

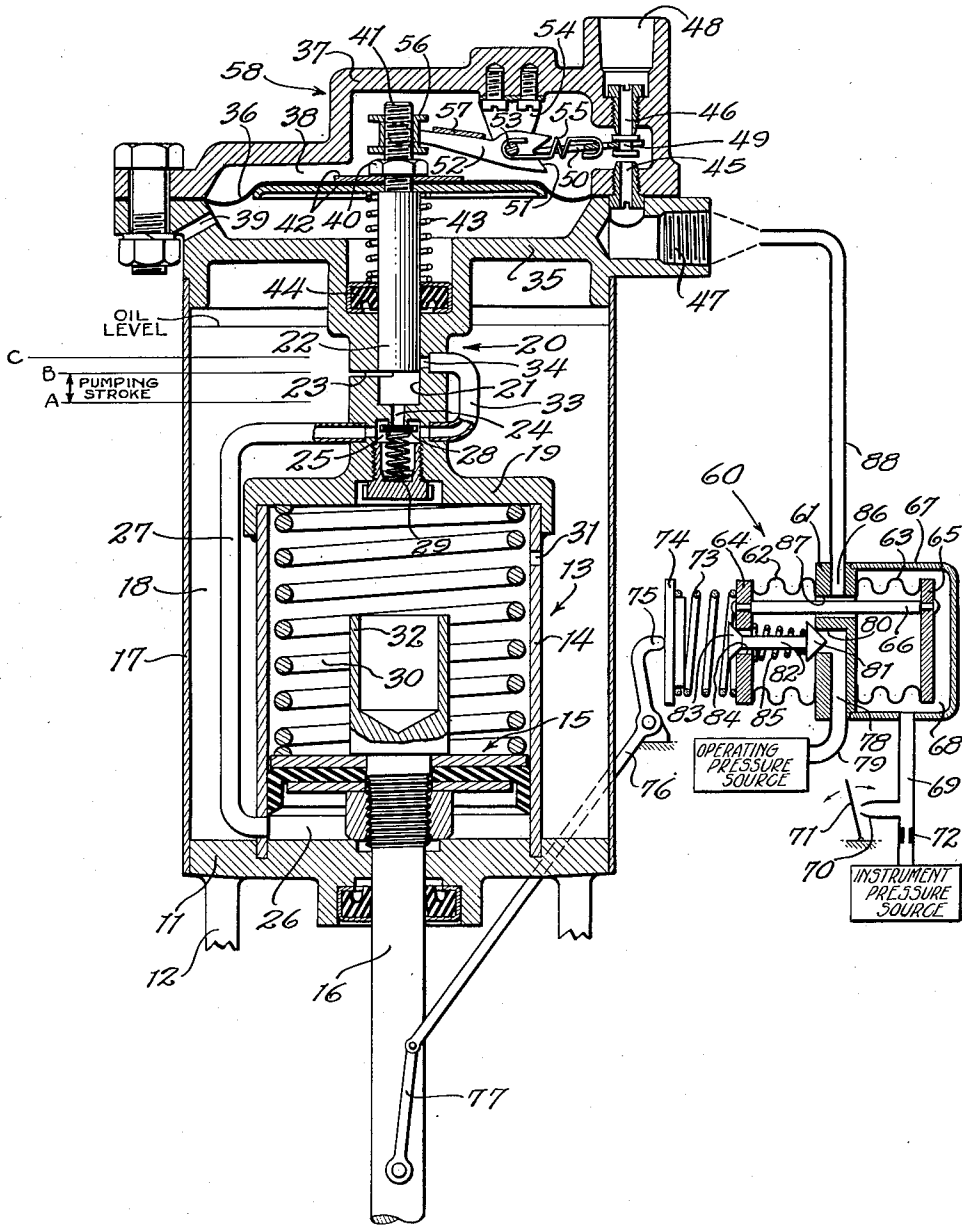
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FLUID PRESSURE OPERATED MOTOR

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FLUID PRESSURE OPERATED MOTOR

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My present invention relates to fluid pressure operated motors, and more particularly to such motors of the type adapted for positioning industrial control devices such as valves, dampers, or the like.

A general object of this invention is, to provide a pressure operated motor which, while of relatively small size and consuming but little power, is capable of accurately positioning large valves, even when the same are of the single-seated or non-balanced type and are subjected to high and varying pressures.

Another object of the invention is to provide a motor of the character described in the preceding object which employs an elastic fluid, such as compressed air, both for its operation and for its control.

Another object is to provide a pneumatically operated and controlled motor whose actuating member is hydraulically operated and locked in position.

For full understanding of the invention, and further appreciation of its objects and advantages, reference is to be had to the following detailed description and accompanying drawing, and to the appended claims.

The single figure of the drawing is a sectional view of a fluid pressure motor embodying the invention; the figure including a diagrammatic showing of a conventional "valve positioner" for controlling the motor.

The motor structure shown in the drawing comprises a disk-like base 11 having a plurality of legs 12 for attaching the structure to a device to be operated, such as a fluid control valve. Mounted on top of the base is a main pressure-motor 13 which comprises a cylinder 14, sealingly secured to the base, and a cooperating plunger 15 having a stem 16 sealingly extending through an opening in the base for connection to the stem of the device to be operated. The space around the motor 13 is confined by a tubular housing 17, secured to the periphery of base 11, to provide a reservoir 18 for hydraulic fluid for operation of this motor; the surface of this fluid being indicated by the legend "Oil level."

On top of the motor cylinder 14, and secured thereto by its flanged base 19, is a pump structure 20 having a bore 21 for a reciprocable piston 22. In the side of the pump structure is a slot 23 through which liquid from the reservoir 18 enters the bore 21 when the piston 22 is in the position shown and, when the piston is moved downwardly (by means to be described), is forced through a passage 24 at the bottom of the bore

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into a chamber 25 and thence to the space or pressure chamber 26 below the plunger 15 of the main pressure-motor by way of a pipe 27 interconnecting these chambers; a check valve 28, biased by a spring 29 into engagement with a seat formed at the bottom of passage 24, preventing return of the liquid when the piston 22 is retracted.

Pumping of liquid into the space 26 below the plunger causes the same to rise against the force of a spring 30 compressed between the plunger and the base 19 of the pump structure; the space above the plunger being in free communication with the reservoir by way of an opening 31 in the upper part of cylinder 14. A projection 32 of the motor stem 16 limits upward movement of the plunger.

The chamber 25 below the pump is also connected by a bent pipe 33 to an opening 34 leading to the piston bore 21 at a point beyond the range of pumping movement of piston 22, so that when (in a manner to be described) the piston is raised slightly above its position as shown in the drawing fluid can escape from the main-motor chamber 26 to the reservoir by way of pipe 27, chamber 25, pipe 33, opening 34, bore 21 and slot 23; the plunger falling under the force of spring 30.

On the dished top portion 35 of the pump structure is a fluid-pressure reciprocating motor, or pulsator, 38 which comprises a flexible diaphragm 36 clamped at its margin between the dished portion 35 and an inverted dished member 37 which defines with the diaphragm a pressure chamber 38; the space below the diaphragm being vented to atmosphere by an opening 39. The central part of diaphragm 36 is clamped to the upper end of piston 22 by a nut 40 threaded on the top extension 41 of the piston; stiffening plates 42 being provided on either side of the diaphragm.

The diaphragm and piston assembly is biased upwardly by a spring 43 encircling the piston and bearing at its bottom on a conventional packing member 44. When the chamber 38 above the diaphragm is at atmospheric pressure the top of piston-extension 41 is in engagement with the member 37 under the force of spring 43; it being assumed that with the parts in the positions shown in the drawing the pressure in chamber 38 is slightly in excess of atmospheric, as will be described.

For supplying pressure fluid to the chamber 38 of the reciprocating motor, and for venting it, there is a pair of aligned valve-jets 45 and 46 projecting into the chamber; the lower jet 45

being secured in openings through the dished members 37 and 35 and communicating with a threaded recess 47 in the latter, the other jet 46 being threaded in an opening through the top wall of member 37. The jet 46 leads directly to atmosphere, but in the event that a fluid such as high-pressure fuel-gas is employed for the reciprocating motor, the recess 48 with which jet 46 communicates may be threaded for the connection of means for utilizing the gas.

Between the jets 45 and 46, and alternately cooperable with the individual jets, is a dual-ended closure 49 carried by an arm 50 whose left-hand end is fulcrumed in the root of a notch 51 provided in the right-hand end of a lever 52 which is pivoted on a pin 53 projecting from a bracket 54 attached to the member 37. As shown in the drawing, the right-hand end of arm 50 is urged in upward direction by a spring 55 tensioned between the arm and pivot pin 53 so that closure 49 is held in engagement with the upper jet 46; the closure being so mounted on arm 50 that it is free to conform to the plane of the tips of the jets. This upward tension on arm 50 is due to the fact that the left-hand edge of the arm (fulcrumed in notch 51) is slightly below the line of force of spring 55. The rounded left-hand end of lever 52 is supported by a grooved collar 56 threaded on the piston-extension 41 (and locked in adjusted position, as by a through pin, not shown) so that when the piston moves downwardly (as will be described) the lever 52 is rocked counterclockwise. When the position of the lever then becomes such that the root of notch 51 is just above the line of force of spring 55 (the bottom of piston 22 being just above the level indicated at A) the arm 50 is snapped to its alternate position with closure 49 in engagement with the lower jet 45. The lever 52 consists of two like portions joined together at the top by a bridge 57 and spaced apart so that the left-hand ends of the lever are in the groove of collar 56 and at opposite sides thereof; the arm 50 being bifurcated so that it has two left-hand ends which rest in the notches in the right-hand side portions of lever 52.

At the right of the motor structure, and generally indicated by the numeral 60, are means for supplying fluid, such as compressed air, to the reciprocating motor 58, and for regulating the supply of fluid in response to variations of a condition, such as temperature or pressure, which variations require corresponding variation of the position of the valve or other device connected to the main-motor stem 16. The means 60 are of conventional design and are therefore shown diagrammatically.

The numeral 61 indicates a stationary member to opposite sides of which one end of a bellows 62 and of another bellows 63 are attached; the bellows carrying at their other ends heads 64 and 65 which are rigidly interconnected by a rod 66 extending freely through an opening 87 in the member 61.

The space around the bellows 63 and its head 65 is enclosed by a housing 67 to provide a pressure chamber 68 which is connected by a pipe 69 to a source of pressure fluid (conveniently, compressed air) indicated by the legend. Branching from the pipe 69 is a jet 70 with which a movable "instrument" arm 71 cooperates. A fixed restriction 72 is provided in pipe 69 ahead of jet 70, so that when the arm 71 is rocked away from the jet the fluid passing the restriction can readily escape through the jet and the pressure

applied to chamber 68 is substantially atmospheric; the pressure in the chamber increasing as the arm 71 is moved toward the jet and becoming equal to that of the source when the jet is closed by the arm. The arm 71 corresponds to the movable element of a condition-responsive instrument such as a thermostat.

The fluid pressure in chamber 68 acts on the bellows head 65 to move it, and the interconnected head 64, toward the left; such movement, however, being opposed by the force of a spring 73 compressed between head 64 and (through a disk 74) the tip 75 of a bell-crank lever 76 whose lower arm is connected by a link 77 to the main-motor stem 16.

The stationary member 61 has a vertical passage 78 which is connected by a pipe 79 to a source, indicated by the legend, of "operating" pressure fluid which may be high-pressure air; the passage 78 having at its inner end a branch opening 80 with which a conical closure 81 cooperates. This closure is connected by a stem 82 to a similar closure 83 which cooperates with a vent opening 84 through the bellows head 64, the closure assembly being biased toward the right by a spring 85. The arrangement is such that both of the closures 81 and 83 are seated when the opposing forces acting inwardly on the bellows heads 64 and 65 are balanced. When, due to the unbalance of these forces, the bellows assembly is moved toward the left closure 81 is unseated; closure 83 being unseated when the assembly is moved toward the right. In the top of member 61 is a vertical passage 86 which joins the transverse opening 87 and is thus in communication with the interior of bellows 62 and 63; passage 86 being connected at its outer end to a pipe 88 which extends to the inlet fitting 47 of the reciprocating motor 58.

From the foregoing it is clear that with rise of instrument pressure in chamber 68 "operating" pressure-fluid is supplied to the reciprocating motor; and with fall of instrument pressure the inlet of the reciprocating motor is connected to atmosphere. It is to be observed that operating pressure-fluid within the bellows acts equally and oppositely on the heads 64 and 65 and therefore does not tend to alter the position of the bellows assembly.

As shown in the drawing the parts are in the positions taken when the instrument arm 71 is in a low-pressure producing position; the pressure in diaphragm chamber 38 is correspondingly low (but not atmospheric); the piston 22 is at the top of its pumping stroke (position B); and the main pressure-motor stem 16 is in its lowermost position.

Assuming now that the instrument arm moves closer to jet 70: the resultant rise of pressure in chamber 68 effects movement of the bellows assembly toward the left so that closure 81 is unseated and operating pressure-fluid passes to the reciprocating motor, forcing the diaphragm and piston 22 downwardly. Just before the piston reaches the end of its downward or pumping stroke (position A) arm 50 is snapped to its alternate position so that the closure 49 is moved out of engagement with jet 46 and into engagement with jet 45. The resultant venting of chamber 38 permits the diaphragm and piston to rise rapidly under the force of spring 43. But just before the piston reaches its B position the position of arm 50 and closure 49 is reversed so that pressure above the diaphragm again rises and the pumping stroke is repeated; each down-

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ward movement of the piston forcing oil from the reservoir to the chamber 26 below the plunger 15 so that the same rises. The accompanying upward movement of stem 16 effects clockwise rotation of bell-crank 76 so that the force of spring 73 is increased and the bellows assembly moves toward the right to effect reseating of closure 81, so that operation of the reciprocating motor ceases; the pressure of the fluid trapped in chamber 38 maintaining the diaphragm and piston stationary at some position within the pumping range, such as the position shown in the drawing.

If the instrument pressure in chamber 68 continues to rise the closure 81 will be again unseated and the pumping operation repeated until the main-motor stem rises to a position wherein the force of spring 73 has been increased sufficiently to balance the higher opposing fluid pressure in chamber 68; it being assumed that the pressure of the "operating" fluid supplied to the reciprocating motor is high enough that the increase of force of the bias spring 30 as the plunger rises is a negligible factor in the operation of the system.

If the instrument arm now moves farther from jet 70, the resultant reduction of pressure in chamber 68 permits the bellows assembly to move toward the right under the force of spring 73, and the vent closure 83 is unseated. When this occurs the diaphragm chamber 38 is vented through jet 45, pipe 60, the interior of bellows 62, 63, and opening 84; it being assumed that jet 45 was open, since that jet is closed only during the brief return stroke of the piston under the force of spring 43.

This venting of chamber 38 by the control apparatus 60 permits the diaphragm and piston to rise to full extent under the force of spring 43; the piston-extension 41 then being in engagement with member 37 and the bottom of the piston in its C position (closure 49 remaining in engagement with jet 46). The liquid under pressure in chamber 26 below the plunger now escapes through the opening 34, which opening is closed by the lower portion of the piston 22 except when the pressure in chamber 38 is at, or only slightly above, atmospheric. The resultant fall of plunger 15 effects reduction of the force of spring 73 to compensate for the reduction of pressure in chamber 68 (which caused the operation just described) and the bellows assembly returns to its balanced position wherein both of the closures 83 and 81 are seated.

Summarizing the foregoing description of operation: with rise of instrument pressure, pressure fluid is supplied to the reciprocating motor 58 so that the pump piston 22 is reciprocated to force liquid to the space below plunger 15, causing the same to rise until the resultant increase of force of spring 73 balances the instrument pressure, whereupon operation of the pump ceases due to seating of closure 81. With fall of instrument pressure, the reciprocating motor is vented so that the piston 22 rises above its pumping range to permit venting, through the opening 34 then uncovered by the piston, of liquid from the main pressure-motor so that plunger 15 falls until it reaches a position wherein the opposing forces acting on bellows 62, 63 are again balanced and the vent-closure 83 seated. In this manner the valve, or other device, connected to stem 16 is operated to positions corresponding to those of the instrument arm 71, and is locked securely

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in those positions due to the trapped liquid which fills the space below the plunger.

In the event of leakage from the main-motor chamber 26 or from the diaphragm chamber 38, the resultant fall of stem 16 effects unseating of closure 81 so that additional pressure fluid is supplied to the reciprocating motor and liquid is pumped in an amount sufficient to return the stem 16 to its previous position (assuming that the instrument pressure has remained constant). It is to be observed that the opening 34 for venting the hydraulic fluid is located close to the top of the pumping range of the piston so that the vent is uncovered by the piston upon small reduction of pressure above the diaphragm; the system therefore responding quickly to the slightest opening of vent closure 83. The follow-up spring 73 is preferably arranged so that its force becomes sufficient to balance the maximum available instrument pressure just before the main-motor stem 16 reaches its limit of upward movement.

The rate of operation of the reciprocating motor and pump is generally proportional to the magnitude of increase of instrument pressure which initiated that operation, since with a large increase of instrument pressure the closure 81 will be withdrawn far from its seat so that the pressure drop thereacross will be small and the fluid will be supplied to the diaphragm chamber at correspondingly high pressure.

The specific embodiment of my invention herein shown and described is obviously susceptible of modification without departing from the spirit of the invention, and I intend therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In combination: a main pressure-motor comprising a movable member adapted to be connected to a device to be positioned, and biased to one position; a pump for forcing fluid to said motor and fluidly connected to the motor so that operation of the pump effects gradual movement of said member toward an opposite position against the force of said bias; a fluid-pressure reciprocating motor for operating said pump and adapted to be connected to a controlled supply of pressure fluid, said reciprocating motor comprising a movable wall operatively connected to said pump, and valve means actuated by movements of said wall when the same is adjacent opposite ends of its range of movement for so applying said pressure fluid to the wall that, when the pressure of that fluid is in excess of a predetermined minimum amount, the wall is automatically reciprocated in said range to operate the pump; and means responsive to the pressure of the fluid supplied to said reciprocating motor and effective, when that pressure falls below said minimum amount, to vent said main pressure-motor so that said member can move toward its biased position.

2. The combination defined in claim 1, and wherein said means for venting said main pressure-motor comprises valve means actuated by movement of said reciprocating-motor wall.

3. The combination defined in claim 1, and wherein said reciprocating-motor wall is biased toward one position, and said means for venting said main pressure-motor comprises valve means actuated by movement of said wall to said one position.

4. The combination defined in claim 1, and wherein said pump comprises a piston, connected to said reciprocating-motor wall, and a cooperat-

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ing cylinder; and wherein the vent for said main pressure-motor is formed by an opening in the wall of said cylinder positioned so that it is closed by the piston in its pumping stroke.

5. In combination: a main pressure-motor comprising a movable member adapted to be connected to a device to be positioned, and biased to one position; a pump for forcing fluid to said motor and fluidly connected to the motor so that operation of the pump effects gradual movement of said member toward an opposite position against the force of said bias; a fluid-pressure reciprocating motor for operating said pump and adapted to be connected to a controlled supply of pressure fluid, said reciprocating motor comprising means defining a pressure chamber having a movable wall biased toward one position and operatively connected to said pump, and valve means actuated by movements of said wall when the same is adjacent opposite ends of its range of movement for alternately applying said pressure fluid to the wall and venting said chamber so that, when the pressure of that fluid is in excess of a predetermined minimum amount, the wall is automatically reciprocated in said range to operate the pump; and means responsive to the pressure of the fluid supplied to said reciprocating motor and effective, when that pressure falls below said minimum amount, to vent said main pressure-motor so that said member can move toward its biased position.

6. The combination defined in claim 5, and wherein said means for venting said main pressure-motor comprises valve means actuated by movement of said reciprocating-motor wall to its biased position.

7. The combination defined in claim 5, and wherein said pump comprises a piston, connected to said reciprocating-motor wall, and a cooperating cylinder; and wherein the vent for said main pressure-motor is formed by an opening in the wall of said cylinder positioned so that it is closed by the piston in its pumping stroke.

8. In combination: a main pressure-motor comprising a movable member adapted to be connected to a device to be positioned, and biased to one position; a pump for forcing fluid to said motor and fluidly connected to the motor so that operation of the pump effects gradual movement of said member toward an opposite position against the force of said bias, said pump comprising a reciprocable piston and means forming a cylinder therefor; a fluid-pressure reciprocating motor for operating said pump and adapted to be connected to a controlled supply of pressure fluid, said reciprocating motor comprising means defining a pressure chamber having a movable wall biased toward one position and operatively connected to said piston, as well as valve means actuated by movements of said wall when the same is adjacent opposite ends of its range of

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movement for alternately applying said pressure fluid to the wall and venting said chamber so that, when the pressure of that fluid is in excess of a predetermined minimum amount, the wall is automatically reciprocated in said range to operate the pump; and means for venting said main pressure-motor so that said member can move toward its biased position, said last-named means comprising additional valve means actuated by said wall when, in response to reduction of pressure in said chamber below said minimum amount, the wall moves under the force of its bias to a position beyond its range of pumping movement.

9. The combination defined in claim 8, wherein the vent for said main pressure-motor is formed by an opening in the wall of said cylinder positioned so that it is closed by the piston in its pumping stroke.

10. In combination: a main pressure-motor comprising a movable member adapted to be connected to a device to be positioned, and biased to one position; a pump for forcing liquid from a source thereof to said motor and fluidly connected to the motor so that operation of the pump effects gradual movement of said member toward an opposite position against the force of said bias, said pump comprising a reciprocal piston and means forming a cylinder therefor, said cylinder having in its side-wall an opening for entrance of liquid from said source when the piston is retracted and closed by the piston in its pumping stroke; a fluid-pressure reciprocating motor for operating said pump and adapted to be connected to a controlled supply of gaseous pressure-fluid, said reciprocating motor comprising means defining a pressure chamber having a movable wall biased toward one position and operatively connected to said piston, and valve means actuated by movements of said wall when the same is adjacent opposite ends of its range of movement for alternately applying said pressure fluid to the wall and venting said chamber so that, when the pressure of that fluid is in excess of a predetermined minimum amount, the wall is automatically reciprocated in said range to operate the pump; and means for venting liquid from said main pressure-motor so that said member can move toward its biased position, said last-named means comprising an additional opening in said cylinder side-wall positioned so that it is normally closed by said piston and is uncovered by the piston only when, in response to reduction of pressure in said chamber below said minimum amount, said movable wall is moved under the force of its bias to a position beyond its range of pumping movement.

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No references cited.