

March 8, 1966

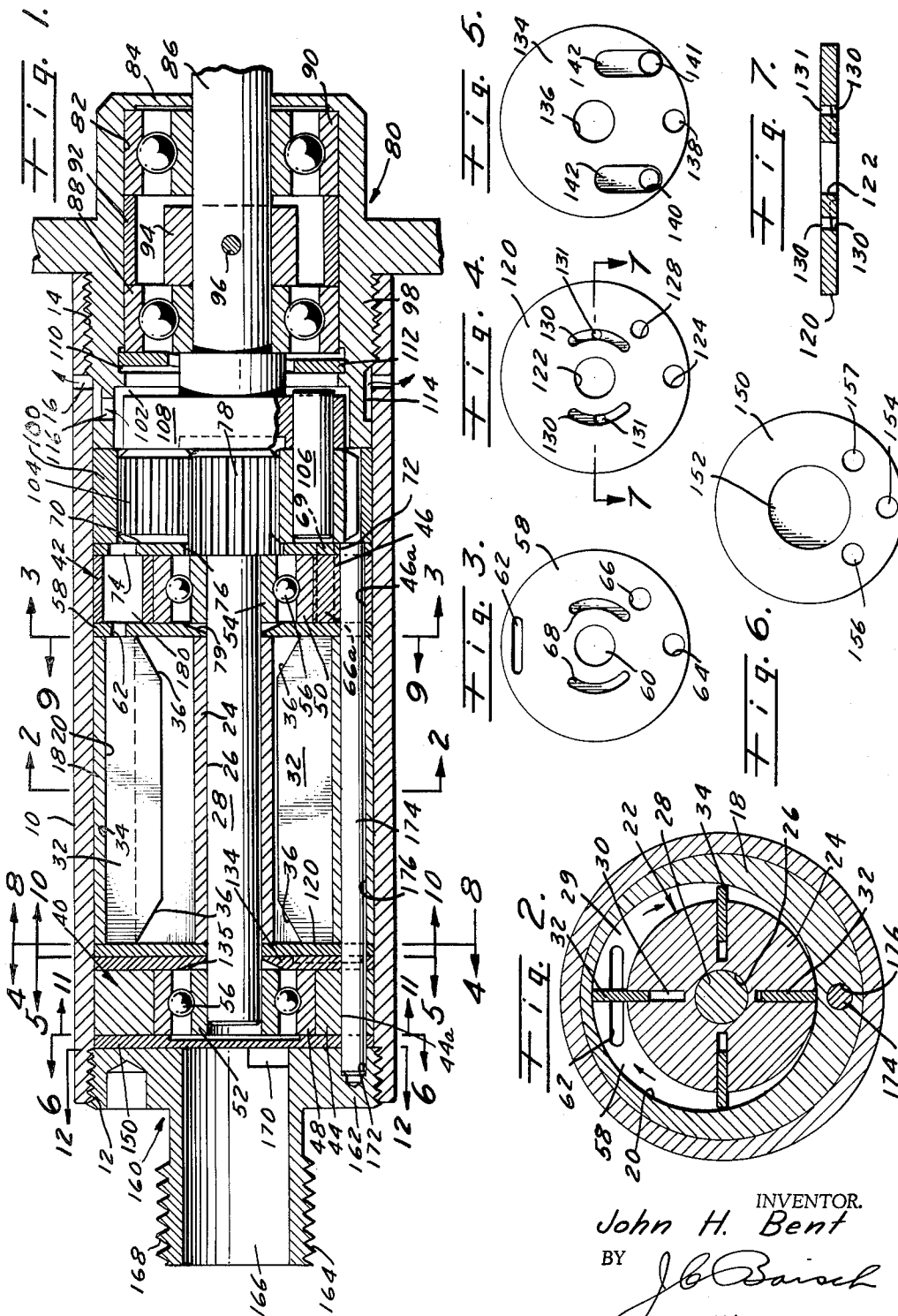
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3,238,848

PNEUMATIC MOTOR

Filed April 8, 1963

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 8.

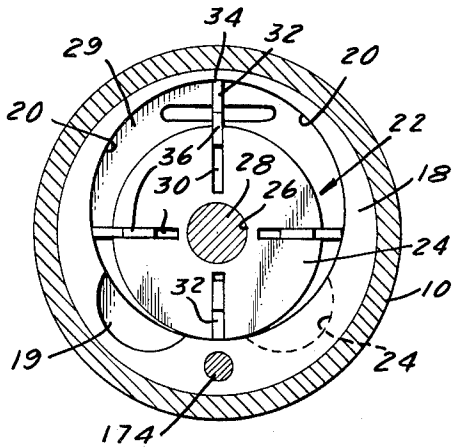


Fig. 9.

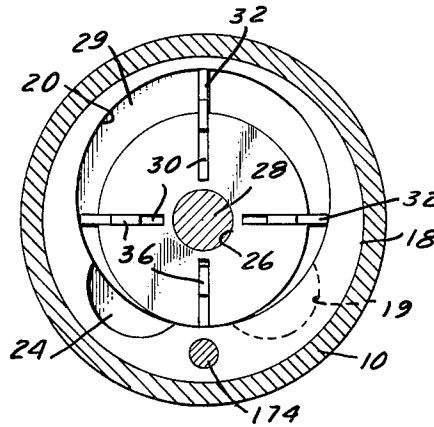


Fig. 10.

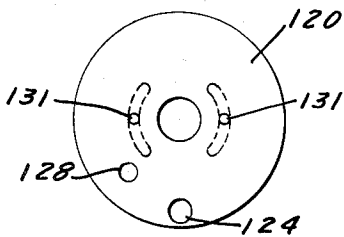


Fig. 11.

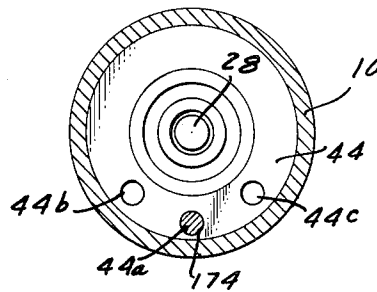
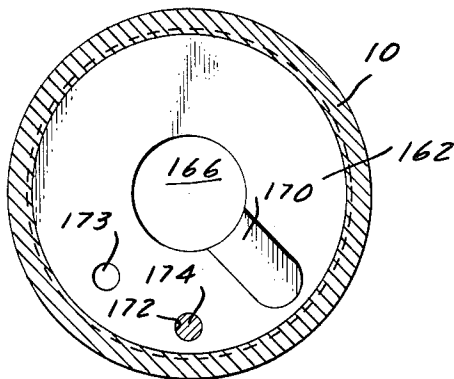


Fig. 12.



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3,238,848

PNEUMATIC MOTOR

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2 Claims. (Cl. 91-138)

This invention relates generally to motors adapted to be actuated by pressure fluid for driving tools, such as, for example, portable screw drivers, wrenches, and the like, and relates more particularly to motors known as the sliding vane type of fluid motor which has a cylinder or stator in eccentric relation with the rotor, said rotor having the vanes which are generally radially movable and which span or traverse the space between the rotor and the cylinder to receive the driving force of the pressure fluid.

While the invention has particular utility embodied in fluid motors driven by air under pressure, and is shown and described thus embodied, it is to be understood that its utility is not confined thereto.

With known air motor structures there are certain known difficulties and problems and it is an object of the present invention to provide a mechanism that overcomes said difficulties and solves said problems.

It is another object of the present invention to provide mechanism of this character that is small and compact and can be conveniently held in the hand of the user and manipulated by said user.

It is still another object of the invention to provide a mechanism of this character that is powerful relative to its size.

It is a further object of the present invention to provide mechanism of this character which will start quickly.

It is a still further object of the invention to provide mechanism of this character wherein the vanes are forced outwardly into operating engagement with the inner wall of the stator immediately upon the admission of operating air under pressure to the motor.

It is another object of the invention to provide mechanism of this character wherein loss of air is reduced to a minimum.

It is still another object of the invention to provide mechanism of this character that is highly efficient.

A still further object of the invention is to provide a motor of this character having novel means for muffling or silencing the high-pitched whistle which otherwise would result from the high-speed operation of the device.

Another object of the invention is to provide a motor of this character having various plates with fluid passages therein.

Still another object of the invention is to provide for operating clearances at the ends of the rotor.

A further object of the invention is to provide a motor of this character that is easily and quickly assembled.

A still further object of the invention is to provide a motor of this character that may be easily and quickly dismantled for inspection, repair, replacement of parts, or otherwise serviced and easily and quickly reassembled.

Another object of the invention is to provide a motor of this character that is simple in construction and that is reliable, rugged and durable.

Still another object of the invention is to provide a motor of this character that will withstand hard usage.

A further object of the invention is to provide a motor of this character that has relatively few working parts.

A still further object of the invention is to provide a motor of this character that has improved features of construction.

Another object of the invention is to provide a motor

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of this character that is relatively inexpensive to manufacture.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawings, which represent one embodiment. After considering this example, skilled persons will understand that variations may be made without departing from the principles disclosed and I contemplate the use of any structures, arrangements, or modes of operation that are properly within the scope of the appended claims.

Referring more particularly to the drawings, which are for illustrative purposes only:

FIG. 1 is a longitudinal sectional view through a motor embodying the present invention;

FIG. 2 is a sectional view taken on line 2-2 of FIG. 1;

FIGS. 3, 4, 5 and 6 are views of various plates as seen from respective lines 3-3, 4-4, 5-5, and 6-6 of FIG. 1;

FIG. 7 is a sectional view of the plates shown in FIG. 4 as taken on line 7-7 thereof;

FIG. 8 is a sectional view taken on line 8-8 of FIG. 1;

FIG. 9 is a sectional view taken on line 9-9 of FIG. 1;

FIG. 10 is a view of the rear end plate as viewed from 10-10 of FIG. 1;

FIG. 11 is a sectional view taken on line 11-11 of FIG. 1; and

FIG. 12 is a sectional view taken on line 12-12 of FIG. 1.

Referring more particularly to the drawings, the motor comprises a cylindrical housing 10 having internally threaded end portions 12 and 14. Adjacent the inner ends of the internally threaded end portion 14 are a plurality of annularly spaced exhaust openings or ports 16 in the cylindrical wall of the housing 10, said ports being in substantially a common plane normal to the axis of said housing 10.

Disposed within the housing 10 is a stator 18, the outside of which is cylindrical and of a diameter to be snugly received in said housing but slidable longitudinally therein.

The stator has an integral, longitudinally extending bore 20 to provide a cylinder for the rotor, indicated generally at 22, the axis of the cylinder being offset relative to the axis of the housing. In other words, bore or cylinder 20 of the stator 18 is eccentric relative to the axis of the housing.

The rotor 22 is disposed in the stator cylinder 20 and comprises a cylindrical body 24 having an axial bore 26 therethrough in which a shaft 28 is received and secured by any suitable means such as a press fit or a pin or key or the like, the axis of shaft 28 being common with the axis of the housing 10.

Thus the rotor 22, when disposed in the cylinder 20 defines therewith a crescent shaped fluid pressure chamber 29.

Body 24 of the rotor is provided with four radial slots 30 which extend longitudinally of said body, said slots being annularly spaced equidistantly apart and in said slots are disposed respective vanes or rotor blades 32 which are slidable radially in said slots 30. While four slots 30 are shown it is to be understood that there can be any suitable number of such slots.

The outer edges 34 of the blades 32 engage the wall of the cylinder 20 and extend the full length of the stator. The inner corners of the blades are cut off, as at 36, so that said inner corner portions of the blades are inwardly and radially inclined to provide additional space in the slots for air entering and leaving the inner portions of the slots 30.

At each end of the stator and rotor there is a ball bearing assembly, indicated generally at 40 and 42, respectively, said bearing assemblies comprising bearing rings 44 and 46, respectively, with outer races 48 and 50, respectively, and inner races 52 and 54, respectively, there being the usual ball bearings 56 disposed operably between the inner and outer races. The outer races are press fit or otherwise secured in the respective bearing rings. As best shown in FIG. 11, the bearing ring 44 of the bearing 40 has a pin receiving opening 44a there-through and air passages 44b and 44c at opposite sides and spaced annularly therefrom.

The bearing assembly 42 is disposed at the forward end of the rotor and a forward end portion of the shaft 28 is operably disposed in the inner bearing race 54 of the bearing assembly 42.

Between the forward end of the stator and rotor and the bearing assembly 42 is a disc or plate 58 which will be termed the forward end plate. This plate abuts against the adjacent end of the stator and has a central or axial opening 60 for reception of the shaft 28. At the top, as viewed in the drawings, said disc or plate has a horizontal slot 62 which would be normal to a perpendicular plane through the axis of the disc. At the bottom said disc is provided with the pin receiving opening or hole 64 and spaced upwardly and to the right, as viewed in FIG. 3, is a relief port 66. At diametrically opposite sides of the shaft opening 60 are oppositely arranged arcuate slots 68.

At the forward end of the bearing assembly 42 is a forward cover plate 70 which abuts against the adjacent side of the bearing assembly 42. The forward cover plate 70 has a pin receiving hole or opening 72 adjacent the bottom thereof and diametrically opposite said hole 72 is a hole 74 for the exhaust air. Plate 72 has a relatively large central opening 76 for reception of the adjacent end portion of a gear 78 integral with the shaft 28.

At the forward end of the housing is an end member, indicated generally at 80, having a cylindrical interior recess 82 and a forward end wall 84, which has an axial opening therein through which an output shaft 86 extends. Within the recess 82 are ball bearing assemblies 88 and 90 in which the shaft 86 is operably disposed. The ball bearing assemblies 88 and 90 are spaced apart longitudinally by a ring-like spacer 92 and a smaller spacer 94 secured on the shaft 86 by a pin 96. A rearward end portion 98 of the end member is externally threaded and screwed into the internally threaded portion 14 at the forward end of the housing 10. The portion 98 of the end member is termed herein a gear case and the rearward end abuts against the forward end of a ring gear 100, the rearward end of the ring gear 100 abutting against the forward cover plate 70. The ring gear 100 and the portion 98 define the gear chamber in which is operably disposed the various gears of the gear system connecting the rotor shaft 28 with the output shaft 86.

This gear system includes the spindle gear 78, three idler gears 104, and the ring gear 100, said idler gears being operably disposed between the ring gear 100 and the spindle gear 78. The idler gears 104 are mounted on respective idler pins 106, which have their forward ends secured in a support member 108 integral with the output shaft 86 and at the rear thereof. The interior of the gear case is provided with an interior annular groove 110 for reception of a retaining ring 112 of any suitable well known character for retaining the bearings 88 and 90 and the spacer 92 in position in the end member 80.

The gear case also has an annular external groove 114 which communicates with the outlet ports 16 in the housing 10 and in turn has connections 116 with the gear chamber 102.

At the rear of the stator and rotor assembly is a disc or plate 120 which abuts against the adjacent end of the

stator. Plate 120 will be termed the rear end plate and has a central opening 122 through which the shaft 28 extends. At the bottom of the plate, as shown in FIG. 4, there is a pin receiving hole or a pin hole 124. Upwardly of the pin hole 124 at one side of the vertical plane extending through the axis of the shaft opening 122 and center of the hole 124 is a hole or air passage 128. Concentric with the hole 122 and at opposite sides thereof are short arcuate grooves 130 arranged in opposite relationship to each other. The grooves 130 are at the side of the plate 120 adjacent the rotor or, in other words, at the forward side of said plate 120 and there are holes 130 through plate 120 communicating with respective grooves 130 intermediate the ends thereof.

At the rear of plate 120 and between said plate and the adjacent bearing assembly 40 is a vent plate 134 which has a central opening 136 therein through which shaft 28 extends. Vent plate 134 has a pin receiving opening or hole 138 at the bottom thereof, as seen in FIG. 5, and upwardly of said hole 138 and at opposite sides of vertical plane extending through the center of hole 138 and opening 136 are openings 140 and 141. In the forward side of vent plate 134 are a pair of vertical grooves 142 which are parallel to each other and at opposite sides of said plane. The lower ends of grooves 142 are connected at the lower ends with the openings 140 and 141 and said grooves extend upwardly to substantially the height of the axis of the opening 136 and are in communication with respective holes 131.

It is to be noted that the forward side of the end plate 58 is countersunk, as at 79, to provide clearance for the inner race 54 of the forward ball bearing assembly 42. It is also to be noted that the rear side of the vent plate 134 is similarly countersunk, as at 135, to provide similar clearance for the inner race 52 of the rear ball bearing assembly 40.

At the rear end of the ball bearing assembly 40 there is a rear cover plate 150 having a central recess 152 in the forward side thereof of greater diameter than the inner race 52 of the rear bearing assembly 40, and thereby provides suitable clearance so that there will be no binding of said inner race 52. The relief or countersunk portions 79 and 135 of the plates 58 and 134 also provide the clearance so that there will be no binding effect between the inner races of the ball bearing assemblies and the respective plates 58 and 134.

Rear cover plate 150 also includes a pin receiving hole 154 at the bottom thereof and upwardly of said hole 154 and at opposite sides of a plane extending through the center of said hole 154 and the axis of said cover plate are holes 156 and 157 through said plate 150.

At the rear of the housing 10 there is a head member or head, indicated generally at 160, which includes a disc portion 162 which is externally threaded and screwed into the internally threaded rear end portion 12. Head 160 has an outwardly extending tubular portion 164 having an air passage 166 therethrough and including an externally threaded outer or rear end portion 168, whereby an air hose or the like may be readily attached to provide pressure air for operating the motor. Lubricant may, of course, be supplied to the mechanism by introducing same into said pressure air. Head 160 is provided with a radially extending slot 170, FIG. 12, in the part 162 for pressure air. The part 162 of the head also has a pin receiving recess 172 in the forward end thereof and an exhaust port 173 therethrough.

A pin 174 extends longitudinally of the device with the central portion thereof received in an opening 176 provided therefor in the thicker part of the stator, as shown in FIGS. 1 and 2. A forward end portion of the pin 174 extends through the openings 64, 46a and 72 in the plate 58, bearing ring 46 and plate 70 to thereby hold these parts in predetermined operative relationship.

A rear end portion of the pin 174 extends rearwardly of the stator and is received in pin receiving openings 124

and 138 of respective plates 120 and 134, opening 44a of bearing ring 44 and opening 154 of plate 150. This part of the pin also extends into the recess 172 of the part 162 of the head 160.

The entire motor assembly is secured in the housing by the end member 80 and the head member or head 160.

With the parts assembled as shown in FIGS. 1 and 2, pressure air entering the passage 166 flows into the recess 170 and thence into the opening 157 of plate 150, as shown in FIG. 6. Hole 157 is in register with the passage 44b through the bearing ring 44, said bearing ring passage being connected with the right hand opening 141 in the vent plate 134 and the right hand groove 142 which extends upwardly and connects with the small right hand opening 131 in plate 120 as shown in FIG. 4, said opening or hole 131 communicating with the arcuate recess 130 at the right hand side in FIG. 4.

The right hand opening 141 in plate 134, as shown in FIG. 5, also communicates with the right hand opening 128 of the rear end plate 120 and this opening connects with a recess 19 in the adjacent end of the stator, said recess 19 connecting with the cylinder 20 of the stator at one side of a vertical plane through the axis of the mechanism as viewed in FIG. 2. It is to be noted that this recess 19 is positioned closely adjacent to said plane whereat the periphery of the rotor operably engages the inner wall of the stator. Hence pressure air is delivered into the cylinder 20 at the rear end thereof and at one end of the pressure chamber 29.

The air entering the chamber 29 acts on the blades 32 extending between the rotor and wall of the chamber 20 and forces said blades in a clockwise direction, as viewed in FIG. 2, so that the rotor 24 rotates in a clockwise direction.

Air is exhausted from the chamber 20 at its larger part, which is substantially midway between the pointed ends of said chamber 20, said air being exhausted through the slot 62 into a passage 180 in the bearing ring 46, thence through the opening 74 in forward cover 70, into the gear case 98 through the ports 116, into annular groove 114, and thence out of the exhaust ports 16.

In order to relieve the pressure that would otherwise develop ahead of the blades as they move from their upper position toward their lower position, as viewed in FIG. 2, the forward end of the stator is provided with a semicircular groove or recess 24a which communicates with the chamber 29 at the annular end opposite the end with which the groove 19 communicates.

From the recess or groove 24a the air passes through the opening 66 in the plate 58, through an opening 66a provided therefor in the ring 46 of the forward bearing assembly 42 and a registering opening 69 in the forward cover 70 and thence into the gear case 98 for discharge therefrom through the ports 116, groove 114 and exhaust ports 16.

It has been found that when the air supplied to the motor is cut off and the motor stops rotating, the rotor blades in sequence are moved into the rotor slots 30 and tend to remain in this retracted position due to the cohesion of the lubricant so that when pressure air is again introduced into the motor the blades are usually retracted. This allows air entering port 128 to escape directly from exhaust ports 62 and 66 without causing rotation of the rotor.

In order to solve this problem and get the rotor rotating without delay, a small portion of pressure air is introduced into the rotor slots 30 behind or in back of the blades, the removed portions 36 of the blades at the rear end thereof providing adequate clearance for the entrance of such air. This portion of the pressure air passes through the right hand hole or opening 131 and thence into the radial slots 30 of the rotor as the rear ends of said slots come into communication with the right hand opening 131 through right hand groove 130. The air behind the vanes or rotor blades 32 exhausts from the slots

by way of the left hand groove 130 as the rear ends of said slots come into communication with said left hand groove 130. This air then passes from said groove by way of the respective openings 131 from which it passes into the registering left hand groove 142 of vent plate 134, respective hole 140, hole 44b in bearing 44, hole 156 in plate 150, and to atmosphere by way of exhaust port 173 in the disc portion 162 of head member 160.

It will be noted that the openings 140 and 156 are larger than the opening 128 which results in a pressure drop through or pressure differential across the opening 128 so that the pressure introduced beneath or behind the rotor blades forces said blades outwardly against the wall of the stator cylinder, sealing the primary air flow into the chamber 20 and effecting positive starting of the motor.

The invention and its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the arrangement hereinbefore described being merely by way of example, and I do not wish to be restricted to the specific forms shown or uses mentioned except as defined in the accompanying claims, or in various portions that have been separated for clarity of reading and not for emphasis.

I claim:

1. A fluid pressure motor, comprising:

- (A) a hollow cylindrical housing having internally threaded end portions;
- (B) a cylindrical stator within said housing, said stator having a longitudinally extending bore therethrough providing a rotor cylinder having an axis offset from the axis of said housing;
- (C) a rotatable shaft extending through the bore of said stator, said shaft being coaxial with the axis of said housing and having end portions extending longitudinally outwardly of the respective ends of said stator;
- (D) a cylindrical rotor having an axial bore therethrough in which is secured said shaft, said rotor defining with the rotor cylinder a crescent shaped pressure chamber, said rotor having a plurality of annularly spaced longitudinally extending radial slots therein;
- (E) a rotor blade radially slidable in each rotor slot, the outer edges of said blades being engageable with the inner cylindrical surface of the stator bore, said blades having inner end corner portions extending radially and longitudinally inwardly;
- (F) a ball bearing assembly for each end of said shaft, said ball bearing assemblies including inner and outer races with the end portions of the shaft operably disposed in the inner races;
- (G) a forward end plate between the outlet end of the stator and the adjacent ball bearing assembly, said plate being mounted on the shaft and having a flaring opening at the outer side to provide clearance for the inner race of said ball bearing assembly, said plate having an elongated slot comprising an outlet passage means for exhaust air from the larger portion of the chamber in the stator, the outer race of the adjacent forward bearing assembly having a passage therethrough with which said inlet passage means communicates;
- (H) an end member screwed into the adjacent interiorly threaded forward end portion of the housing;
- (I) an output shaft rotatably mounted in said end member;
- (J) gearing in a gear chamber in the housing, interconnecting the rotor shaft and the output shaft;
- (K) a second plate, between the bearing assembly and the gearing and having exhaust air passage means therethrough with which the passage in the outer race of said forward bearing assembly communicates said

housing having a plurality of air exhaust ports annularly spaced in a substantially common plane outwardly of the gearing and connected to the space in which the gearing is disposed;

- (L) a rear end plate abutting against the rear end of the stator and said rear end plate having a pair of oppositely arranged arcuate grooves in the side facing the stator, openings therethrough communicating with respective arcuate grooves, and an air port therethrough;
- (M) a vent plate on said shaft between said rear end plate and the rear bearing, said vent plate having a shaft receiving opening therethrough, a relieved portion for the inner bearing race, and a pair of vertical grooves in the side thereof facing the rear plate, inner ends of said vertical grooves communicating with the respective arcuate grooves in said rear end plate through bleed openings in said rear end plates, said vent plate having other openings therethrough at the outer ends of said vertical grooves;
- (N) and an outer end plate at the outer side of the last mentioned bearing assembly and having a recess therein to provide clearance for the inner race of said bearing assembly, said outer end plate having air ports therethrough;
- (O) a head threaded into the internally threaded rear end of the housing, said head having an air inlet passage therein and an air outlet port;
- (P) pin receiving holes in the various plates, bearings, and in the inner side of the head;
- (Q) a pin bore in thickest portion of the stator wall, said pin bore extending longitudinally of the stator and having end portions extending into said pin receiving holes, whereby the various parts of the mechanism are retained in operative alignment, the openings and recesses in said plates providing parts of inlet passageway means for primary pressure air to enter the rotor cylinder for actuating said rotor, and secondary air into the rotor grooves behind the blades therein, and exhaust passageway means for the primary air to exhaust to said gear chamber from which said air is exhausted through exhaust ports provided therefor in the forward end of said housing, and exhaust passageway means from said rotor grooves to the air exhaust port in said head, the air port in said rear end plate comprising a restriction for causing a differential of pressure between the pressure behind said blades and the rotor cylinder whereby said blades are forced radially outwardly into sealing engagement with the wall of the rotor cylinder.
2. In a fluid pressure motor
- a hollow cylindrical housing;
- a cylindrical stator within said housing, said stator having a longitudinally extending bore therethrough providing a cylinder having an axis offset from the axis of said housing;
- an operably mounted rotatable shaft extending through the bore of said stator, said shaft being coaxial with the axis of said housing and having end portions extending longitudinally outwardly of the respective ends of said stator cylinder;
- a cylindrical rotor axially secured to said shaft, said rotor defining with the cylinder a crescent shaped pressure chamber, said rotor having a plurality of annularly spaced longitudinally extending radial slots therein;

a rotor blade radially slidable in each rotor slot, the outer edges of said blades being engageable with the inner cylindrical surface of the stator bore;

a forward end plate at the outlet end of the stator, said plate having an elongated slot comprising an outlet passage means for exhaust air from the larger portion of the chamber in the stator;

an end member secured in the forward end portion of the housing;

an output shaft rotatably mounted in said end member; gearing in a gear chamber in the housing, interconnecting the rotor shaft and the output shaft;

said housing having air exhaust port means, there being passageway means connecting said elongated slot with said exhaust port means;

a rear end plate abutting against the rear end of the stator, said rear end plate having a pair of oppositely arranged arcuate grooves in the side facing the stator, openings therethrough communicating with respective arcuate grooves, and an air port therethrough;

a vent plate on said shaft at the rear side of said rear end plate, said vent plate having a shaft receiving opening therethrough and a pair of vertical grooves in the side thereof facing the rear plate, the inner ends of said vertical grooves communicating with the respective arcuate grooves in said rear end plate through bleed openings in said rear end plate, said vent plate having other openings therethrough at the outer ends of said vertical grooves;

a head secured in the rear end of the housing, said head having an air inlet passage therein and an air outlet port;

means for securing the various parts in the housing in operative position and relationship with each other, the openings and recesses in said plates providing parts of inlet passageway means for primary pressure air to enter the cylinder in the stator for actuating said rotor, and for secondary pressure air to enter into the rotor grooves behind the blades therein, means for the primary air to exhaust to said gear chamber from which said air is exhausted to atmosphere through said exhaust port means provided therefor in the forward end of said housing, and exhaust passageway means from said rotor grooves to the air exhaust port in said head, the air port in said rear end plate comprising a restriction for causing a differential of pressure between the pressure behind said blades and said cylinder whereby said blades are forced radially outwardly into engagement with the wall of the rotor cylinder.

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