June 6, 1933. E. H. SHAFF 1,913,003

ROTARY MACHINE

Filed March 15, 1930 2 Sheets-Sheet 1

Fig. 1

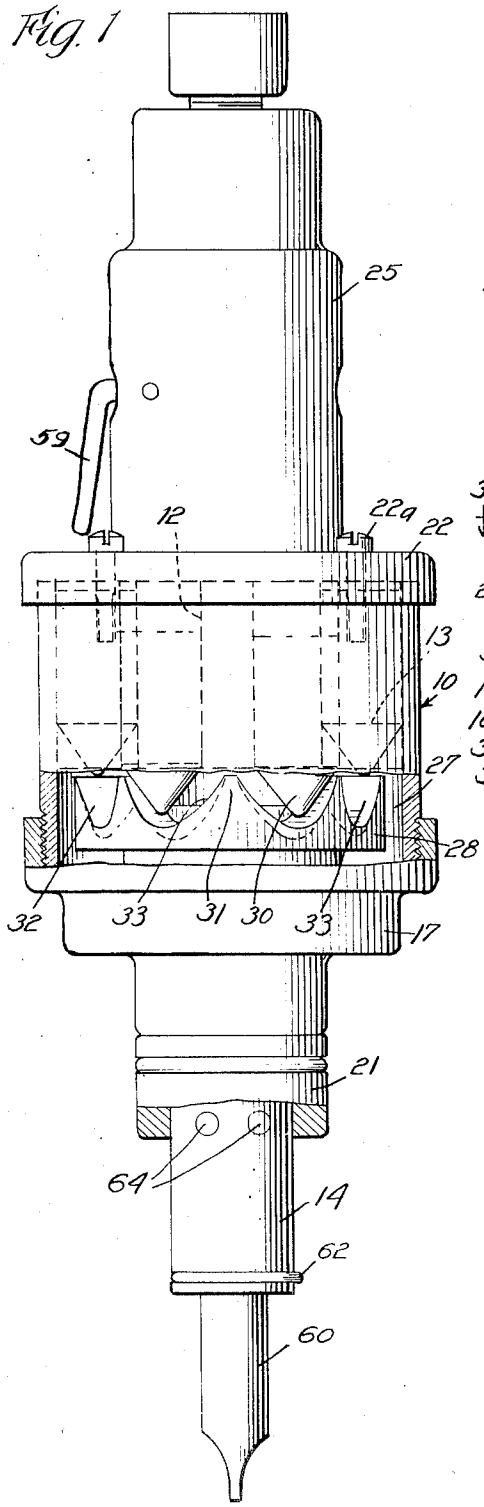
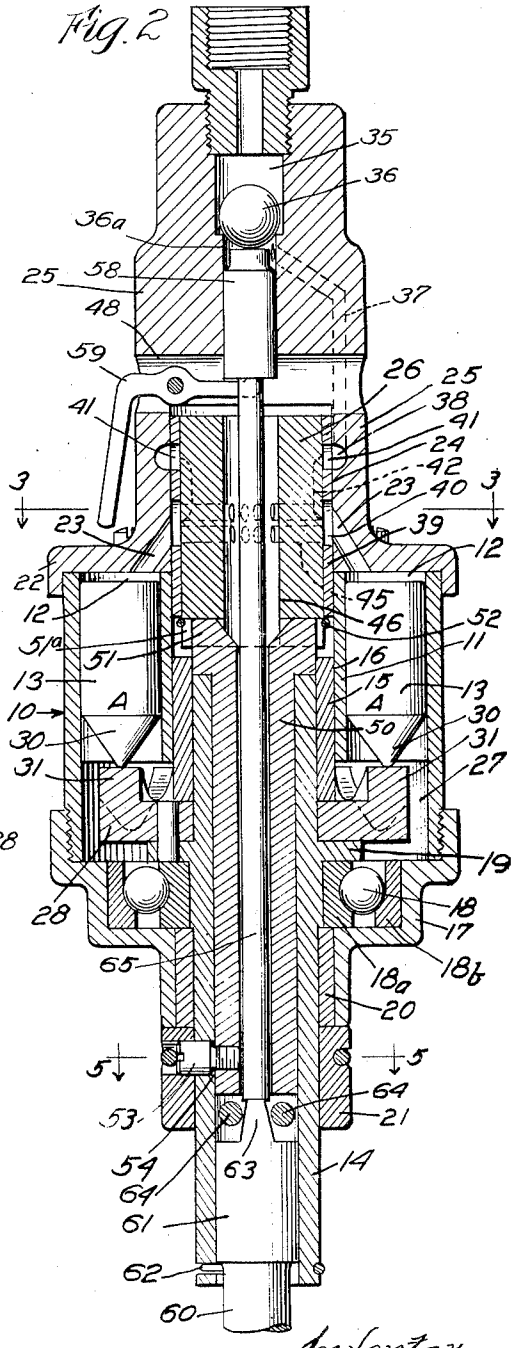


Fig. 2



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Fig. 3

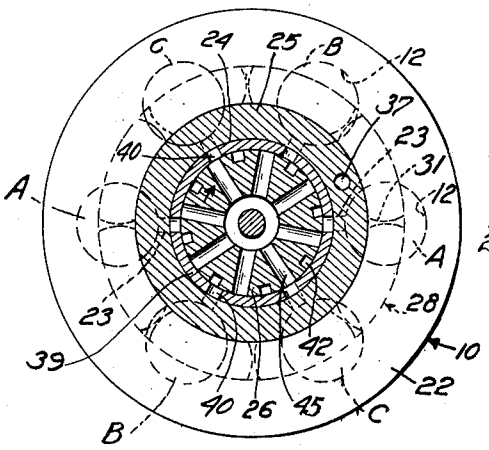


Fig. 4

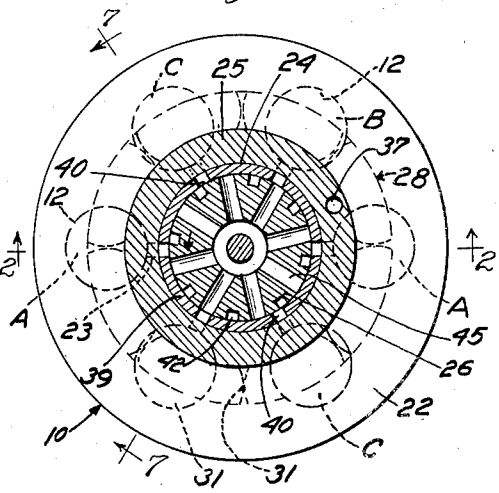


Fig. 7

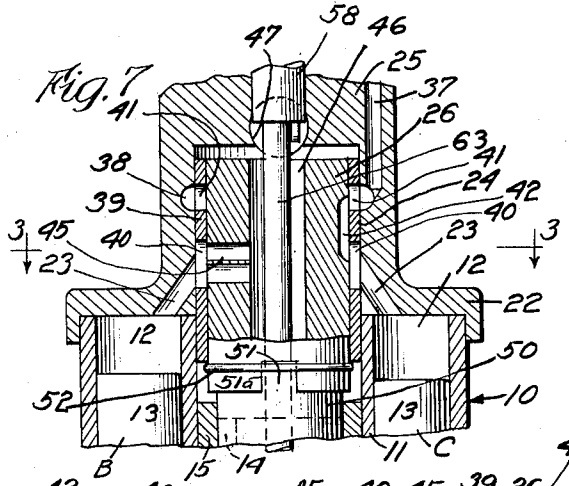


Fig. 5

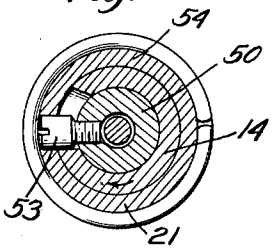


Fig. 6

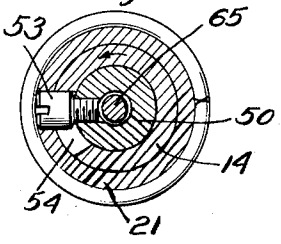
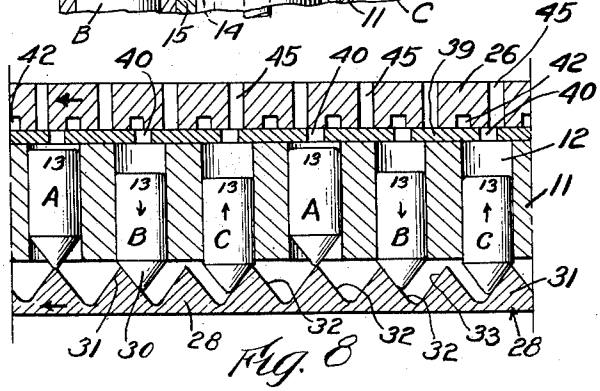


Fig. 8



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UNITED STATES PATENT OFFICE

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ROTARY MACHINE

Application filed March 15, 1930. Serial No. 436,243.

The invention relates generally to rotary machines and more particularly to such a machine having a rotor member and a stator member with reciprocable elements in one of the members, together with means associated with the reciprocable elements and the other member whereby the reciprocable elements may transmit power and motion to or receive power and motion from said rotor member.

The primary object of the present invention is to provide a new and improved machine of this character which is of simple construction and compact form.

Another object is to provide a new and improved motor embodying a novel power-transmission of the character set forth and having a comparatively slow operating speed so as to be adapted for direct driving connection with a tool such as a screw driver.

Another object is to provide such a motor embodying novel and easily operable means for reversing the rotary motion of the motor so that it may be utilized for operating tools which require frequent reversal.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is an elevational view of a motor embodying the preferred form of the invention, a part of the motor casing being broken away to show a part of the actuating means.

Fig. 2 is a longitudinal central sectional view of the motor shown in Fig. 1, the view being taken along the line 2—2 of Fig. 4.

Figs. 3 and 4 are plan sectional views each taken along the line 3—3 of Figs. 2 and 7, showing the distributor valve in its two positions relative to the cam plate and motor shaft.

Figs. 5 and 6 are sectional views taken along the line 5—5 of Fig. 2, showing the motor reversing collar in its two different positions.

Fig. 7 is a fragmental sectional view of the motor taken along the line 7—7 of Fig. 4 so as to show the inlet and exhaust connections to the cylinders.

Fig. 8 is a diagrammatic development of the cylinder block, cam plate and distributor valve, to show the operative relation of the various pistons to the cam plate.

For purposes of disclosure the preferred form of the invention is illustrated in the drawings and will hereinafter be described in detail as applied to a pressure fluid actuated motor, but it is to be understood that this disclosure is not intended as a limitation of the invention to motors or to this type of motor, it being contemplated that various changes might be made by those skilled in the art to adapt the invention to other machines without departing from the spirit and scope of the invention as defined by the appended claims.

In the form illustrated, the motor comprises a generally cylindrical casing or stator 10 including a central cylinder block 11 providing a circular series of parallel cylinders 12 equidistantly spaced apart about the axis of the casing 10. In each cylinder 12 is a slidable trunk piston 13, and through reciprocation in the cylinders the pistons 13 are arranged to impart rotary motion to a rotor in the form of a motor shaft 14 rotatably mounted on the axis of the motor casing 10.

As illustrated herein, the motor shaft 14 extends through the casing 10 and is of tubular form with its upper end journaled in a bearing sleeve 15 positioned in an axial bore 16 formed in the cylinder block 11. The lower end of the shaft 14 extends through an end wall 17 of the casing screw-threaded onto the lower end of the block 11 in spaced relation thereto. To provide a bearing for the shaft 14 the end wall 17 has a central annular recess in which a ball bearing 18 (Fig. 2) is positioned with one side of its inner race 18^a in abutting relation to an annular flange 19 formed on the shaft 14 on the inner side of the bearing. On the shaft 14 on the other side of the bearing 18 is a sleeve 20 abutting the inner race 18^a of the bearing and held in abutment therewith by a collar 21 secured on the shaft 14 outside of the end wall 17.

The upper end of the casing 10 has a closure plate 22 fixed in position by screws

22[a] in overlying relation to the ends of the cylinders 12. Extending through the plate 22 are a plurality of passages 23, one leading from each cylinder 12. All of the passages 23 terminate in the inner periphery of a bore 24 (Figs. 2, 3, 4 and 7) formed in a hub 25 which is integral with the plate 22. To operate the motor, the pistons 13 are actuated by pressure fluid admitted to and exhausted from the cylinders 12 in timed relation to each other under the control of a rotary valve member, designated generally as 26, mounted in the bore 24 and driven by the motor shaft 14. When pressure fluid is admitted to a particular cylinder 12 through the passage 23, the piston 13 therein is forced toward the end wall 17 and into a chamber 27 (Figs. 1 and 2) formed in the casing 10 between its end wall 17 and the cylinder block 11. To receive the rectilinear thrust of the pistons and convert it into rotary motion in the motor shaft, a cam plate 28 is mounted on the shaft 14 in abutment with and pinned to the flange 19. The longitudinal thrust impressed upon the shaft 14 by the pistons is taken by the bearing 18 which has its outer race 18[b] shaped for this purpose.

The present invention contemplates the provision of a powerful, comparatively slow speed motor of small size and to this end, each power stroke of the pistons is utilized to move the motor shaft through an angle which is less than the angular spacing of the pistons. In order to avoid bending stress and side thrust on the motor shaft 14 the pistons 13 are moved in sets disposed about the rotor so that the forces tending to move the rotor transversely are balanced. The present embodiment is such that each set of pistons is composed of two diametrically opposite pistons which are simultaneously actuated and for this reason an even number of equidistantly spaced pistons is provided. The actuation of the pistons in sets or pairs also increases the power of the motor.

In the form shown, six pistons 13 and cylinders 12 are provided, and in the drawings the pistons are designated in pairs, as A, B and C, in order to simplify the description.

For the purpose of converting the rectilinear movement of the pistons 13 into rotary motion in the shaft 14, the pistons have conical ends 30 arranged to cooperate with an annularly arranged series of pointed cam lobes 31 formed in equi-angularly spaced relation to each other on the cam plate 28 and extending toward the conical ends 30 of the pistons 13. Since the present embodiment of the invention contemplates simultaneous actuation of the diametrically opposite pistons, an even number of cam lobes 31 is provided. In the form shown, eight such cam lobes 31 are used since this number causes the strokes of the pairs of pistons to be overlapped and thereby avoids a dead center position of the motor shaft and fulfills the other requirements of the present invention.

Referring particularly to Fig. 8, it will be seen that each cam lobe 31 has a cam surface 32 sloping in one direction at an angle to the axis of the motor shaft 14, and a cam surface 33 sloping at a corresponding angle in the opposite direction. When the cam plate 28 is to be moved in the direction indicated by the arrow in Fig. 8, the pistons of one pair, for example the pair B, are actuated so that the conical ends 30 thereof engage and press against the cam surfaces 32 of two opposite cam lobes 31 so as to move the cam plate angularly. During such movement the other pistons 13 ride upon and are cammed upwardly through their exhaust strokes by the cam surfaces 33 of certain other cam lobes 31. (See the pistons C, Fig. 8).

As soon as the cam plate 28 has been moved sufficiently to position a cam surface 32 opposite each of the pistons of the pair A, this pair of pistons may be actuated. For a short time, the pistons of the pairs A and B may both be actuated, after which the pistons B will be engaged by certain of the cam surfaces 33 and will be moved through their exhaust strokes, it being understood that during such exhaust strokes the cylinders of these pistons will be opened to atmosphere by the valve 26. During this time, the pistons of the pair C are also being moved through their exhaust strokes by certain cam surfaces 33 (Fig. 8) and a cam surface 32 will then be moved into alinement with each of these pistons so that they may be actuated through their power strokes.

It will be seen that each piston stroke moves the shaft 14 through an angle which is considerably less than the angular spacing of the piston so that a great reduction is obtained and a powerful, slow speed motor is provided.

The pressure fluid for actuating the pistons is supplied to a chamber 35 (Fig. 2) formed in the uppermost end of the hub 25 coaxially with the motor shaft 14. From the chamber 35, the fluid, under the control of a ball valve 36 (operated in a manner to be later described), passes into a short counter-bore 36[a]. A passage 37 formed in the hub 25 leads from the bore 36[a] to an annular groove 38 (Figs. 2 and 7) formed in the bore 24 about the sides of the distributor valve 26, and between the valve 26 and the sides of the bore 24 a sleeve 39 is mounted in fixed position.

As shown in Figs. 2, 3, 4 and 7, the sleeve 39 has a plurality of slots 40 formed therein, one communicating with each of the pas-

sages 23 which lead to the cylinders 13. Longitudinally alined with each of the slots 40 is an aperture 41 (Figs. 2 and 7) formed in the sleeve 39 and communicating with the annular groove 38. To conduct the pressure fluid from the groove through the apertures 41 and to the slots 40, a plurality of longitudinally extending grooves 42 (Figs. 2, 3, 4, 7 and 8) are provided in the outer surface of the distributor valve 26. Since each of the pistons 13 is intended to act upon and apply power to each cam lobe 31 as it is positioned in alinement with the piston, there are eight equally spaced grooves 42 arranged for coaction with the six slots 40.

Since the distributor valve 26 moves with the motor shaft 14, the inlet grooves 42 bear a definite relation to the cam lobe 31 so that each time the cam lobe is moved into operative relation with respect to a piston, that piston will be actuated. With this construction each of the pistons operates eight times during each revolution of the shaft 14, and each piston acts on each of the cam surfaces.

The distributor valve 26 also controls the exhausting of the pressure fluid from the cylinders 13 and for this purpose a plurality of radial port holes 45 are formed in the valve 26, extending outwardly from a central bore 46 formed in the valve. The radial ports 45 are positioned so as to communicate at proper times with the slots 40 in the sleeve 39. Each cylinder 13 must, of course, be allowed to exhaust eight times during each revolution of the valve 26, and eight equally spaced ports 45 are therefore provided.

As shown in Figs. 3 and 4, the exhaust ports formed by the radial ports 45 are positioned intermediate the inlet grooves 42, and in order to provide sufficient area in the exhaust ports, two ports 45 may be used in each angular position, spaced longitudinally of the valve 26 as shown in Figs. 2 and 7. From the bore 46 in the valve 26, the pressure fluid passes to the atmosphere through a transverse passage 48 (Figs. 2 and 7) formed in the hub 25.

Referring to Figs. 3, 4 and 8, it will be seen that the inlet grooves 42 and the exhaust ports 45 are proportioned so that the power strokes of the pairs of pistons are slightly overlapped whereby uniform operation of the motor is insured.

The present embodiment of the invention provides for conveniently reversing the motor and for this purpose the distributor valve 26 is mounted on the motor shaft 14 so that it may be adjusted angularly with respect to the shaft. This mounting is provided by a sleeve 50 positioned inside of the tubular motor shaft and having a transverse tongue 51 projecting from its end into a transverse groove 51^a formed in the adjacent end of the valve 26. The valve 26 is held in proper axial position with the tongue 51 and groove 51^a engaged by means of a ring 52 fitted into an annular groove in the valve 26 and engaging the lower end of the sleeve 39.

The sleeve 50 may be shifted angularly with respect to the motor shaft 14 by means of the collar 21 which has a screw 53 (Figs. 1, 5 and 6) extending radially through an arcuate slot 54 in the shaft 14 and engaging the sleeve 50. The shifting movement of the sleeve 50 is limited by engagement of the screw 53 with the ends of the slot 54. The position of the sleeve 50 shown in Fig. 5 corresponds to the position of the valve 26 which is shown in Fig. 3, and when the valve is in this relation to the motor shaft and cam plate, the shaft will be rotated in the direction indicated by the arrow in Figs. 3 and 5.

It will be clear, therefore, that the valve 26 will remain in the position in which it is set, since the valve is driven by the abutment of the end of the slot 54 with the screw 53. This same result will follow when the sleeve 50 and the collar 21 are shifted to the relation shown in Fig. 6, since this relation corresponds to the valve position shown in Fig. 4 which causes rotation of the shaft 14 in the direction indicated by the arrows in Figs. 4 and 6.

As hereinbefore pointed out, the flow of pressure fluid to the motor is governed by the ball valve 36, and for the purpose of unseating the valve 36 a plunger 58 is slidably mounted in the bore 36^a so that one end thereof may be forced toward the valve 36 to lift it from its seat. The other end of the plunger 58 extends into the transverse exhaust passage 48 and a pivoted lever 59 extending into the passage 48 engages the end of the plunger so as to constitute a manual control lever for the valve 36.

The motor herein shown is adapted to be used for operating a tool such as a screw driver 60 (Figs. 1 and 2) which has an enlarged head 61 positioned within the outer end of the motor shaft 14 and held in this position by a spring device 62. At its inner end the head 61 has a tongue 63 projecting between two transverse pins 64 fixed in the shaft 14 so that the tool will be rotated with the shaft.

The head 61 in the present case is arranged to have a limited movement inwardly of the shaft away from the spring device 62 so that when the screw driver 60 is applied to the work, the head 61 will be moved. This movement is preferably utilized to actuate the ball valve 36 and to this end, a rod 65 formed integrally with the plunger 58 extends through the valve 26 and the sleeve 50 and into the path of the tongue 63 on the screw driver.

Thus the motor will be started as an inci-

dent to the application of the tool to the work and will also be stopped automatically when the tool is withdrawn from the work.

From the foregoing it will be apparent that the invention provides a motor having an unusually low operating speed for this type of motor so that it is adapted to be used to drive a tool such as a screw driver. It will also be evident that by reason of the fact that the power impulses are simultaneously applied to oppoiste sides of the motor shaft, all side thrust on the shaft and the distributor valve is avoided and the efficiency of the device is increased. By causing each piston to operate through a plurality of cycles during each rotation of the motor shaft, the motor is rendered highly advantageous since the power of a motor of a given size is greatly increased.

The use of a cam plate of the character herein shown materially simplifies the construction of the motor since a straight motor shaft may be used. The use of a straight motor shaft, in turn, facilitates the use of a control valve which is opened and closed as an incident to the application of the tool to the work.

The usefulness of the motor herein disclosed is greatly increased by the provision of a convenient means for reversing its direction. The arrangement of the reversing means herein shown is of particular advantage since the rotary motion of the motor shaft tends to maintain the valve in the position in which it is manually set.

It is to be understood that the particular arrangement and number of pistons and cam lobes employed in the present embodiment of the invention might be varied by those skilled in the art without departing from the spirit and scope of the invention as defined by the claims. While the invention, as disclosed herein, is embodied in a motor adapted to be actuated by pressure fluid it is to be understood that the principles of the invention are capable of embodiment in other types of rotary machines.

I claim as my invention:

1. A pressure fluid operated motor comprising, in combination, a casing, a hollow shaft rotatably mounted in said casing and having one end projecting out of said casing, piston and cylinder means in said casing operable to rotate said shaft, a rotary distributor valve in said casing alined with said shaft and operable to control the flow of pressure fluid to said cylinders, and a sleeve within said shaft forming a driving connection between said valve and said shaft, said sleeve being mounted for limited angular shifting movement with respect to said shaft between two positions, in one of which said valve causes said pistons to rotate said shaft in one direction and in the other of which it causes said shaft to be rotated in the other direction.

2. A pressure fluid operated motor comprising, in combination, a casing, a hollow shaft rotatably mounted in said casing and having one end projecting out of said casing, piston and cylinder means in said casing operable to rotate said shaft, a rotary distributor valve in said casing alined with said shaft and operable to control the flow of pressure fluid to said cylinders, a sleeve within said shaft forming a driving connection between said valve and said shaft, said sleeve being mounted for limited angular shifting movement with respect to said shaft between two positions, in one of which said valve causes said pistons to rotate said shaft in one direction and in the other of which it causes said shaft to be rotated in the other direction, said shaft having an arcuate slot therein outside of said casing, and a pin in said sleeve projecting through said slot, said valve being arranged so that the engagement of the end of the slot with said pin acts to drive said valve from said motor shaft.

3. A pressure fluid operated motor comprising, in combination, a casing, a hollow shaft rotatably mounted in said casing and having one end projecting out of said casing, piston and cylinder means in said casing operable to rotate said shaft, a rotary distributor valve alined with said shaft and operable to control the flow of pressure fluid, means on said shaft providing a pair of angularly spaced abutments, means connected to said valve and engageable with either of said abutments, said valve being arranged so that when one of said abutments is in engagement with said means the shaft will be driven in a direction tending to maintain said engagement and when the other abutment is in engagement with said means, the shaft will be driven in the other direction so as to tend to maintain the same relation between said means and said other abutment.

4. A pressure fluid actuated motor comprising, in combination, a casing, a tubular motor shaft rotatably mounted in said casing and having one end projecting out of said casing, a cylinder block in said casing providing a plurality of cylinders, reciprocable pistons in said cylinder adapted to apply power to said shaft to rotate the same, a distributor valve for controlling the operation of said pistons, mounted in said casing in alinement with said shaft, a sleeve mounted within said motor shaft and having a driving connection with said valve, said shaft having an arcuate, circumferentially extending slot formed therein outside of said casing, and a member extending through said slot and engaging said sleeve, whereby

said valve may be adjusted angularly with relation to said shaft.

5. A portable pressure fluid operated hand tool comprising, in combination, an elongated casing, an annular cylinder block forming a part of the casing and having a plurality of open-ended cylinders circumferentially arranged in closely spaced relation and extending axially of said block, a piston in each of said cylinders, a shaft concentric with the axis of said block and projecting through one end of said casing, said shaft being adapted to retain a tool in the projecting end, a cam plate fast with said shaft positioned opposite the end of said block and within said casing and having a plurality of cam lobes adapted to be engaged by said pistons to rotate said plate, said casing including a cap, secured at the end of said cylinder block opposite said cam plate, having an elongated cylindrical portion forming a hand grip for the tool and terminating in an annular flange closing the adjacent end of the cylinders, said cap having a pressure fluid supply passage and branch passages leading to said cylinders, a manually operable valve controlling the supply passage, and a distributor valve member located in said cap and rotatable with said shaft to control the branch passages to regulate the supply and exhaust of pressure fluid to said pistons.

6. A portable pressure fluid operated hand tool comprising, in combination, an elongated casing of a size conveniently to be held in the hand of an operator and formed in part of an intermediate cylindrical portion, said intermediate portion including a block providing a plurality of open-ended cylinders circumferentially spaced and extending axially of said casing, a piston in each of the cylinders, a cap forming the rearward end of said casing and having an annular flange closing one end of the cylinders, a cap forming the forward end of said casing, a shaft concentric with the axis of said casing and projecting through the forward end of the casing, said shaft being adapted to retain a tool in the projecting end, a cam plate within the casing fast on said shaft and having a plurality of cam lobes positioned to be engaged by said pistons to rotate said shaft, a bearing located in the forward cap to receive the axial thrust of said cam plate, and a cylindrical valve member located in said rear cap and rotatable with said shaft to control the supply and exhaust of pressure fluid to said cylinders.

7. A pressure fluid operated motor comprising, in combination, a casing, a shaft rotatably mounted in said casing and having one end projecting out of said casing, piston and cam means in said casing operable to rotate said shaft, a distributor valve member rotatable in fixed angular relationship with said shaft and operable to control the flow of pressure fluid to said piston means, and means operatively interposed between said shaft and said valve member manually adjustable to change the angular relationship of said shaft and valve member thereby to reverse the direction of rotation of said shaft.

In testimony whereof I have hereunto affixed my signature.

ERNEST H. SHAFF.