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[54] **SEQUENTIAL VALVE FOR ROTARY VANE AIR MOTORS**

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[22] Filed: **Dec. 30, 1970**

[21] Appl. No.: **102,802**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 781,061, Dec. 4, 1968, abandoned.

[52] **U.S. Cl.** **137/630.15,** 137/596, 418/268

[51] **Int. Cl.**.....**F04b 49/02**

[58] **Field of Search** .137/596, 628, 630.15; 251/250; 418/268, 269

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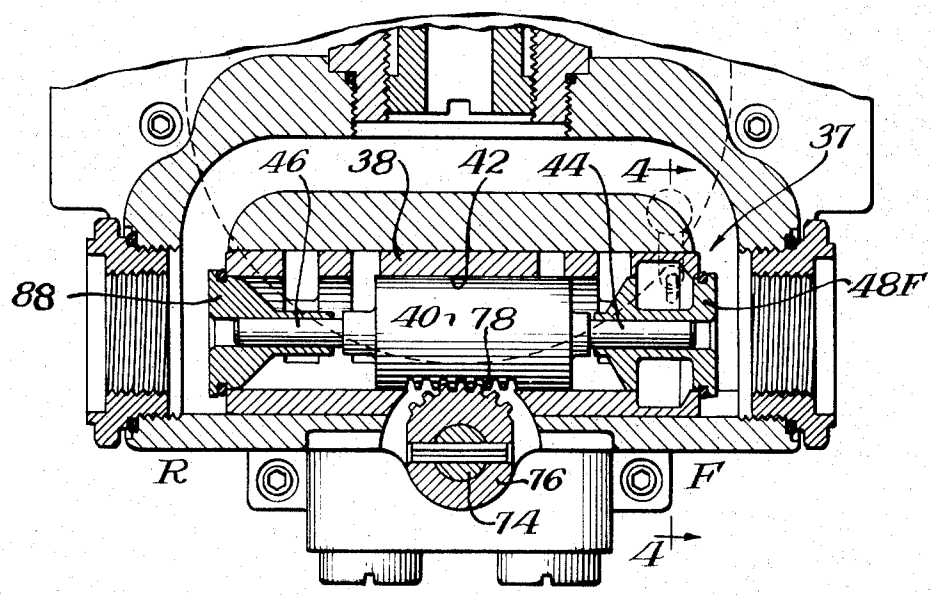
[57] **ABSTRACT**

An improved valve assembly has one inlet and two outlets. The valve is operable to sequentially provide a fluid flow path first between the inlet and one outlet and next between the inlet and both outlets. Utilization of the valve assembly for a rotary vane type air motor driven hoist is described as a preferred embodiment.

14 Claims, 10 Drawing Figures



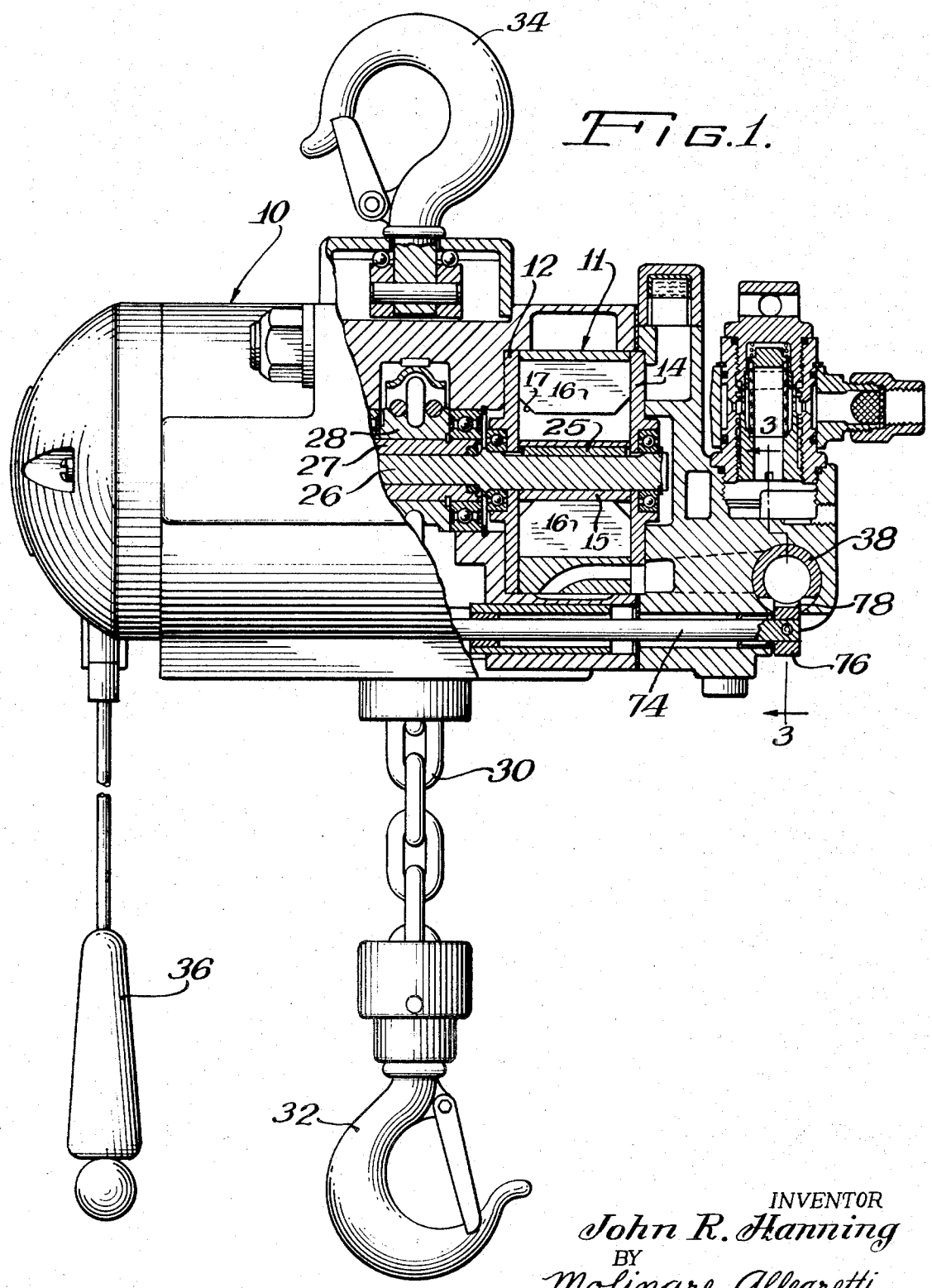


FIG. 1.

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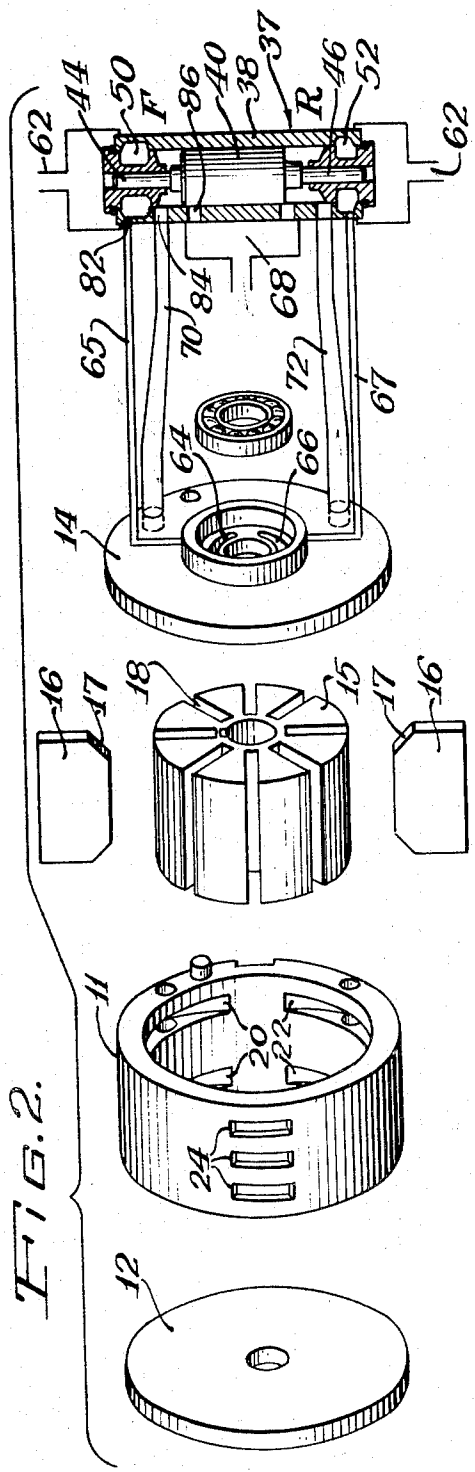

FIG. 2.

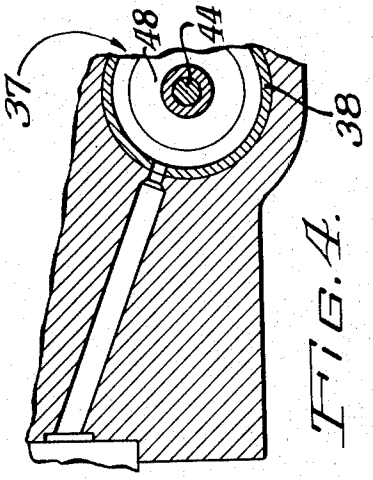

FIG. 4.

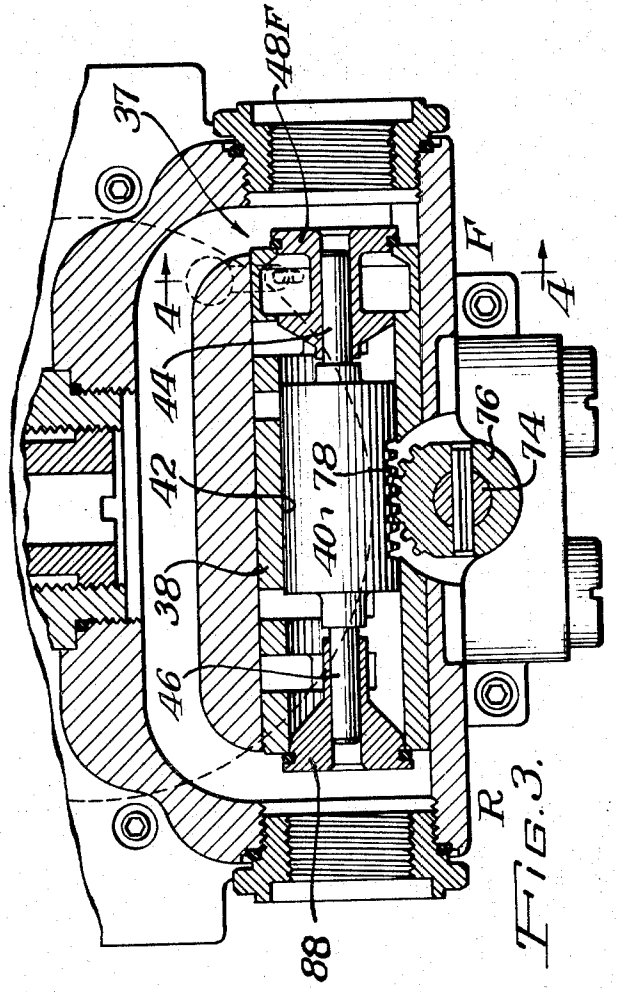

FIG. 3.

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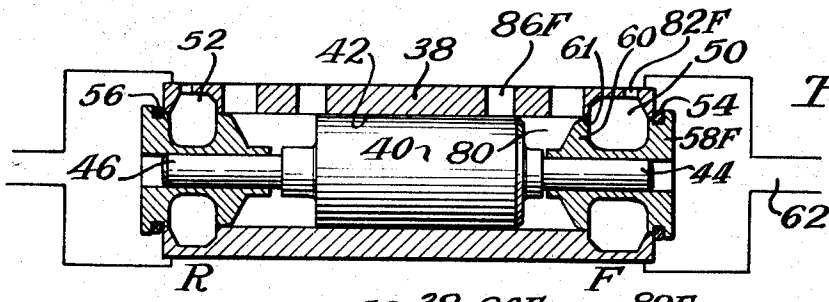

Fig.5.

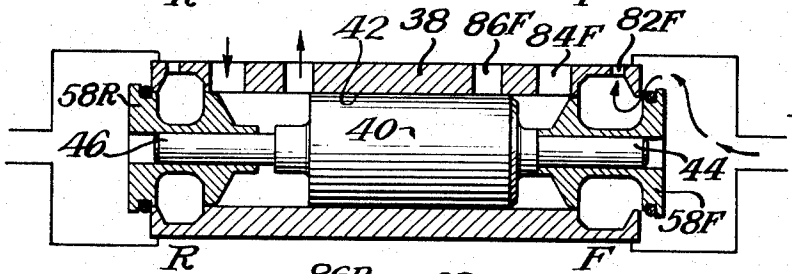

Fig.6.

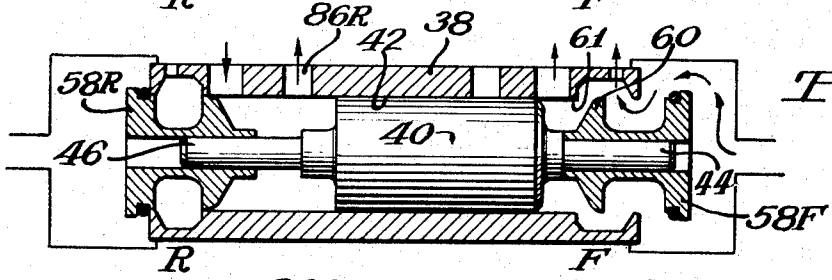

Fig.7.

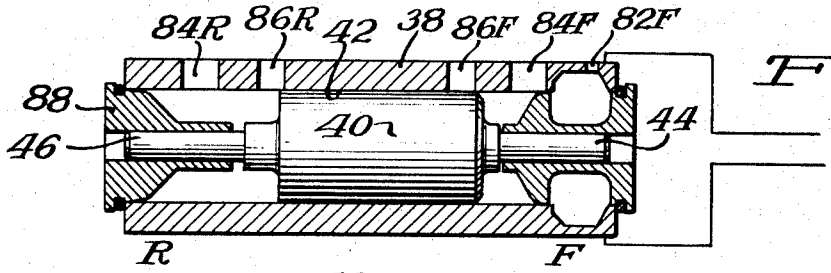

Fig.8.

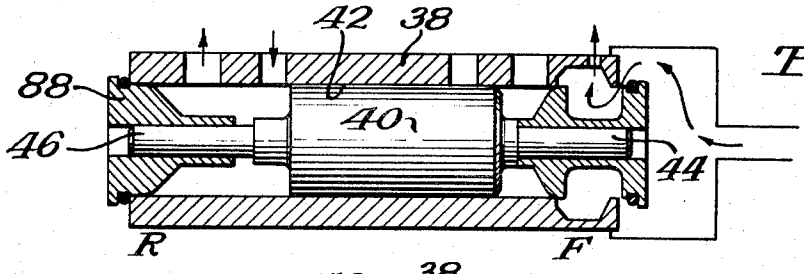

Fig.9.

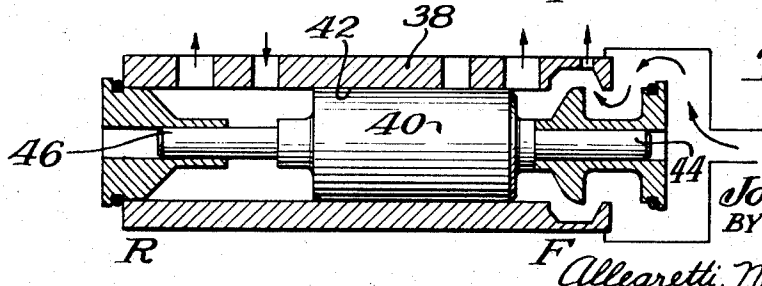

Fig.10.

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SEQUENTIAL VALVE FOR ROTARY VANE AIR MOTORS

CROSS REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of patent application Ser. No. 781,061 filed Dec. 4, 1968, now abandoned, by the same inventor for a "Vane Type Motor Having Fluid Pressure Biased Valves."

BACKGROUND OF THE INVENTION

A common practice in vane type motors is to provide springs in the bottoms of the vane slots of the rotor which exert outward pressure on the vanes. Such springs are subject to fatigue, wear and eventual breakage. Sometimes gravity or centrifugal force are depended upon to bias the vanes outwardly in their slots. These forces are not always of the proper value for most efficient motor operation. Consequently, arrangements are often provided whereby the driving, pressurized fluid is diverted, in part, against the back side of the vanes. The vanes are biased outward by the continuous fluid pressure.

Fluid biased vanes are very desirable and can be controlled for efficient motor operation. However, when starting the motor the vanes ought to be biased outward prior to providing driving fluid for the motor. Such a preliminary outward biasing force is especially desirable for applications where the motor is constantly being turned on and off.

SUMMARY OF THE INVENTION

A passageway and port system are provided supplying fluid pressure to the bottoms of the slots in a rotor in which vanes are mounted that contact the inner surface of a stator surrounding the rotor. A control valve is provided which upon initial movement toward open position admits fluid pressure to the passageway and port system just mentioned to insure proper outward biasing of the vanes prior to motor operation. Thereafter the control valve may be used to meter the flow of fluid pressure to the motor. The motor and control valve are of reversing type so that my biasing system (also designed as a reversible one) is operable in either direction of rotation of the motor.

An object of the present invention is to provide an improved valve assembly having one inlet and at least two outlets.

A further object is to provide the valve bushing with admission seats for the poppet heads and metering flanges for the valve bore, the passageways leading to the vane slot ports being under initial control of the poppet heads and the inlet and exhaust ports being under secondary control of the valve actuating plunger and the metering flanges of the valve plugs, the control valve being thus a double-end type making possible its use in conjunction with a reversing type motor.

These and other objects, advantages and features of the invention will be set forth in the detailed description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

In the detailed description which follows, reference will be made to the drawing comprised of the following figures:

FIG. 1 is a side elevation of a fluid pressure operated hoist as an example where my vane-type motor having fluid pressure biased vanes may be used, one portion of the hoist being shown in section which includes the motor and control valve;

FIG. 2 is a semi-diagrammatic exploded isometric view of the parts of the motor and the control valve to show the relationship of such parts, the valve body and portions of the valve being shown in section at right angles to the valve shown in FIG. 1 to illustrate details;

FIG. 3 is a cross-sectional view of the valve assembly taken substantially along line 3—3 in FIG. 1;

FIG. 4 is a cross-sectional view of the interconnection between the first outlet of the valve assembly and the back side of the vanes;

FIGS. 5, 6 and 7 illustrate in partial schematic, cross-sectional views a symmetrical embodiment of the valve assembly of the invention in distinct operational position; and

FIGS. 8, 9 and 10 illustrate in partial schematic cross-sectional views an asymmetrical embodiment of the valve assembly of the invention in distinct operational positions.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

On the accompanying drawing I have used the reference numeral 10 to indicate a hoist housing which houses a vane type motor of the kind herein contemplated and provided with fluid pressure biased vanes. A tubular stator 11 is located in the housing 10 and includes end plates 12 and 14 to form a complete closure for a rotor. FIG. 2 illustrates the stator 11 and the end plates 12 and 14 and also a rotor 15 which rotates inside the stator and which has substantially radial slots 18 in which vanes 16 slide with their outer ends in contact with the inner surface of the stator 11. The vanes 16 are contoured with beveled corners 17 to facilitate entry of fluid pressure under the inner ends of the vanes. The stator 11 is provided with inlet ports 20, secondary exhaust ports 22 and primary exhaust ports 24 for actuation of the motor as will hereinafter appear.

The motor shaft is shown at 26, FIG. 1, the rotor 15 being secured thereto as by a key 25. The left end of the motor shaft 26 extends into the left end of the housing 10 wherein suitable step-down gearing is provided for driving a bearing supported sleeve 27 at slow speed compared to the relatively high speed of the motor shaft 26. Since such gearing forms no part of my present invention, it is not shown on the drawings.

A chain wheel 28 is secured to the sleeve 27 and a hoisting chain 30 is trained thereover and terminates in a hoisting hook 32 to engage with a load to be hoisted, the housing 10 being suitably supported as by a supporting hook 34. A pendant control 36 is shown for controlling the fluid pressure operated motor comprising the stator 11, the rotor 15 and the vanes 16 as will hereinafter appear.

A control valve 37 which comprises the invention is shown in each FIGURE of the drawing and is of special construction with passageways for the inlet ports 20, the exhaust ports 22 and the bottoms of the vane slots 18 as shown diagrammatically in FIG. 2. The control valve 37 comprises a valve body 38 having a forward end F and a reverse end R. Slidable therein is a valve

actuating piston or plunger **40**, the valve body **38** being provided with a bore **42**, having ends which serve metering purposes as will be explained. The plunger **40** has reduced ends or shafts **44** and **46** which are slidable relative to valve members or plugs **48F** (forward) and **48R** (reverse).

Referring particularly to FIGS. **2**, **5**, **6** and **7**, the valve bushing **38** beyond the ends of the bore **42** is provided with chambers **50** (upper end in FIG. **2**) and **52** (bottom end) terminating at the ends of the valve body in admission seats **54** and **56**. Each valve plug **48F** and **48R** is provided with a poppet head **58F** and **58R** having O-rings normally seated against their adjacent admission seats **54** and **56** and a flange **60** normally in abutment with the adjacent outer end surface **61** of the metering bore **42**.

A fluid pressure supply passageway **62** is shown diagrammatically in the FIGURES for supplying fluid pressure such as compressed air against the outer ends of the poppet heads **58F** and **58R** of the valve plugs **48F** and **48R**. An inlet passageway **70** leads from the upper end of the metering bore **42** (diagrammatically in FIG. **2**) and through the end plate **14** whereupon it is continued as shown at **70** in the wall of the stator **11** to communicate with the inlet ports **20** of the stator. Similarly, an exhaust passageway **72** extends from the metering bore **42** adjacent to its lower end through the end plate **14** and into the stator **11** where it communicates with the secondary exhaust ports **22**.

The end plate **14** is also provided with arcuate vane slot ports **64** and **66** as shown in FIG. **2** and these communicate by means of passageways **65** and **67** respectively with the chambers **50** and **52** of the valve bushing **38** as also shown diagrammatically in FIG. **2**. FIG. **2** also shows an exhaust passageway system **68** diagrammatically which eventually opens to atmosphere through a suitable silencer in the usual way (not illustrated).

The control valve **37** is normally in neutral position when fluid pressure is supplied to the passageways **62** and thus to the outer ends of the poppet heads **58** so that the pressure tends to keep the poppet heads seated. The pendant control **36** is operable to rock a control shaft **74** having a pinion sector **76** secured to the right hand end thereof as shown in FIG. **1** and meshing with rack teeth **78** of the valve actuating plunger **40**. The pendant control **36** usually comprises an "UP" handle and a "DOWN" handle whereby rocking the shaft **74** from the neutral position will move the plunger **40** and one or the other of the control valve plugs **48** of the valve **37** in one direction and will cause the motor to rotate in a forward direction or vice versa.

Reference is now made to FIGS. **5**, **6** and **7** and, in particular, to the right hand or forward portion, F, of the valve assembly depicted therein. The plug **48F** is slidably mounted on the shaft **44**. Plug **48F** includes a poppet head **58F** with an outer valve portion **78** for engaging with seat **54**. Flange or bushing **60** is also provided and seals the fluid flow passage between chamber **50** and a chamber **80** defined by the bushing **60** and plunger **40**. As plunger **40** and thus shaft **44** and plug **48F** translate or move to the right, fluid can flow in through inlet **62** and out through a first outlet **82**. However, flange **60** remains in sealing contact with surface **61** as shown in FIG. **6**. Thus, no fluid can flow through to a second outlet **84**.

Further translation of plunger **40** causes flange **60** to open the passage to outlet **84** as shown in FIG. **7**. Thus, fluid flow passes from inlet **62** through to the two outlets **82** and **84**. In the embodiment shown, outlet **82** is connected with passage **65** so that upon initial translation of plunger **40**, Fluid pressure is supplied to the base or bottom of vanes **16**. Subsequently and sequentially upon further translation of plunger **40**, the flow of fluid through outlet **84** fluid in this case, through passage **70**. This activates or drives the rotary motor.

The width of flange **60** may be varied to control the dwell time, i.e. the time during which fluid flows from inlet **62** to only outlet **82** as the plunger **40** is being translated at a uniform speed in body **38**. The outlet **84** may also be maintained in a closed position by translating the plunger for a limited distance as illustrated in FIG. **6**. In any event, fluid flows sequentially first through outlet **82** and then through both outlets **82** and **84**.

In FIGS. **5**, **6** and **7**, the valve assembly is symmetrical in construction. Thus, the plug **48R** on shaft **46** is constructed in the same manner as the plug **48F** previously described on shaft **44**. Operation is also the same except that it occurs when the plunger **40** is translated to the left.

As a further feature, an exhaust outlet or passage **86F** is also associated with each plug **48**. Thus, as plunger **40** is translated to the left in FIGS. **5**, **6** and **7**, the head **58** seats on seat **54** and ultimately plunger **40** moves to permit fluid flow between outlets **84** and **86**. In practical application as applied to the hoist described above, fluid may exhaust from outlet **86F** through outlet **84F** as also shown in FIG. **2**. In a similar manner when plunger **40** translates to the right, fluid may exhaust through the outlet **86R**.

Note that the symmetrical valve assembly of FIGS. **5**, **6** and **7** provides for exhaust of one side of the assembly while simultaneously providing for fluid supply via the opposite side of the assembly. Also, a separate plug **48** is associated with each side of the valve assembly whereas a single plunger **40** is associated therewith. In operation, the valve assembly as incorporated in an air hoist of the type described positively drives the vanes outward in their slots prior to causing the rotary motor to operate.

Other uses of the valve assembly are also possible, particularly where a first fluid flow is required before a second fluid flow. In addition, the symmetrical assembly of FIGS. **5**, **6** and **7** permits reversible operation of apparatus by means of the valve assembly of the invention. Such reversing operation has utility for applications other than with reversible rotary air motors.

Reference is now made to FIGS **3**, **8**, **9** and **10**, wherein there is illustrated an asymmetrical valve assembly. The forward plug **48F** is identical in construction to that previously described. Likewise, operation of the forward plug and its associated flange **60** is the same. However, an asymmetrical plug **88** is provided for cooperation with shaft **46**. The flange **60** has been eliminated from plug **88**. Of course, the elimination of the flange **60** also eliminates the sequencing arrangement possible with the plug **48**. Therefore, the valve assembly of FIGS. **3**, **8**, **9** and **10** operates through plug **48F** to provide sequential fluid flow and exhaust through exhaust outlet **86** and second outlet **84**. Plug **88** merely permits fluid flow from inlet **62** to an outlet **84R** or from exhaust outlet **86R** through outlet **84R**.

The construction of FIGS. **3**, **8**, **9** and **10** was found quite acceptable for utilization in a rotary motor hoist since sequential operation of the motor is not deemed essential when the motor is reversed in order to lower chain **30**.

What is claimed is:

1. An improved valve assembly for sequentially providing a supply of pressurized fluid from a fluid inlet to first and second fluid outlets, comprising, in combination:

a valve housing having inlet, first and second outlets and an exhaust opening;

a movable Valve member within said housing, said movable valve member including means for sealing said inlet and also including means for sealing one of said outlets from the other of said outlets;

means for moving said movable valve member in a first direction to a first position to open said inlet to said housing to provide a fluid flow path from said inlet to one of said outlets;

further means for moving said movable valve member in said first direction to a second position to provide a fluid flow path from said inlet to both of said outlets and thereby unseal said means for sealing one of said outlets from the other outlet; and

second means for sealing said exhaust opening whenever said inlet is opened.

2. The improved valve assembly of claim **1** wherein said valve member is movable within said housing along an axis of translation and wherein said inlets and outlets are spaced from one another along said axis of translation.

3. The improved valve assembly of claim **1** wherein said valve member includes a land in sealing engagement with said housing and interposed between said outlets, said valve member being movable to said second position to provide said path from said inlet to both of said outlets.

4. The improved valve assembly of claim **1** wherein said means for sealing said exhaust opening is movable in said valve housing to connect said second outlet with said exhaust opening when said inlet is sealed.

5. The improved valve assembly of claim **1** wherein said valve member is movable along an axis of translation and including a second valve member translatable within said housing along the same axis of translation and in the opposite sense.

6. The improved valve assembly of claim **1** including a second separate valve member in said valve housing cooperative with a second inlet and another separate outlet in said housing, and means for moving one or the other of said valve members out of sealing engagement with its associated inlet.

7. The improved valve assembly of claim **1** including a second separate valve member in said valve housing cooperative with a second inlet and another separate outlet, two separate exhaust openings in said housing connectable respectively with an outlet of each valve member, and means for moving one or the other of said valve members out of sealing engagement with its associated inlet, said means for sealing movable to seal the exhaust opening associated with the valve member that is positioned to open its associated inlet.

8. The improved valve assembly of claim **7** wherein said means for moving said valve members and said means for sealing said exhaust openings comprise a plunger in said housing, intermediate said valve members and reciprocal to engage one or the other of said valve members.

9. The improved valve assembly of claim **1** wherein said means for sealing comprise a plunger slidable within said bore and having a radius substantially equal to the internal radius of said bore, said plunger also including a portion extending from one end thereof for guiding and engaging with said valve member.

10. The improved valve member of claim **1** wherein said valve member includes a surface area on the one side of said inlet which is greater than the surface area on the other side of said inlet so as to bias the valve member into a closed position by means of fluid pressure.

11. An improved valve assembly for sequentially providing a supply of pressurized fluid from a fluid inlet to first and second fluid outlets comprising, in combination:

a valve housing having an inner fluid chamber, an inlet to said chamber, first and second outlets from said chamber and an exhaust opening from said chamber;

a valve member translatable within said chamber, said valve member including an inlet seal and a second seal for sealing fluid flow between said outlets;

means for translating said valve member to open said inlet and provide a fluid flow path to said first outlet, said second seal maintaining sealing between said outlets;

means for further translating said valve member to open a fluid flow path between both of said outlets and said inlet; and

plunger means within said housing for sealing said exhaust opening whenever said inlet is opened.

12. The valve assembly of claim **11** wherein said valve housing is substantially cylindrical and wherein said first valve member comprises a spool within said housing and translatable along the longitudinal axis of said housing, said inlet comprising an open end of said housing, and wherein said first and second outlets comprise adjacent, spaced openings along the longitudinal axis of said housing.

13. The valve assembly of claim **12** wherein said spool includes an end seal for said inlet of said housing and wherein said spool also includes a landed surface bearing against the interior of said housing and providing a seal between said outlets.

14. The valve assembly of claim **11** wherein said exhaust opening in said housing is adjacent said second outlet and wherein said plunger is slidable in said housing to provide a fluid flow path between one of said outlets and said exhaust opening whenever said valve member is seated to close said inlet.

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