Sept. 17, 1957 J. R. SIMMONS 2,806,449

FLUID OPERATED MOTOR

Filed March 3, 1955 2 Sheets-Sheet 1

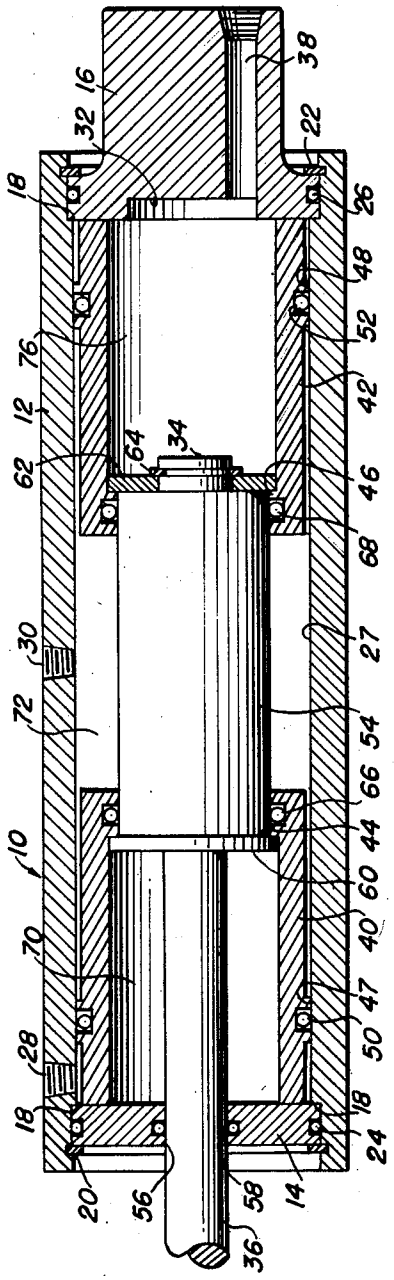


FIG. 1.

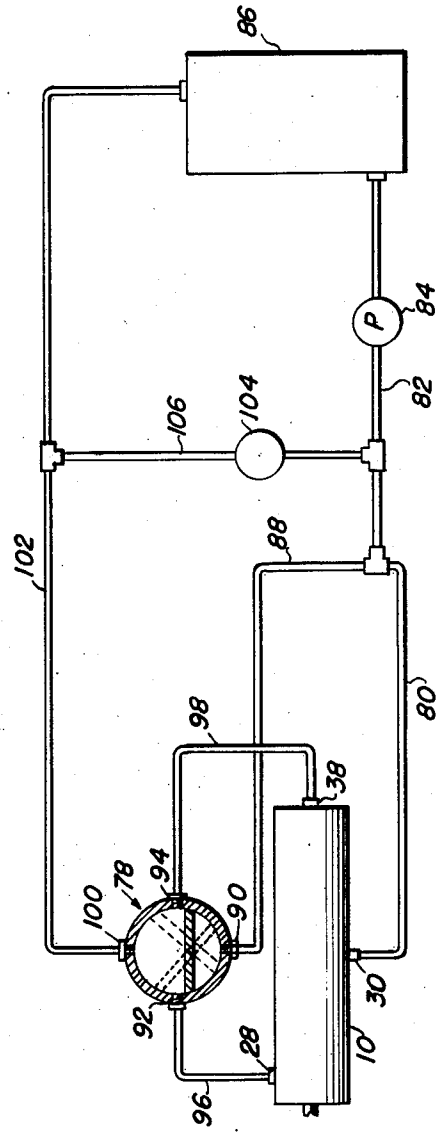


FIG. 4.

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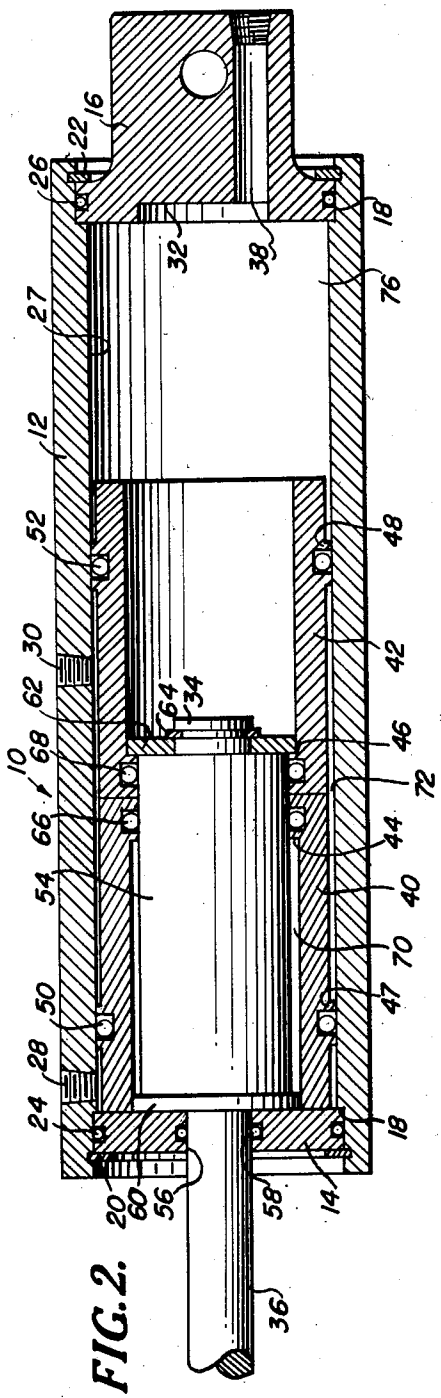


FIG. 2.

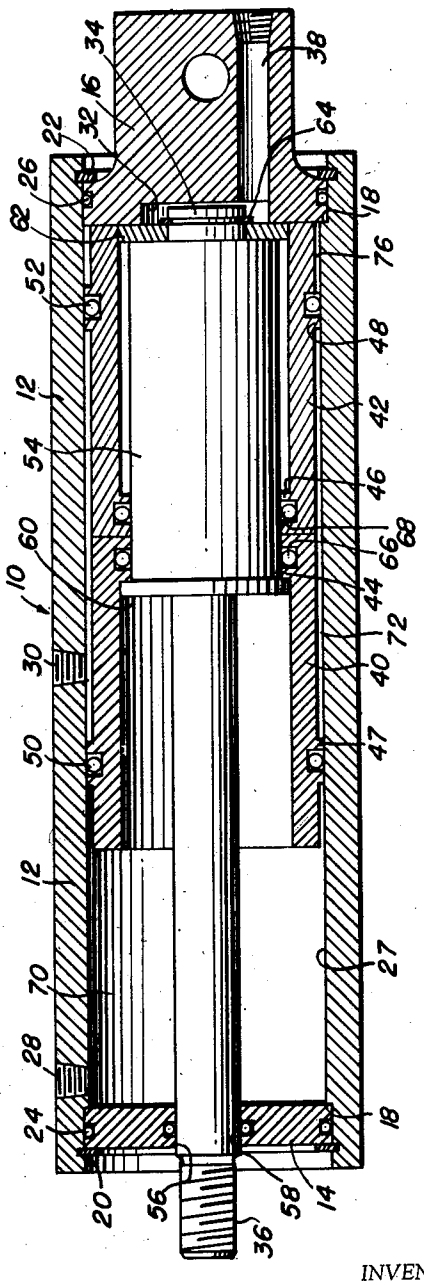


FIG. 3.

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FLUID OPERATED MOTOR

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11 Claims. (Cl. 121—38)

The present invention relates to fluid apparatus, and, more particularly, to a reciprocating fluid motor which may directly actuate, or serve as a servo-motor for actuating, any of an infinite variety of mechanisms.

More especially, this invention relates to a three-position fluid motor that can be controlled by a simple four-way valve.

It is a primary object of this invention to provide an improved three-position fluid motor.

It is another object of this invention to provide a fluid pressure motor which may be easily constructed from readily available materials with ordinary tools and which represents an advancement in design inasmuch as the number and complexity of working parts are reduced.

It is another object of this invention to provide a fluid pressure motor which may be economically constructed and which, due to its simplicity, may be operated for long periods of time with a minimum of maintenance.

It is another object of this invention to provide a fluid pressure motor which may be easily and rapidly assembled and installed and which may be quickly broken down for any necessary inspection, maintenance and repairs.

It is a further object of this invention to provide an improved fluid pressure motor which can be used in combination with standard and easily obtainable control apparatus of standard makes, shapes, sizes and capacities.

These and other objects of the invention will be fully understood from the following detailed description of a typical preferred form and application of this invention, throughout which description reference is made to the accompanying drawings in which:

Figure 1 is a longitudinal section of a fluid pressure motor embodying this invention and showing the motor in its intermediate position.

Figure 2 is a view corresponding to Figure 1 but showing the motor in one of its two extreme positions.

Figure 3 is a view corresponding to Figure 1, but showing the motor in the other extreme position.

Figure 4 is a schematic showing of a hydraulic control circuit for operating the motor shown in Figure 1.

Referring to Figure 1, a fluid pressure motor **10** embodying this invention comprises an elongated hollow cylinder **12**, having the forward end thereof closed, as by a plug **14**, and having the rear end thereof closed, as by plug **16**. Preferably, the plugs **14** and **16** seat against corresponding interior shoulders **18** formed by counterbores in the ends of the cylinder and are retained in place by split snap rings **20** and **22**, respectively. The plugs **14** and **16** are sealed to the cylinder by O-rings **24** and **26**, respectively, disposed in circumferential grooves in the plugs and engaging the interior counterbored surfaces of the cylinder. The cylinder, between the plugs **14** and **16**, has a smooth-walled bore **27** of uniform diameter and has a side wall port **28** adjacent one end of the bore just inwardly of the plug **14** and has a side wall port **30** located at or near the mid-point of the length of the bore **27**. The end plug **16** has its inner face recessed, as at **32**, to receive the stub end **34** of a piston rod **36**, and has

a longitudinally extending port **38** formed therein. Ports **28**, **30** and **38** may be suitably tapped to receive a threaded end of a pressure-fluid conduit, as will be discussed hereinafter.

It should be here stated that while port **38** is illustrated as being in the end plug **16** and port **28** is indicated as being in the side wall of the bore **27**, it is entirely within the contemplation of this invention that the relative position of these ports may be reversed, or that both ports may be in either the end plugs or in the bore side wall.

Slidably disposed within the cylinder **12** is a pair of tandemly aligned tubular pistons **40** and **42**, which preferably are identical for convenience of manufacture and interchangeability. The inner, or neighboring, ends of the tubular pistons have inwardly extending abutment means which preferably consist of circumferential flanges **44** and **46**, respectively. The tubular pistons **40** and **42** are also provided with exterior peripheral collars **47** and **48**, respectively, which are longitudinally located somewhat inwardly of the outer ends of their respective pistons. Thus the collar **47** is located somewhat inwardly of the port **28** so that pressure-fluid admitted therethrough will act on the outer ends of the piston **40** when the latter abuts the end plug **14**, as shown in Figures 1 and 2. The collars **47** and **48** may be suitably fixed to the tubular pistons **40** and **42**, respectively, or may be cast, or otherwise formed, integral therewith. The peripheral surfaces of the collars **47** and **48** are provided with circumferential grooves having O-ring seals **50** and **52**, respectively, therein which serve as piston rings to seal with the cylinder bore **27**.

When the fluid motor is in its intermediate position, as shown in Figure 1, the tubular pistons **40** and **42** abut the end plugs **14** and **16**, respectively, and have their neighboring ends, which are provided with flanges **44** and **46**, respectively, spaced apart a substantial distance. An imperforate piston **54**, having a piston rod **36** fixed thereto or formed integrally therewith, is disposed coaxially within the tubular pistons **40** and **42**. The piston rod **36** extends outside the cylinder **12**, for connection to any mechanism to be operated, through a central aperture **56** in the forward end plug **14**. To effect a seal between the rod **36** and the aperture **56**, the inner periphery of the aperture is provided with a circumferential groove having an O-ring seal **58** therein. As illustrated in Figure 1, the piston **54** extends between, and within, the two tubular pistons **40** and **42**, when the latter are in their spaced positions shown in Figure 1. The piston **54** is formed as a smooth cylinder dimensioned to slide within the flanges **44** and **46**, and has its ends provided with abutments **60** and **62** extending radially therefrom a sufficient distance to engage the flanges. In the preferred illustrated embodiments, at least one of the abutments is detachable for assembly purposes. Hence, the abutment **60** may consist of a collar formed integral with the piston, while the abutment **62** consists of a washer mounted on a stub end of the piston rod **36** and fixed thereto, as by a snap ring **64**, in an abutting relationship to the piston.

The inner periphery of the flanges **44** and **46** are provided with circumferential grooves having O-rings **66** and **68**, respectively, therein which sealingly engage the piston **54**.

It will be seen that the seals **50** and **52**, together with seals **66** and **68**, serve to segregate the interior of the cylinder **12** into three chambers **70**, **72** and **76**, here termed the forward pressure chamber, the intermediate pressure chamber and the rear pressure chamber, respectively. As the piston **54** and the tubular pistons **40** and **42** are slidably disposed relative to both the cylinder **12** and to each other, the volumes of the chambers **70**, **72** and **76** will vary during the operation of the motor, although the sum total of their volumes remains constant, except

as affected by the volumetric displacement of the piston rod 36.

The seals alone define the pressure chambers, and all sliding or contacting metal surfaces, not provided with seals, allow the pressurized fluid to pass freely therebetween. For example, while the tubular piston 40 has been illustrated (Figures 1 and 2) as abutting the forward end plug 14, it should be clear that no pressure seal is affected between these two members, and it is within the contemplation of this invention that the outer end faces of the tubular pistons 40 and 42 may be radially grooved or otherwise formed, if necessary, to allow a free flow of pressurized fluid around their ends.

Referring more particularly to Figure 4, in which there is illustrated a schematic diagram of the fluid pressure motor 10 operatively connected into a hydraulic circuit including a simple control valve 78 for operating the motor, it will be seen that the motor has its intermediate port 30 constantly in direct fluid communication, via conduits 80 and 82, with a source of pressure-fluid, here shown as the discharge side of a pump 84, which withdraws fluid from a sump or reservoir 86. The discharge side of the pump 84 is also in direct fluid communication, through supply conduit 88, with the inlet 90 of a conventional three-piston control valve 78 which has two control ports 92 and 94 that are connected, via conduits 96 and 98, respectively, with the motor ports 28 and 38, respectively, and has a vent port 100 that is constantly in communication with atmospheric pressure, as by a return conduit 102 to the sump 86. Preferably, an adjustable pressure release valve 104 is connected into a bypass conduit 106 that is connected between the conduits 82 and 102 to maintain a substantially constant operating pressure for the motor.

The control valve 78 may be set in either of three positions: In the first, the forward pressure chamber 70 of the motor is connected to the pressure fluid source and the rear pressure chamber 76 is vented; in the second, both the forward pressure chamber 70 and the rear pressure chamber 76 are vented; while in the third, the rear pressure chamber 76 is pressurized and the forward pressure chamber 70 is vented. It is again pointed out that the intermediate pressure chamber 72 is constantly pressurized. In Figure 4, the valve 78 is illustrated in the second position. Phantom lines illustrate the disposition of the valve when in the first and third positions.

Operation

When the piston 54 is in the intermediate position illustrated in Figure 1, and it is desired to actuate a mechanism operatively engaged with the piston rod 36, the control valve 78 is selectively manipulated to the proper position, whereby one of the end pressure chambers is vented and the other is supplied with pressurized fluid. If, for example, it is desired to extend the piston rod 36, that is to move the piston rod, and hence the piston 54, towards the forward end of the cylinder, the control valve 78 is manipulated to connect the rear pressure chamber with supply conduit 88, while simultaneously connecting the forward pressure chamber 70 with the return conduit 102. When these connections are made, pressure chambers 72 and 76 will contain equally pressurized fluid, while pressure chamber 70 will contain fluid at substantially the vent or atmospheric pressure.

It will be seen that the pressure differential between the intermediate pressure chamber 72 and the forward pressure chamber 70 will be manifested in forwardly directed axial forces acting on the transverse plane of the forward tubular piston 40. However, as the tubular piston 40 is abutting the plug 14, no motion of the tubular piston 40 will result from these unbalanced forces. The pressure differential between rear pressure chamber 76 and forward pressure chamber 70 results in unbalanced forwardly directed forces on the planar end of the piston 54, and it will, therefore, move towards the forward end of the cylinder, thus extending the piston rod 36. As the piston moves forward, its collar 62 will engage the flange 46 and it will, therefore, carry tubular piston 42 with it. As the pressures in the rear pressure chamber 76 and the intermediate pressure chamber 72 have a common source and are, therefore, substantially equal, the tubular piston 42 is not subjected to any unbalanced pressure forces and will, therefore, remain in a substantially fixed position relative to piston 54, as the two members move forwardly as described hereinabove. This forward movement will continue until the pressure in the rear pressure chamber 76 is relieved by manipulation of the control valve 78 or until the movement is mechanically retarded by the abutment of the forward end of piston 54 against the forward end plug 14, or by the abutment of the tubular piston 42 against tubular piston 40, the latter of which is held fast as discussed hereinabove. In the preferred embodiment, best illustrated for consideration of this feature in Figure 2, this piston rod extension movement will be mechanically restrained by both of the above-mentioned abutments at substantially the same instant, although it is within the contemplation of this invention that the longitudinal dimension of the piston 54 may be changed with the result that either one or the other of such abutments will occur first.

If it is then desired to move the piston rod 36 through the intermediate position to the retracted position illustrated in Figure 3, the control valve 78 is manipulated to supply the forward pressure chamber 70 with pressurized fluid while simultaneously connecting the rear pressure chamber 76 to the return conduit 102. The pressure differential between the forward pressure chamber 70 and the rear pressure chamber 76 will result in unbalanced forces upon the planar end of the piston 54 which will move it towards the rear end of the cylinder. Similarly, the pressure differential between the intermediate pressure chamber 72 and the rear pressure chamber 76 will result in unbalanced axial forces upon the tubular piston 42 which will act to move it towards the rear end of the cylinder. Due to the abutment of flange 46 and collar 62, the tubular piston 42 cannot proceed ahead of the piston 54, rather, it will move with it maintaining a substantially constant relative position therewith. If the tubular piston 42 lags, relatively speaking, behind the piston 54, the effective operation of the motor is unchanged. As the two pistons, that is the tubular piston 42 and the piston 54, move to the rear, they pass through the intermediate position illustrated in Figure 1 and proceed to the retracted position illustrated in Figure 3. As the piston 54 moves into the retracted position, its collar 60, in abutting engagement with flange 44, will pull the tubular piston 40 along with it.

As shown in Figure 3, when the motor is in the full retracted position, the stub 34 of the piston rod 36 extends within the recess 32 in the rear end plug 16, but does not block the end port 38.

When the piston is located in either the extended or the retracted position and it is desired to transpose it to the intermediate position, the control valve 78 is manipulated to vent both end ports 28 and 38. As the intermediate port 30 is constantly in direct fluid communication with the discharge side of the pump 84, the intermediate pressure chamber 72 will always be supplied with pressurized fluid. This pressure in the intermediate pressure chamber 72 results in unbalanced axial forces on the tubular pistons. One of the tubular pistons is held fast in its position abutting its end plug, and the other tubular piston is moved towards the opposite end of the cylinder. The tubular piston which is so moved will pull the piston 54, by engagement of its flange with the collar (60 or 62), in the manner discussed hereinabove, so that the respective elements will arrange themselves in the intermediate position illustrated in Figure 1.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art and falling within the scope of the following claims.

I claim:

1. A fluid pressure motor comprising a cylinder having closed ends; first and second opposed tubular pistons therein; a third imperforate piston of smaller diameter than said tubular pistons and telescopingly arranged within said tubular pistons and separating the interior of said cylinder into two end pressure chambers and an intermediate pressure chamber; means for connecting each of said chambers with a source of fluid under pressure; a piston rod connected to said third piston and extending through one of said cylinder ends; a lost motion connection between said third piston and each of said tubular pistons for movement of each of the latter with said third piston when said third piston moves toward the correspondingly opposite end of said cylinder, said lost motion connection being engageable between the third piston and a given tubular piston when the end of the third piston most remote from the given tubular piston moves away from the given tubular piston.

2. The structure defined in claim 1 in which the first and second tubular pistons are dimensioned for substantial abutment against their corresponding cylinder ends when both of the lost motion connections are engaged.

3. The structure defined in claim 1 including means for supplying the intermediate chamber with pressure fluid and means for supplying pressure fluid to and exhausting pressure from the end pressure chambers.

4. The structure defined in claim 1 including means for constantly supplying the intermediate chambers with pressure fluid and means for alternately supplying pressure fluid to one of the end chambers while venting the other, supplying pressure fluid to said other end chamber while venting the one, and venting both of said end chambers.

5. A fluid pressure motor comprising a closed cylinder having end ports and an intermediate port; a pair of tandemly aligned tubular pistons within said cylinder; an imperforate piston of smaller diameter than said tubular pistons and telescopingly arranged within each of said tubular pistons and separating the interior of said cylinder into two end pressure chambers and an intermediate pressure chamber; said intermediate port being in constant communication with said intermediate chamber; said intermediate port being constantly connected to a source of fluid pressure; limit means to prevent the complete withdrawal of said imperforate piston from either of said tubular pistons; and sliding sealing means between each of said tubular pistons and said imperforate piston.

6. The structure defined in claim 5 in which the cylinder has a length substantially equal to the combined length of the tubular pistons and the imperforate piston, when the latter is withdrawn from both of said tubular pistons to the extent defined by the limit means.

7. The structure defined in claim 6 in which the limit means comprises inwardly extending abutments on the neighboring ends of each of the tubular pistons and spaced outwardly extending abutments on said imperforate piston for engagement with said first-mentioned abutments.

8. The structure defined in claim 7 in which each of the first-mentioned abutments comprises a circumferential flange having the sealing means disposed in the periphery thereof.

9. The structure defined in claim 8 and further including a three-position valve having the end ports connected thereto for selectively connecting one end port with the pressure source while venting the other end port, connecting the other end port to said pressure source while venting the one end port, and venting both end ports simultaneously.

10. A fluid pressure motor comprising a closed cylinder; a pair of tandemly aligned tubular pistons, said tubular pistons being slidably sealingly disposed within said cylinder; a third piston having one end slidably sealingly disposed within one of said tubular pistons and having the other end slidably sealingly disposed within the other of said tubular pistons, limit means for preventing a complete withdrawal of said third piston from either of said tubular pistons and forming lost motion connections therebetween; said limit means comprising outwardly extending formations on the exterior periphery of the third piston having an exterior diameter less than the interior diameter of said tubular piston, and inwardly extending projections formed on the interior periphery of said tubular pistons, and having an interior diameter greater than the diameter of said third piston; said cylinder having end ports at each end thereof to selectively conduct pressure fluid to axially urge all of said pistons towards the opposite end of said cylinder; said cylinder having an intermediate port for conducting pressure fluid to axially displace at least one of said tubular pistons toward one of said ends; and a piston rod connected to said third piston and extending without said closed cylinder.

11. The structure defined in claim 10 in which the intermediate port is constantly connected to a source of fluid pressure; and including a three-position valve having the end ports connected thereto for selectively connecting one end port with the pressure source while venting the other end port, connecting the other end port to said pressure source while venting the one end port, and venting both end ports simultaneously.

References Cited in the file of this patent

UNITED STATES PATENTS

767,732	Bromley	Aug. 16, 1904
2,524,488	Stevens	Oct. 3, 1950