

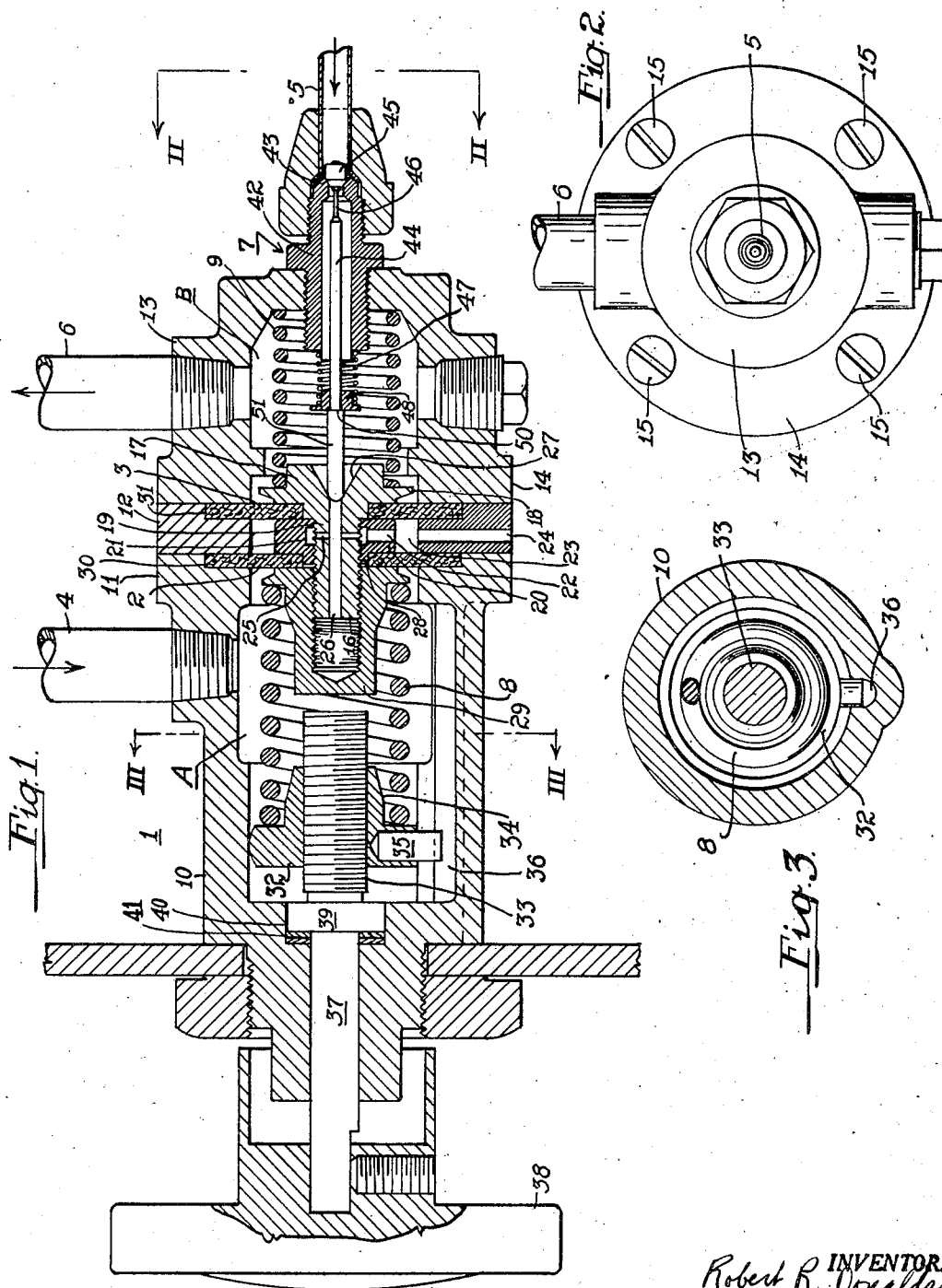
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PRESSURE RESPONSIVE DEVICE

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PRESSURE-RESPONSIVE DEVICE

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This invention relates to pressure-actuated devices and more particularly to pressure-actuated relay devices of the type adapted to respond to a primary pressure or impulse and to send out a sending pressure or impulse that is proportional to the primary pressure and at the same time maintain the sending pressure constant at the particular value called for by the primary pressure or impulse.

An object of this invention is to provide a device of the character referred to above that shall be simple in construction, sensitive and accurate in operation, and readily assembled, adjusted, and repaired.

Another object of the invention is to provide an improved valve assembly and an improved pressure-responsive actuating mechanism therefor.

The aforementioned and other objects of the invention will be apparent to those skilled in the art, from the following description taken in conjunction with the accompanying drawing in which:

Figure 1 is a view in longitudinal section of a device embodying a form of the invention;

Figure 2 is an end view of the device as seen in looking in the direction of arrows II—II on Fig. 1; and

Figure 3 is a view in transverse section taken on line III—III of Fig. 1.

Throughout the drawing and the specification like reference characters indicate like parts.

The device embodying the invention in the form illustrated in Fig. 1, comprises a hollow body 1, the interior of which is subdivided into chambers A and B by means of spaced flexible pressure-sensitive diaphragms 2 and 3. Chamber A is disposed to receive a primary or actuating impulse from a pipe 4, and chamber B is arranged to receive a sending pressure impulse from a supply pipe 5 which is transmitted from chamber B to a sending line 6 to be utilized for operating a device (not shown) which may be located at either a remote or relatively short distance from the device. The supply pressure received by chamber B from supply line 5 is maintained substantially constant by any suitable mechanism (not shown). The value of the pressure in chamber B is established and maintained by means of a valve mechanism 7 that is operated by movement of diaphragms 2 and 3 and is, of course, determined and dependent upon the degree of force exerted against diaphragms 2 and 3 within chamber A whether effected by means of a pressure medium or a purely mechanical means.

The valve mechanism is so constructed that air or other suitable pressure medium is admitted from pipe 5 to chamber B to increase the pressure therein in response to movement of diaphragms 2 and 3 in one direction, i. e., to the right as seen in Fig. 1, and to shut off the admission of such medium and exhaust, the same from chamber B through an exhaust passage to reduce the pressure therein in response to movement of the diaphragms in the opposite direction.

Diaphragms 2 and 3 are urged in one direction by means of an adjustable compression spring 8 located in chamber A and a compression spring 9 located in chamber B. Spring 8 may be adjusted so that it exerts a force in the direction of chamber B that is equal to the force that is exerted by spring 9 in the opposite direction or spring 8 may be adjusted to exert a greater force or a lesser force depending upon whether the pressure sent out through pipe 6 is to be greater or less than the pressure received by chamber A from pipe 4.

Body 1 comprises a bonnet or housing 10 which is closed at one end and open at the other with the open end terminating in an annular flange 11, an annular spacer ring 12, and a bonnet or housing 13 in which chamber B is formed. Bonnet 13 likewise is closed at one end and open at the other, the open end terminating in a flange 14. Flange 11, spacer 12, and flange 14 as shown in Fig. 1 have substantially the same diameter so that they may be placed one on the other in abutting relationship and bolted together by means of bolts or cap screws 15.

Diaphragms 2 and 3 are mounted in spaced relationship as an assembly or unit. This assembly comprises a tubular-threaded member 16, having at one end a head 17. The outer face of this head is machined to form a flange 18 to receive one end of spring 9. The under side of head 17 is machined to provide a shoulder 19 that extends through an aperture in diaphragm 3 and serves to position the diaphragm. Diaphragm 3 is clamped tightly against flange 18 by means of annular ring 20 which passes over 16. The inner face of member 20 is provided with a groove 21 that terminates in an opening 22 leading into the space 23 between diaphragms 2 and 3 and this space communicates with the atmosphere through a passageway 24 that is drilled in spacing ring 12.

Passageway 24 and space 23 have communication with the interior of chamber B through a port 25 drilled transversely through member 16 and a longitudinal passage 26 in member 16

and a valve port 27 formed in head 19. Valve port 27 is controlled by valve 7 as will be described later on in connection with the description of the valve assembly.

The central portion of diaphragm 2 rests against spacer 20 which is provided with a shoulder 28 located in the central aperture of the diaphragm. The inner portion of diaphragm 2 is clamped tightly against spacer 20 with a cap nut 29 threaded on the end of member 16.

The outer edge of diaphragm 2 is clamped between flange 11 which is recessed at 30 to receive the diaphragm, and spacer 12, and the outer edge of diaphragm 3 is clamped tightly between spacer 12 and flange 14. Spacer 12 is recessed at 31 to receive the outer edge of diaphragm 3.

The means provided for adjusting the tension of spring 8 comprises a traveling nut 32 which has screw thread engagement with a rotatable but stationary screw 33 disposed within bonnet 10. The traveling nut is provided with a shank 34 that extends into spring 8 so that the end of the spring in contact with the nut will be maintained in a fixed position with reference to the axis of screw 33. In order to prevent turning of the nut as it is advanced or retracted along the screw, a dowel pin 35 is provided. One end of pin 35 extends into an edge of the traveling nut while its outer end is disposed to slide in a guide-way or groove 36 formed on the interior of bonnet 10. The dowel pin and guide-way hold nut 32 so that it cannot rotate on screw 33. The screw is formed with a shaft 37 that extends through the closed end of bonnet 10 and is provided at its outer end with a handwheel 38 whereby the traveling nut may be moved along the screw to adjust the tension of spring 8 as required. A collar or flange 39 is formed on the shaft and this flange is journaled in a recessed bearing and packing gland 40, packing 41 being interposed between flange 39 and the bottom of the recessed bearing and gland 40 to prevent the escape of air or pressure medium along shaft to the atmosphere.

Valve 7 comprises a valve body 42 which is threaded through a threaded opening in the closed end of bonnet 13. This valve body is hollow and is provided with a valve seat 43 at its outer end through which pressure from pipe 6 is admitted into chamber B. Valve 7 also includes a valve rod 44 which is disposed within the valve body and formed at its outer end with a valve element 45 which is mounted on a reduced end portion 46 of the rod. The valve rod is urged in a direction to seat valve element 45 on seat 43 by means of a relatively light compression spring 47. One end of spring 47 bears against the inner end of valve body 42 and the other end is supported on a flanged collar 48 disposed over the middle portion of the valve rod and resting on a shoulder 50 formed on the valve rod. The inner end portion 51 of the valve rod extends into port 27 of head 17 and serves to open or close the port. Port 27 is preferably conical in form so that it will keep valve rod 44 in line and make positive seating of portion 51 in the valve port when it is positioned to close the port.

When the tension of spring 8 is adjusted so that it exerts a force equal and opposite to that exerted by spring 9, valve element 45 will be seated on valve seat 43 and the inner end of the valve rod will be seated to close port 27, whereby pressure may neither be exhausted from chamber B nor introduced into it from the supply pipe 5.

Whenever the springs 8 and 9 exert equal and

opposite forces on the diaphragm assembly and a pressure medium is introduced into chamber A from pipe 4 then the valve assembly will move towards the right as seen in Fig. 1, whereby valve element 45 is lifted off its valve seat, and allow pressure from pipe 5 to flow into chamber B and into sending pipe 6. As soon as the pressure in chamber B exerts a force on diaphragm 3 equal to the force exerted on diaphragm 2 by the pressure in chamber A, valve element 45 will be moved to the left until it seats on valve 43 and shuts off further introduction of pressure from pipe 5 into chamber B. At this point an equilibrium is reached and the device is in balance.

As has already been stated, if springs 8 and 9 exert equal and opposite forces on the diaphragm assembly, then, as the pressure in pipe 4 and chamber A increases or decreases, the valve mechanism will be actuated to establish a pressure in chamber B that is equal to the pressure in chamber A. If the pressure in chamber A remains steady but the pressure in line 5 varies because of leakage in line 6 or in the device (not shown) being operated by the pressure in pipe 6, the diaphragms 2 and 3 will flex in such a direction that pressure from pipe 5 will be introduced into chamber B to build up the pressure therein to the required value. If the pressure tends to fall in chamber A, the diaphragms will flex in a direction to close the inlet to chamber B and open the exhaust port 27, allowing pressure in chamber B to escape through the exhaust passages to the atmosphere. Therefore the pressures in chamber B and in pipe 6 will always be equal to the value of pressure transmitted to chamber A by pipe 4, and under steady pressure conditions in chamber A the diaphragms and valve 7 will operate to regulate the pressure in chamber B and pipe 6 to a constant steady value.

If the compression of spring 8 is increased by turning the handwheel 38 in a direction to move traveling nut 32 towards cap nut 29, the excess of force exerted by spring 8 in opposition to that exerted by spring 9 will represent the equivalent of a loading pressure in chamber A. This will mean that even though no pressure is transmitted from pipe 4 to chamber A, the inlet port to chamber B will be opened because of the excess force exerted by spring 8 to allow pressure from pipe 5 to enter chamber B until a pressure is built up therein that will balance the loading of spring 8 and effect a closing of the inlet port of the valve mechanism. In other words, the pressure in chamber B will come to a steady value when the force of pressure exerted on diaphragm 3 balances the force exerted by spring 8 over and above that exerted in opposition thereto by spring 9.

With an adjustment such as above described, it follows that as the pressure in chamber A is increased the pressure in chamber B will likewise be increased, but the pressure in chamber B will exceed that in chamber A by the amount of the loading imposed on the diaphragm assembly by spring 8. If the pressure in chamber A decreases then diaphragms 2 and 3 will flex to the left as seen in Fig. 1 and uncover the exhaust valve port 27, allowing pressure to escape to the atmosphere until the pressure in chamber B has been reduced to a value that will balance the force of the pressure in chamber A and the loading of spring 8.

The device shown may also be used as a manually-operated sending device. Thus, if no pressure is transmitted to chamber A from pipe 4,

pressures may be sent out through pipe 6 by adjusting the compression of spring 8. Through adjustment of spring 8, it is possible to have sending pressure sent out through pipe 6 that will vary from zero gauge pressure to the maximum of the pressure in pipe 5.

No matter what loading is imposed by spring 8 when the device is manually operated, diaphragm 3 will act to regulate the pressure in chamber B and maintain it at a value called for by the loading of spring 8.

While only a single form of my improved pressure-sensitive relay device has been shown and described, and while only a single form of the improved valve mechanism has been disclosed, it will be apparent to those skilled in the art that various modifications and changes may be made without departing either from the spirit or from the scope of the invention. Therefore, what I claim and desire to secure by Letters Patent is:

1. A relay for sending and maintaining pressures to a sending line that vary with and are proportional to an actuating force comprising a relay body having at least two flexible diaphragms mounted therein and forming a pressure-tight chamber within the body, said chamber being adapted for connection to a sending line, means for applying an actuating force to said diaphragms, means in said chamber acting on said diaphragms and yieldingly opposing said actuating force, said diaphragms being mounted in spaced relation to each other and provided with a hollow member located between them at their middle portions, a clamping member extending through said spacer and diaphragms and being rigidly secured thereto but movable therewith, said spacer having a passageway opening into the space between the diaphragms, said body having an exhaust opening providing communication between the space between the diaphragms and the atmosphere, said clamping member having a passageway formed therein extending from the chamber side thereof to the said hollow member, thereby providing a passageway from the interior of said chamber to the atmosphere, a valve body mounted on said relay body and having an inlet port adapted for connection to a source of pressure medium, a valve stem within said valve body and having a valve element adapted to seat on said inlet port, the other end of said valve stem extending into said chamber and seating in the chamber end of the passageway in said clamping member, whereby in response to an actuating force being applied to said diaphragms in one direction, the valve stem is

actuated to admit pressure to said chambers, said inlet and said exhaust passageway being closed when the force exerted by the pressure on said diaphragm balances the actuating force and the inlet being closed and the exhaust passage is uncovered when the force of pressure exceeds the actuating force.

2. A relay for sending pressures to a sending line and maintaining such pressures at values that are proportional to an actuating force applied to the relay, comprising a housing, a diaphragm assembly forming a closed chamber at one side thereof in said housing, actuating means on the other side of said diaphragm assembly yieldingly urging the diaphragm assembly in one direction, valve means associated with and actuated by said diaphragm assembly for delivering pressure medium to the chamber and sending line until the pressure therein is of a value sufficient to balance the actuating force, said diaphragm assembly comprising spaced diaphragms, means for holding said diaphragms in spaced relation at the edges and the middle portions thereof, the holding means at the middle portions of the diaphragms being provided with a passageway establishing communication between the chamber and the atmosphere, there being an exhaust valve seat formed at the chamber end of said passageway, the valve assembly having a valve stem one end of which is positioned to cover or uncover the exhaust valve seat, the other end of the valve stem controlling the inlet of said valve, the valve stem being disposed to close the exhaust valve seat and to open the inlet port of the valve when the actuating force exceeds the force exerted on the diaphragm by the pressure in said chamber, to close both ports when the actuating force and the force exerted by the pressure in the chamber on the diaphragms are in balance, and to open the exhaust passage valve seat and close the inlet of the valve when the force exerted by the pressure on the diaphragms exceeds the opposing actuating force.

3. A device according to claim 2 characterized by the fact that the valve means comprises a body adjustably mounted on the housing and extending into the pressure chamber, a valve stem extending through said body and provided with a valve element at one end adapted to open or close the inlet port of the valve body and having its opposite end adapted to be received in the exhaust valve seat associated with the diaphragm assembly, and means yieldingly urging the valve stem in a direction to close the inlet port.

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