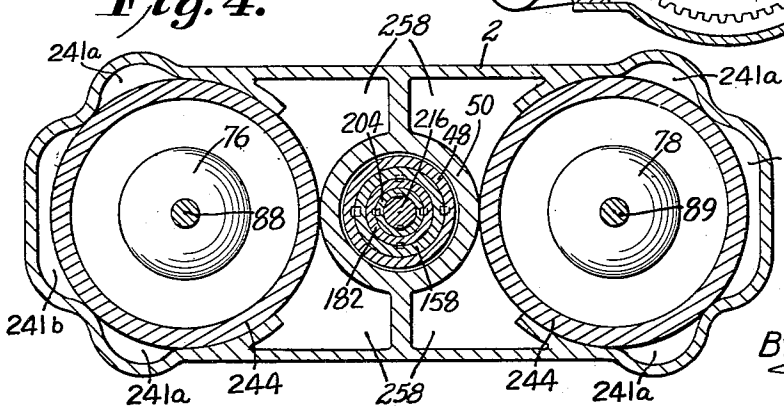


Fig. 4.



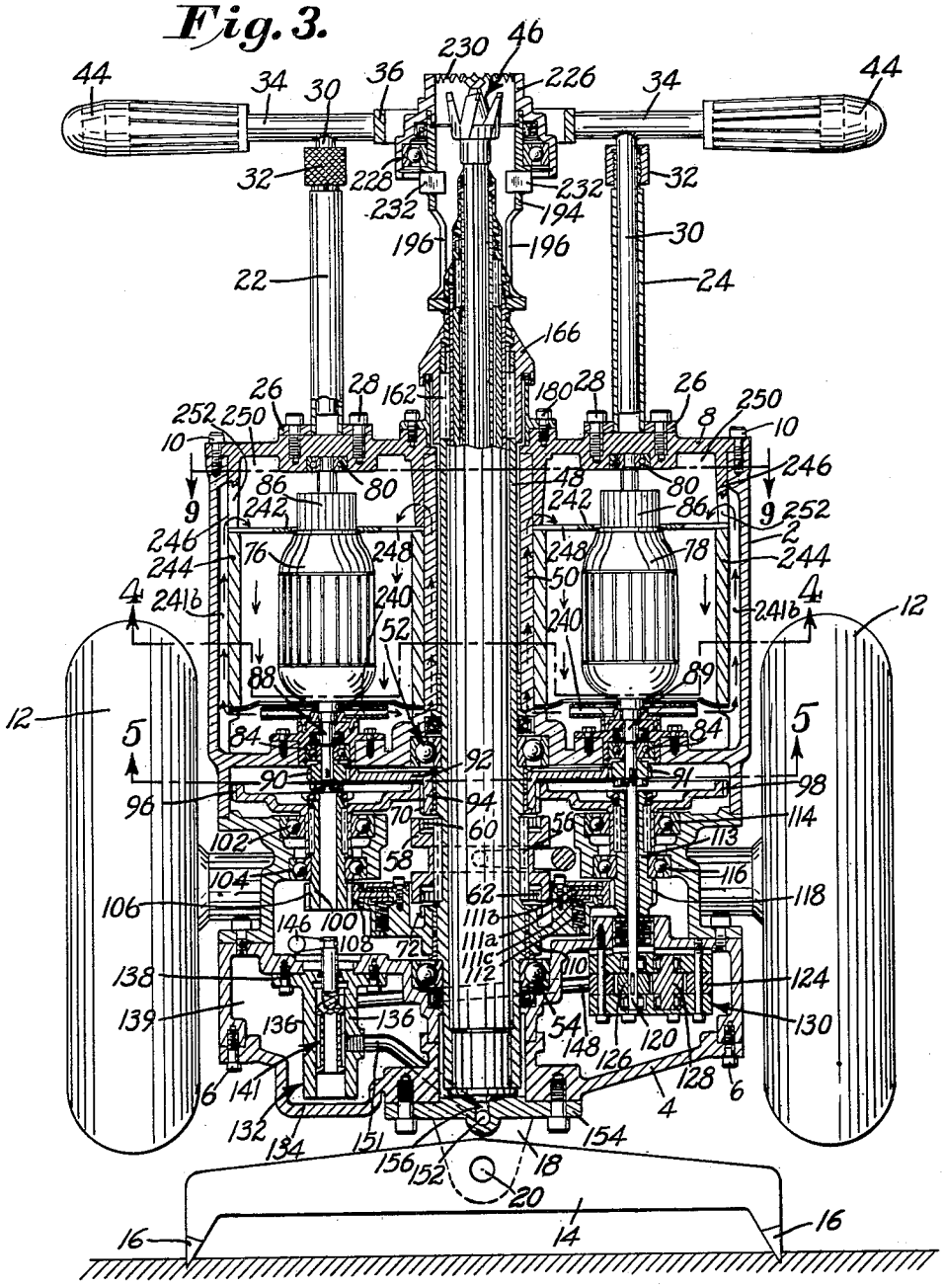
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Fig. 3.



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Fig. 6.

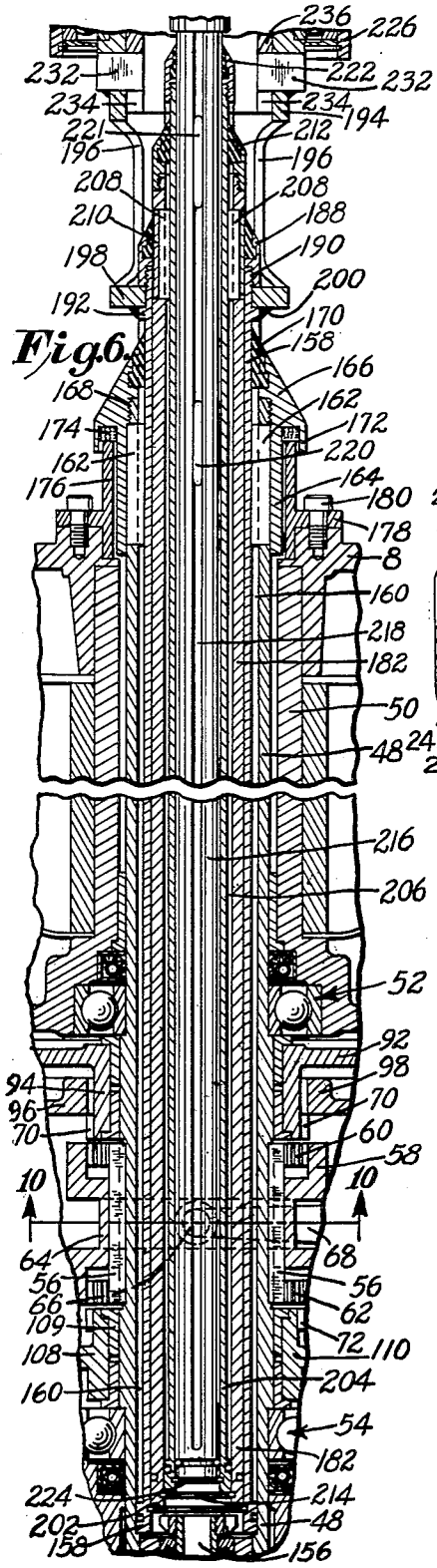


Fig. 7.

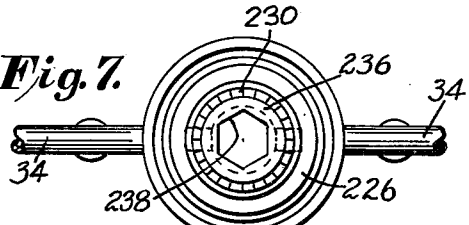


Fig. 9.

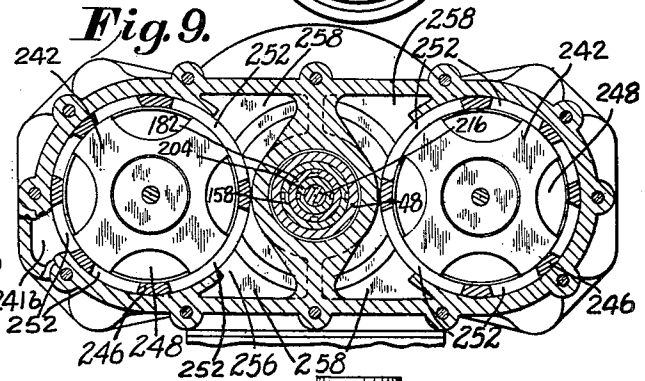
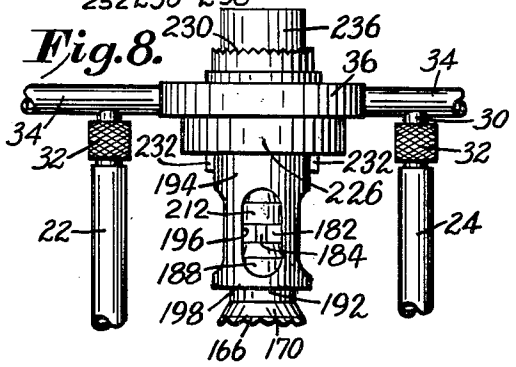


Fig. 8.



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Fig.10.

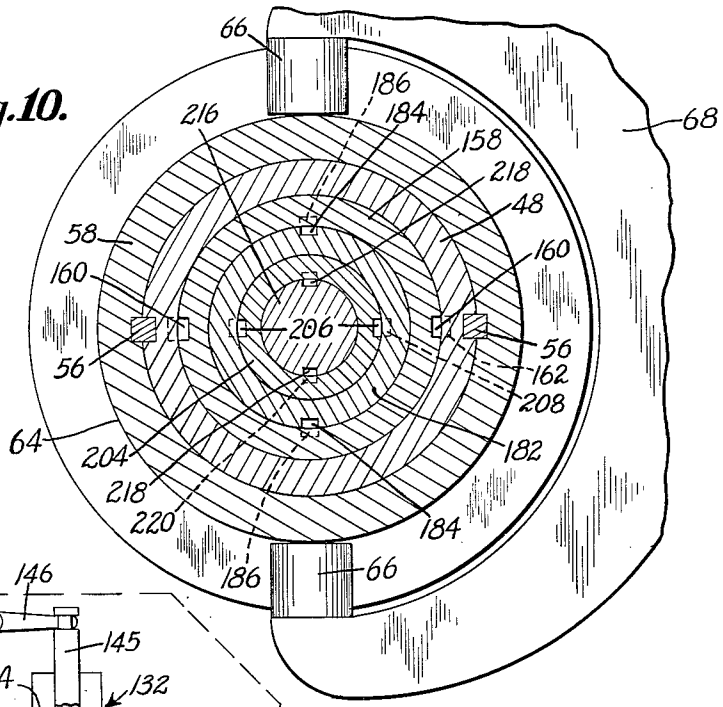


Fig.11.

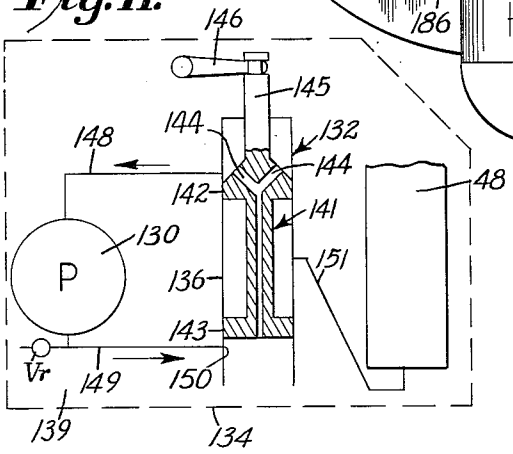


Fig.12.

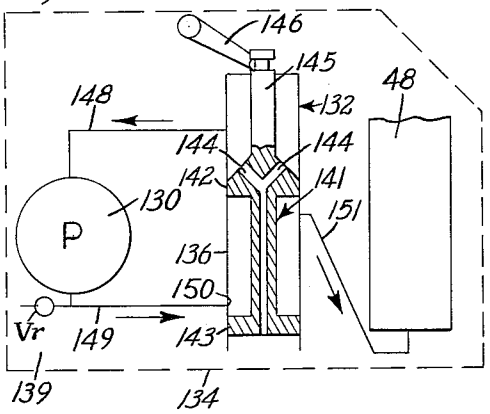
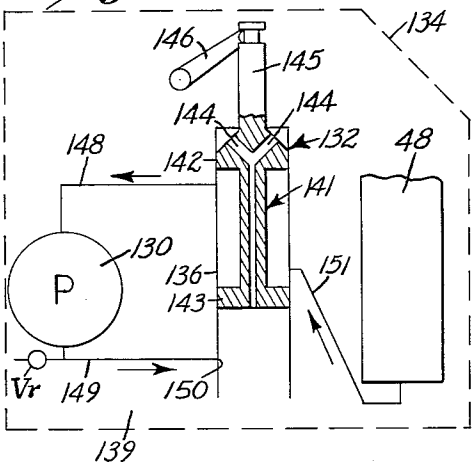


Fig.13.



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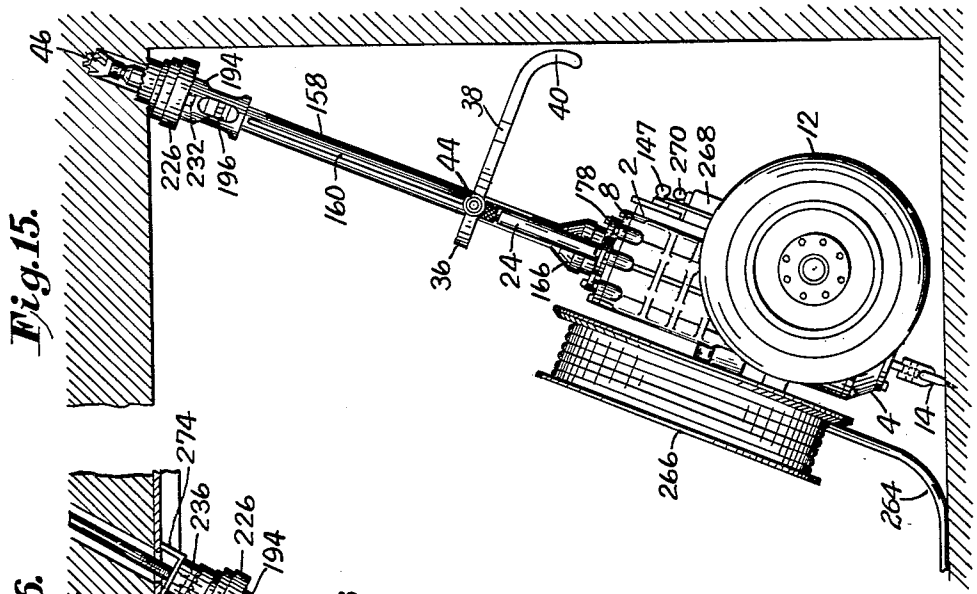


Fig. 15.

Fig. 16.

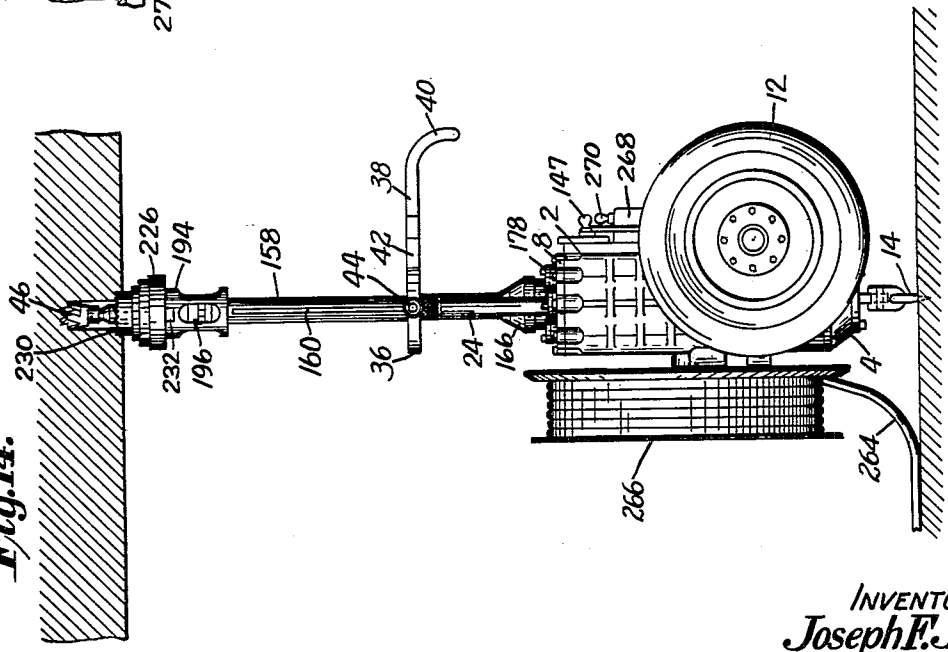


Fig. 14.

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United States Patent Office 2,741,461 Patented Apr. 10, 1956

2,741,461

DRILL

Joseph F. Joy, Pittsburgh, Pa., assignor to Joy Manufacturing Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application September 7, 1950, Serial No. 183,585

10 Claims. (Cl. 255—47)

This invention relates to a combination wrench and drill device, especially to a portable device for use in mines.

There are many requirements in underground mining today for drilled holes. One such application is connected with the relatively new practice of roof bolting as a substitute for timbering to prevent roof falls. This method of roof control is disclosed in my application Ser. No. 120,734, filed October 11, 1949, and necessitates drilling holes into the mine walls, locating an expansion bolt in each hole thus made, and bolting a plate, angle iron, channel, or the like tightly against the strata by means of the expansion bolt. The strata are thus held to a minimum of flexing and roof falls are effectively prevented.

With this method of roof control, it often happens that the hole which is to be drilled must be substantially longer than the dimension of the space in which the work must be done. There is, accordingly, a real need for a light, mobile drill, capable of standing erect, and of drilling a hole into the strata which is greater in depth than the height of the space in which the drill is located. There is moreover, a need for a tool which can quickly tighten up the nuts on the bolts in order to avoid the time-consuming tightening of these nuts by hand. It may be noted, however, that the need is not limited to holes in the roof, and the device of this invention is capable of general application to drilling in underground mines.

It is, accordingly, an object of this invention to provide an improved device which carries a drilling tool and which is telescopically mounted and is extensible to a length greater than the drill height; it is a further object of this invention to provide such a device which is capable of engaging and tightening the nuts on the roof bolts. Other objects and advantages will be apparent to those skilled in the art.

In the drawings:

Fig. 1 is a view in elevation of the device as seen from the cable reel side.

Fig. 2 is a top plan view of the device.

Fig. 3 is a view in section substantially on line 3—3 of Fig. 2.

Fig. 4 is a view in section substantially on line 4—4 of Fig. 3, but on a larger scale.

Fig. 5 is a view in section substantially on line 5—5 of Fig. 3.

Fig. 6 is an enlarged detailed sectional view through the rotatable shaft which carries the drilling tool. This figure is a section on substantially the same plane as that of Fig. 3, but on a larger scale, and is limited to the hydraulic cylinder details and parts immediately adjacent thereto.

Fig. 7 is a top plan view of just the end of the extensible drive means showing the wrench in place.

Fig. 8 is a side elevation view of those parts of the device shown in Fig. 7.

Fig. 9 is a view in section substantially on line 9—9 of Fig. 3, but on a larger scale.

Fig. 10 is a view in section substantially on line 10—10 of Fig. 6, but on a larger scale.

Fig. 11 is a schematic diagram of the hydraulic system which is connected to supply power to extend the telescopic drive means. The apparatus is shown in Fig. 11 in its neutral position—i. e., in the position in which fluid is trapped in the hydraulic cylinder.

Fig. 12 is a view similar to Fig. 11, but showing the valve in the operating position in which fluid is supplied to the hydraulic cylinder to extend the telescopic drive means.

Fig. 13 is a view similar to Fig. 11, but showing the valve in position to allow fluid to be withdrawn from the hydraulic cylinder.

Fig. 14 is an operational side elevation view showing the device in an erect position placed between the floor and the roof and drilling a hole in the roof.

Fig. 15 is a similar operational view, but showing the device located to drill a hole in the roof at an angle from the vertical, and

Fig. 16 is a partial view in elevation of the extensible drive means, but showing the wrench in place and in engagement with a nut on the end of a roof bolt.

Referring now to the drawings in detail, a device made according to this invention is shown as having a support such as a housing 2 provided with a bottom plate 4 removably secured to the housing by means of bolts 6, and a cover 8 removably secured to the top of the housing by means of bolts 10.

The device is preferably made mobile by providing a pair of rubber-tired wheels 12 suitably mounted on the housing. The wheels 12, of course, constitute a floor-engaging support by which the device is readily moved about from job to job. A second floor-engaging support 14 is suitably secured to the bottom plate 4. The support 14 in the preferred embodiment consists of a beam having downturned ground points 16 at its ends, and being pivotally secured at a point between its ends to the bottom plate 4 by means of a bracket 18 and a pin 20.

The cover 8 supports a pair of tubular columns 22 and 24 by means of flanges 26 secured to the lower ends of tubes 22 and 24; the flanges in turn are secured to the cover 8 by any suitable fastening means such as the bolts 28. Rods 30 have telescoping engagement with the tubes 22 and 24, and are clamped in any desired position by means of the knurled nuts 32 which have threaded engagement with the split upper ends of tubes 22 and 24. Handle bars 34 are secured to the upper ends of rods 30, and are connected by a central ring 36. A leg 38 having a curved foot 40 is secured to the ring 36 by means of a pair of brackets 42. Hand grips 44 are provided at the outer extremities of the handle bars 34.

A drilling tool 46 of any suitable type is extensibly carried and driven by a hydraulic cylinder 48 (Figs. 3, 6, and 10). Hydraulic cylinder 48 is rotatably carried in a hollow support 50 which is preferably an integral part of the main housing 2. Hydraulic cylinder 48 is rotatably mounted in bearings such as the anti-friction bearings shown generally at 52 and 54. As is best evident in Figs. 3 and 6, cylinder 48 is held against axial movement by the same anti-friction bearings 52 and 54.

Near its lower end, cylinder 48 is fitted with keys 56. A shipper ring 58 has sliding engagement with the keys 56, and carries internal teeth 60 and 62 at its opposite ends. The ring 58 is grooved between its ends as shown at 64, the groove 64 being adapted to receive the pins 66 of a shipper yoke 68.

The internal teeth 60 and 62 of the shipper ring 58 com-

prise a dog clutch engageable alternatively with external gear teeth 70 and 72, respectively. The shifting of the shipper ring 58 by means of shipper yoke 68 is accomplished by an operating handle 74 (Fig. 2) which may be connected in any suitable manner, as will be understood by those skilled in the art, to manipulate the yoke 68.

The drive of external teeth or splines 70 and 72 is effected by two electric motors, the rotors of which are shown at 76 and 78, mounted in the housing 2. It will, of course, be understood that one motor could be used, but one of the advantages of using two motors is that the heat can be better dissipated and better balance secured. Accordingly, in the preferred embodiment of the invention the drive is accomplished by two motors arranged on opposite sides of the hydraulic cylinder. The rotors are mounted for rotation in anti-friction bearings 80 and 84. It will be understood by those skilled in the art that the showing of the motors is incomplete; for the sake of simplicity, the motor field windings and the brushes which contact the commutators 86 are not shown.

It will be understood that the motors are substantially identical in order that the parts thereof may be interchangeable. The rotor shafts extend downward as shown at 88 and 89 and carry near their lower ends drive pinions 90 and 91. The pinions mesh with and drive a large gear 92 (see also Fig. 5). Large gear 92 is provided with an integral hub 94 on which are formed the gear teeth 70 referred to above as being engageable with the internal teeth 60 of the shipper ring 58. See also Fig. 6. The teeth 70 extend substantially the full length of the hub 94, and engage at their upper ends a pair of gears 96 and 98. The gear 96 is keyed to and drives a shaft 100 which is rotatable in anti-friction bearings 102 and 104. Shaft 100 is provided at its lower end with external teeth 106 forming a drive pinion which meshes with a centrally located gear 108 rotatable on a sleeve bearing 109 on the hydraulic cylinder 48. Gear 108 is provided with a central hub 110 on which are formed the gear teeth or splines 72, referred to above as being engageable with the internal teeth or splines 62 of shipper ring 58.

Gear 108 desirably incorporates a clutch having a disc 111*a* integral with the gear teeth and gripped between discs 111*b* and 111*c*. Springs 112 provide the pressure to achieve the necessary friction between discs.

Similarly, gear 98 is keyed to a hollow shaft 113 which is rotatable in antifriction bearings 114 and 116. Shaft 113 carries an integral pinion 118 which corresponds to the pinion 106, and which also meshes with the large centrally located gear 108.

From the foregoing, it will be evident to those skilled in the art that the external gear teeth 70 are driven by the electric motors at a given speed, and that the drive for the external gear teeth 72 is at a substantially reduced speed. A desirable speed of the teeth 70 is 520 R. P. M., to drive the drilling tool 46; and a desirable speed of the teeth 72 is 53 R. P. M., to drive the wrench (later described). Thus the gears having teeth 70 and 72 comprise a plurality of driven members connected to the electric motor or motors, and shipper ring 58 is a drive member; the shipper fork and handle 74, together with their connecting linkage etc., form means to connect a selected one of the driven members 70 and 72 with the drive member 58 to drive one of said driven members.

In order to provide for the above-mentioned interchange of parts, both extensions 88 and 89 of the two rotor shafts are notched at their lower ends. Extension 88 of rotor 76 serves no other purpose than to drive its cooperating pinion 90, which is held in place on the extension 88 by any suitable nut means. Pinion 91 on the extension 89 of rotor 78 is similarly held in place. However, in this instance, a shaft 120 extends through the hollow shaft 113, and is provided with a tongue at its upper end to engage the notched lower end of extension 89. Shaft 120 is thus driven by rotor 78. At its lower end, shaft 120 is rotatably mounted in a gear casing 124 by any suitable bearing means, and carries secured thereto a gear 126 which meshes with another gear 128. Gears 126 and 128, together with the casing 124, constitute a gear pump 130. Gear pumps of this type are well known in the art and need not be detailed here.

Gear pump 130 provides fluid under pressure for the hydraulic system that includes the hydraulic cylinder 48 and a valve 132. It will be understood that this hydraulic system uses the well 134 in bottom plate 4 at one side of the machine as a sump. The valve body or cylinder 136 is provided with a flange 138 at its upper end which is bolted to a septum in the lower part of housing 2, thus completing an enclosed chamber 139 for the valve 132. The chamber 139 and the corresponding space in the other side of the casing are filled with oil and serve as a reservoir. The valve cylinder or body 136 is open at its lower end to the sump 134. Reciprocable within the valve body or cylinder 136 is a valve member 141 in the shape of a hollow spool having an upper land 142 and a lower land 143, with a groove between them. The upper land 142 is provided with diagonal passages 144 communicating with the hollow of the spool. At its upper end, the spool carries an extension 145 which is grooved to receive the actuating pin of a shipper arm 146. The shipper arm 146 is connected in a suitable manner to be actuated from the exterior of the housing by an operating handle 147 (Fig. 2), as will be well understood by those skilled in the art.

Conduit 148 connects the upper end of cylinder 136 with the pump suction, and a conduit 149 (Figs. 11, 12 and 13) connects the pump discharge with the lower end of cylinder 136 by way of passage 150. A conduit 151 connects valve 132 with the lower end of hydraulic cylinder 48, by way of a radial passage 152 in cylinder head 154 and an axial passage 156 extending upward from the radial passage 152. A pressure relief valve V_r is located in a branch off conduit 149, and discharges into the reservoir space. Obviously, valve V_r is effective (and necessary) only for the operating position of member 141 shown in Fig. 12.

As is best seen in Fig. 6, axial passage 156 opens into the lower interior of cylinder 48. Slidable axially within cylinder 48 is an annular member 158. Annular member 158 is preferably provided at its lower end with any suitable seal, such as the O-ring shown lying in the groove (Fig. 6). Annular member 158 is provided with keyways 160 throughout its length except for the head portion at the lower end containing the groove in which the O-ring lies. At its upper end, cylinder 48 is slotted axially to receive keys 162. Keys 162 are held against radially outward movement by a skirt 164 depending from upper cylinder head 166. Upper cylinder head 166 has threaded connection with cylinder 48 at 168, and is provided with a resilient annular ring 170 of any suitable substance, such as rubber or the like. A second short depending skirt 172 forms with the skirt 164 an annular groove which receives a suitable packing material 174. The packing 174 is engaged by the upper end of a sleeve 176 which is provided with a flange 178 whereby it is secured by means of bolts 180 to the cover 8.

A second annular member 182, similar to but smaller than annular member 158, is reciprocable inside the annular member 158. The two annular members 158 and 182 are keyed together against relative rotation by means of keyways 184 provided in the outer surface of member 182, and keys 186 (shown in dotted lines in Fig. 10), carried in annular member 158 in its upper end. A second upper cylinder head 188 is screwed to the upper end of annular member 158 at 190. Upper cylinder head 188 has no depending skirt to hold the keys 186 in place in annular member 158 in the manner that upper cylinder head 166 holds the keys 162 in place in cylinder 48. Instead, keys 186 merely fit through slots (not shown) in member 158, and are preferably welded in place.

Annular member 158 has secured to its upper end 192 a

sleeve 194, slotted as shown at 196 to discharge the cuttings; sleeve 194 is provided with an internal flange 198 at its lower end. Flange 198 is welded as shown at 200 to the annular member 158 at the upper end 192. Upper cylinder head 188 is screwed to the upper end of annular member 158, as indicated above, and bears against the upper face of flange 198. At the lower end of its interior, annular member 158 is grooved to receive a snap ring 202. The snap ring 202 serves as a lower limit stop for the annular member 182.

A third annular member 204 is reciprocable or slidable telescopically within the annular member 182, and is secured against rotation relative thereto by means of keyways 206 in annular member 204 and keys 208 secured in slots in annular member 182 and held in those slots against radially outward movement by the keeper strips 210 which may be secured in place in any suitable manner. A third upper cylinder head 212 is threaded to the upper end of annular member 182. At the lower end of its interior, the annular member 182 is grooved to receive a snap ring 214 which serves as a lower limit stop for the annular member 204.

As in the case of the annular members 158 and 182, the annular member 204 is provided at its lower end with a pistonlike portion which is not cut by the keyways 206, and which carries an O-ring to provide a fluid seal.

A shaft 216 is telescopically mounted with respect to the annular member 204 and is held against rotation with respect thereto by means of keyways 218 in the shaft and keys 220 and 221 secured in the annular member 204 near its upper end. Keys 220 and 221 may be secured in place in any suitable manner, as by being inserted through slots in the wall of the annular member 204, and welded in place.

A fourth upper cylinder head 222 is threaded to the upper end of annular member 204. Near the lower end of its interior, annular member 204 is grooved to receive a snap ring 224. Snap ring 224 serves as a lower limit stop for the rotatable shaft 216.

Cylinder heads 188, 212, and 222 are provided with seals or annular rings of rubber or the like, similar to the annular ring 170 provided for cylinder head 166. It will be understood that the rubber seals will have radially inward projecting ribs filling in the keyways to keep foreign matter out of the mechanism.

The sleeve 194 carries at its upper end a device 226 to engage an extraneous abutment, as for example the roof of a mine room. Inasmuch as the abutment engaging device 226 will be stationary with respect to the abutment it engages, it must be rotatable with respect to the annular member 158 on which it is carried by means of the sleeve 194. This relative rotation is provided by the antifriction bearing 228. Device 226 may be, and preferably is, provided with serrations 230 at its upper end.

Sleeve 194 is provided with openings to receive pins or dogs 232. Dogs 232 extend radially inward beyond the inner surface of sleeve 194 and serve to engage slots 234 of a tool such as a wrench 236. The wrench attachment 236 is provided with a suitably designed central opening 238 (Fig. 7) adapted to fit the nuts that are to be screwed to the ends of the expansion bolts.

Reference is made again to the electric motors which drive the gear pump and the hydraulic cylinder. The rotors 76 and 78 of these motors are shown as provided with cooling fans 240 at their lower ends. Suitable axial passages will be provided through the field windings (not shown) to allow the passage of cooling air through these windings. Other axial passages 241*a* (Fig. 4) and 241*b* are provided in the outer portion of the casing 2. Brush supports in the form of discs 242 are secured adjacent the commutators of the rotors by being clamped between the upper ends of the motor housings 244 and depending skirts 246 of cover 8. As is best seen in Fig. 9, discs 242 are provided with peripheral recesses 248 to permit the passage of the cooling air into the field windings from the end spaces 250 provided by the cover 8. The skirts 246 are slotted as shown at 252.

Power is supplied to the electric motors in any suitable manner, as for example through a power cable 264 carried on a cable reel 266. Suitable switch means housed in a box 268 and having an operating button 270 is provided in order to allow the power circuit to the motors to be made and interrupted at will.

Operation

In the use of a device made according to this invention, the device is wheeled about in the room to the location where it is desired to drill a hole, as taught in my above-identified application Ser. No. 120,734, filed October 11, 1949. By way of illustration, it will be assumed that a hole is to be drilled in the roof. The machine is upended on the ground-engaging support 14 into the position shown in Figs. 3 and 14, or Fig. 15, whereupon the operator manipulates the handle 74 to engage the shipper ring 58 with the gear teeth 70 or the gear teeth 72, depending on the operation. In this case, it is assumed that a hole for a roof bolt is to be drilled, so the ring 58 will be shifted upward in order to make the connection for high speed. The electric power switch is then closed by pressing button 270 to complete a circuit to the motors. With the motors operating, the gear pump 130 is rotating and is supplying oil under pressure to the valve 132 by way of conduit 149.

With the valve in the position shown in Fig. 11, oil merely circulates through the center of the hollow spool. The operator moves the handle 147 to shift the valve member from the position shown in Fig. 11 to the position shown in Fig. 12. Oil under pressure is then supplied from the pump to the bottom of the hydraulic cylinder 48.

With oil under pressure supplied to the lower end of cylinder 48, annular members 158, 182, and 204, and shaft 216 all move upward together, until the roof-engaging device 226 brings its serrations 230 into contact with the roof. There may be some slight penetration of the roof by the roof-engaging device (but such penetration will be largely superficial) until substantial resistance is offered by the roof, whereupon the drill presents a substantially rigid column extending from the mine bottom to the roof by way of the telescopic hydraulic cylinder and annular member 158.

It will be remembered that meanwhile the two motors are rotating the hydraulic cylinder, the annular members and the rotatable rod by means of pinions 90 and 91, gear 92, gear teeth 70, internal gear teeth 60, shipper ring 58 and keys 56, 162, 186, 208, 220 and 221. This is the high-speed drive and the drill 46 rotates at drilling speed.

As soon as the roof-engaging device 226 encounters substantial resistance and stops its upward movement, the next annular member 182 moves telescopically outward and upward from the annular member 158. The drill cuts into the roof strata and the cuttings drop downward and fall out through slots 196. Annular member 182 continues to move telescopically outward, sliding axially within annular member 158, until the ends of keyways 184 come against the lower ends of keys 186. When this limit of travel of the annular member 182 is reached, annular member 204 slides within annular member 182 until the lower ends of keyways 206 come against the lower ends of keys 208.

When the upper limit of travel of annular member 204 is reached, shaft or rod 216, which now acts as a piston in the hydraulic cylinder, moves telescopically upward, advancing the drill into the roof. Rod 216 moves upward within annular member 204 until the ends of keyways 218 come against the lower ends of keys 220. This represents the absolute upper limit of travel of the drill, but it will be observed that the drill is now extended upward from the position shown in Figs. 3 and 6 by sub-

stantially the length of annular members **182** and **204**, and rotatable rod **216**, plus such upward movement of annular member **158** as was possible until roof-engaging device **226** came into contact with the roof, minus, of course, the limitations imposed by the fact that the several keyways must of necessity remain in engagement with their respective keys.

It may be noted that relief valve V_r may be by-passing oil some of the time during upward movement of the drill. Valve V_r will be set to open at a pressure high enough to give an adequately high pressure to advance shaft **216** alone against the resistance of the roof strata. If the drill should move upward so fast as to overload the drill drive motors, the operator can slow down the feed by manipulating valve member **141** so as to throttle the fluid going to cylinder **48**.

It will be observed that the drill bit cuts an opening larger than the outside diameter of the largest cylinder entering the drilled hole—namely, the annular member **182**.

To lower the drill and its connecting rotating rod and annular members, the operator manipulates the handle **147** in order to shift the valve member from the position shown in Fig. 12 to the position shown in Fig. 13, in which position the suction of pump **130** is connected with hydraulic cylinder **48**, by way of conduits **148** and **151**, and cylinder **136**. After the several annular members and the rotatable rod have been telescoped back down out of the hole in the roof, the operator manipulates the handle **147** to shift the valve member from the position it occupies in Fig. 13 into the position shown in Fig. 11, in which position fluid is trapped in cylinder **48**, and the downward movement of the drill is arrested, if it has not already reached the extreme lower limit of travel. The operator manipulates handle **74** to shift the shipper ring **58** into neutral, and then slips the wrench attachment **236** into place with the slots **234** engaging the pins **232**.

A roof bolt is put into place and secured in the hole just made by the drill. Roof bolts of any suitable type may be used, such as the bolts disclosed and claimed in my copending application Ser. No. 120,734, filed October 11, 1949, referred to above. A crossbeam or plate **272** may then be placed against the roof and a nut started manually on the projecting end of the bolt; if the hole is at an angle as in Fig. 16, an angle iron **274** may be added, after which the operator manipulates the handle **147** to admit oil under pressure to the bottom of the hydraulic cylinder **48**, moving annular member **158** upward until the wrench engages plate **272** (or angle **274**), at which time the opening **238** in the wrench attachment is in position to receive the nut. The operator then manipulates the handle **147** to trap the oil within cylinder **48** to hold the wrench in the desired position. The shipper ring **58** is then shifted to mesh teeth **62** and **72**, rotating the wrench at low speed, whereupon the nut is screwed up tight by power of the electric motors to clamp the plate **272** firmly against the roof. When the nut is tight, the clutch discs **111*b*** and **111*c*** stop, and disc **111*a*** slips between them.

The above description of operation of a device made according to this invention has concerned its application to the task of drilling a hole in the roof, securing a bolt in place in that hole, and tightening a nut on the bolt. It will of course be evident to those skilled in the art that the device can be used to drill holes in the mine strata other than in the roof. For examples of applications of the bolting of mine strata, roof or otherwise, reference can be had to my above-identified copending application Serial No. 120,734, filed October 11, 1949.

As will be understood by those skilled in the art, a device made according to this invention can also be used to remove nuts from roof bolts, merely by reversing the drive motors. Other uses will become evident to those skilled in the art.

The electric motors are kept within operating temperatures by the circulation of cooling air. Air is drawn downward through the motor windings by the fans **240** and circulates upward again through the passages **241*a***, **241*b***, and **258** in the housing **2**, giving up its heat to the surrounding mass of metal, which in turn radiates the heat to the surrounding atmosphere. Thus, the air circulated through the motor is always the same air and is never contaminated with dust from the mine atmosphere. The specific air cooling means shown here forms no part of this invention.

It will be evident to those skilled in the art that this invention provides an easily movable power-operated drill and wrench which will work in a space of low vertical height and which can drill holes equal in length to several times the vertical height of the working space or room; and that this invention provides a further advantage in embodying in one machine a drill as well as a power operated wrench. Other advantages will be apparent to those skilled in the art.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration, and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

I claim:

1. A drill comprising a floor-engaging support, a fluid pressure cylinder rotatably carried by the support, an annular member having telescopic engagement with the cylinder and being extensible upon admission of fluid to the cylinder, a roof-engaging member, means to mount the roof-engaging member on the annular member for free rotation relative thereto, a piston reciprocably mounted in the annular member and having means for fixing it against rotation relative to the cylinder, means to mount a drilling tool on the piston for axial movement and for rotation therewith, means to supply fluid under pressure to the cylinder and to withdraw fluid from the cylinder, and means for rotating the cylinder.

2. In a drill, a rotatably mounted fluid pressure cylinder, an annular member having telescopic engagement with the cylinder and being extensible upon the admission of fluid to the cylinder, means drivingly engaging the cylinder and the annular member, a roof-engaging member, means for rotatably mounting said roof engaging member on the annular member, a piston reciprocably mounted in the annular member, means drivingly engaging the annular member and the piston, means to mount a drilling tool on the piston for axial movement and for rotation by the piston, means to supply fluid under pressure to the cylinder and to withdraw fluid from the cylinder, and means to rotate the cylinder.

3. A drill as in claim 1 in which the roof-engaging member is annular, and has a plurality of closely spaced serrations on the member in position to engage a roof.

4. A drill as in claim 3, in which the annular roof-engaging member is provided with a bore and the means to mount the roof-engaging member on the annular member includes a bearing in said bore.

5. A drill as in claim 1, in which the two last-named means include a common drive motor.

6. A drill as in claim 1, in which the roof-engaging member is provided with a bore and the means to mount the roof-engaging member on the annular member includes a bearing in said bore.

7. A drill as in claim 6, in which the fluid supply means and the cylinder rotating means include a common drive motor.

8. In a drill as in claim 2, a plurality of closely spaced serrations on the roof-engaging member in position to engage the roof.

9. A drill as in claim 2, in which the roof-engaging

member has an internal bore and the roof-engaging member is rotatably mounted on the annular member by means of a bearing in said bore.

10. A drill as in claim 2, in which the fluid supply means and the cylinder rotating means include a common drive motor.

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