This invention relates to rotary bit operating mechanisms, and more particularly to mechanism including a rotary motor and stator adapted for use in connection with drill bits or other earth boring tools.

The principal objects of the present invention are to provide hydraulic means including a rotor having vanes pivoted on trunions for rotation or oscillation of an earth boring tool connected to a drill pipe, the oscillation or rotation being accomplished by pressure of drilling fluid through the tool while the barrel remains stationary and for release of some of the fluid upwardly through the barrel thereby relieving pressure partially at the drill bit should the pressure become too great at that point; to provide passageways through the barrel and rotary mechanism whereby fluid will be forced therethrough to the earth boring tool and pressure will be relieved at the lower portion of the turbine and bit, thereby providing release of pressure in the barrel to facilitate rotation of the mechanism; and to provide for passage of fluid through the mechanism and deposit the same at the end of the drill bit and to conduct the earth formation loosened by the bit from the bore hole. The water courses are so arranged in the barrel that there are restricted outlets at the top of the barrel. The lower outlets through the drill bit are larger and there will be some resistance to water thereon and to the mud and other material in the bottom of the well hole entering the face of these holes. This resistance and pressure building up at the drill bit and bottom of the hole and lower part of the rotor will cause some of the fluid to pass upwardly through the barrel and out the restricted pipes through the top thereof. The water leaves the restricted outlets with great force and will cause a suction action on the fluid around the drill bit and lower part of the barrel and will facilitate removal of such fluid through the casing to the top of the well hole.

Other objects of the present invention are to provide means above the barrel for spacing the same from the wall of the bore hole so that the barrel will not contact the bore hole in the drilling operation; to provide the spacing means with vanes so that the action of the drilling fluid returning from the bottom of the hole upwardly through the bore hole will pass therethrough at an angle to cause rotation of the spacer and thus clean the bore hole of loosened earth material, tending to help keep the drill bit on a straight angle and help to seal off cave-ins, water formations, rocks, etc. from the bottom of the hole; and to provide a bearing support for the rotor including a trunnion for mounting pinion gears for rotation of the drill bit.

Still further objects of the invention are to provide a lining for the rotor chamber forming a cam along one side, the cam surrounding one of the water outlets; to provide means on the vanes for urging the same outwardly to contact the wall of the rotor chamber; to provide the vanes with a coating material to form a contacting surface with the lining of the barrel, said coating or lining being removable and replaceable; to provide a tube through the cam side of the rotor chamber for returning fluid to the top of the barrel; and to provide a devise of this character simple, economical to manufacture, and efficient in operation.

In accomplishing these and other objects of the present invention, I have provided improved details of structure, the preferred form of which is illustrated in the accompanying drawings, wherein:

Fig. 1 is an elevational view of my rotary bit operating mechanism carrying a drill bit and attached to a drill pipe with parts broken away to better illustrate the invention.

Fig. 2 is an elevational longitudinal section of the upper part of the rotor particularly illustrating the water courses to and from the barrel.

Fig. 2A is a longitudinal section of the lower part of the rotor and drill bit.

Fig. 3 is a cross-section taken on a line 3—3, Fig. 2.

Fig. 4 is a cross-section taken on a line 4—4, Fig. 2.

Fig. 5 is a cross-section taken on a line 5—5, Fig. 2.

Fig. 6 is a cross-section taken on a line 6—6, Fig. 2.

Fig. 7 is a cross-section taken on a line 7—7, Fig. 2A.

Fig. 8 is a cross-section taken on a line 8—8, Fig. 2A.

Fig. 9 is a cross-sectional view of the valve for release of excessive pressure on the lubricant.

Fig. 10 is a cross-sectional view taken on a line 10—10, Fig. 2A.

Fig. 11 is a cross-sectional view of the spacing means taken on a line 11—11, Fig. 2, illustrating the vanes for rotating the same.

Referring more in detail to the drawings:

I designates a rotary bit operating mechanism embodying the features of my invention attached to a drill pipe 2 and having a drill bit 3 secured to the lower end of the turbine. The mechanism consists of a cylindrical casing or barrel 4 inter-
nally threaded at its upper end as at 5 and adapted to receive a coupling member or head 6 provided with external threads 7 for receiving the internal end of a tubular coupling member 8. The coupling member has a reduced neck 9 and enlarged upper end 10 internally threaded and adapted to receive the drill pipe 2.

The head 6 has a central opening 11 counterbored as at 12, the upper end of which is provided with threads 13 adapted to receive an externally threaded inverted cup 14. The top 15 of the inverted cup is centrally bored and provided with a threaded plug 16 for a purpose later described. 17 designates a rotor, the upper end of which is provided with a trunnion or shaft 18 extending into the central bore 14 of the head 6. A roller bearing 19 is provided for the trunnions and engages the side walls of the counterbore 12 of the head, the upper end of which bears against the lower edge of the inverted cup member as indicated at 20, Fig. 2. Packing 21 is provided below the roller bearing and 22 designates a packing gland as is the usual practice.

Lubricant 23 is inserted through the opening in the inverted cup by removal of the threaded plug 16 for lubricating the bearing parts and is sealed therein by the packing 21.

The lower end of the barrel is internally threaded as indicated at 24 and adapted to be screw-threadedly attached thereto is a bearing support or coupling member 25 for a trunnion 26 for anchoring the lower end of the rotor 17. The bearing support 24 is centrally bored as indicated at 27 and counterbored at 28 through which the trunnion 26 extends. The upper end of the trunnion is provided with a threaded shank 29 adapted to engage in a threaded bore 30 of the lower end of the rotor 17. End plates 31 and 32 are provided at the respective upper and lower ends of the rotor and adapted to engage over the trunnions 18 and 28 respectively. The respective ends of the rotor are provided with threaded bore openings 33 adapted to receive the threaded shanks 34 of bolts 35 which extend through the plates 31 and 32 for securing the plates to the rotor.

The barrel 4 provides a chamber 36 in which the rotor rotates and the inner wall of the barrel 37 preferably of a hard material such as plastic, hard rubber or the like. One side of the lining is thickened as indicated at 38 (Fig. 5) to provide a cam surface for a purpose later described. The inside of the barrel is provided with longitudinal grooves 39 and the lining with longitudinal ribs 41 for engagement therewith to hold the lining in place.

39 designates a duct for exhaust of fluid upwardly, also as will later be described. The duct 39 is provided with straps 40 extending in a substantially radial direction around the side of the chamber 36 and the thinned lining extends on the inner faces of the straps as best illustrated in Fig. 5, the straps forming a support and making a more rigid structure for the duct 39 as well as stabilizing the cam plastic lining. The rotor 17 is substantially cylindrical in form and is provided with a plurality of longitudinal recesses or grooves 41 running the entire length of the rotor. The plates 31 and 32 at the respective ends of the rotor are provided with aligning apertures 42 forming bearing portions for the trunnions 43, the trunnions being journaled in the recesses of the plates. Formed integrally with the inner ends of the trunnion 43 are vanes 44 adapted to selectively retract within the longitudinal grooves 41 when the rotor is rotated. The integrally formed end of the vanes are substantially flush with the end of the rotor forming shoulders 45 which will engage against the body of the rotor to form a stop and prevent their being urged too far by the action of the fluid. The back of curved portion of the vanes are cut away as indicated at 46 and secured to this curved outer side of the vanes by suitable means is a lining material 47 such as plastic, rubber or the like. The inner end engages against the cut-away portion of the vane and engages the edge of the vane as indicated at 48.

Counter-recesses 47 are formed in the longitudinal grooves 41, and I preferably provide two of such counter-recesses in each groove although any number may be employed as desired. The counter-recesses 47 are provided with threaded bores 48 adapted to receive the threaded shank 34 of bolts 49 for securing flat springs 50 in the longitudinal recesses. The springs 50 have arms 51 set at a slight angle to the base 52 thereof and the longitudinal grooves are provided with longitudinal ribs 53 against which the back of the springs will be urged when the vanes contact the cam 33 and will act as a stop for the springs for a purpose later described. The vanes 44 are provided with webs 54 to act as a bearing surface against which the arms 51 of the springs 50 will engage for exerting outward pressure on the vanes as the rotor rotates within the chamber 35. It will be noted the vanes run longitudinally of the rotor and the ends extend beyond the end of the main body of the rotor and are substantially flush with the outer sides of the end plates 31 and 32. The head 6 and bearing support 25 for the rotor 17 form bearing surfaces against which the respective ends of the rotor rotate, and also the respective ends of the vanes, it being understood that the plates 31 and 32 are secured to and are a part of the rotor.

The trunnion 26 has a reduced end forming a drive shaft 55 upon which is mounted a drive pinion gear 56 which meshes with a plurality of pinion gears 57 mounted on bolts 58 having their threaded ends engaging in threaded bosses 59 in the bearing support 25 for the rotor trunnion. The bolts are provided with washers 60 as best illustrated in Fig. 2A. The trunnion 26 is provided with roller bearings 61, a packing ring 62 being provided at the upper end of the bearing support and a packing ring 63 of a packing gland 54 is also provided above the roller bearing to form a seal at the upper end of the trunnion. Ball bearings 65 are provided on the shaft 55 and are held in place by an upper race 66 and a lower race 67. The lower race 67 has an upwardly extending flange which is tapered as indicated at 68 and forms a retainer for the ball bearings 65. A collar 99 is provided above the upper race 55 to hold the roller bearings in place and to exert pressure on the packing gland 64. The collar 99 has openings to allow lubricant to pass therethrough to the roller bearings as will later be described.

The bearing support 25 for the rotor has a substantially Y-shaped extension as indicated at 70 (Fig. 2A) which forms ducts 71 and 72 for the
flowing of fluid through the mechanism, the duct 71 being connected at its upper end with the chamber 35. The duct 72 extends upwardly through the bearing support 25 and connects with the duct 39, extending through the cam portion of the liner 31. The leg 75 of the Y-shaped extension of the tubular shaft 80 is of substantially cylindrical in shape and is concentric with the rotor trunnion 26 and with the chamber 36.

The barrel 4 is formed in three parts and the lower part is designated 44. Located within the barrel 4, is a tubular member 76 upon the upper end of which is integrally formed a ring gear 77 having internal teeth 78 meshing with the pinion gears 57. The tubular member 76 forms the lower portion of the chamber 35 and has a neck portion 79 externally threaded and connected with a rotatable tubular drive shaft 82 with which connects with the drill bit 3 as later described.

The neck 79 of the tubular member 76 is counterbored as indicated at 81 (Fig. 2A) and engages the leg portion 75 of the Y-shaped extension 25 of the rotor trunnion 26. The leg 75 of the Y-shaped extension is a packing ring 82 which is held in place by a bushing 83 and retains the packing in sealing relation with the cylindrical leg 75 of the Y-shaped extension and the leg of the tubular member 76. The tubular neck 19 of the member 76 is internally threaded to receive the threads of the bushing 83 as indicated at 84.

The lower end of the barrel 4 is provided with internal screw threads 85 adapted to receive a sleeve 98 having threads 97 on its outer periphery adapted to engage the threads 95 on the tapered member 86. The lower portion of the tubular member 76 to which the ring gear 77 is attached is provided with external threads 86 adapted to receive a screw threaded upstanding flange 89 of the rotatable tubular shaft 80 which extends below the end of the barrel 4. The rotatable tubular shaft 80 has a passage 90 through substantially the center thereof which leads from and connects with the leg 75 of the Y-shaped extension 25.

A tubular shaft 80 has ball and roller bearing engagement with the sleeve 86 and with the tubular member 76 to which the main ring gear 77 is attached, which preferably consists of a raceway in the upper portion of the sleeve adapted to receive ball bearings 91 between the tubular member 76 and the sleeve 86. The ball bearings 91 are retained in place by suitable cylindrical rings 92 and 93 which provide the raceway for the ball bearings. The sleeve 86 is provided with an enlarged upper portion having a longitudinal cylindrical recessed portion 94 providing a shoulder 95 adapted to receive roller bearings 96.

The tubular shaft 80 is formed with an annular shoulder 97 providing a raceway 88 for ball bearings 99 held in place by retaining rings 100 and 101. The shank of the rotatable tubular shaft is offset inwardly providing a shoulder 102 and a raceway 103 for roller bearings 105 located between the sleeve 86 and the tubular shaft. A packing ring 105 engages the lower end of the roller bearings and is held in place by a bushing 106 externally threaded to engage internal threads 107 on the lower end of the sleeve 86.

The drill bit 3 may be of any suitable construction and is shown to have a shank 108 having a screw threaded bore opening 109 adapted to receive the external threads 110 on the lower end of the rotatable tubular shaft 80 forming the lower portion of the rotor for attaching the bit to the rotor. The bit is provided with a head 111 having teeth 112 of suitable construction. Ports 113 are provided in the bit head in communication with the passage 90 to provide for flow of drilling fluid from the chamber 36 to the bit head and thence to the teeth for a purpose later described.

The duct 39 extends the full length of the chamber 36 as shown in dotted lines in Fig. 2. The upper end of the duct 39 connects with a duct 114 extending through the head 6 and is suitably connected to a tube 115 which extends through the wall of the coupling member 8 and is open to atmosphere as illustrated in Fig. 2. The lower end of the duct 39 connects with the duct 71 of the Y-shaped extension as previously described.

The duct 72 of the Y-shaped extension 25 extends upwardly through the bearing support for the rotor trunnion and connects with the chamber 36 substantially to one side of the chamber and substantially at the edge of the cam surface of the hard rubber or plastic liner 31 farthest removed from the duct 72 for a purpose later described. I prefer the lining for the barrel and the removable face of the vanes 46 to be of different material. If one is plastic the other may be hard rubber or the like.

The head 6 is provided with a duct 116 in substantial alignment with the upper end of the duct 72, just above described. The duct 116 has a reduced portion forming a port 117 adapted to receive the lower end of a tube 118 extending through an opening 119 in the upper portion of the coupling member 8 opposite the tube 115, the opening 119 being threaded to receive threads 120 on the tube 118. The upper portion of the head 6 is counterbored as indicated at 121 and the tube 118 is pressed thereinto, the tube 115 being similarly connected to the head and coupling member. The tubes 115 and 118 are made removable so as to disengage the head from the coupling member when desired.

An elongated passageway 122 is provided in the head 6 substantially opposite from the port 116 and has its lower end connected with the chamber 35 and its upper end connecting with the tubular coupling member 8 for a purpose later described.

Loosely secured to the coupling member 8 below the enlarged portion 10 so that it will rotate freely thereon is a spacer or mudder 125 of greater diameter than the barrel 4 which is adapted to engage the walls of the bore hole made by the drill bit. The spacing member is made in two pieces and comprises substantially semi-circular members 126 and 127. Each member has spaced inner and outer rings 128 and 129 having radial arms 130 therebetween. The arms are provided with blades or fins 131 formed integrally therewith. The two semi-cylindrical members are secured together by bolts 132 and 133. The spacer is made in two pieces for assembly or disassembly for attachment to the coupling member. The blades or fins are spaced apart to provide openings 134 therebetween so that drilling fluid and loose material from the bottom of the bore passing upwardly will flow through said openings. The blades are set at an angle in the rings so that the fluid passing upwardly will cause the spacer to rotate and the ring will engage the bore hole and mud up the same and hold the barrel of the turbine spaced therefrom.
openings in the spacer are in substantial alignment with the tubes 115 and 118, respectively, so that fluid discharged upwardly therefrom will also flow upwardly through the spacer.

The chamber formed by the lower portion 4' of the barrel surrounding the substantially Y-shaped extension 10 sealingly contains a lubricant as indicated at 135 for supplying the machine to the ring and pinion gears and roller and ball bearings contained in the mechanism.

In assembling a device constructed as described, the plastic lining 37 with its cam 38 is first assembled in the barrel 4. The springs 51 are secured in the counter-recesses 47 of the rotor, and the vanes 44 are pivotally mounted in the grooves 41 of the rotor 17 by securing the end plates 31 and 32 to the respective ends of the rotor by bolts 34, the end plates containing the bearings 42 for trunnions 43 of the vanes 44. The rotor 17 with the vanes 44 attached thereon is then inserted in the barrel 4. The head 6 is then threadedly secured to the upper end of the barrel 4, thus engaging the trunnion 18, the head 6 containing the packing and roller bearings in the centrally bored portion, the latter of which are held in place by the inverted 122 cup 14.

The trunnion 25 is then secured in the lower end of the rotor and the bearing support 25 for the rotor with its roller and ball bearing assembly, as well as the packing gland inserted therein, is placed over the trunnion and threadedly secured to the lower end of the barrel 4, the substantially Y-shaped extension 16 being formed integrally with the bearing support for the trunnion member will extend therefrom as above described. The pinion 55 is placed on the reduced end 59 of the trunnion, and pinions 57 are placed on the bolts 58 of the bolts secured to the bearing support for the rotor trunnion so that the pinions will engage with the teeth of the main drive pinion 56.

The ball bearings 91 and roller bearings 95 are then assembled and the sleeve 96 screw-threadedly engages with the lower end of the barrel 4'. The ball bearings 89 with the retaining rings 100 and 101, are then assembled and the rotor tubular shaft 88 then screw-threadedly engages with the depending neck 79 of the tubular support or coupling member 78. The retaining ring 82 is then inserted in the recess between the depending neck 79, and the packing bushing 83 is screw-threadedly engaged with the depending neck 78. Holes or the like 140 are provided in the packing nut with which a tool may be engaged for tightening the packing nut. Also I preferably provide sockets 141 around the rotatable tubular shaft 80 to be engaged by a tool for tightening the rotor with respect to the coupling member.

The roller bearings 104 are then placed in the groove 142 provided between the sleeve 88 and the rotatable shaft 80, the recesses forming raceways for the roller bearings, and the roller bearings are held in place by a packing ring 105 held in place by the bushing 106, also provided with holes to which a tool may be engaged for tightening the packing nut.

The entire assembly just above described is then moved into threaded engagement with the bearing support for the rotor 26 so that the teeth 78 of the ring gear 71 will mesh with the teeth of the pinion gear 137. The bearing support member 76 upon which the ring gear is mounted together with the tubular drive shaft 80 connected thereto just above described is then rotated to screw-threadedly engage the bearing support for the rotor to connect the entire assembly together so that the tubular shaft 88 will rotate with the rotor while the barrel and sleeve 86 remain stationary.

The coupling 8 is screw-threadedly attached to the upper portion of the head 5 as best illustrated at 135 for supplying the machine to the ring and pinion gears and roller and ball bearings contained in the mechanism.

Operation of a device constructed and assembled as described is as follows:

Drilling fluid, such as water or the like, may be forced through the drill pipe 2 by a pump (not shown), and enter the elongated passages 1 through the barrel 4 and the rotor 17, and the fluid will be forced through the rotor chamber 36 where it will contact the pockets of the extended vanes 44 of the rotor. As the water contacts the vanes on the rotor, the rotor will be caused to rotate thus causing rotation of the drive pinion gear 56, pinions 57 and ring gear 71 secured in the lower end of the barrel 4' and the ring gear being attached to the tubular drive shaft 80 will cause the shaft to rotate and thus rotate the drill bit 3 at the bottom of the bore hole.

By referring to Fig. 6, it will be noted that I have provided a cam 38 along the inner wall of the barrel which engages in the stator. When the rotor is rotated the outer edges of some of the vanes 44 will contact the cam member and be depressed against the springs 50 so that not more than two of the vanes contact the wall of the barrel at one time. It will be noted that the spring 59 only contacts the vanes when they are depressed by the cam to urge them outwardly when they become depressed as the centrifugal force due to rotation of the rotor will extend the vanes 44 and together with the force of the drill bit fluid thereon will hold them in extended position. It is important in applicant's invention that not more than two of the vanes contact the barrel at one time so as to not allow fluid to pass between the rotor and the cam.

The substantially Y-shaped extension 10 consisting of ducts 71 and 72 extends upwardly through the ring gear and through the bearing support for the rotor trunnion and the duct 72 has connection with the chamber 36 substantially at the shallow end of the cam 38. Most of the drilling fluid from the rotor will pass downwardly through the enlarged portion 73 of duct 72 to the leg portion of the Y-shaped extension and enter the tubular drive shaft and then on through the openings 113 to the drill bit. Due to the resistance met by the water when it enters at the bottom of the hole, back pressure will be encountered and some of the fluid will bypass through port 73 some of which will pass upwardly through port 39 and out through tube 115 at the top of the coupling member and part of which will pass upwardly through the tube 115 to the leg portion 78 of the Y-shaped extension 70. In normal operation, some of the fluid from the rotor will also flow upwardly through duct
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In the head 6 and out through tube 118, the tubes 115 and 118, being in substantial alignment through the openings 134 in the plate 125, will direct flow of said fluid up through the lengths of the tube 128, carrying the loose material and debris therewith and contacting the angle rods or blades 131 will cause the spacer to rotate giving a swirling action to the fluid to carry the material up through the hole to the surface. The reduced size of the tubes 115 and 118 causes the fluid to be exhausted at considerable pressure causing a suction action in the fluid around the drill bit to increase the rate of flow from the bottom of the well hole and thereby cause faster rotation of the drill bit.

In some instances, there may be a gas pressure built up in the chamber for the lubricant 135 due to rotation of the rotor and drill shaft in the barrel and in order to relieve this pressure, I provide an opening 151 in the wall of the barrel 4 and adapted to engage in the opening is a valve 152 comprising a head 153 having a seat portion 154 and stem 155. A spring 156 is provided for engagement around the stem having its inner end engaging the valve head 153 and its other end engaging against a retaining ring 157 pressed into the opening 151. The valve stem 154 has a groove 158 so that the gas may pass through the opening in the barrel to the chamber 159 and out through the groove 158 in the valve stem.

It will be obvious from the foregoing that I have provided an improved rotary bit operating mechanism for an earth boring device in which the bit will be rotated solely by fluid pressure and which provides for release of fluid pressure in the device upwardly therefrom should the pressure become too great at the bottom of the well hole, and thus relieve bottom hole pressure and for fast release of the fluid after passing the rotor and facilitating rotation of the mechanism.

What I claim and desire to secure by Letters Patent is:

1. A rotary motor of the character described adapted to be attached at its upper end to a drill pipe and at its lower end to a drill bit having apertures therein comprising, a barrel, a coupling having a head for attaching said barrel to the drill pipe, a rotor in said barrel, a transmission means within the barrel spaced from said head, said barrel having a lining and a cam surface at one side thereof, said surfaces of said curved portions of the vanes having a removable lining for contacting the lining of the barrel, said passing fluid under pressure through the coupler to the upper end of the rotor chamber in spaced relation to the first named outlet to contact the vanes and effect rotation of the barrel and bit whereby some of the fluid from the rotor will pass upwardly through the first named outlet and some of the fluid will pass through said second duct connected with the other leg of the Y-shaped duct and through the outlet thereof, and some will pass downwardly through the Y-shaped duct to said bit for releasing pressure at the bottom of the well hole and facilitating passage of the fluid from the rotor.

2. A rotary motor of the character described adapted to be attached at its upper end to a drill pipe and at its lower end to a drill bit comprising, a barrel forming a chamber, a coupling having a head for attaching said barrel to the drill pipe, a rotor in said chamber, a transmission means within the barrel spaced from said head, said barrel having a lining and a cam surface at one side thereof extending the length of said rotor, said rotor having grooves longitudinally thereof, vanes pivotally mounted in said grooves, said vanes having curved portions at their outer edges forming pockets along their inner surfaces, the outer surfaces of said curved portions of the vanes having a removable lining for contacting the lining of the barrel, said passing fluid medium through said coupler to the upper end of said rotor chamber to contact the pocket portion of the vanes and effect rotation of the rotor and bit, said fluid passing from the rotor chamber through the outlet duct and second duct and discharging at the upper end of the barrel.

3. A rotary motor of the character described adapted to be attached at its upper end to a drill pipe and at its lower end to a drill bit comprising, a barrel, spaced end members secured in the barrel and forming a chamber therebetween, said members having bores extending longitudinally therethrough, a rotor in said chamber and inextensive therewith, shafts fixed on the ends of the rotor and extending longitudinally thereof, bearing members in the bores of the end members spaced from the ends of the rotor and rotatably mounting said shafts, packing means in said bores surrounding said shafts between the bearings and rotor, means for compressing said packing means to effect seals between the shafts and the end members, a coupling having a head for attaching said barrel to the drill pipe, a transmission means within the barrel below the lower end member, said barrel having a lining and a cam surface at one side thereof extending the length of said rotor, said rotor having grooves longitudinally thereof, vanes pivotally mounted in said grooves, said vanes having curved portions at their outer edges forming pockets along their inner surfaces, the outer surfaces of said curved portions of the vanes having a removable lining for contacting the lining of the barrel, said
grooves having recesses therein, flat springs mounted in said recesses and adapted to engage said vanes to urge the same outwardly as they are depressed by said cam, said transmission means having operative connection with said bit, means forming an enclosing chamber for the transmission means, a shaft extending from the rotor into the last named chamber and having operative connection with said transmission means, a fluid outlet duct communicating with the lower end of the rotor chamber, a second duct connected with the outlet duct and extending to the upper end of the barrel, and means for passing fluid medium through said coupler to the upper end of said rotor chamber to contact the pocket portion of the vanes and effect rotation of the rotor and bit, said fluid passing from the rotor chamber through the outlet duct and second duct and discharging at the upper end of the barrel.

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References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,265,193</td>
<td>Guinn</td>
<td>May 7, 1918</td>
</tr>
<tr>
<td>1,265,836</td>
<td>Leverett</td>
<td>Jan. 18, 1921</td>
</tr>
<tr>
<td>1,453,683</td>
<td>Kochendarfer</td>
<td>May 1, 1923</td>
</tr>
<tr>
<td>1,730,460</td>
<td>Capelinschnicoff</td>
<td>Jan. 27, 1931</td>
</tr>
<tr>
<td>1,804,193</td>
<td>Wintner</td>
<td>May 5, 1931</td>
</tr>
<tr>
<td>1,850,403</td>
<td>Lee</td>
<td>Mar. 22, 1932</td>
</tr>
<tr>
<td>2,002,387</td>
<td>Bannister</td>
<td>May 21, 1935</td>
</tr>
<tr>
<td>2,473,537</td>
<td>McDonald</td>
<td>June 21, 1949</td>
</tr>
</tbody>
</table>