Nov. 24, 1925. 1,562,769

L. B. HUBBARD

REVERSIBLE ROTARY MOTOR (STEAM)

Filed July 16, 1923 2 Sheets-Sheet 1

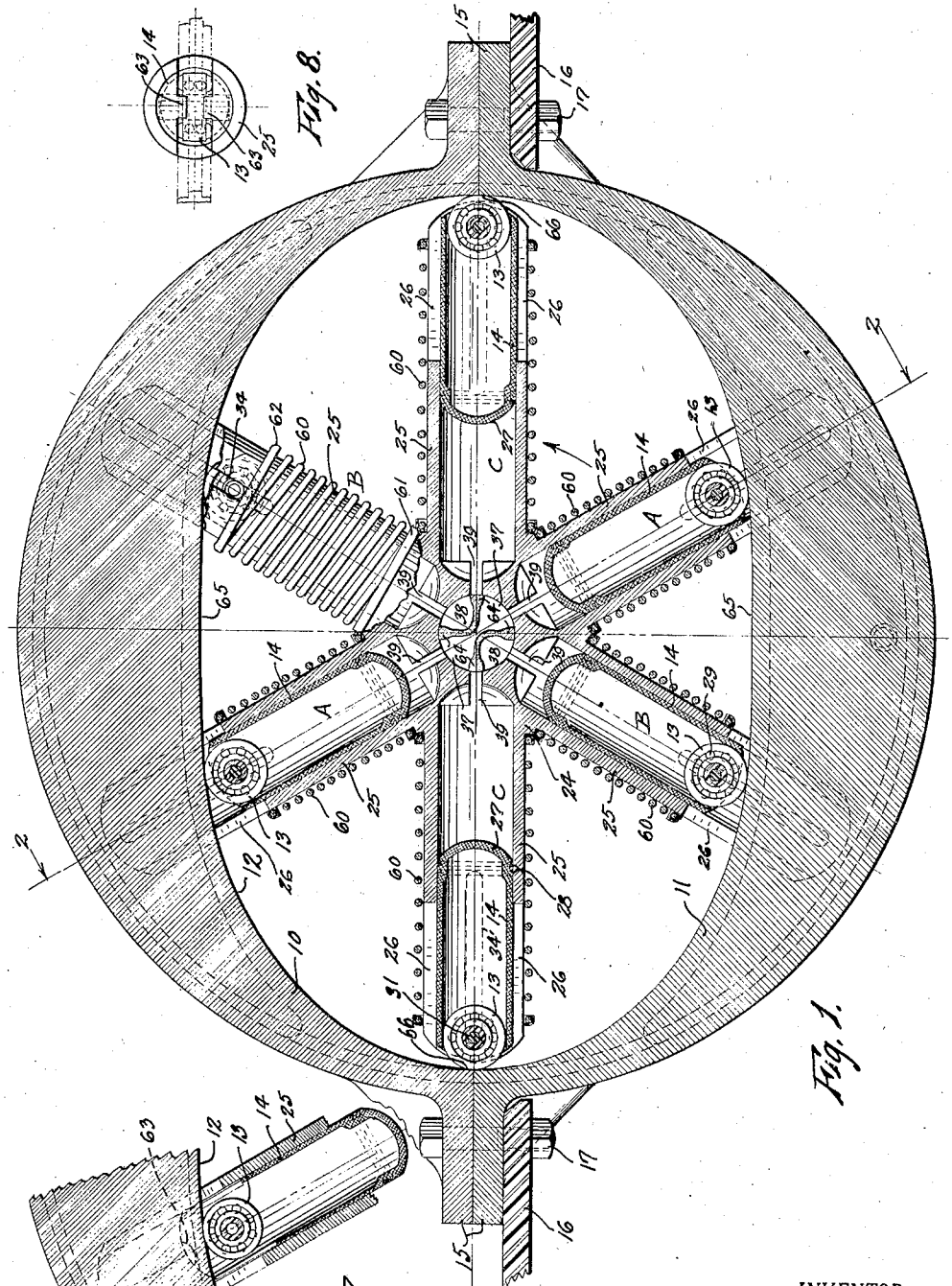


Fig. 1.

Fig. 7.

Fig. 8.

INVENTOR.
Lloyd B. Hubbard
BY Wooster & Davis
ATTORNEYS.

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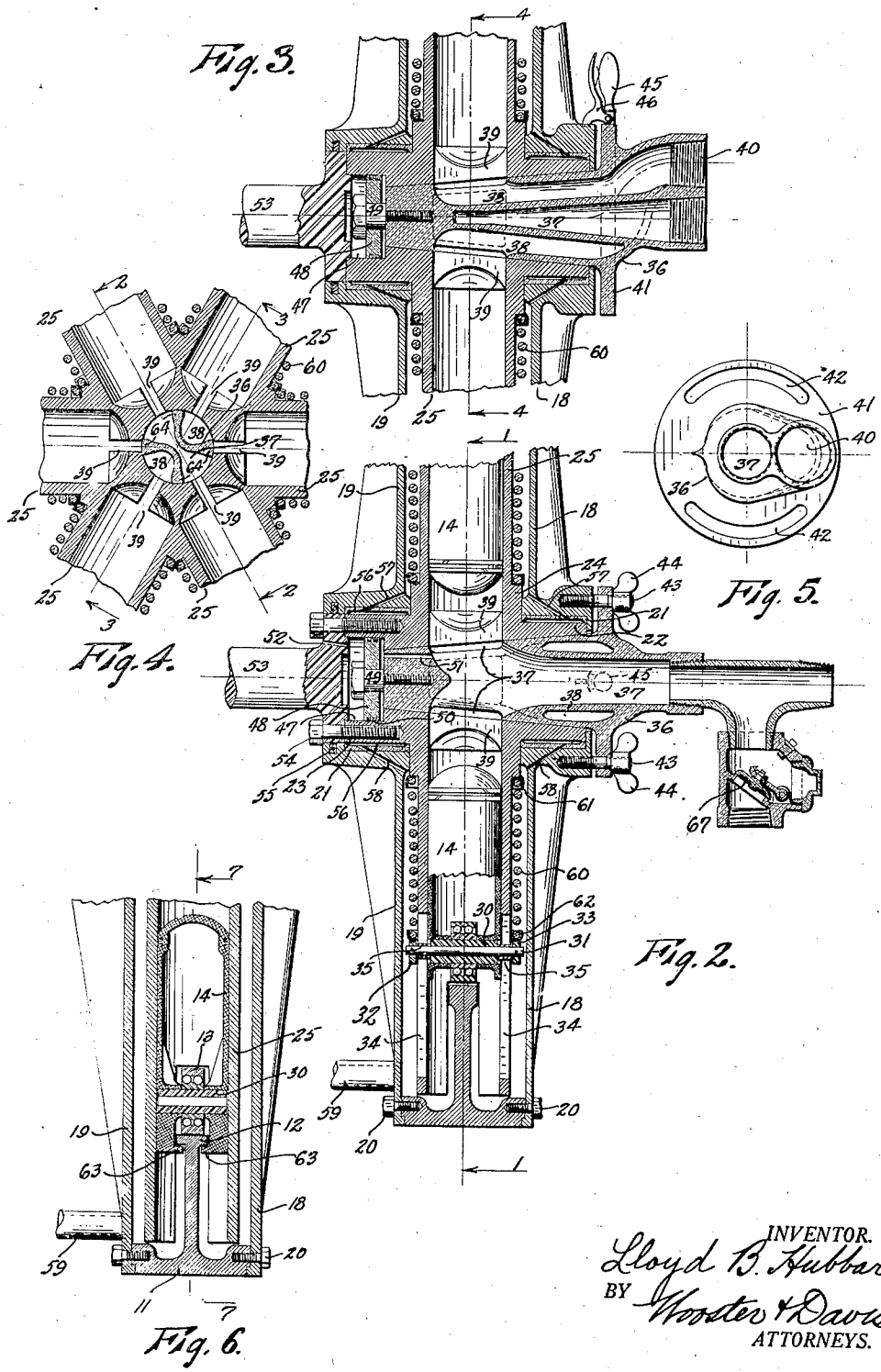


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 2.

Fig. 6.

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Patented Nov. 24, 1925. 1,562,769

UNITED STATES PATENT OFFICE.

LLOYD B. HUBBARD, OF WICHITA FALLS, TEXAS, ASSIGNOR TO HUBBARD REVERSIBLE ROTARY MOTOR CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

REVERSIBLE ROTARY MOTOR (STEAM).

Application filed July 16, 1923. Serial No. 651,754.

To all whom it may concern:

Be it known that I, LLOYD B. HUBBARD, a citizen of the United States, residing at Wichita Falls, county of Wichita, State of Texas, have invented new and useful Reversible Rotary Motors (Steam), of which the following is a specification.

This invention relates to rotary engines, particularly the type in which there is a rotor having a plurality of radially disposed cylinders in which there are reciprocating pistons which carry rollers reacting on an oval track or an eccentric track to rotate the rotor, and has for an object to provide a motor of this type in which the torque is substantially constant throughout the entire revolution of the rotor.

It is also an object of the invention to provide an engine in which the usual cranks, connecting rods, gears, eccentrics and connected parts are eliminated so the engine is extremely simple in construction requiring a minimum number of parts, and is light and compact.

It is a further object of the invention to provide an improved control valve and means for automatically retaining this valve tight so that it will not leak, but which will also yield to allow for expansion and contraction incident to the changes in temperature during the operation of the motor.

It is a further object to so arrange this valve that the tightness of its fit with the rotating element will vary with the pressure of the fluid used in driving the motor, so that the greater the pressure of the driving fluid the greater will be the pressure between the valve and the rotating element.

It is a still further object of the invention to provide a construction for this type of motor which may be more easily and efficiently lubricated, and with the use of a minimum amount of oil.

It is also an object of the invention to provide a construction in which there is practically no loss of power due to wire drawing through the inlet valve when this valve is opened for the admission of the motive fluid, and it is a further object of the invention to provide an engine and valve which will allow quick and easy reversal of the engine by a simple movement of a single element.

With the foregoing and other objects in view I have devised the construction illustrated in the accompanying drawing, in which

Fig. 1 is a transverse vertical section through the motor at substantially the center line thereof as indicated in line 1—1 of Fig. 2.

Fig. 2 is a longitudinal section through one of the cylinders, the control valve and a portion of another cylinder substantially on line 2—2 of Figs. 1 and 4.

Fig. 3 is a similar section substantially on line 3—3 of Fig. 4.

Fig. 4 is a transverse section view substantially on line 4—4 of Fig. 3.

Fig. 5 is an end view of the control valve looking from the right of Fig. 3.

Fig. 6 is a transverse section of a portion of the casing and a cylinder showing a slightly different construction.

Fig. 7 is a transverse section substantially on line 7—7 of Fig. 6, and

Fig. 8 is an end view of the cylinder shown in Figs. 6 and 7.

The engine comprises a stator, preferably made of a plurality of sections, there being two sections 10 and 11 which are substantially T-shaped in cross section, as shown in Figs. 2 and 6, and which together form an oval shaped guide track 12 upon which the rollers 13 carried by the reciprocating pistons 14 run. The sections 10 and 11 are provided with supporting lugs or brackets 15 by which the casing may be mounted on suitable supports, as shown at 16, by suitable bolts 17. The open sides of the casing are closed by a pair of plates 18 and 19 which may be secured in position by any suitable means, such as screws 20. The plates 18 and 19 are provided with bearings for the rotor, preferably bushings 21 in which the outwardly projecting cylindrical bearings 22 and 23 on the rotor 24 are mounted to rotate.

The rotor comprises a plurality of cylinders 25 radially disposed about the axis of rotation, and I prefer to use six of these cylinders, although a larger or smaller number may be employed if desired. In the embodiment illustrated I have shown six cylinders, and these cylinders are slotted at their outer ends, as shown at 26, to straddle the track 12 throughout a portion of the revolution to assist in keeping the elements in alignment. Mounted to reciprocate in the cylinders are pistons 14 which are preferably

hollow but closed at their inner ends 27, and are provided adjacent this closed inner end with circumferential grooves 28 for resilient or other packing rings to make a tight fit as is the common construction. At their outer ends each piston is provided with a roller 13 which runs on the track 12, and is mounted with ball-bearings 29 to reduce the friction as far as possible. To support this roller a transverse sleeve 30 is mounted adjacent the outer end of the piston on a pin 31 which has a head 32 at one end and a nut or washer 33 secured thereto at the other end, the head and nut or washer being outside the cylinder with the pin extending through slot 34 in the cylinder walls, and rollers 35 are preferably mounted on this pin in the slots to reduce the friction as the piston reciprocates.

At the center of the rotor is a tapered longitudinally extending bearing opening in which is mounted a correspondingly tapered valve member 36. This valve member has longitudinally extending passages 37 and 38 forming inlet and exhaust passages respectively for the motive fluid, such as steam or air, and which passages extend laterally through the sides of the valve member. The rotor is provided with a passage 39 leading from the bearing opening for the valve member to the inner end of each cylinder, and this preferably extends throughout the entire width of the cylinder, and longitudinally of the valve member so that a large fluid passage may be secured. The inlet and exhaust passages are connected to inlet and exhaust pipes for conducting the fluid to the valve from any suitable source of supply as a boiler, and for conducting the exhaust to any suitable point of discharge. It will be noted that the inlet and exhaust passages 37 and 38 are located in a single valve member, the inlet passage being preferably in the center extending longitudinally thereof, and there being two exhaust passages located on opposite sides of this inlet passage but leading to a single outlet opening 40. This arrangement provides a simpler construction and also greatly facilitates reversing the engine.

For this purpose the valve member is provided outside the stator with a flange 41 which is provided with a pair of slots 42 arranged on the arc of a circle through which studs 43 extend, these studs having threaded engagement with the hub of the plate 18, and are provided with suitable nuts 44 for retaining the valve member against withdrawal from the rotor. A handle 45 is secured to this flange and carries a suitable spring pressed latch 46 adapted to engage notches in the hub to retain the valve in different desired positions. By means of this handle the valve element may be rotated about its axis in either direction to vary the position of the inlet and exhaust openings to vary the cut-off and exhaust, and also for reversing the engine in a manner that will later be described.

At the inner end of the valve member the rotor is provided with a cylindrical bore 47, in which there is a piston 48 which is connected to the inner end of the valve element 36 by any suitable means, as a screw 49, and this piston preferably has in its periphery suitable grooves 50 for packing to maintain a tight fit with the walls of the cylinder 47. Leading from the inner side of this piston to the inlet passage 37 is a small passage 51 to conduct fluid pressure to the inner side of this piston. This piston is made sufficiently larger than the inner end of the valve member so that the pressure of the steam or other motive fluid acting on this piston will tend to draw the valve member inwardly and retain its tapered outer wall in close engagement with the tapered bearing opening in the rotor, and will thus prevent leakage of fluid through the bearing between these two elements. It will be noted that the pull of this piston 48 on the valve member will vary with the pressure of the motive fluid, so that the greater pressure of the motive fluid the tighter will the valve member be held against the bearing. This is as it should be to prevent leakage of the motive fluid. It also prevents excessive pressure between the elements and thus excessive and unnecessary wear when the fluid pressure is low. The passage or opening 51 is not necessary, because if desired the tapered bearing between the inlet passages 39 and the cylinder 47 may be made sufficiently loose to allow the fluid to leak into this cylinder to act on the piston 48. A discharge passage 52 is preferably provided leading from this cylinder beyond the piston to allow exit of steam or water which may leak past the piston 48 and to prevent pressure building up on this side of the piston. It is especially to be noted that as the cylinder 47 is in the rotor the fluid pressure in this cylinder has no tendency to push the rotor laterally or longitudinally of its axis of rotation. Thus there is no side thrust on the rotor and no thrust bearing is required.

Secured to the rotor 24 on the opposite side of the inlet and exhaust pipes is a shaft 53 which may be connected to any suitable driving means, such as a pulley or gear, not shown, and it is connected to the rotor by any suitable means such as bolts 54. The hub of the plate 19 is preferably provided with a groove 55 about the flange of the shaft to hold a suitable packing to prevent leakage of oil or motive fluid.

To facilitate oiling, oil grooves 56 are provided in bushings 21 and oil passages 57 are provided leading through the hubs of

the plates 18 and 19 to these grooves from the inner walls of these plates and above the bearings, as shown in Figs. 2 and 3, and similar outlet passages 58 are provided leading from the bottom of these bearings to the inner walls of the casing below these bearings. There is also provided an outlet pipe 59 leading from the lower part of the casing to conduct the used oil from the casing, and also any condensation from any steam or water which may have leaked from these cylinders or the control valve. By this construction and arrangement there is a continuous and positive lubrication of all the bearing surfaces with less oil. The oil is admitted with the motive fluid through the central valve member and it of course lubricates this member between the valve and the rotor. It also passes into the cylinders with the motive fluid and is carried by the action of the pistons and centrifugal force to the outer ends of the cylinders where it lubricates the bearings for the rollers 13, both in the piston and on the track, and also lubricates the bearings for the roller 35 and the slots 34. The oil is then thrown out against the casing and that on the upper half flows down the inner surfaces of plates 18 and 19 where some of it is carried by the passages 57 to the bearings and the bushings 21. If desired, grooves, ribs or similar collecting and guiding means may be provided on the inner surfaces of plates 18 and 19 to conduct the oil to the passages 57. After passing through these bearings it runs out through the passages 58 and then runs down on the surfaces of the plates 18 and 19 through the lower part of the casing from which it is conducted by the pipe 59.

When the engine is running the rollers 13 are normally held in engagement with the track 12 by fluid pressure in the cylinders and centrifugal action, but when the engine is stopped, unless some means is provided for retaining these rollers in contact with the track, the upper pistons will drop inwardly to the center of the rotor. One means of preventing this is the coiled springs 60, which are placed about each cylinder and bear at their opposite ends in rings 62. The rings 62 bear against the pins 31 and thus tend to push the piston outwardly. There is practically no loss of power through the use of these springs as in operation when the piston moves outwardly the force of the spring assists in rotating the rotor and practically balances the force required to compress the springs when the pistons are moving inwardly.

Another way of preventing the pistons dropping inwardly when the rotor is at rest is shown in Figs. 6, 7 and 8, in which the lugs 63 are carried by the piston on opposite sides of the track 12 beyond the roller, and so prevent the piston moving inwardly. If preferred rollers may be substituted for these lugs.

In operation, assuming the rotor is moving counterclock-wise as viewed in Fig. 1, it will be apparent that immediately a passage 39 passes by the wall 64 between the inlet and exhaust passages of the valve member, motive fluid will be admitted to the cylinder, and in the present instance to two diametrically opposite cylinders. The track 12, however, is preferably not a true ellipse but is what I call a two to one curve, that is, in shaping this track the gears for feeding the cutting tool in and out have a ratio of two to one with the gear driving the chuck which carries the track, so that for a single rotation of the track the tool is moved inwardly and outwardly twice. This gives the track a shape substantially as shown in Fig. 1 in which the curvature gradually increases from the centers of the upper and lower sides to the opposite ends, and the centers of the upper and lower sides, as shown at 65, are substantially flat for a short distance. It is while the rollers 13 are on this substantially flat portion that the passages 39 are opened for the inlet of motive fluid. It will, therefore, be apparent that the inlet valves are opened while the piston is moving but a very short distance, and therefore, the cylinder is filled with motive fluid before the piston has covered any material portion of its stroke. In other words the inlet valve is wide open before the piston has any material movement and there is practically no loss of power through wire drawing of the motive fluid as it passes through the inlet, as is often the case in reciprocating engines in which there is not sufficiently rapid opening of the inlet valve. As the piston is pushed outwardly under the action of the fluid pressure, the reaction of the rollers 13 on the track 12 from point 65 to point 66 will tend to rotate the rotor, but there will be two diametrically opposite pistons, indicated at A, operating exactly the same. As the roller runs along the track 12 and approaches the point 66, as the curve varies in approaching this point the lateral push on the piston may decrease, the maximum being at a point substantially half way between these points or about 45 degrees, but as the distance of the point of contact between the roller and the track increases from the axis of rotation of the rotor, the leverage increases so that there is not the reduction in turning effort beyond the mid-point that there would be if this leverage remained constant. The turning effort of the cylinder as it leaves the substantially flat portion 65 of the track is also less than the maximum, but this is at a time when the cylinder C is approaching the point 66, and the turning efforts of the two cylinders A and C are practically the same as that of the one cyl-

inder at the point of maximum turning effort. Thus the torque is practically uniform throughout the entire revolution. Immediately after the rollers pass the point 66 the passages 39 come into communication with the exhaust passage 38 allowing the steam from the cylinder to exhaust, and the pistons are driven inwardly under the action of the track until the rollers again reach the point 65. The pistons thus have two working strokes per revolution so that the piston speed for a given rate of rotation of the rotor is twice what it would be with an ordinary reciprocating engine, and thus the loss of heat energy by conduction through the cylinder wall is much less than it is with the ordinary reciprocating engine.

In the operation there is a steam control valve in the steam pipe, not shown, for cutting off the steam supply or allowing passage of steam to the engine at will. If when the engine is running the steam supply is cut off the momentum of the rotor causes the pistons to operate as pumps tending to create a vacuum in the cylinders and the inlet passages 37. To prevent formation of this vacuum I provide in the steam pipe between the steam control valve and the valve member 36 a non-return valve 67 connected with the atmosphere but arranged to open inwardly under atmospheric pressure and allow air to enter to prevent formation of this vacuum. When the engine is running this valve will automatically close to prevent the escape of motive fluid.

The point of opening of the inlet and exhaust valves may be varied as desired by shifting the valve member 36 about its axis, and it will be apparent that by shifting it through an angle of approximately 90 degrees from the position shown in Fig. 1 the inlet passage 37 will be in communication with the passages 39 when the pistons are on the opposite sides of the vertical center line, or in other words the rotor will rotate clock-wise as viewed in Fig. 1. Thus all that is necessary to reverse this engine is to swing the valve member 36 through an angle of approximately 90 degrees. This may be done without any ill effects even when the engine is running. This feature is of particular advantage in certain kinds of work, as in drilling oil wells and so forth. In this type of work it is necessary to reverse the engine often. The advantage of the simple reversing means of the present device will be obvious. Not only may the engine be reversed by simply shifting a single element, the valve member 36, but this member may be shifted to the reversing position when the engine is running without any ill effects. As the torque on this engine is substantially uniform throughout an entire revolution it may be run at low speed under a comparatively heavy load, and there is no danger of it stopping on dead center, as it has no dead center.

It will be apparent from the foregoing description that the engine is very simple in construction, and that the construction of the control valve prevents leakage of motive fluid, automatically compensates for wear, and also automatically compensates for expansion and contraction because of variations in temperature incident to the operation of the motor, and therefore the valve will not be too tight at times when the temperature is high or too loose at other times when the temperature is low. Another advantage of this type of valve in combination with the piston 48 to hold the valve on its seat through the action of the motive fluid pressure, is that when the engine is stopped there is no pressure on piston 48 and so there is no means tending to force the valve member 36 against its seat. Thus as the elements cool the contraction is easily compensated for. As the valve is not forced tightly against its seat at this time it will not bind and become set by expansion of the valve member when steam is passed through the member upon starting the engine again. It will further be apparent that the engine may be quickly and easily reversed, and that there is no complicated valve mechanism for operating the control valves, the usual cranks, connecting rods, gears, eccentrics and connecting elements being eliminated. If desired the valves may be so positioned as to admit steam to the cylinders throughout a great portion of the piston stroke and thus secure a heavy torque in starting or under abnormal load. As the rotor is completely balanced there will be practically no vibration in operation.

Having thus set forth the nature of my invention, what I claim is:

1. A motor comprising a rotor having a plurality of radially disposed cylinders, reciprocating pistons in said cylinders, rollers carried by said pistons, a stator having a track reacting with said rollers to rotate the rotor as the pistons are reciprocated, said rotor being provided with a central, transverse, tapered bearing opening and fluid passages leading from said opening to the cylinders, a stationary tapered tubular valve member in said opening having lateral inlet and exhaust openings adapted to register with said fluid passages, a piston secured to the inner end of said valve member, and means whereby fluid pressure from the supply passage may be communicated to the piston to retain the valve member in said opening.

2. A motor comprising a rotor having a plurality of radially disposed cylinders, reciprocating pistons in said cylinders, rollers carried by said pistons, a stator having a track reacting with said rollers to rotate the

rotor as the pistons are reciprocated, said rotor being provided with a central, transverse, tapered bearing opening and fluid passages leading from said opening to the cylinders, a stationary tapered tubular valve member in said opening having lateral inlet and exhaust openings adapted to register with said fluid passages, said rotor being provided with a cylinder at the smaller end of said valve member, a piston in said cylinder and secured to said valve member, and means forming communication between the inner end of said cylinder and said fluid inlet passage.

3. A motor comprising a rotor having a plurality of radially disposed cylinders, reciprocating pistons in said cylinders, rollers carried by said pistons, a stator having a track reacting with said rollers to rotate the rotor as the pistons are reciprocated, said rotor being provided with a central, transverse, tapered bearing opening and fluid passages leading from said opening to the cylinders, a stationary tapered tubular valve member in said opening having lateral inlet and exhaust openings adapted to register with said fluid passages, said rotor being provided with a transversely extending cylinder, a piston in said cylinder and connected with said valve member, and means whereby fluid pressure may be applied to said piston to hold the valve member in said bearing opening.

4. A motor comprising a rotor having a plurality of radially disposed cylinders, reciprocating pistons in said cylinders, rollers carried by said pistons, a stator having a track reacting with said rollers to rotate the rotor as the pistons are reciprocated and also having plates to enclose the rotor on opposite sides of the track, said rotor being provided with a central transverse bearing opening and fluid passages leading from said opening to the cylinders, a stationary tubular valve member in said bearing opening provided with lateral inlet and exhaust openings adapted to register with said fluid passages, bearings in the side plates, bearings carried by the rotor in the bearings in the plates, said plates being provided with oil passages leading from their inner surfaces to said bearings.

5. A motor comprising a rotor having a plurality of radially disposed cylinders, reciprocating pistons in said cylinders, rollers carried by said pistons, a stator having a track reacting with said rollers to rotate the rotor as the pistons are reciprocated, said rotor being provided with a central, transverse, tapered bearing opening and fluid passages leading from said opening to the cylinders, a stationary tapered tubular valve member in said opening having lateral inlet and exhaust openings adapted to register with said fluid passages, a flange carried by said valve member outside the casing and provided with one or more arcuate slots, studs extending through said slots provided with securing means, and means for shifting the valve member about its axis.

6. A motor including a stator, a valve supported thereby and tapered toward one end, means for holding the valve against rotation, means for admitting steam to the large end of the valve and delivering it radially therefrom, a rotor mounted on the valve and having radial cylinders, an equalizing piston connected to the small end of the valve and lapping a portion of the rotor, means for directing steam from the valve against the equalizing piston to maintain a tight bearing between the valve and the rotor, pistons within the cylinders, and means within the stator cooperating with the pistons for rotating the rotor during the actuation of the pistons.

7. A motor including a stator, a tapered valve carried thereby having a steam inlet at its large end provided with fluid passages for directing pressure radially from the valve, there being an exhaust passage extending inwardly from the periphery of the valve and opening through the large end thereof, a rotor on the valve having a recess in one end, a piston connected to the small end of the valve and supported within the recess, means for directing pressure from the steam inlet against said piston to react against the rotor and maintain a tight bearing between the rotor and the valve, cylinders radiating from the rotor, pistons therein, and cooperating means upon the pistons and stator for rotating the rotor by the reciprocation of the pistons.

In testimony whereof I affix my signature.

LLOYD B. HUBBARD.