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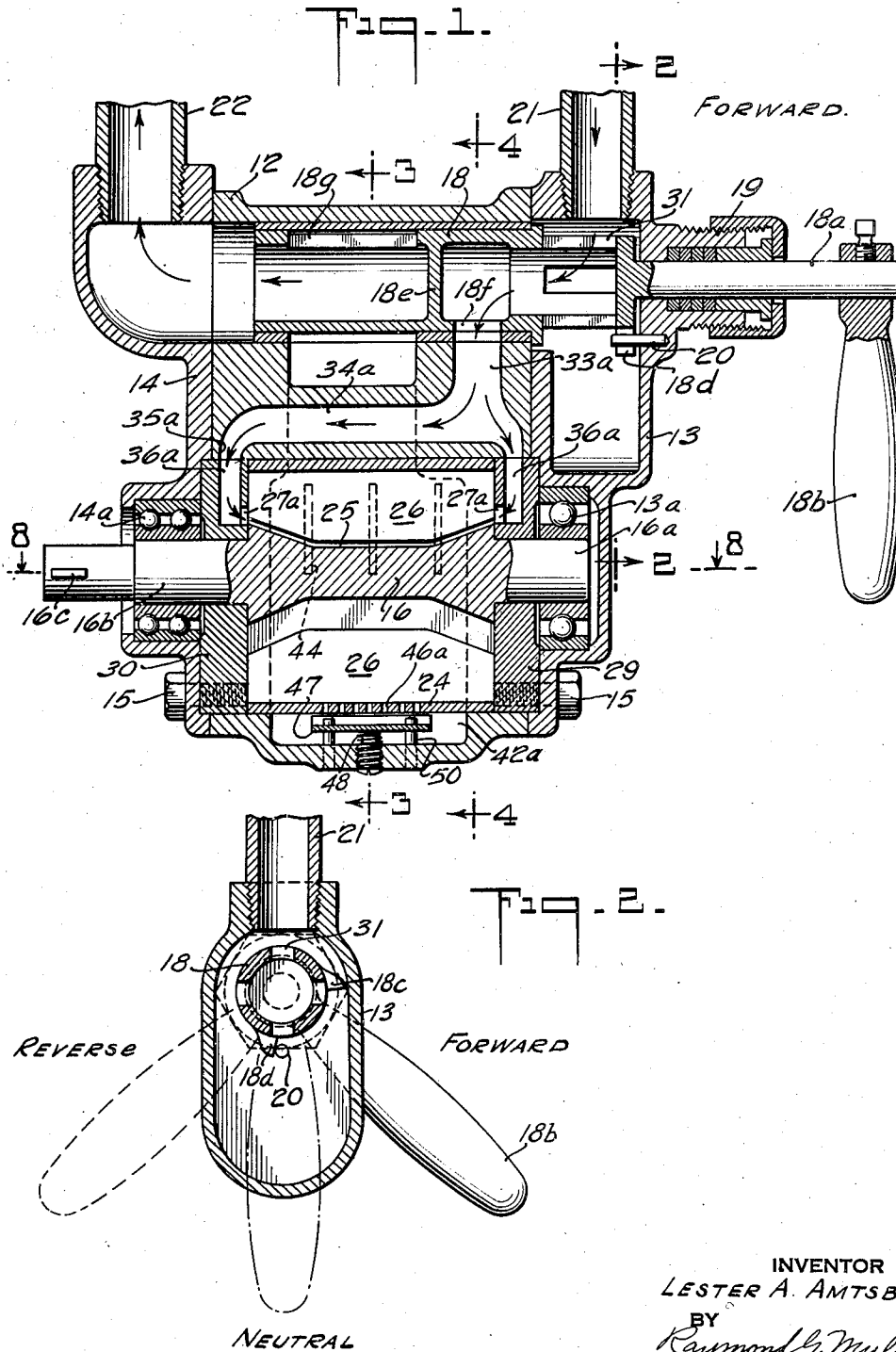
L. A. AMTSBERG

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REVERSIBLE ROTARY MOTOR

Filed Aug. 13, 1935

3 Sheets-Sheet 1



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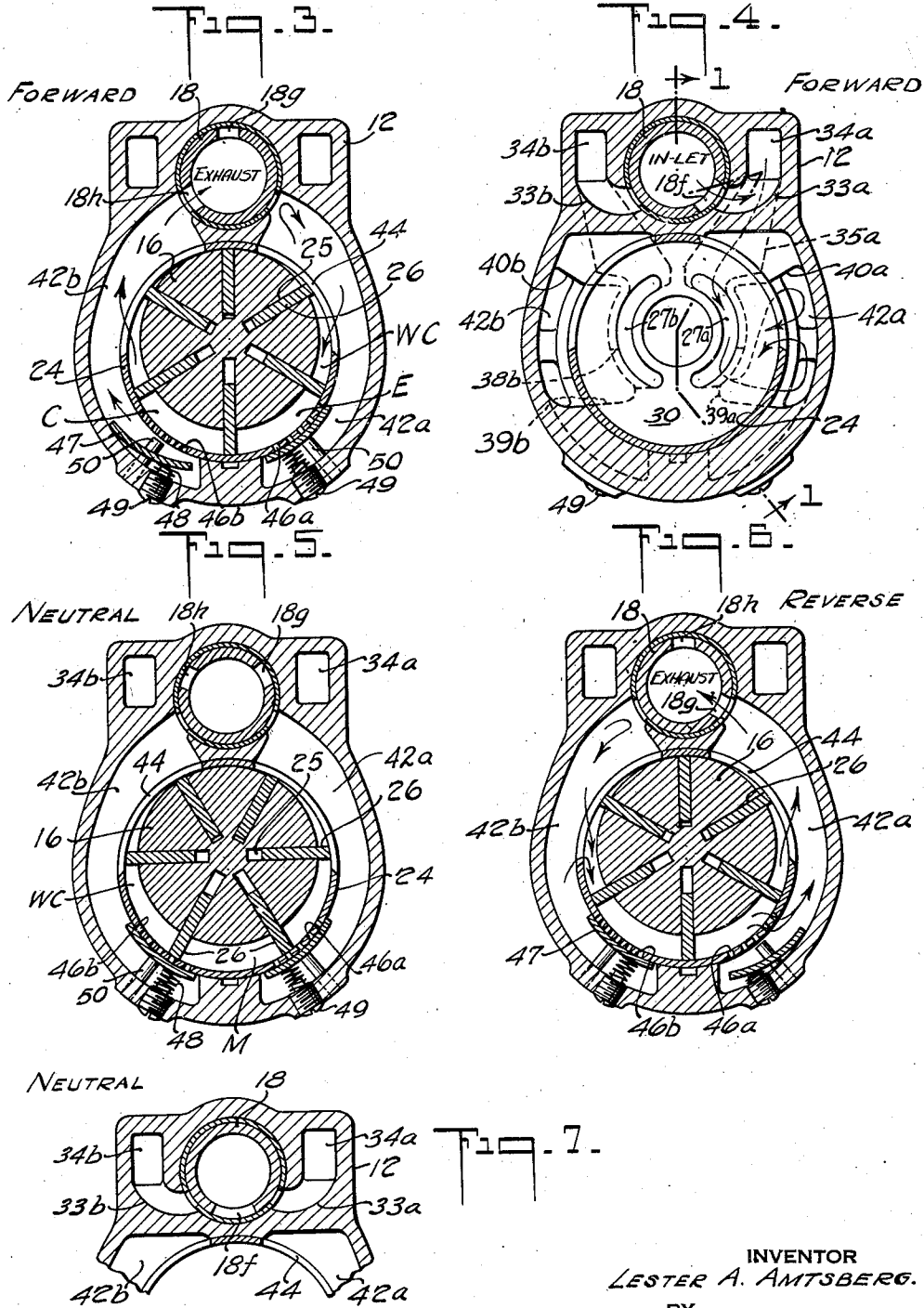
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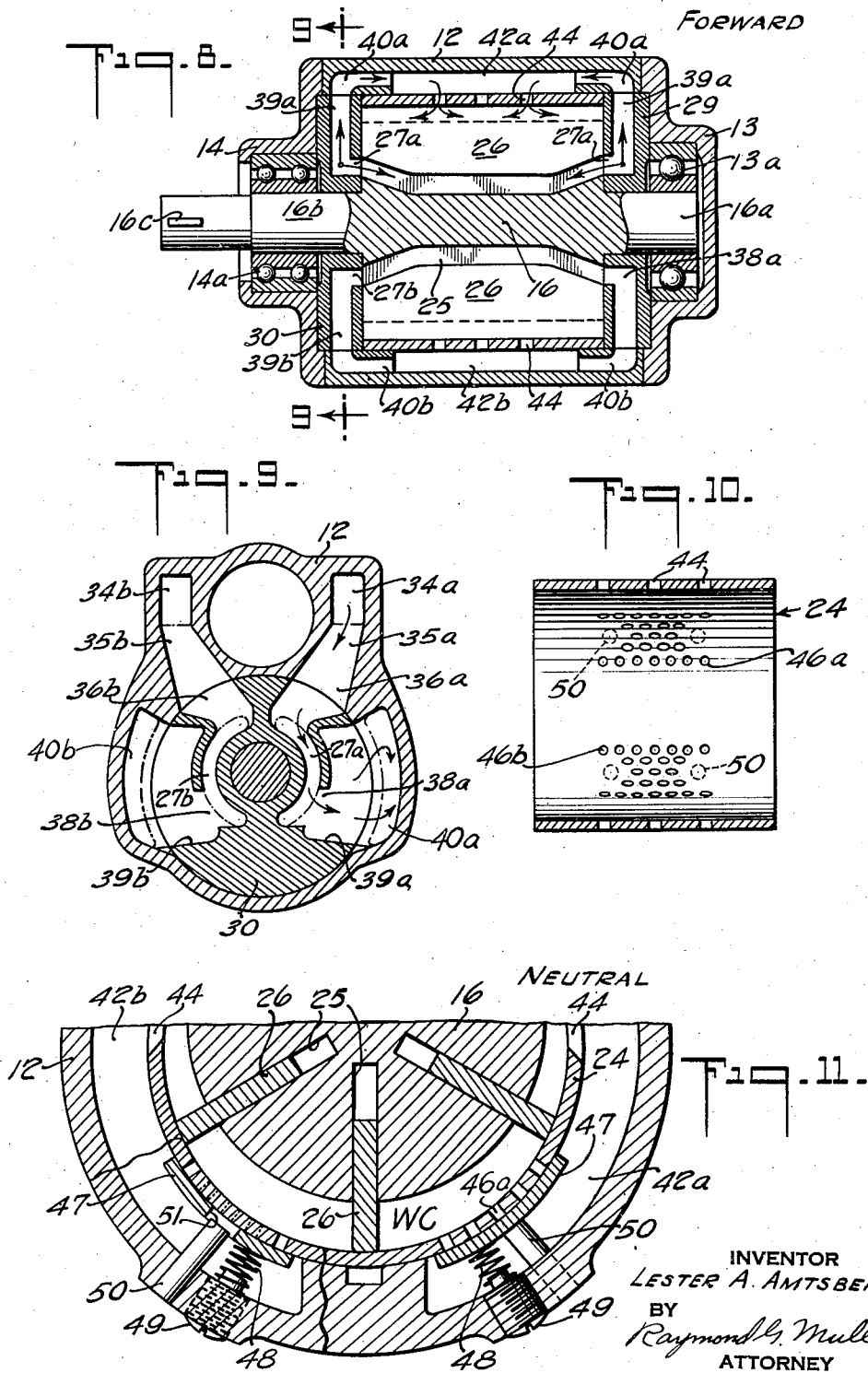
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## UNITED STATES PATENT OFFICE

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## REVERSIBLE ROTARY MOTOR

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3 Claims. (Cl. 121—87)

This invention relates to rotary motors operated by an expansible fluid, such as air, steam, or gas, and more particularly to reversible rotary motors of the movable blade type in which the blades are carried by a rotor eccentrically mounted in a cylinder.

The usual types of reversible rotary motors are inherently much less efficient than corresponding non-reversible machines, the air consumption for the same amount of power being approximately fifty per cent greater. This is particularly true of machines in which the ports of the cylinder are so arranged that the inlet port for one direction of rotation is convertible into an outlet port for the other direction and vice versa.

In designing a reversible rotary engine it is the usual practice to arrange the cylinder ports near the ends of a crescent shaped working chamber which separates the rotor from the cylinder, the inlet and exhaust ports being symmetrically arranged at the same distance from the mid-point of the working chamber. The result is that after each blade passes the center of the working chamber, and until such time as the preceding blade uncovers the exhaust port, it acts as a pump to compress air in the gradually diminishing space between the rotor and cylinder wall. Maximum efficiency for one direction of rotation requires that the exhaust port be relatively close to the center of the working chamber, but this condition is not attainable in conventional motors because any relocation of the exhaust port results in a corresponding change in position of the inlet port. On the other hand, any attempt to bring both the inlet and exhaust ports closer to the mid-point of the working chamber would shorten the power stroke, as a result of which there would not be sufficient time or space for expansion of air on the power stroke. Consequently, previous designers of reversible rotary motors have arranged the ports to provide either less expansion of air on the power stroke, or more compression on the exhaust side, or both, as compared with a one-way machine, with the resultant increase in air consumption, reduction in power and loss of efficiency.

An object of the invention is to increase the efficiency and power and to reduce the air consumption of a reversible rotary motor, whereby to obtain the advantages of a one-way motor in a reversible machine. A more specific object is to eliminate, as far as possible, loss of power due to compression without shortening the power stroke of the piston.

In accordance with this invention, a rotor of

the type having blades carried thereby is eccentrically mounted in a cylinder to provide a working chamber of crescent shape, inlet ports are symmetrically arranged on opposite sides of the working chamber, auxiliary exhaust or relief ports are arranged intermediate the inlet ports and means are provided for closing the relief port or ports on the power side of the chamber. In the preferred embodiment of the invention, the relief ports are controlled by a pair of plate valves normally held in closed position by springs. The relief valves are so arranged that pressure in the working chamber of the cylinder forces the valve on the exhaust side open and the impingement of exhaust air through the relief ports against the face of the valve holds it in open position.

Other objects and features will appear more clearly from the following description taken in connection with the accompanying drawings and appended claims:

In order to illustrate the invention, one concrete embodiment thereof is shown in the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view of a reversible rotary motor with the throttle valve shown in forward position, the section being taken approximately along the broken line 1—1 indicated in Fig. 4;

Fig. 2 is a sectional view looking in the direction of the arrows 2—2 in Fig. 1;

Fig. 3 is a sectional view looking in the direction of the arrows 3—3 in Fig. 1;

Fig. 4 is a section as shown by the arrows 4—4 in Fig. 1, the rotor being omitted;

Fig. 5 is a sectional view corresponding to Fig. 3 but with the throttle valve adjusted to neutral position;

Fig. 6 is a section corresponding to Figs. 3 and 5 but with the throttle valve in reverse position;

Fig. 7 is a fragmentary sectional view corresponding to Fig. 4 but with the throttle valve in neutral position;

Fig. 8 is a longitudinal section through the line 8—8 in Fig. 1 looking downwardly;

Fig. 9 is a section along the line 9—9 in Fig. 8;

Fig. 10 is a longitudinal section of the cylinder, taken in the same plane as Fig. 8 and looking downwardly; and

Fig. 11 is a fragmentary sectional view similar to Fig. 5 but on a larger scale.

The embodiment of the invention chosen for the purpose of illustration comprises a motor having a casing 12 and cylinder heads 13 and 14, which are maintained in assembled relation by suitable securing means comprising studs 15.

Heads 13 and 14 provide bearings 13a and 14a, respectively, for the shaft ends 16a, 16b of rotor 16. Shaft end 16b projects beyond head 14 and bearing 14a to provide a power take-off 16c. In the upper part of casing 12, a control or throttle valve 18 is supported for limited rotary movement with its stem 18a projecting through a stuffing box 19 of any suitable or desired type on cylinder head 13, an operating handle 18b being secured to the outer end of the stem. Stops 18c and 18d (Fig. 2) on valve 18 are arranged to engage a fixed stop 20 (Figs. 1 and 2) on head 13 to limit the movement of valve 18. A fluid pressure supply pipe 21 is mounted on cylinder head 13 and connects with one end of the chamber in which valve 18 is mounted, while an exhaust pipe 22, secured to cylinder head 14, leads from the opposite end. A partition 18e across valve 18 separates the live pressure fluid from the exhaust.

Rotor 16 is eccentrically mounted within a rotor chamber provided by a cylinder 24 secured to casing 12. A crescent-shaped working chamber WC is thus formed between the rotor and cylinder. Rotor 16 has radial slots 25 in which are slidably supported vanes or blades 26. Fluid pressure is utilized to hold the blades in contact with cylinder 24. To this end the motor is so arranged that pressure fluid is first admitted directly beneath blades 26 and is then conducted into the working chamber.

As shown in Figs. 1 and 8, the slots 25 are preferably deeper at the central portion than at the ends of the rotor, and the blades 26 are of corresponding shape. At the ends of the rotor, the inner edges of the slots 25 are adapted to register in succession with arcuate grooves or ports 27a (or 27b depending on the direction of rotation), which are adapted to deliver live motive fluid to the slots. These ports for supplying the rotor slots with live air are provided in the end plates 29 and 30 for the cylinder. By comparing Figs. 3 and 4, it will be observed that each blade registers at its inner edge with the fluid supply port 27a or 27b for a considerable part of its travel and accordingly will be forced outwardly against the cylinder wall 24 during this interval to provide a tight seal at the outer edge of the blade.

The manually controlled throttle mechanism for supplying live air to the arcuate supply ports 27a and 27b in the end plates will now be described. Figs. 1, 2, 3, 4 and 8 show control valve 18 in forward position. Live air enters the motor through supply pipe 21, passes through ports 31 to the inlet side of control valve 18, through valve port 18f, (see Figs. 1 and 4) and then through a series of passages in the motor housing and end plates which lead to the arcuate port 27a. A similar series of passages is adapted to convey live air from the port 18f in the valve to the supply ports 27b when the throttle valve 18 is turned to reversing position. Referring particularly to Figs. 1, 4 and 9, each of these series of passages comprises a port 33a (or 33b), a horizontal duct 34a (or 34b), and vertical slots 35a (or 35b) in motor casing 12 which register with slots 36a (or 36b) in the end plates, terminating at the arcuate supply ports 27a or 27b.

The series of passages just described serve also to supply live air to the working chamber for driving the rotor. Referring to Figs. 8 and 9, live air delivered to the arcuate groove 27a is adapted to pass out of a port 38a provided in each of the end plates 29 and 30, said port being

at the lower end of the groove and communicating with a radial slot 39a through which the air passes out of the end plate. The motor casing 12 has an angular passageway 40a arranged to receive live air from the radial slot 39a and deliver the same to a large chamber 42a positioned between the cylinder 24 and the peripheral wall of casing 12. Symmetrically arranged on the opposite side of the motor housing is a corresponding chamber 42b adapted to be supplied with live air through ports 38b and radial slots 39b in the end plates, and angular passageways 40b in the motor casing when the throttle valve 18 is adjusted to the reverse position.

Chambers 42a and 42b are kept in constant communication with the respective ends of the working chamber WC by means of slots 44 in the cylinder. When the throttle valve 18 is turned to the forward position, it opens chamber 42b to exhaust, through valve port 18h and exhaust pipe 22, and closes the upper end of chamber 42a, as seen in Fig. 3. Chamber 42a thereby becomes an accumulator for delivering fluid under relatively constant pressure to the inlet side of the working chamber WC. In the reverse position of the valve, chamber 42b becomes the accumulator or live air chamber while chamber 42a is open to exhaust through valve port 18g.

As will be understood by those skilled in the art, live air admitted through the slots 44 in the cylinder 24, on the right-hand side of Fig. 3 acts against the blade immediately below the slots to force the blade and consequently the rotor in a clockwise direction. After the rotor has moved so that the succeeding blade cuts off the supply of live air through the slots in the cylinder, the air in the pocket E, between the two blades referred to, expands due to the gradually increasing width of the working chamber WC at this phase. The expansion of air in the pocket E, of course, transforms the potential energy of the compressed air into kinetic energy in driving the rotor. As the rotor continues revolving, the size of the pocket between the blades reaches a maximum (see pocket M in Fig. 5) and then diminishes, as in the case of the pocket positioned at C in Fig. 3. If no escape were provided for the air in pocket C, the contraction in the size of this pocket would necessitate compression of air therein at the expense of the kinetic energy received from the rotor, and the rotor would expend power in acting as a pump.

In accordance with this invention, loss of power due to compression on the exhaust side of the working chamber WC may be reduced or eliminated by exhausting the air from a pocket defined by two adjacent blades at approximately the time that the pocket has reached its maximum size and begins contracting. Although this result might be accomplished in a nonreversible machine by the expedient of increasing the length of the slots 44 on the exhaust side, this expedient could not be used advantageously in a reversible machine because in the reverse operation there would be a corresponding reduction in the space in which the air is permitted to expand in the pocket on the power side of the working chamber.

The present invention contemplates the use of auxiliary exhaust means for one side of the working chamber, which reduces or eliminates compression by the rotor, but which becomes ineffective when the direction of rotation is reversed, in order not to interfere with expansion of air on the power side. As illustrated in the drawings, the auxiliary exhaust means comprises two sets of

relief ports 46a and 46b in the cylinder 24, one set being on each side of the center of the crescent-shaped working chamber WC. As seen in Fig. 5, the ports are so arranged that they are uncovered by a blade 26 at approximately the time that the pocket M in back of the blade has attained its maximum width. Associated with each set of relief ports is a plate valve 47 adapted to fit the outside wall of the cylinder and cover each port in the set. An expansion spring 48, guided by a stud 49 screwed in the casing 12, engages the outer face of the valve near one end thereof, and normally holds the valve in closed position. Guide pins 50 fixed to the casing cooperate with holes 51 in the valve 47 to prevent undue displacement of the valve. The assembly comprising the valve, pins and spring is situated in the accumulator chamber 42a (or 42b) in order that live air may act on the outer face of the valve to supplement the spring pressure and to oppose the pressure transmitted to the inner face through the ports 46a or 46b. The combined force of the live air and spring pressures is sufficient to hold the valve closed on the power side of the working chamber WC. On the exhaust side, however, pressure inside the cylinder 24 is sufficient to force the valve open, the valve being rocked about the end adjacent to the spring. The stream of air, exhausting through the auxiliary relief ports 46a or 46b, impinges against the inside face of the valve 47 to hold it in open position.

When the motor is not running, both of the relief valves 47 are held in closed position by the springs 48 as shown in Figs. 5 and 11. When the throttle valve is adjusted to the forward position, the valve covering ports 46a remains closed while the other relief valve opens the auxiliary exhaust ports 46b in response to pressure transmitted therethrough and remains open as long as the motor is running forwardly. A corresponding action takes place when the motor is driven in the reverse direction.

The diameter or circumferential length of the relief ports 46a and 46b should be smaller than the width of the blades 26 in order to prevent motive fluid from by-passing around the outer edge of a blade on the power side of the working chamber WC.

From the above description, it will be seen that the relief ports 46a and 46b are arranged to prevent compression on the exhaust side of the working chamber WC without interfering with the pressure side or the operation of the machine in the reverse direction.

Briefly summarizing the operation of the preferred embodiment of the invention, let it be assumed that inlet pipe 21 is connected to live air, and exhaust pipe 22 to atmosphere, and the operator turns the throttle valve 18 from neutral to forward position as indicated in Fig. 2. Referring now particularly to Figs. 1 and 9, live air from pipe 21 passes through throttle valve ports 31 and 18f, motor casing passages 33a, 34a and 35a, and then through end plate slots 36a which communicate with the arcuate ports 27a in end plates 29 and 30. From the arcuate ports, the compressed air follows two paths, one of which comprises the ports and passages 38a, 39a and 40a leading to the accumulator chamber 42a. Before pressure has built up to its normal value in the accumulator chamber, pressure fluid from the arcuate ports 27a follows the other path above mentioned which extends through rotor slots 25 along the inner edges of the blades 26 to force them into tight contact with the wall of cylinder 24. Pressure

chamber 42a is closed at its upper end while the corresponding chamber 42b on the other side of the cylinder is open to exhaust through valve port 18h and exhaust pipe 22. Pressure chamber 42a and exhaust chamber 42b communicate, by means of slots 44 in the cylinder, with the respective ends of the crescent-shaped working chamber WC.

The difference in pressures at the ends of the working chamber WC causes rotation of the rotor, with the consequent variation in the size of pockets confined between two adjacent blades in the working chamber WC. Referring to Fig. 3, the pocket E, which is increasing in size, is cut off from communication with either the pressure chamber 42a or the exhaust chamber, and the air in this pocket is permitted to expand and consequently transform energy to the rotor. Pressure in the chamber 42a, combined with the force of spring 48, holds the relief valve 47 against the cylinder 24 to prevent communication through relief ports 46a.

About the time the pocket has reached its maximum size, corresponding to pocket M in Fig. 5, blade 26 begins to uncover the relief ports 46b and the air pressure in the pocket is transmitted through these ports or holes in the cylinder to the inside face of relief valve 47, which forces the valve to the open position illustrated in Fig. 3. Thereafter, the stream of air exhausting through the relief ports impinges against the inside face of relief valve 47 to hold the latter open as long as the motor is running in the forward position. As the pocket contracts in size, (see pocket C in Fig. 3), air escaping through the relief ports 46b as well as through slots 44 reduces or eliminates loss of power that might otherwise result from the piston blades compressing the air in this pocket.

While the invention has been particularly described with reference to a single illustrative embodiment, it will be apparent that many changes and adaptations thereof may be made within the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. A reversible rotary motor comprising a cylinder, a rotor eccentrically mounted therein to form a working chamber between the rotor and the cylinder, said working chamber being of maximum width at its center and converging at both sides toward the ends of the working chamber, blades carried by the rotor and mounted for radial movement in slots formed in the rotor, the outer ends of the blades being adapted to contact with the inner circumferential wall of the cylinder, a pair of fluid openings in the cylinder symmetrically arranged on opposite sides of the working chamber and communicating with the latter, means adapted to admit live pressure fluid to the opening on one side of the working chamber and connect the opening on the other side to exhaust and vice versa, whereby the rotor may be driven in opposite directions, a pair of sets of auxiliary exhaust ports, one set being on each side of the working chamber and communicating with the latter, a valve associated with each set of auxiliary ports and adapted to close the associated set of ports when the opening on the same side of the working chamber is connected to live pressure fluid, said valve fitting the outside of the cylinder and covering said ports and being held in engagement with the cylinder by live pressure fluid, said valve being free to move in a radial direction out of contact with the

cylinder to open said ports when the opening on the same side of the working chamber is connected to exhaust, and means for preventing leakage between the outer edges of the blades and the inner wall of the cylinder, said means comprising passages admitting pressure fluid to the inner edges of the rotor slots to force the blades outwardly, said blades being of greater thickness than the width of any of the auxiliary exhaust ports in a circumferential direction.

2. A rotary reversible fluid pressure motor comprising a casing, a cylinder in said casing, a rotor eccentrically mounted in said cylinder to provide a working chamber between the rotor and cylinder, said working chamber being of maximum width at its center and converging at its sides toward the ends of the working chamber, radially movable blades carried by the rotor and projecting into the working chamber, a pair of fluid chambers between the cylinder and casing, one at each side of the working chamber, one or more openings in the cylinder adapted to maintain said chambers in constant communication with each of the respective ends of the working chamber, selectively operable means including a throttle valve for simultaneously admitting live pressure fluid to one of the fluid chambers and exhausting the other fluid chamber and vice versa, whereby to drive the rotor in opposite directions, means for shortening the effective length of the exhaust side of the working chamber as compared with

the power side, said means comprising a plurality of relief ports extending through the cylinder, each of said relief ports being at one side of the working chamber and situated nearer to the center thereof than any of said openings, said relief ports being adapted to communicate with the adjacent fluid chamber when the latter is connected to exhaust, and means for closing said relief ports when the adjacent fluid chamber is connected to live pressure fluid, the last-mentioned means comprising a relief valve of segmental cylindrical shape adapted to fit the outside of the cylinder and to cover said ports, said relief valve being arranged to move entirely out of engagement with the cylinder in response to pressure in said working chamber and to be held out of engagement therewith by the impingement of pressure fluid discharged through said ports, means for guiding the relief valve in its movement toward and away from the cylinder, said guiding means being supported by the casing, and a spring supported by the casing and contacting with said relief valve to urge the latter toward the cylinder.

3. A rotary reversible fluid pressure motor according to claim 2 in which the guiding means for the relief valve comprises a plurality of radially extending pins received within apertures in the relief valve, said apertures being out of registry with any of the relief ports.

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