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W. R. RAY

2,399,294

HYDRAULIC OPERATOR

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Fig. 1

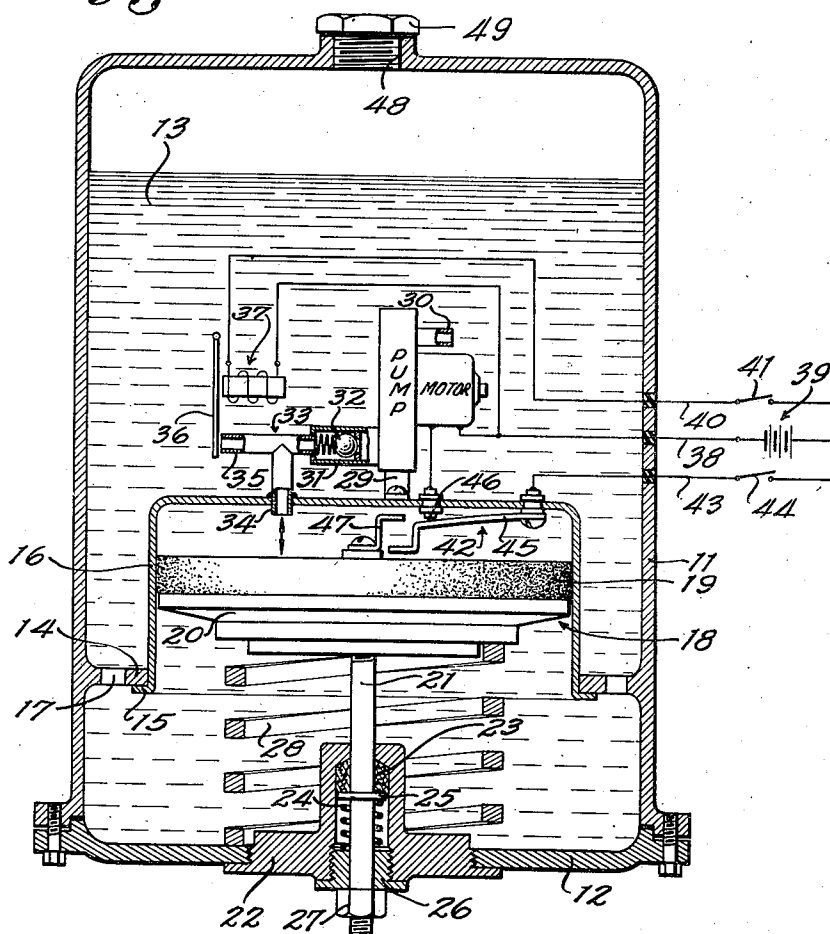


Fig. 2

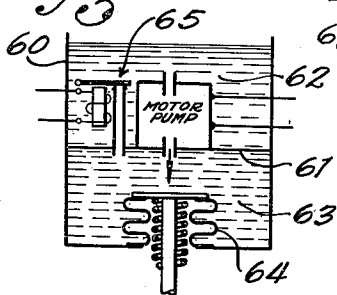


Fig. 3

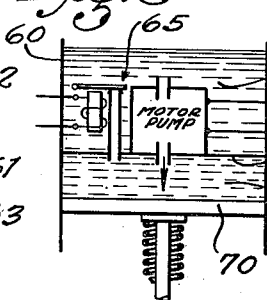
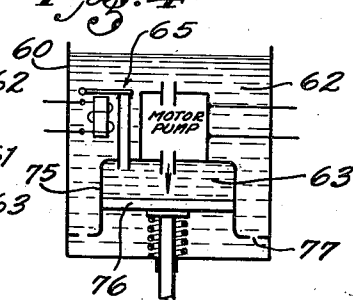


Fig. 4



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HYDRAULIC OPERATOR

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4 Claims. (Cl. 60—52)

My present invention relates to hydraulic operators of the type commonly employed for the operation of fluid control valves, dampers, and the like.

An operator of the type indicated comprises means defining a pressure chamber and having a "movable wall" to which the device to be operated is connected, liquid being forced into the chamber to move the wall. Such a movable wall may be in the form of a flexible diaphragm, an expansible-contractible metallic bellows, or a piston reciprocable in a cylinder formed by the pressure chamber. A diaphragm is usually employed only when relatively low pressure is involved. A wall of the metallic bellows type is capable of withstanding high pressure, but, if it is frequently flexed, cracks may in time develop in the metal, thus rendering it unserviceable. An operator employing a piston as its moving wall is probably the most reliable, but the piston has the inherent disadvantage of permitting more or less of the compressed liquid to leak past it so that the liquid must be replenished periodically. It is therefore an object of my present invention to provide an improved hydraulic operator, employing a piston as its moving element, which under normal conditions requires no replenishment of the liquid, even when high pressures are produced in the operator.

Another object is the provision of an operator, of the character described in the preceding object, wherein a reservoir is provided for the liquid employed for the transmission of power to move the piston, the open end of the piston cylinder being so arranged that it is in continuous communication with the liquid in the reservoir.

Another object is the provision of an operator, of the character described in the preceding object and having the stem of its piston extended through a wall of the reservoir which is exposed to the liquid, wherein the sole force tending to cause leakage of liquid around the stem is that due to gravity acting on the liquid in the reservoir—regardless of the pressures produced in the cylinder in operation.

Another object is the provision of an operator, of the character described in the preceding objects, wherein the pressure cylinder is held in operative position against an abutment formed in the reservoir, solely by the force of the liquid compressed between the piston and the cylinder.

The present invention may be considered, in certain respects, as an improvement on that disclosed in my copending application, Serial No.

348,064, filed July 27, 1940; now Patent No. 2,276,591, dated March 17, 1942.

Other objects and advantages of the invention will be found in the description, the drawing, and the appended claims; and for complete understanding of the invention, reference may be had to the following detailed description and accompanying drawing, wherein:

Figure 1 is a vertical sectional view, mainly in diagram, of a hydraulic operator embodying my invention; and

Figures 2, 3 and 4 are diagrammatic views illustrating, respectively, prior art forms and the present form of hydraulic operators.

In Fig. 1 of the drawing, the numeral 11 indicates a casing, the bottom end of which is closed by a plate 12, which serves as a reservoir for liquid 13, such as oil. Extending from the inner side wall of the casing is a rib 14 which provides an abutment for a flange 15 formed at the bottom end of an inverted cup-shaped member, or cylinder, 16. The rib 14 is apertured at 17 to permit free circulation of the liquid between its opposite sides. Reciprocable in the cylinder 16 is a piston 18 comprising a cup-washer 19 of leather or the like. Threaded in the piston head 20 is a stem 21, the lower end of which extends through a guide fitting 22 threaded in a central opening in the plate 12. The lower end of the bore of this fitting is enlarged to accommodate packing means 23 which is compressed around the stem by a spring 24, compressed between a washer 25 provided below the packing and a hollow nut 26 threaded in the bottom of the fitting bore. The outer end portion of stem 21 is threaded for connection to a device to be operated, and also for a nut 27 which serves to limit upward movement of the stem and piston. Urging the piston upwardly is a spring 28, compressed between the head 20 and the plate 12.

Mounted on the top wall of the cylinder by a bracket 29, and indicated by the legends, is an electric-motor-driven pump having an inlet connection 30 and an outlet connection 31, wherein is provided a ball-type check-valve 32 which serves to prevent reverse flow of liquid through the pump. Connected to the pump outlet is a T-pipe 33, the vertical portion 34 of which is soldered in an opening through the top wall of the cylinder. Cooperable with the free end of the horizontal portion 35 of the T-pipe is a pivoted flat armature 36 which is adapted to be attracted by an electromagnet 37, so that when the same is energized, the armature tightly closes the mouth of pipe 35.

One of the terminals of the electromagnet and of the motor are connected in common by a wire 38 to a source of electrical energy 39, which source may be of the A. C. or D. C. type. The other terminal of the electromagnet is connected by a wire 40, through a manual switch 41, to the source 39; and the other terminal of the motor is connected through a normally-closed switch 42 mounted within the cylinder 16, wire 43, and manual switch 44 to the source. The switch 42 comprises a metal blade 45 normally flexed into engagement with a contact element 46, each of these parts being insulatively mounted on the inner side of the top wall of the cylinder. The free end portion of the blade 45 is extended downwardly and horizontally so that in a predetermined downward movement of the piston 18 it is engaged by a Z-shaped arm 47 attached to the top of the piston, further downward movement of the piston acting to open switch 42 and thus open the motor circuit.

In assembling the operator, the various parts are mounted on the cylinder, which is then inserted as a unit into the empty casing, the casing preferably then being in inverted position. The piston is then mounted by its stem in the end plate and the whole lowered into position and bolted to the casing. The operator is then reinverted and supplied with oil through an opening 48 in its top wall which is normally sealed by a plug 49. It will be seen that, when the space between the cylinder and the piston is filled with liquid under superatmospheric pressure, the cylinder is held in position in the casing (in engagement with rib 14) solely by the pressure of the liquid in that space. A preferred practical construction of a motor, pump, and relief-valve (35-36) assembly is shown in my aforementioned copending application, Serial No. 348,064, now Patent No. 2,276,591.

The operation of the device illustrated in Fig. 1 is as follows: If the manual switch 41 is closed, the electromagnet 37 will be energized and the armature 36 attracted into engagement with the mouth of pipe 35, closing it against passage of liquid in either direction. If switch 44 is then also closed, the pump motor will be energized and liquid drawn from the reservoir through the inlet 30 and forced by the pump through the check-valve 32 and pipe 34 into the space above the piston 18 in cylinder 16 (it being assumed that the air originally in this space has been replaced by the liquid) moving the piston downward against the bias of spring 28. If the motor switch 44 is opened before the piston has completed its downward stroke, the piston will remain in its moved position since escape of the liquid compressed above the piston is prevented by the check-valve 32 and the closed relief-valve constituted by the pipe 35 and armature 36. If upward movement of the piston is desired, the electromagnet switch 41 is opened, permitting the force of spring 28 acting on the piston to discharge the liquid above the same through the open relief-valve 35-36. If both of the manual switches are closed and maintained in that condition, the piston will travel downward until the engagement of the arm 47 with the blade 45 opens the switch 42, thus deenergizing the pump motor. The piston will remain substantially in this position until leakage of liquid past the piston eventually permits it to rise sufficiently to reclose switch 42, whereupon the motor will be momentarily operated to return the piston to its fully-moved position. In the event of failure of the source of

electrical energy, the piston will return to its raised position, as shown in Fig. 1, due to the resultant opening of the relief-valve. In Fig. 1, the cylinder 16 is shown with its flange 15 in engagement with the rib 14, regardless of the fact that, since valve 35-36 is open, the pressure of the fluid below the cylinder head is the same as that in the reservoir and hence ineffective to support the cylinder. However, friction between the cup-washer 19 and the cylinder wall is normally sufficient to overcome the force of gravity urging the cylinder downwardly.

An operator of the general type disclosed is adapted to develop relatively very high pressures which cause constant leakage of a certain amount of liquid past the piston. However, in the operator of my present invention, that liquid is not lost but returns directly to the reservoir for recirculation. It will be observed that the only force tending to cause leakage around the stem 21 to the exterior of the operator is that due to gravity acting on the liquid in the reservoir, and hence such leakage can readily be prevented by ordinary means. The foregoing statement is true under substantially all conditions of the operator since no change of pressure is produced in the reservoir by movement of the piston.

The diagrams of Figs. 2 and 3 illustrate well known prior art forms of hydraulic operators, while in Fig. 4 the operator of the present invention is similarly diagrammatically shown so that the improvement will readily be apparent. In Fig. 2, a casing 60 is shown divided by a partition 61 into an upper reservoir 62, and a lower pressure chamber 63 having a movable wall in the form of an expansible-contractible bellows 64. Flow of liquid into and out of the pressure chamber is effected, respectively, by a "motor-pump" and an electromagnetically operated relief-valve 65. The operator shown in Fig. 3 differs from that shown in Fig. 2 only by the substitution of a piston 70 for the bellows. Under ordinary conditions, the operator shown in Fig. 2 may be satisfactory unless by frequent flexure cracks develop in the bellows. The piston-type operator shown in Fig. 3 is therefore probably more reliable in protracted service, but has the inherent disadvantage that, due to the high pressures developed in the chamber 63, the liquid constantly leaks past the piston and hence must be replaced. The improved operator shown in Fig. 4 differs from that shown in Fig. 3 in that the partition separating the chamber into a reservoir and a pressure chamber is formed by the outer surfaces of cylinder 75 and its piston 76; the reservoir 62 extending to the bottom of the casing because of openings 77 in the lower flange of the cylinder, and the pressure chamber 63 being the space within the cylinder above the piston. The novel features of the improved operator of Fig. 4 have been pointed out above in connection with the corresponding showing of Fig. 1.

While I have herein shown and described a specific embodiment of my invention, I wish it to be understood that modifications may be made without departing from the spirit of the invention, and that I intend therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a hydraulic operator, in combination: a reservoir containing a liquid; means within said reservoir forming a pressure cylinder for a piston; a piston reciprocable in said cylinder and having a stem sealingly extending through an opening in a wall of the reservoir, contacted by

said liquid, for connection to a device to be operated; and means for forcing liquid from the reservoir into the cylinder to move the piston relative to the cylinder; said cylinder being slidable in assembly of the operator, along the axis of said piston stem, in an inner portion of the reservoir and having means, engageable with a fixed portion of the reservoir when said forcing means is operated, for limiting movement of the cylinder relative to the reservoir.

2. The combination defined in claim 1, wherein said liquid-forcing means comprises a pump mounted on said cylinder and submerged in the liquid in the reservoir.

3. In a hydraulic operator, in combination: a reservoir containing a liquid; a hollow cylinder within said reservoir, one end of said cylinder being closed and the other end having an outward-

ly extending flange; a piston reciprocable in said cylinder and having a stem sealingly extending through an opening in a wall of the reservoir, contacted by said liquid, for connection to a device to be operated; and means for forcing liquid from the reservoir into the cylinder to move the piston relative to the cylinder; said cylinder being slidable in assembly of the operator, along the axis of said piston stem, in an inner portion of the reservoir; said flange of the cylinder being engageable with a surface of said portion, when said forcing means is operated, whereby movement of the cylinder relative to the reservoir is limited.

4. The combination defined in claim 3, wherein said liquid-forcing means comprises a pump mounted on said closed end of the cylinder.

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