United States Patent

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[54] **V-TYPE FLUID DRIVEN MOTOR**
6 Claims, 13 Drawing Figs.

[52] U.S. Cl. **91/180,** 91/450, 91/470
[51] Int. Cl. **F01l 33/02,** F15b 13/07
[50] Field of Search .... 91/180, 449(cursory), 450(cursory)

[56] **References Cited**

UNITED STATES PATENTS

265,473	10/1882	Vanduzen	91/180
866,922	9/1907	Duntley	91/180

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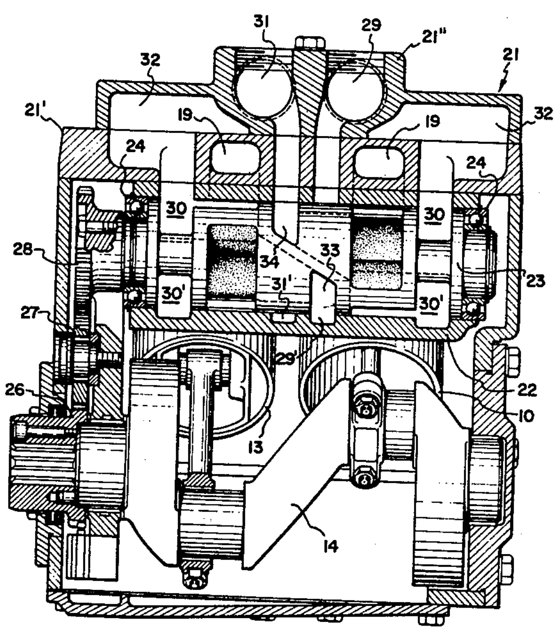
Attorney—Richard F. Bojanowski

ABSTRACT: A V-type air motor having a rotary valve journaled at both ends in antifriction bearings. Exhaust porting for initial release of pressure from the cylinders is arranged adjacent the bearings while the high-pressure air distribution ports and lands are located near the longitudinal center of the valve remote from the bearings. The high-pressure air distribution zones are located symmetrically about the valve axis to balance the valve. The valve rotates in a housing located in heat exchange relationship with the interior of the crankcase whereby the cooling effect of expanding exhaust air prevents overheating of crankcase oil while residual heat prevents buildup of ice in the valve.



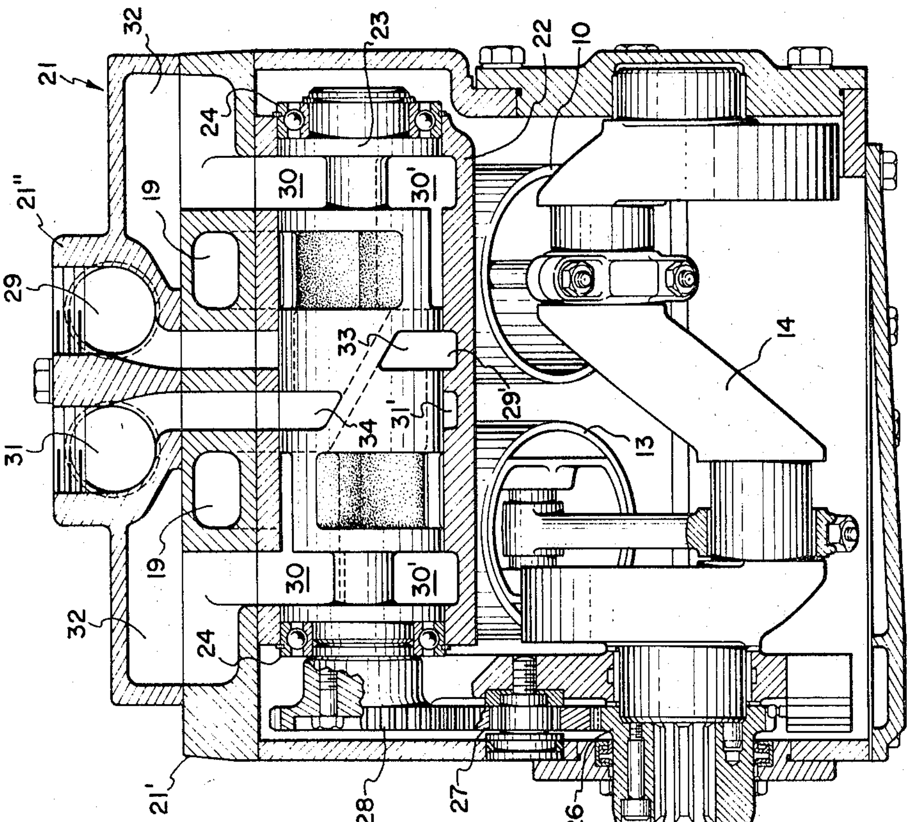


FIG. 2

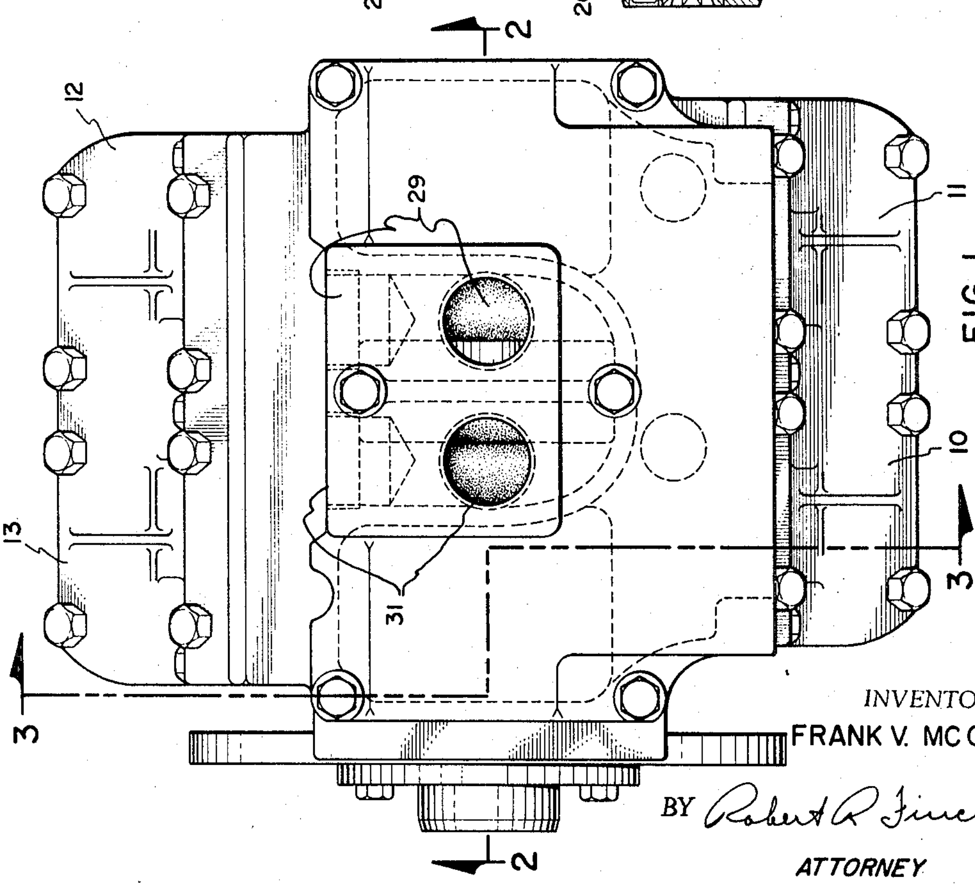


FIG. 1

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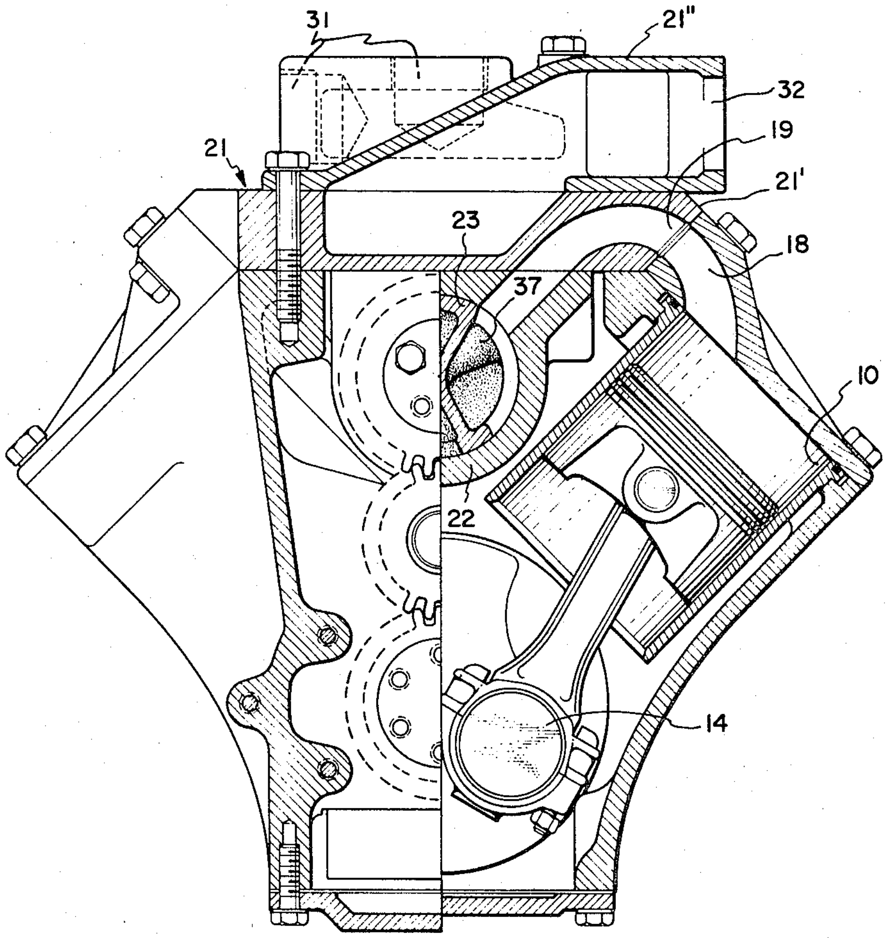

FIG. 3

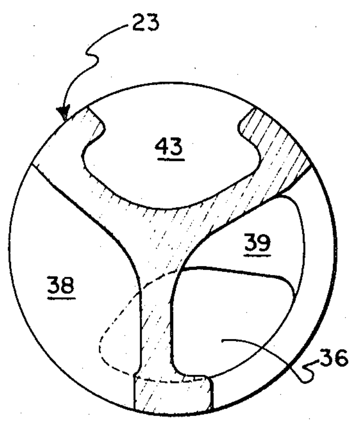

FIG. 12

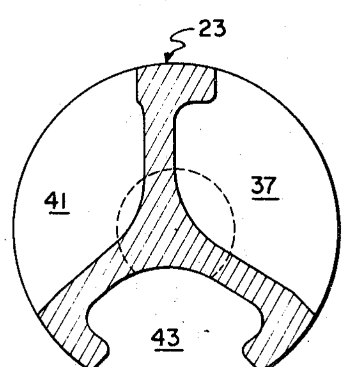

FIG. 13

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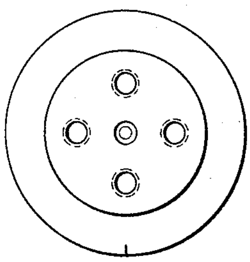

FIG. 5

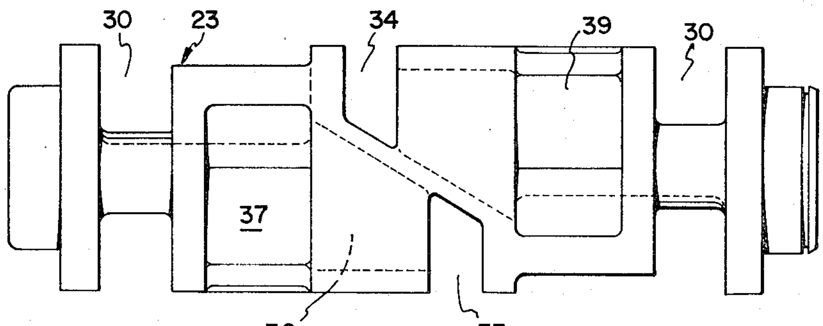

FIG. 4

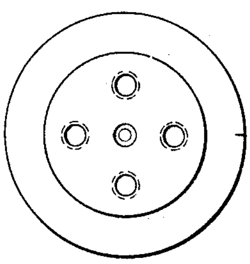

FIG. 7

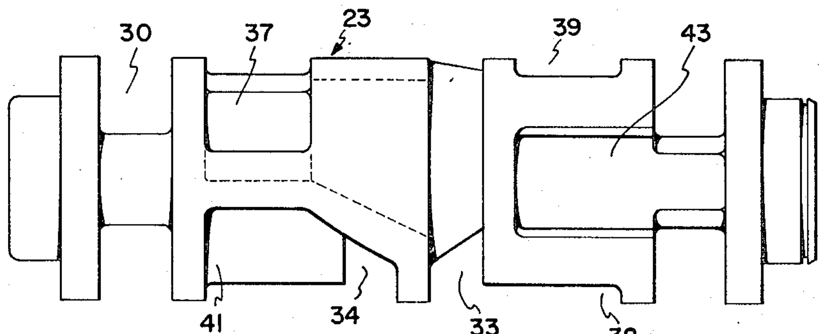

FIG. 6

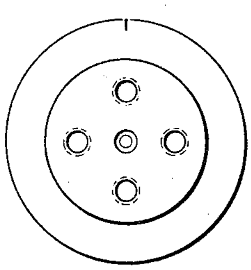

FIG. 9

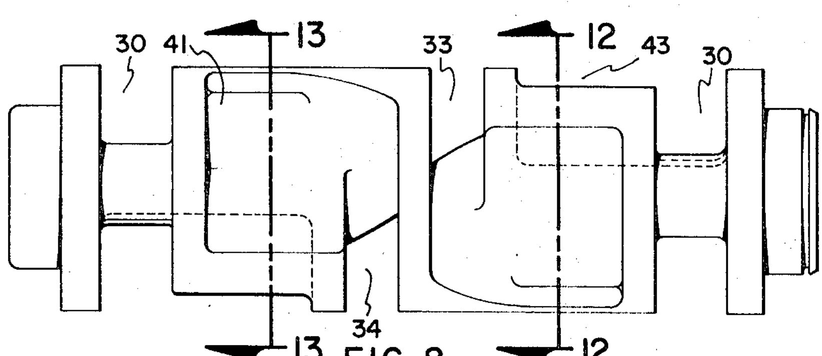

FIG. 8

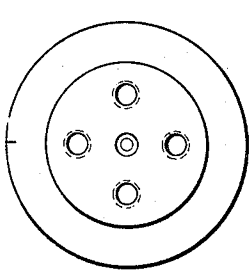

FIG. 11

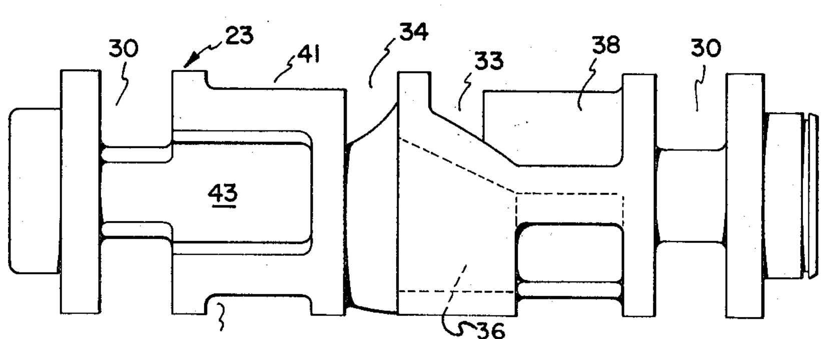

FIG. 10

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V-TYPE FLUID DRIVEN MOTOR

BACKGROUND OF THE INVENTION

The invention relates to air motors of the type employing a rotary valve for air introduction and in particular to motors in which the cylinders are arranged in V-shape

In one prior form of such motors the rotary valve has dual purpose porting that is used alternately to supply pressured air to the cylinders during the work cycle and to discharge air therefrom during the exhaust cycle. This has the disadvantage that pressured air is alternately introduced and discharged through the same ports in the valve. This is wasteful of pressured air and contributes to inefficiency.

In another known type of motor, the rotary valve is used only to introduce high-pressure air to the cylinders while separate exhaust valves are provided in each cylinder. Such motors, although useful, are complicated by the extra valving mechanisms.

In all prior forms of motors using rotary valves, the valve has been subjected to pressure on one side only and this caused excessive wear on only one side of the valve.

During continuous operation friction and agitation of crankcase oil often causes overheating of the motor and oil with consequent breakdown of lubricating oil. Paradoxically, excessive buildup of ice in exhaust passages may occur simultaneously with overheating; and the icing may be so extensive that exhaust ports become blocked thus creating a back pressure which results in loss of efficiency.

SUMMARY OF THE INVENTION

The primary object of this invention is to provide an air motor with a rotary valve in which the pressures on the valve are constant and the pressure zones in the valve are balanced thereby to distribute forces and thus minimize wear.

Another object is to provide such a motor in which the valve is arranged so that the cooling effect of the exhausting gas absorbs heat from the motor while at the same time the residual motor heat is used to prevent excessive buildup of ice.

A further object is to provide a structure enabling the valve to be mounted for rotation by journaling its ends in antifriction bearings yet protecting the bearings from contamination by dust particles and moisture carried by incoming pressured fluid.

In accordance with the invention, the foregoing and probably other objects are attained by a motor structure having a rotary valve with separate passages for the supply of pressured air and the discharge of exhaust gas therefrom; and in which the rotary valve is journaled in antifriction bearings for rotation within a valve housing. Exhaust passages for permitting rapid release of fluid pressure at completion of the work cycle are located adjacent the valve ends so that only low pressure exists adjacent the bearings and the resulting low-pressure drop keeps contaminants such as moisture and solids carried by the high pressure gas from passing through the bearings. This is especially important when the housing and bearings are located in the crankcase because it protects the crankcase oil from such moisture and solid particles.

The valve housing is located between the cylinder banks and in heat exchange relationship with the interior of the crankcase so that heat generated by the motor due to friction and stirring of the oil is absorbed by the expanding exhaust air. Thus the engine is kept warm but does not overheat. However, warm crankcase oil splashes on the valve housing thus warming it and preventing ice buildup in the valve. Instead, as ice is formed it is immediately swept out with the exhaust air. This keeps the exhaust passages clear thus facilitating gas exhaust and maintaining high engine efficiency.

In the valve, the distribution system for high-pressure air is arranged symmetrically about the axis of rotation, so that pressure zones are substantially opposite each other. That is, 180° apart on opposite sides of the valve axis and only slightly displaced axially. During operation, pressured air is continuously supplied to the valve so the system is maintained under continuous pressure and the opposed pressure zones offset each other and keep the rotating valve balanced so there is no single direction side thrust against the bearings.

So that the invention may be more readily understood and carried into effect,, reference is made to the accompanying drawings which are offered by way of example only and are not to be taken as limiting the invention, the scope of which is defined by the appended claims which are intended to embrace equivalent structures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top elevational view of a V-type air motor embodying the invention.

FIG. 2 is a sectional view taken in the plane of line 2–2 of FIG. 1 looking in the direction of the arrows, certain parts being shown in elevation for purposes of clarity.

FIG. 4 is a side elevational view of the rotary valve of this invention hidden passages being shown in broken lines.

FIG. 5 is an end view, looking toward the left end of the valve of FIG. 4.

FIGS. 6 and 7 are views of the valve of FIGS. 4 and 5 but with the valve rotated 90° counterclockwise.

FIGS. 8 and 9 are views of the valve of FIGS. 4 and 5 but with the valve rotated 180° counterclockwise.

FIGS. 10 and 11 are views of the valve of FIGS. 4 and 5 but with the valve rotated 270° counterclockwise.

FIG. 12 is a sectional view taken in the plane of line 12–12 of FIG. 8 looking in the direction of the arrows.

FIG. 13 is a sectional view taken in the plane of line 13–13 of FIG. 8, looking in the direction of the arrow.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawings:

As best shown in FIGS. 1—3, the air motor is of V construction comprising a housing containing a plurality of cylinders 10, 11, 12 and 13 arranged in pairs with the cylinders of each pair being angularly displaced from each other on opposite sides of the crankshaft 14 and with the front pair of cylinders 10 and 13 displaced from the rear cylinders 11 and 12 axially along the crankshaft, all of which is usual. All pistons are reciprocatably mounted in their respective cylinders and are connected to the single crankshaft.

A passage 18 leading from the top of each cylinder connects to another passage 19 formed in a removable valve assembly 21 which passage in turn connects with a valve housing 22 forming a part of the valve assembly. There are separate passages 18 and 19 for each cylinder. The valve housing is located in heat exchange relationship with the interior of the crankcase. A rotary valve 23 extends through the housing and has its opposite ends journaled for rotation in antifriction bearings 24 located at opposite ends of the housing. The bearings are lubricated by the crankcase oil splashing thereon. The valve is rotatably driven from the crankshaft 14 by a gear train comprising successive gears 26, 27 and 28. The gears are sized to rotate the valve at the same speed and in the same direction as the crankshaft.

Ports 29 and 31 are provided for supply of pressured air or other fluid and the discharge of residual low-pressure air as hereinafter described. In the construction shown, ports 29 and 31 are furnished in pairs with one top opening and one side opening port as shown in FIGS. 1 and 3. In operation, one port of each pair will be plugged.

One of the ports 29 or 31 supplies pressured air for forward motion of the motor and the other for reverse.

After the work cycle is completed in a cylinder the pressured air is first released through passages 18 and 19 into a groove 30 adjacent the end of the valve then exit from port 32. This is a quick escape route that quickly reduces the air pressure to zero. After this, the low-pressure air still in the cylinder is, upon continued rotation of the motor and valve, pushed by the rising piston out through the inlet system not in use to discharge from its inlet port 29 or 31.

For ease of construction, the valve assembly 21 comprises a main portion 21', which includes the valve housing 22, and a cap 21'' suitably secured thereto.

FIGS. 4—13 illustrate details of the rotary valve employed in the reversible motor shown in FIGS. 1—3.

In the valve, the pressure air inlet slots 33 and 34 communicate respectively with ports 29 and 31. From FIG. 2 it will be appreciated that the inlet passages 29 and 31 communicate with annular grooves 29' and 31' formed in the interior wall of the valve housing. Thus, whenever pressured air is supplied through either port 29 ro 31, the corresponding groove 29' or 31' in the housing and the mating inlet 33 or 34 in the valve will continuously receive pressured air as will all other sections of the valve communicating with inlet grooves 33 or 34. Illustratively, pressured air introduced through port 29 and groove 29' will enter passage 33 of the valve thence flow through an interior passage 36, outlined in dotted lines, to a pressure zone 37. At the same time the pressured air also flows from the groove 33 through a surface passage to another pressure zone 38 located on the opposite side of the valve from the first pressure zone 37. In addition to being located on opposite sides of the valve from each other, the two zones are also spaced axially on the valve so that one zone may serve the cylinders connected to the front crank and the other zone may serve the cylinders connected to the rear crank of the crankshaft.

If the motor is reversed, air is admitted through port 31 and groove 30' whence it passes into groove 34 thence to pressure zones 39 and 41 which are located symmetrically about the valve axis similarly to previously described zones 37 and 38.

Primary exhaust grooves 30 are formed in the valve adjacent its ends. These communicate with annular grooves 30' in the valve housing and also connect to the exhaust gas receiving chambers 43 located adjacent the valve ends. The grooves 30 and 30' as well as the chambers 43 are all of substantial size thus facilitating rapid expansion of gas immediately following the down stroke of the piston.

OPERATION

For clockwise rotation of the motor of FIG. 2, pressured air is introduced through port 29, whence it flows through groove 29', inlet 33 into zones 37 and 38. From zone 37 gas flows through passages 19 and 18 into the right front cylinder 10 to drive the piston down rotating the crankshaft and the valve. As the valve rotates an exhaust chamber 43 comes into register with passage 19 thus allowing rapid release of pressured gas from the cylinder. Meanwhile pressure zone 38 has come into register with the inlet passages for the left rear cylinder 12 to introduce pressured air thereinto to drive that piston down. As this occurs, the right front piston moves up driving the residual low-pressure gas out through passages 18 and 19 into zone 41 thence to groove 34 to finally exit from port 31. Pressure zone 38 rotates into register with the passage leading to the right rear cylinder 11 to supply pressured air thereto while exhaust of the left rear cylinder 12 occurs as previously described in connection with the right front cylinder 10. To complete the entire cycle the left front cylinder 13 is pressured when pressure chamber 37 rotates into register with the passage 19 serving that cylinder.

To reverse the motor, pressured air is supplied through port 31 instead of port 19, the latter being left open to atmosphere. Rotation is counterclockwise but the pressure zones 39 and 41 are active in the work cycle while zones 37 and 38 are used to exhaust residual gas.

Although not shown in the drawings, any suitable air valve may be used to selectively and controllably supply air to the ports 29 and 31.

Regardless of motor direction, the rotary valve 23 is always in balance due to the symmetrical arrangement of pressure zones. Thus, on rotation, it moves easily in its bearings and does not put uneven or concentrated side thrusts on them. Since the high-pressure supply passages to the valve and on the valve remain pressured at all times loss of pressured air in any cycle is minimized.

The various pressure or exhaust zones referred to herein are in a sense, chambers in the valve opening outwardly therefrom and they are sometimes referred to in the claims in that manner. For convenience, the various zones or chambers may be located with respect to each other by reference to a plane transverse to the longitudinal axis of the valve. Chambers so located will, on valve rotation register or communicate sequentially with any cylinder served by such chambers.

Although the invention has been described with reference to a four-cylinder motor utilizing air as the driving fluid it is obvious that the exact number of cylinders is not critical and that the motor may be driven by any compressible fluid. Also, the invention will be of equal application to single direction air motors with but minor modification to the valve. Briefly, in a single direction valve only one pressured gas inlet and distribution system will be provided and all exhaust will be accomplished through the end grooves. The distribution system will be balanced as in the valve described hereinabove.

I claim:

1. A pressure fluid-driven motor comprising a crankcase; a plurality of cylinders each having a piston reciprocatably mounted therein; a single crankshaft in the crankcase and means connecting all of said pistons thereto; a supply inlet for supplying pressured fluid to said motor and an outlet for exhausting fluid therefrom; exhaust passage means for discharge of fluid from said cylinders to exit from said outlet; and fluid distribution means for conducting pressured fluid sequentially to said cylinders, said distribution means comprising a valve housing positioned within said crankcase and in heat exchange relationship therewith, a rotary valve rotatably mounted in said housing, means connecting said valve to said crankshaft enabling rotation of said valve by said crankshaft, first passage means providing communication between said valve housing and said inlet, a pair of pressure-balanced pressure chambers in said valve opening outwardly of the surface thereof said chambers being located on opposite sides of the valve from each other, passage means in the valve providing continuous communication between said first passage means and said pair of pressure chambers, a separate port in said housing wall for each cylinder each of said ports being located to register with one of said outwardly opening pressure chambers upon rotation of said valve, and a separate final passage connected to each port providing communication between said port and the upper portion of one of said cylinders.

2. A motor according to preceding claim 1 in which said cylinders are arranged in angularly displaced banks in the form of a V, means mounting said valve housing between said banks, antifriction bearings mounted in opposite ends of said valve housing inside of said crankcase, said valve being journaled for rotation in said bearings.

3. A motor according to preceding claim 2 including at least two pairs of cylinders and pistons, the cylinders of each pair being angularly displaced from each other in the form of a V and on opposite sides of the crankshaft, each pair being displaced from the other pair axially of the crankshaft, and said outwardly opening pressure chambers in said valve being displaced from each other axially of said valve to enable one of said openings to communicate sequentially with said final passages leading to the cylinders of one said pair of cylinders and the other opening to communicated sequentially with said final passage leading to the cylinders of said other pair.

4. A motor according to claim 3 in which said exhaust means includes a pair of exhaust chambers in said rotary valve opening outwardly of the valve surface, each of said exhaust chambers being angularly displaced from one of said pressure chambers and located in the same plane transversely of the valve axis as said one pressure chamber, a pair of annular exhaust grooves in said valve located one adjacent each end thereof inboard of said antifriction bearings, separate passage means in said valve interconnecting each of said exhaust chambers with its corresponding annular exhaust groove, and

passage means interconnecting said annular exhaust grooves with said outlet for discharging fluid from said motor.

5. A pressured fluid-driven motor comprising a crankcase; a plurality of cylinders each having a piston reciprocatably mounted therein; a single crankshaft in the crankcase and means connecting all of said pistons thereto; a first and second inlet through which pressured fluid can be either supplied to or exhausted from said motor depending on motor direction; an outlet for exhausting fluid quickly therefrom; exhaust passage means for discharge of fluid from said cylinders to exit from said outlet; and fluid distribution means for conducting pressured fluid sequentially to said cylinders, said distribution means comprising a valve housing position within said crankcase and in heat exchange relationship therewith, a rotary valve rotatably mounted in said housing, means connecting said valve to said crankshaft enabling rotation of said valve by said crankshaft, first and second passage means providing communication between said valve housing and said first and second inlets respectively, two pairs of pressure-balanced pressure chambers in said valve and opening outwardly of the surface thereof, one pressure chamber of each pair being located on the opposite side of the valve from the other, passage means in the valve providing continuous communication between said pressure chambers of each of said pairs, a separate port in the wall of said valve housing for each cylinder, said port being located to register with one of said outwardly opening pressure chambers upon rotation of said valve, and a separate final passage connected to each port providing communication between said port and the upper portion of one of said cylinders.

6. A motor, according to claim 5, wherein one of said second pair of pressure chambers being in the same transverse plane with one of said first pressure pair of pressure chambers and the other of said second pair of pressure chambers being in the same transverse plane with the other pressure chamber of said first pair of pressure chambers.