United States Patent

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[54] **FLUID PRESSURE OPERATED MOTORS**
13 Claims, 4 Drawing Figs.

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[51] Int. Cl. F15b 9/10
[50] Field of Search 91/376, 369

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ABSTRACT: A fluid pressure operated motor in which chambers on opposite sides of a movable dividing member are normally both connected to a source of relatively low fluid pressure and a valve is provided to disconnect one of the chambers from the low-pressure source and connect it to a higher pressure source to actuate the motor, the valve comprising a first closure member to isolate the chambers one from the other and a second closure member to open the said one chamber to the higher pressure source, the second closure member cooperating with apertures in a movable wall and being connected to the first closure member by thrust means.

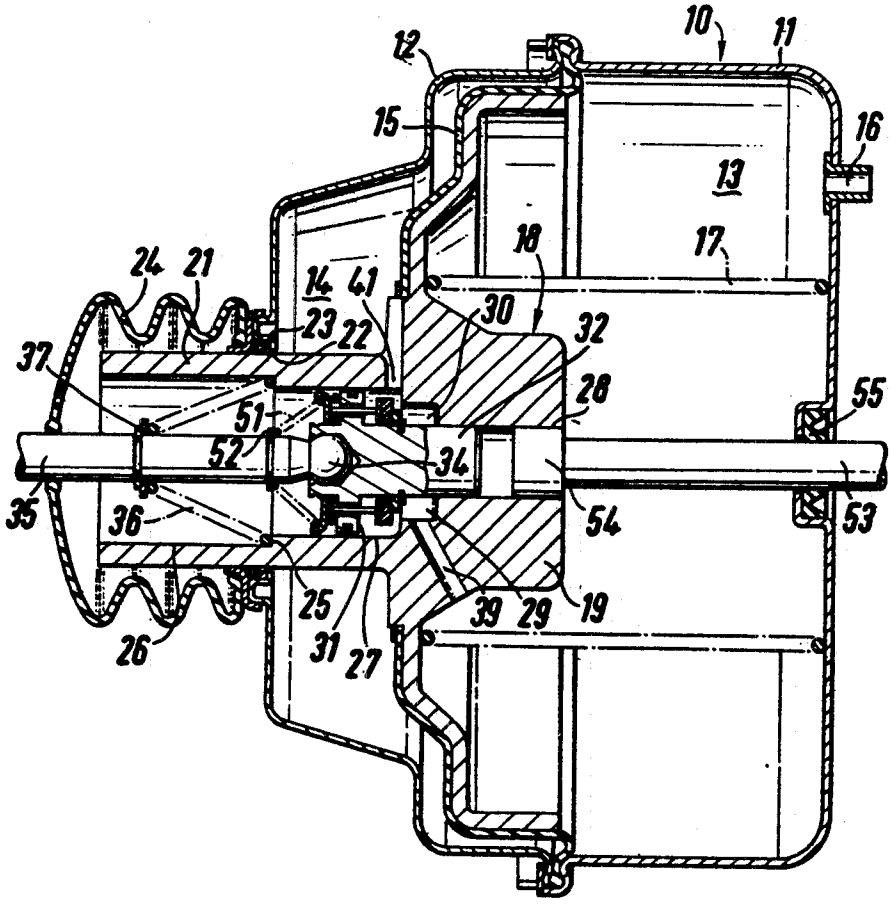


FIG. 1.

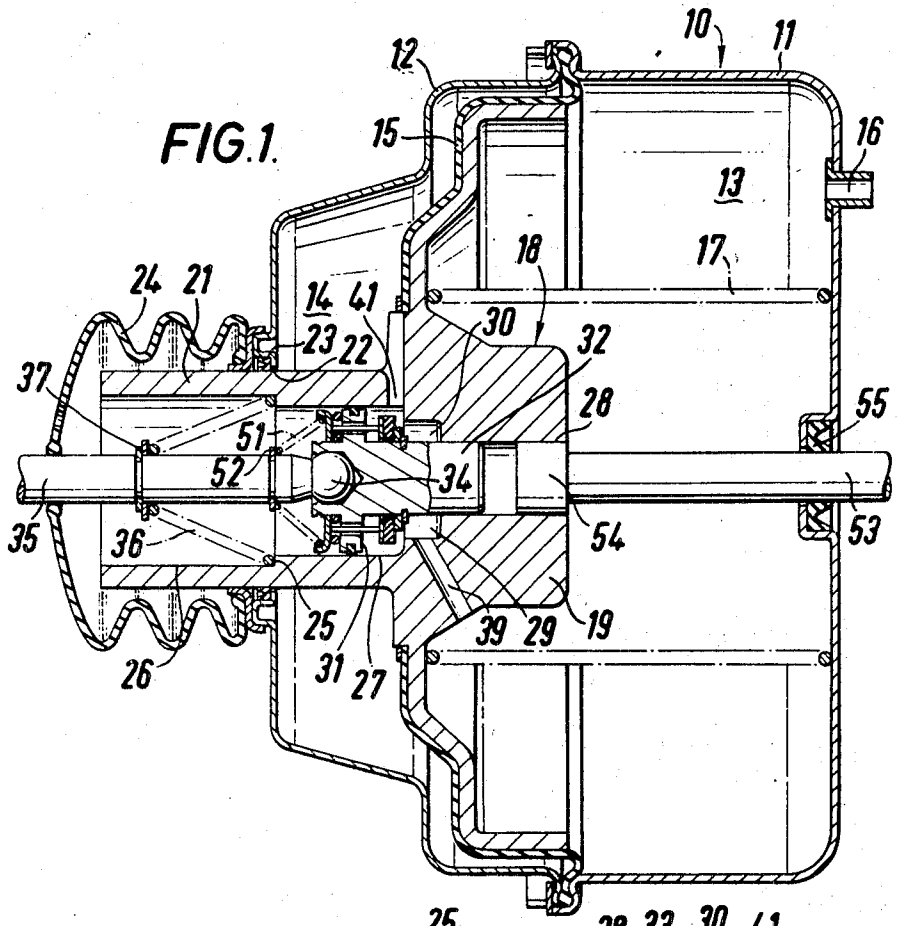
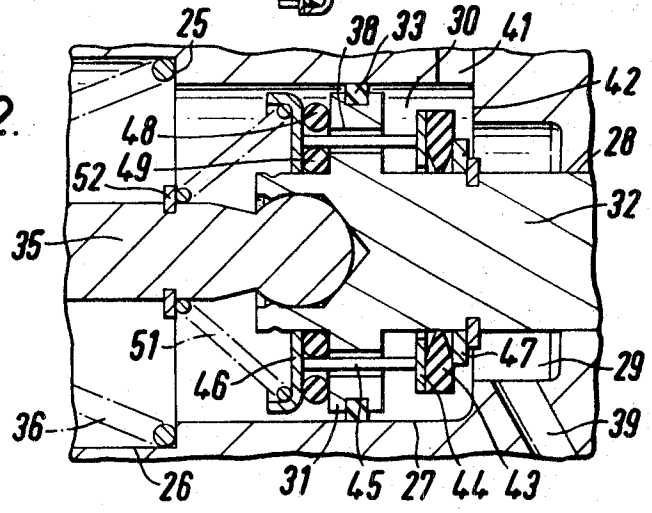


FIG. 2.



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FIG. 3.

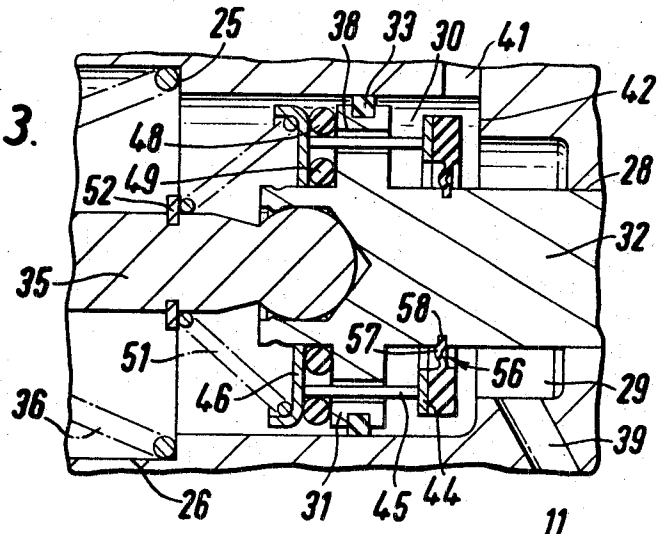
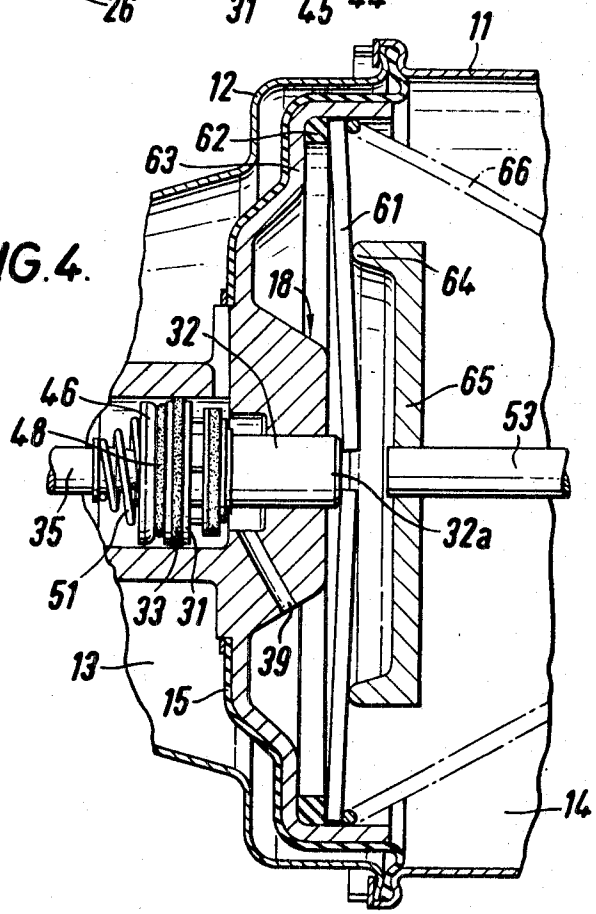


FIG. 4.



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FLUID PRESSURE OPERATED MOTORS

The present invention relates to fluid pressure operated motors of the kind comprising a casing the interior of which is divided into two chambers by a movable dividing member such as a diaphragm or piston, both chambers being connected, when the motor is inoperative, to a source of fluid, such an air, at a relatively low pressure and the admission of fluid at a relatively higher pressure to the chamber on one side of the movable dividing member to effect displacement of the said movable dividing member is controlled by valve means supported by the said movable dividing member so as to be movable therewith, the actuation of the valve being controlled by a pedal or other operator actuated control.

An object of the invention is to provide improvements in the construction of the valve means in a fluid pressure operated motor of the kind above referred to.

According to the present invention, a fluid pressure operated motor comprises a casing divided by a movable dividing member into first and second chambers of which the first is in constant communication with a source of fluid at a relatively low pressure and valve means carried by and movable with the said movable dividing member to connect the second chamber selectively to said first chamber or to a second source of fluid at a relatively higher pressure said valve means comprising a valve chamber closed at one end by a movable wall having at least one aperture therein communicating with the source of fluid at the relatively higher pressure, a seating in said valve chamber passages opening into said valve chamber at opposite sides of the seating and connecting said valve chamber respectively to said first and second chambers, an operator control operative to move said movable wall, a first valve closure member to cooperate with the seating in the valve chamber, a second valve closure member to cooperate with the aperture in the movable wall, and thrust means interconnecting said valve closure members, the arrangement being such that when the motor is inoperative the second valve closure member closes the aperture in the movable wall and the first valve closure member is unseated so that the first and second chambers are interconnected and movement of the movable wall by the operator control first moves the first valve closure member on to the seating, to isolate the second chamber from the first chamber, further movement of the operator control causing relative movement between the said movable wall and the second valve closure member to admit fluid from the higher pressure source to the valve chamber and to the second chamber in the motor casing to create a differential pressure across the movable dividing member and cause operation of the motor.

The invention will not be described with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal sectional view of one form of fluid pressure operated motor according to the invention;

FIG. 2 is a sectional elevation, on a larger scale than FIG. 1, of the valve means included in the fluid pressure operated motor shown in FIG. 1;

FIG. 3 is a sectional elevation similar to FIG. 2 but showing a modified valve means; and

FIG. 4 is a sectional view, similar to part of FIG. 1, showing means by which a resistance can be applied to the operator control proportional to the thrust exerted by the motor, to enable the operator to feel the degree of thrust being exerted.

The fluid pressure operated motor shown in FIG. 1 is of the so-called vacuum suspended type, and is intended to provide power assistance in a fluid pressure braking system of a vehicle, the said motor being arranged, in use, to operate the piston of a liquid pressure master cylinder. The invention is not, however, limited to fluid pressure operated motors for that purpose.

Referring to FIG. 1 of the drawings, the motor comprises a casing 10 made from two dished shells 11 and 12 assembled to form a substantially cylindrical casing, the interior of the casing being divided into two separate chambers 13 and 14 by a flexible diaphragm 15 secured in position by trapping a peripheral edge portion of the diaphragm between overlapping portions of the two dished shells 11 and 12. The chamber 13 is hereinafter referred to as the first or vacuum chamber, the chamber 14 being referred to as the second or working chamber. The casing 10 has an opening 16 for connecting the vacuum chamber 13 to a source of vacuum (not shown), for example the exhaust manifold of the vehicle engine, the diaphragm 15 being spring loaded by a coil spring 17 in the vacuum chamber 13 to bias the diaphragm towards the working chamber 14.

The diaphragm 15 has a centrally disposed hub 18 which is secured to the diaphragm so as to be movable therewith. The hub 18 consists of a body portion 19 disposed on the vacuum chamber side of the diaphragm 15 and a sleeve portion 21 disposed on the working chamber side of the diaphragm. The sleeve portion 21 of the hub extends axially through the working chamber 14 and out of the casing 10 through an aperture 22 in the end wall of the working chamber, the sleeve being slidable in the aperture upon movement of the hub with the diaphragm. A sealing member 23 is provided to ensure a fluidtight seal between the wall of the aperture and the outer periphery of the sleeve portion. The end of the sleeve portion 21 projecting out of the working chamber 14 is open and provides an air inlet. A boot or flexible cover 24 is advantageously provided at this end of the sleeve bore, at least a part of which is formed of wire mesh or other perforate material to form an air filter. The bore of the sleeve portion 21 of the hub is stepped at 25 to provide a bore section 26 of larger diameter at the outer end of the sleeve portion, and a bore section 27 of smaller diameter at the inner end thereof. A central bore 28 in the body portion 19 of the hub, coaxial with the bore sections 26, 27, is enlarged adjacent its end which opens into the bore section 27 as shown at 29. In the bore section 27 there is slidable a flange 31 formed on a stem 32 one end of which is slidable in the body bore 28, the said flange carrying, on its peripheral edge, a sealing ring 33 making a fluidtight slidable joint with the wall of the bore section 27. The flange 31 thus forms a movable end wall for a valve chamber 30 defined by the bore section 27 and the enlargement 29 of the body bore 28.

At its other end, the stem 32 has a recess to receive, and retain against relative axial movement, a ball end 34 on a push rod 35 which passes axially through the sleeve portion 21 of the hub, the push rod 35 being connectable, by suitable linkage (not shown) to the brake pedal of the vehicle. A spring 36, acting between a stop 37 on the push rod 35 and the step 25 in the bore of the sleeve portion of the hub, urges the push rod, and with it the stem 32 and flange 31, towards a retracted position corresponding to the deenergized condition of the fluid pressure operated motor.

Drillings 38 (FIG. 2) in the flange 31 parallel to its axis provide passages for the flow of air from the outer end of the sleeve portion 21 of the hub into the valve chamber 30. A drilling 39 in the body portion 19 of the hub connects the first or vacuum chamber 13 to the enlargement 29 of the body bore, and a drilling 41 connects the second or working chamber 14 to the end of the bore section 27 adjacent the enlargement 29. The inner edge of a shoulder 42 at the junction of the bore section 27 and the enlargement 29 provides a seat for a first valve closure member consisting of an annular washer 43 of natural or synthetic rubber, plastics or other suitable material, surrounding the stem 32, the inner periphery of the washer 43 sealing around the outer periphery of the stem. The annular washer 43 is carried by and secured to a flat ring 44 from which project a plurality of rigid axially extending rods 45 passing, with clearance, through the drillings 38 and abutting against another ring 46 on the other side of the flange 31. A ring 47, located on the stem 32 by a clip ring, provides an abutment for the annular washer 43 limiting its movement along the stem away from the flange 31. The washer 43, when in contact with the shoulder 42, separates the parts of the valve chamber 30 which are connected to the vacuum chamber 13 and to the working chamber 14 respectively.

The ring 46 carries, on its side facing the flange 31, two spaced coaxial sealing rings 48 and 49, which may be O-rings, adapted to engage the flange 31 respectively radially outside and radially inside the ring of drillings 38, the ring 46 and sealing rings 48 and 49 thus providing a second valve closure member to prevent the entry of air into the valve chamber 30 through the said drillings. A coiled compression spring 51, taking its abutment on a clip ring 52 carried by the push rod 35, urges the sealing rings 48 and 49 into engagement with the flange, and, through the rods 45, urges the annular washer 43 towards the ring 47.

A second push rod 53 having a head 54 fixed in the bore 28 of the hub 18, extends through an opening in the end wall of the vacuum chamber 13 to engage the piston of a liquid pressure master cylinder (not shown) coupled to motor cylinders for actuating the vehicle brakes, a fluidtight seal 55 being provided in the opening.

When the brakes of the vehicle are not applied, the fluid pressure operated motor is deenergized.

The push rod 35 is urged by the spring 36 to the retracted position, the stem 32 also being held by the push rod 35 in a position in which the annular washer 43 forming the first closure member is unseated, the O-rings 48, 49 forming the second closure member being seated against the adjacent face of the flange 31 by the spring 51. With the first closure member unseated, the casing chambers 13 and 14 are open to one another through the drillings 39, 41 in the hub and the valve chamber 30 so that the diaphragm is held by the spring 17 in the position shown in FIG. 1, in which the volume of the working chamber 14 is a minimum. The second closure member being seated prevents air from entering the working chamber 14 through the drillings 38. When the brake pedal is operated to apply the brakes, the push rod 35 is moved inwardly of the hub against its spring loading. The stem 32 moves correspondingly, carrying the closure members with it. During this movement, the annular washer 43 forming the first closure member is seated on the shoulder 42, to isolate the working chamber 14 from the vacuum chamber 13, and when it is so seated, further movement of the rings 44 and 46 is prevented so that continued movement of the push rod 35 causes the stem 32 to move relative to the said rings, whereby the flange 31 is separated from the O-rings 48, 49 to uncover the axial drillings 38 and permit air to enter the valve chamber 30 and pass into the working chamber 14. The admission of air into the working chamber 14 results in the creation of a differential pressure on the diaphragm 15 so that the same said diaphragm is deflected against its spring loading, the movement of the diaphragm causing movement of the second push rod 53 in the usual manner to actuate the master cylinder and effect brake operation. When the brake pedal is released, the push rod 35 and stem 32 are retracted by the spring 36 acting on the push rod the spring 51 acting on the spider ring 46 returning the closure members to their original positions relative to the stem and the retraction of the stem moving the washer 43 away from the shoulder 42. Thus the air supply to the working chamber 14 is shut off and vacuum is restored in that chamber, allowing the diaphragm 15 to return to its initial position.

In the above described embodiment of the invention the stem 32 is adapted to slide through the annular washer 43 forming the first closure member. However, to avoid friction, which may result in undesireable drag, the first closure member may, as shown in FIG. 3, be in the form of a diaphragm 56 having a relatively thick outer portion secured to the ring 44 and a thinner, flexible inner portion 57 the inner periphery of which engages in an annular groove 58 in the stem 32 so that deflection of this diaphragm occurs to permit the movement of the stem relative to the outer portion of the diaphragm. The second closure member could be formed as a one-piece moulding, including the disc 46 and washers 48, 49, in natural or synthetic rubber, plastics or other suitable material. Alternatively the second closure member could comprise a disc 46 formed as a moulding in plastics material, the O-rings of the said second closure member each being disposed in concentric grooves in the appropriate face of the disc.

Advantageously, means are incorporated for providing "braking feel" to the driver through the brake pedal. This can be obtained by, for example, the provision of spring means between the stem 35 of the valve means and the push rod 53 operable by the diaphragm of the motor.

Alternatively, the "feel" can be obtained by transmitting the thrust from the diaphragm 15 to the push rod 53 through a lever mechanism which applies a reaction thrust to the stem 32 and so to the push rod 35. Thus, referring to FIG. 4 the stem 32 has an extension 32*a* extending from the hub 18 into the vacuum chamber 13, and radial levers 61, engaging at their outer ends with a resilient ring 62 supported by a plate 63 carried by the hub 18, and at their inner ends with the stem extension 32*a*, also engage, intermediate their ends, with a cylindrical rim 64 on a disc 65 fixed to the push rod 53. The spring which acts to return the diaphragm 15 to its initial position, shown at 66, acts on the levers 61 adjacent their outer ends. When the fluid pressure operated motor is activated by operation of the valve, the thrust on the diaphragm 15 is transmitted through the plate 63 and resilient ring 62 to the outer ends of the levers 61 and so through the disc 65 to the push rod 53, a reaction being exerted by the inner ends of the levers on the stem 32 and push rod 35.

The lever 61 may be replaced by a dished spring washer, the essence of the arrangement, whether levers or a dished spring washer are used, being that the lever means constituted by the levers or the dished spring washer engage the dividing member of the motor at a radially outer zone, the stem at a radially inner zone, and the thrust member which transmits thrust from the motor to the master cylinder at a radially intermediate zone.

I claim:

1. A fluid pressure operated motor comprising a casing divided by a movable dividing member into first and second chambers of which the first is in constant communication with a source of fluid at a relatively low pressure and valve means carried by and movable with the said movable dividing member to connect the second chamber selectively to said first chamber or to a second source of fluid at a relatively higher pressure, said valve means comprising a valve chamber closed at one end by a movable wall having at least one aperture therein communicating with the source of fluid at the relatively higher pressure, a seating in said valve chamber, passages opening into said valve chamber at opposite sides of the seating and connecting said valve chamber respectively to said first and second chambers, an operator control operative to move said movable wall, a first valve closure member to cooperate with the seating in the valve chamber, a second valve closure member to cooperate with the aperture in the movable wall, and thrust means interconnecting said valve closure members, the arrangement being such that when the motor is inoperative the second valve closure member closes the aperture in the movable wall and the first valve closure member is unseated so that the first and second chambers are interconnected and movement of the movable wall by the operator control first moves the first valve closure member onto the seating, to isolate the second chamber from the first chamber further movement of the operator control causing relative movement between the said movable wall and the second valve closure member to admit fluid from the higher pressure source to the valve chamber and to the second chamber in the motor casing to create a differential pressure across the movable dividing member and cause operation of the motor.

2. A fluid pressure operated motor according to claim 1, wherein the movable wall closing one end of the valve chamber is carried by a stem extending through the valve chamber and guided in a bore extending from the other end of said valve chamber.

3. A fluid pressure operated motor according to claim 2, wherein the first valve closure member includes an annular

sealing member, the seating with which it cooperates being formed by a shoulder in the valve chamber, the said annular sealing member being carried by a ring movable axially relative to the stem and making sealing engagement at its inner edge with the stem.

4. A fluid pressure operated motor according to claim 3, wherein the sealing member is slidably engaged with the stem.

5. A fluid pressure operated motor according to claim 3, wherein the sealing member includes a flexible diaphragm portion the inner edge of which engages a groove in the stem.

6. A fluid pressure operated motor according to claim 1, wherein the second valve closure member comprises a ring urged towards the face of the movable wall external to the valve chamber by a spring, the said ring carrying sealing means to engage the said face of the movable wall.

7. A fluid pressure operated motor according to claim 6, wherein the sealing means carried by the ring comprise two coaxial sealing rings so positioned as to lie respectively radially inside and radially outside a ring of apertures in the movable wall.

8. A fluid pressure operated motor including a first valve closure member according to claim 1, wherein said first valve closure member includes an annular sealing member, the seating with which it cooperates being formed by a shoulder in the valve chamber, the said annular sealing member being carried by a ring movable axially relative to the stem and making sealing engagement at its inner edge with the stem, wherein said second valve closure member comprises a ring urged towards the face of the movable wall external to the valve chamber by a spring, the said ring carrying sealing means to engage the said face of the movable wall, and said sealing means comprises two coaxial sealing rings so positioned as to lie respectively radially inside and radially outside a ring of apertures in the movable wall, and wherein the ring of one of the said valve closure members carries a plurality of rods extending with clearance through the apertures in the movable wall to engage the other valve closure member so that displacement of the either valve closure member relative to the stem and towards the movable wall is accompanied by movement of the other valve closure member away from the movable wall.

9. A fluid pressure operated motor according to claim 1, wherein means are provided for transmitting to the operator control a reaction thrust proportional to the thrust exerted by the said motor.

10. A fluid pressure operated motor according to claim 9, wherein lever means acted on by the dividing member in a radially outer zoned and engaging a stem movable by the operator control at a radially intermediate zone by a circular rim carried by an output thrust member of the motor, so that thrust exerted on the dividing member by differential fluid pressure in the motor is transmitted to the output thrust member through the lever means and a reaction thrust is applied by the said lever means to the stem.

11. A fluid pressure operated motor according to claim 10, wherein the lever means comprise a plurality of radial levers.

12. A fluid pressure operated motor according to claim 10, wherein the lever means comprise a dished spring washer.

13. A fluid pressure operated motor according to claim 10, wherein a resilient seating is interposed between the dividing member and the lever means.