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FLUID PRESSURE CONTROL MECHANISM

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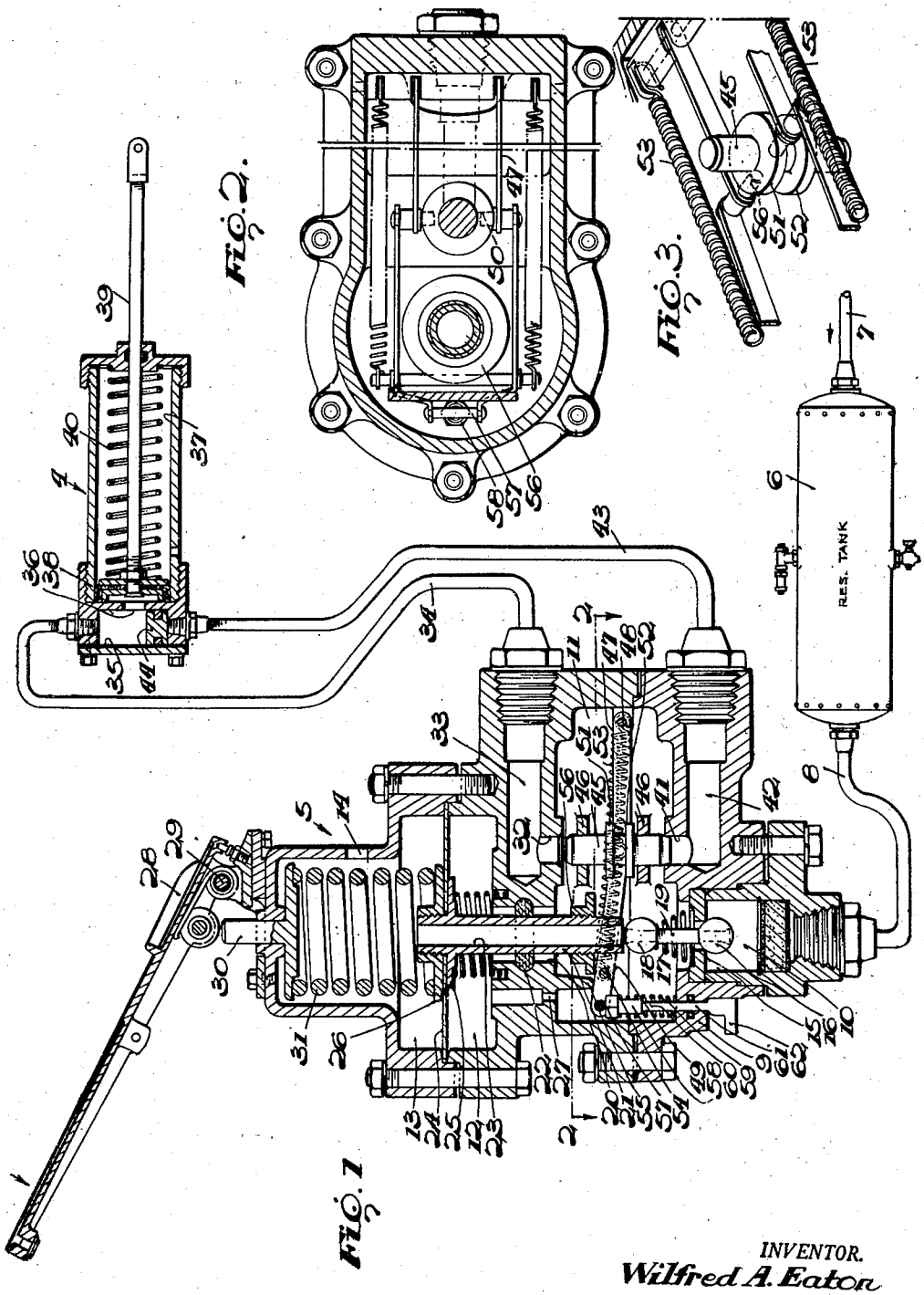


FIG. 1

FIG. 2.

FIG. 3.

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FLUID PRESSURE CONTROL MECHANISM

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This invention relates to fluid pressure control mechanism, and more particularly to fluid pressure control mechanism for a remotely positioned fluid actuator.

It has previously been proposed to utilize control valves, and more particularly control valves of the so-called self-lapping type, in order to control the supply of fluid pressure to remotely positioned fluid actuators, the fluid being transmitted from the valve to the actuator through the usual conduit. Difficulties have been experienced in some cases, however, due to breakage of the conduit, with resultant failure of the actuator to operate in response to operation of the control valve, and it is accordingly an object of the present invention to provide mechanism so constituted as to overcome these difficulties.

Another object of the invention is to provide control mechanism of the above type wherein an auxiliary conduit is provided for transmitting fluid pressure from the control valve to the actuator, the control mechanism being so constituted as to automatically render the auxiliary conduit effective in the event of failure of the regular conduit.

Yet another object of the invention is to provide, in a system of the above type, auxiliary control valve mechanism associated both with the actuator and the control valve so constituted as to insure continued operation of the actuator under the control of the valve mechanism in the event of failure of a conduit connecting the control valve and actuator.

Still another object of the invention is to provide novel fluid pressure control valve mechanism having more than one fluid pressure outlet, together with means controlled by the operation of the valve mechanism for supplying fluid pressure to one of the outlets in the event of failure of a conduit connected to another of the outlets.

A still further object of the invention is to provide, in connection with a system of the above type, means controlled by the operation of the valve mechanism for automatically directing the supply of fluid pressure from the control valve to the actuator through one conduit or another together with means for permitting resetting of the control means by the operator.

In order that those skilled in the art may more fully appreciate the nature of the present invention, one modification has been set forth hereinafter by way of description and exemplification in the accompanying drawing. It is to be expressly understood, however, that the drawing is employed for purposes of illustration only and is not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawing wherein similar reference characters refer to similar parts through the several views;

Fig. 1 is a diagrammatic view, partially in section, of a fluid pressure control system constructed in accordance with the principles of the present invention;

Fig. 2 is a sectional view of the operator's control valve mechanism shown in Fig. 1, and

Fig. 3 is a view in perspective of a portion of the control valve illustrated in Figs. 1 and 2.

Referring more particularly to Fig. 1, the invention is illustrated therein as embodying a fluid actuator 4, an operator's control valve 5, and a fluid pressure reservoir 6 for supplying fluid pressure to the control valve and actuator, the reservoir being supplied with fluid pressure from a compressor, not shown, through a conduit 7, it being supplied from the reservoir to the control valve through a conduit 8. The control valve is generally of the type illustrated and described in the patent to William J. Andres and Roy S. Sanford, No. 2,133,275, dated October 18, 1938. The control valve is provided with a casing 9, provided with an inlet chamber 10 connected with the conduit 8, an outlet chamber 11, a diaphragm chamber 12 and an exhaust chamber 13, the latter being connected with atmosphere by means of a suitable port 14 in the casing. The inlet chamber is separated from the outlet chamber by means of a ported partition 15, and communication between the chambers is normally prevented by means of an inlet valve 16 normally maintained in the position shown by means of a spring 17 interposed between the upper surface of the partition and the lower surface of an exhaust valve 18 carried on a stem 19 extending upwardly from the inlet valve. The upper end of the outlet chamber 11 is provided with a bore 20 having a valve operating element 21 concentrically mounted therein for sliding movement, leakage past the outer surface of the element being prevented by means of a suitable seal 22. The valve operating element is positioned in substantial alignment with the exhaust valve 18, and is provided with a centrally located bore 23 in communication at its lower end with the outlet chamber 11 and at its upper end with the exhaust chamber 13, the lower end of the bore being adapted on downward movement of the element to contact the upper surface of the exhaust valve in order to prevent communication between the outlet chamber and

the exhaust chamber. A flexible diaphragm 24 is clamped in the housing as shown and serves in connection therewith to separate the diaphragm chamber from the exhaust chamber, the diaphragm being clamped at its center to the valve operating element 21 by means of a suitable flange 25 and a nut 26 carried by the element. The diaphragm is subjected at all times to the pressure in the outlet chamber by virtue of a restricted passage 27 connecting the outlet and diaphragm chambers. The diaphragm thus serves to move the valve operating element in an upward direction when there is a positive pressure in the outlet chamber and diaphragm chamber, downward movement of the element being controlled by means of an operator's pedal 28 pivotally mounted on the casing by means of a pin 29, together with a valve operating plunger 30, slidably mounted in the upper end of the housing and connected with the diaphragm nut 26 by means of a graduating spring 31 interposed between the lower end of the plunger and the upper surface of the diaphragm nut.

In view of the foregoing description and on reference to the above referred to patent, it will be understood that with the parts in the position shown, communication is prevented between the inlet and outlet chambers and is permitted between the outlet chamber and the exhaust chamber, while on downward movement of the control pedal, the tension of the graduating spring is increased in order to move the valve operating element downward, whereupon the mechanism is effective to establish communication between the inlet and outlet chambers and to prevent communication between the outlet and exhaust chambers until such time as the pressure established in the outlet chamber is sufficient to move the diaphragm and valve operating element upward against the force exerted by the graduating spring in order to permit closing of the inlet valve, the pressure at this time being substantially proportional to the degree of depression of the control pedal. The outlet chamber is provided with an outlet port 32 connected by a passage 33 formed in the casing with a conduit 34 leading to the upper end of a cylinder 35 formed in the left end of the fluid motor 4, the cylinder 35 in turn being connected with the interior of the fluid motor by means of a port 36. The fluid motor is provided with a cylindrical portion 37, and a piston 38 is slidably mounted therein and provided with a piston rod 39 adapted to actuate any desired devices, not shown, the piston being normally maintained in the position shown by means of a return spring 40 interposed between the end of the cylinder and the right side of the piston. Thus on operation of the control pedal 28 to increase the pressure of fluid in the outlet chamber 11, this fluid will be conveyed to the interior of the cylinder 37 on the left side of the piston through the port 32, the passage 33, the conduit 34, the cylinder 35, and the port 36.

In the event of failure of conduit 34, it is desirable to provide other means for supplying fluid pressure to the fluid actuator 4, and to this end a second outlet port 41 provided in the wall of the outlet chamber 11, this port being connected with the lower end of the cylinder 35 in the fluid motor through a passage 42 and a conduit 43, communication between conduit 43 and conduit 34 being prevented by means of a valve element or piston 44 slidably mounted in the cylinder 35 and adapted on movement to the upper end of the cylinder to establish communication between conduit 43 and the interior of the fluid motor through the cylinder 35 and the port 36. Thus in the event of breakage of conduit 43 with the parts in the position shown, it will be understood that the escape of fluid pressure through the broken conduit from the conduit 34 and the cylinder 35 is prevented by the sliding valve member 44, the mechanism constituted by the cylinder 35 and the valve member 44 being a well-known type of so-called double check valve. As shown in the drawing, communication between the outlet chamber 11 and the passage 42 through the port 41, with the parts in the position shown, is prevented by means of a double-ended valve element 45, which is slidably mounted in suitable brackets 46 formed in the casing and serves to normally close the upper end of the port 41, the upper end of the valve 45 being, in this position, spaced from the lower end of the port 32 in order to permit the passage of fluid therethrough. The valve is maintained in the position shown by means of a suitable toggle mechanism, illustrated more fully in Figs. 2 and 3, this toggle mechanism comprising a pair of links 47 pivotally connected to the valve casing by means of a pivot pin 48, together with a pair of links 49 which are pivotally connected with the links 47 by means of suitable pins 50. The inner ends of these pins are in engagement with the lower and upper surfaces respectively of collars 51 and 52 formed on the valve 45. The links are also connected by means of spiral springs 53, these springs being connected at their right ends to the pin 48 and at their left ends to a pin 54 on the links 49, the arrangement being such that the center line of the springs is above the center line of the pins 50 with the parts in this position. The upper surfaces of the links 49 rest against a stop 55 formed on the housing, the toggle thus being urged in a downward direction in such a manner that the pins 50 serve to maintain the valve 45 in the closed position shown.

As illustrated in Fig. 1, the valve element travel required to close the exhaust valve and subsequently open the inlet valve is so chosen with respect to the dimensions of the toggle links and the location of the center line of the spiral springs that with the intake valve opened a normal amount, the center line of the springs still passes through a point above the center line of the pins 50. Experiments with this general type of control valve have shown that with the outlet chamber connected to a suitable actuator, the pressure in the outlet chamber, on operation of the mechanism to open the inlet valve, increases so rapidly that it is impossible to move the valve element downward more than a predetermined distance due to the rapid build up of pressure in the diaphragm chamber which tends to return the element in the other direction. If, on the other hand, the conduit 34 is ruptured, for example, operation of the element to open the intake valve does not result in a rapid build up of pressure in the outlet chamber due to escape of fluid pressure from the ruptured conduit, and consequently it is possible for the operator to move the valve operating element through a much greater distance, this distance being such, in the construction shown, that a collar 56 mounted on the valve operating element moves the pin 54 downward sufficiently to snap the toggle mechanism over center, whereupon the spring acts to collapse the toggle in the other direction and the left ends of the links 49 are moved rapidly downward. A pin 57 mounted as shown on

the links 49 is normally in contact with a resetting plunger 58 normally maintained in the position shown by means of a relatively light spring 59. On downward movement of the pin 57 under the action of the springs 53, the spring 59 is collapsed and a shoulder 60 formed on the member 58 abuts the casing in order to provide a stop for the pin 57. When this action occurs, a fulcrum is provided for the pin 57 and the springs 53 act to move the pins 50 upward in order to rapidly move the valve 45 upward in order to open the upper end of the port 41 and to close the lower end of the port 32. When this action occurs communication is established between the conduit 43 and the outlet chamber 11 through the port 41 and the passage 42, and since fluid pressure is thus supplied to the lower surface of the piston 44 in the cylinder 35, the piston is moved upward to close off the end of the conduit 34, and communication is established between conduit 43 and the interior of the fluid actuator through the cylinder 35 and the port 36, while at the same time, the valve 45 effectively prevents the escape of pressure through the broken conduit 34. The control valve mechanism is then operative to control the actuator 4, and the conduit 34 can be repaired when desired. In order to reset the toggle mechanism for the purpose of returning the valve 45 to the position shown after repair of the ruptured conduit, the member 58 is provided with a downwardly extending stem 61 provided with an operating button 62 at its lower end. When this is pushed upward by the operator, the links 49 may be moved upward until their upper surface contacts the lower end of the stop 55, whereupon the stop acts as a fulcrum to permit the pins 50 in the right ends of the links 49 to be moved downward in order to return the valve 45 to the position shown in the drawing, this action at the same time serving to permit the return of the springs 53 to the position shown.

As heretofore described, novel means have thus been provided for normally establishing communication between the control valve mechanism and actuator through a service conduit, and for closing off the conduit at either end in the event of failure thereof and for establishing communication between the control valve and fluid actuator through an auxiliary conduit, this mechanism being ineffective however, until such time as the rate of pressure build-up in the control valve outlet and diaphragm chambers is appreciably limited due to the escape of fluid through the broken service conduit. In addition to the foregoing, means have been provided for permitting the operator to readily reset or recondition the automatic valve operating mechanism as soon as the broken conduit has been repaired.

While the invention has been described and illustrated herein with considerable particularity, it will be understood that the same is not limited to the form shown, but may receive a variety of mechanical expressions, as will readily appear to those skilled in the art. Reference will, therefore, be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. The combination in a self-lapping control valve mechanism having an inlet valve, a valve operating element, an outlet chamber, means including a resilient member for moving the element in one direction to open the inlet valve to admit fluid pressure to the outlet chamber, and means including a member responsive to the pressure in the outlet chamber for opposing movement of said element by said resilient member and for moving the element in the opposite direction to permit closing of the inlet valve, of a pair of outlet ports in the outlet chamber, valve means operable for alternately closing one or the other of said ports, means for normally biasing said valve means to close said one port, and means associated with said biasing means and valve means for moving the latter to open said one port and close said other port when the element is moved by said resilient member to open said inlet valve more than a predetermined amount.

2. The combination in a self-lapping control valve mechanism having an inlet valve, a valve operating element, an outlet chamber, means including a resilient member for moving the element in one direction to open the inlet valve to admit fluid pressure to the outlet chamber, and means including a member responsive to the pressure in the outlet chamber for opposing movement of said element by said resilient member and for moving the element in the opposite direction to permit closing of the inlet valve, of a pair of outlet ports in the outlet chamber, valve means operable for alternately closing one or the other of said ports, means for normally biasing said valve means to close said one port, and means associated with said biasing means and valve means for moving the latter to open said one port and close said other port when the element is moved by said resilient member to open said inlet valve more than a predetermined amount and for thereafter maintaining said valve means in a position to close said other port.

3. The combination in a self-lapping control valve mechanism having an inlet valve, a valve operating element, an outlet chamber, means including a resilient member for moving the element in one direction to open the inlet valve to admit fluid pressure to the outlet chamber, and means including a member responsive to the pressure in the outlet chamber for opposing movement of said element by said resilient member and for moving the element in the opposite direction to permit closing of the inlet valve, of a pair of outlet ports in the outlet chamber, valve means operable for alternately closing one or the other of said ports, means for normally biasing said valve means to close said one port, means associated with said biasing means and valve means operable by said element for moving the valve means to a position to open said one port and close said other port and for maintaining the valve means in said position when the element is moved more than a predetermined distance by said resilient member to open the inlet valve, and manually operable means for moving said element operated means to move the valve means to open said other port and to close said one port.

4. The combination in a self-lapping control valve mechanism having an inlet valve, a valve operating element, an outlet chamber, means including a resilient member for moving the element in one direction to open the inlet valve to admit fluid pressure to the outlet chamber, and means including a member responsive to the pressure in the outlet chamber for opposing movement of said element by said resilient member and for moving the element in the opposite direction to permit closing of the inlet valve, of a pair of outlet ports in the outlet chamber, valve means operable in one position to close one of

said ports and operable in another position to open said one port and to close the other of said ports, and resilient means for normally maintaining said valve means in said one position and operable by said element on movement of the latter to open the inlet valve more than a predetermined amount to move and to maintain the valve means in said another position.

5. The combination in a self-lapping control valve mechanism having an inlet valve, a valve operating element, an outlet chamber, means including a resilient member for moving the element in one direction to open the inlet valve to admit fluid pressure to the outlet chamber, and means including a member responsive to the pressure in the outlet chamber for opposing movement of said element by said resilient member and for moving the element in the opposite direction to permit closing of the inlet valve, of a pair of outlet ports in the outlet chamber, valve means operable in one position to close one of said ports and operable in another position to open said one port and to close the other of said ports, resiliently biased toggle means for normally maintaining the valve means in said one position, and means associated with said element for operating said toggle means to move and to maintain the valve means in said another position when the element is moved more than a predetermined distance to open the inlet valve.

6. The combination in a self-lapping control valve mechanism having an inlet valve, a valve operating element, an outlet chamber, means including a resilient member for moving the element in one direction to open the inlet valve to admit fluid pressure to the outlet chamber, and means including a member responsive to the pressure in the outlet chamber for opposing movement of said element by said resilient member and for moving the element in the opposite direction to permit closing of the inlet valve, of a pair of outlet ports in the outlet chamber, valve means operable in one position to close one of said ports and operable in another position to open said one port and to close the other of said ports, means for operating said valve means including a pair of pivotally connected links having a connection with the valve means and resilient means connecting the links for operating the latter to maintain the valve means in either of said positions, and means for connecting said element and one of said links whereby the links and resilient connecting means are actuated to move the valve from one of said positions to the other of said positions when the element is moved more than a predetermined distance to operate the inlet valve.

7. The combination in a self-lapping control valve mechanism having an inlet valve, a valve operating element, an outlet chamber, means including a resilient member for moving the element in one direction to open the inlet valve to admit fluid pressure to the outlet chamber, and means including a member responsive to the pressure in the outlet chamber for opposing movement of said element by said resilient member and for moving the element in the opposite direction to permit closing of the inlet valve, of a pair of outlet ports in the outlet chamber, valve means operable in one position to close one of said ports and operable in another position to open said one port and to close the other of said ports, means for operating said valve means including a pair of pivotally connected links having a connection with the valve means and resilient means connecting the links for operating the latter to maintain the valve means in either of said positions, means for connecting said element and one of said links whereby the links and resilient connecting means are actuated to move the valve means from one of said positions to the other of said positions when the element is moved more than a predetermined distance to operate the inlet valve, and manually operable means connected with said one link for actuating said links and resilient means to move the valve means back to its original position.

8. Control mechanism for a fluid actuator including a casing having an outlet chamber, an inlet valve for controlling the supply of fluid pressure to the chamber, an element for controlling the operation of the inlet valve, means for moving the element in one direction to open the inlet valve, means including a member responsive to the pressure in the outlet chamber for moving the element in the other direction and opposing movement of the element by the first named means, a pair of outlet ports in the outlet chamber, means including a valve for normally closing one of said ports and operable on inlet valve opening movement of said element beyond a predetermined distance for opening said one port and closing the other of said ports, a valve device associated with the actuator having a pair of fluid receiving ports, a port connected with the actuator, and a member responsive to the pressures supplied to said fluid receiving ports for preventing communication between the last named ports and operable when unequal pressures are supplied to said receiving ports to connect the port receiving the higher pressure with the actuator port and to prevent communication between the actuator port and the other of said fluid receiving ports, and a pair of conduits for respectively connecting one of the fluid receiving ports with the normally closed port of the outlet chamber and the other of said fluid receiving ports with the other of said outlet ports.

9. Control mechanism for a fluid actuator including a casing having an outlet chamber provided with a pair of outlet ports, a pair of conduits for connecting said ports with the actuator, means associated with the actuator including a member responsive to the pressures in said conduits for preventing communication therebetween and operable in response to differential pressures in the conduits to prevent one or the other of said conduits from conducting fluid pressure from the outlet chamber to the actuator to operate the latter, and means carried by the casing for controlling the supply of fluid pressure to the actuator through said conduits including a valve movable to close either of said outlet ports, means for normally maintaining the valve in a position to close one of the outlet ports and operable to move the valve to open said one port and close the other of said ports and to maintain the valve in a position to close said other port, means including a valve operating element movable in one direction to supply fluid pressure to said outlet chamber, means responsive to the pressure in said chamber for opposing movement of the element in said one direction and for moving it in the other direction, and adjustable means for connecting said element and maintaining means for moving the latter to move the valve to close said other port when the element is moved a predetermined distance in said one direction.

10. Fluid pressure control valve mechanism in-

cluding a casing having an outlet chamber provided with a pair of outlet ports, a pair of outlet conduits connected with said ports, a transfer valve operable in one position to close one of said ports and open the other of said ports and in another position to open said one port and close said other port, valve operating means associated with the transfer valve for normally maintaining the latter in said one position and operable to move said valve to said another position, means for controlling the supply of fluid pressure to said outlet chamber and to the conduit connected with the open outlet port including an inlet valve, an element operable in one direction for moving the inlet valve to open position to increase the pressure in said outlet chamber, and operator-controlled resilient means for moving said element to open the inlet valve, means for connecting said element and transfer valve operating means for operating the latter to move the transfer valve to said another position when said element is moved more than a predetermined distance in said one direction to open said inlet valve, and means dependent on the rate of pressure increase in said outlet chamber for normally preventing movement of said element through a greater distance and for permitting movement of the element through said greater distance on failure of the conduit connected to said one port and a corresponding decrease in said rate of pressure increase including a member responsive to the pressure in said outlet chamber and said one conduit for opposing movement of said element to open the inlet valve and for moving said element to inlet valve closing position when the pressure in the outlet chamber acting on the pressure responsive member is sufficient to move the element against the force exerted thereon by the action of said resilient means.

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