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FLUID PRESSURE FEED OR REDUCING VALVE
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This invention relates to valves and more particularly to an improved electrically operated valve of the feed or pressure reducing variety.

Solenoid-operated feed valves of the pressure reducing variety are known in the art but heretofore such valves have usually comprised a solenoid plunger which operates against the load of a relatively heavy graduating spring and the resistance of a diaphragm, to effect an opening of the valve. These valves must have large solenoid windings which require a considerable amount of electrical energy and because of the massiveness of the moving parts, such valves are sluggish and the reduced delivery pressure can vary over a fairly large range on either side of the desired present loading of the valve spring.

An object of the present invention is to eliminate the disadvantages of prior art solenoid-operated feed valves.

More particularly it is an object of the present invention to provide a solenoid-operated feed valve wherein the solenoid plunger for opening the valve moves independently of the graduating spring and the diaphragm.

Another object of the invention is to provide a solenoid-operated feed valve which is readily adjusted and which maintains the adjusted pressure within close limits.

Other objects and their attendant advantages will become apparent as the following detailed description is read in conjunction with the accompanying drawings wherein:

FIG. 1 is a vertical cross-sectional view of the valve of the present invention; and

FIG. 2 is an enlarged broken cross-sectional view of part of the valve of the present invention.

Referring now to the drawings, the valve of the present invention comprises a body member 10 having an upper part 12 connected in any convenient manner to a lower part 14 which contains an inlet port 16 and a delivery port 18 respectively communicating with inlet and delivery cavities 20, 22 in the lower part 14 of the valve. The inlet and delivery cavities are separated by a wall 24 having therethrough an inlet port 26 surrounded by a valve seat 28 normally engaged by a valve member 30 having a downward extending stem 32 slideable in a bore 34 in a closure member 36 received in a shouldered recess 38 in the bottom of the lower member 14 where the member 36 is locked in place by a conventional lock ring 40. The bore 34 is open to atmosphere through a port 42 and a spring 44 interposed between the upper surface of the member 36 and the valve serves to retain the latter in its normal seated position against the valve seat 28.

Clamped between the upper and lower parts 12, 14 of the valve body is a diaphragm 46 whose lower surface is exposed to the pressure in the delivery cavity and whose upper surface is exposed to atmospheric pressure in an upper cavity 48 which is connected at all times to atmos-

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phere through a port 50. The diaphragm 46 has centrally connected thereto an exhaust plunger guide assembly 52 comprising a flanged member 54 having an upstanding hollow stem 56 adapted to receive exteriorly a clamping member 58 which is forced in clamping relationship against the diaphragm and flange of member 54 by means of locknut 60 threaded onto the upper end of the stem 56 as shown.

Slidably received in the hollow stem 56 is an exhaust plunger 62 containing an exhaust passage 64 whose lower end comprises an exhaust valve seat 66 which normally is spaced above the valve member 30 but is adapted to be brought into sealing engagement with the valve member, by means to be described, to close off the exhaust passage 64 and then, by continued movement of the plunger, to move the valve member 30 off the seat 28 to connect the inlet and delivery cavities 20, 22. The upper end of the exhaust passage 64 is connected to the atmospheric cavity 48 by way of lateral ports 68 through an enlarged head portion 70 whose lower surface 72 is normally spaced above the upper edge 74 of the hollow stem 56 but is designed to engage the edge 74 upon sufficient downward movement of the plunger in a valve opening direction. The diaphragm is normally urged to the downwardly deflected position of the drawing by means of a relatively heavy adjusting spring 76 acting between the upper surface of the clamping member 58 and the lower surface of a disc 78 received in a shouldered recess in the lower end of an inverted cup-like member 80 which is slidably received in the upper end of the chamber 48. When the diaphragm is in the position of FIG. 1 the lower surface of the flange of member 54 engages a shoulder 82 in the cavity 22 thus limiting the extent of downward movement of the diaphragm and the exhaust plunger guide assembly 52.

With the diaphragm in its down position, the plunger 62 is retained in position with respect to the diaphragm by means of a spring 84 acting between the upper surface of the wall 24 and a snap ring 86 which engages the lower surface of the flanged member 54 to serve as a stop and limit the upward movement of the plunger 62 with respect to the diaphragm when the latter is in its normal position.

The spring 76 is adapted to be adjustably loaded by means of an adjusting screw 88 extending through a threaded aperture in the upper end of the upper body member 12 and into engagement with the cup-shaped member 80. It will be apparent that as the screw 88 is screwed inwardly or outwardly the spring 76 will be compressed or extended so that the upward force on the diaphragm 46 required to overcome the force of the spring will be determined by the degree of compression of the spring.

Contained within the slideable cup member 80 between the upper end thereof and the disc 78 is a solenoid winding 90 connected by suitable means through a switch (not shown) to a source of electrical energy (not shown). Contained within the solenoid is a magnetic armature 92 in abutting relationship with a non-magnetic spacer member 94 which in turn is in abutting relationship with the enlarged upper end 70 of the exhaust plunger 62. The armature 92 extends upwardly through a suitable aperture in the upper end of the cup-like member 80 and the spacer 94 serves to position the armature with respect

to the solenoid coil so that the former is at the optimum distance above the center of the coil where maximum pull-in force can be obtained.

From the foregoing description it will be apparent that the solenoid armature is not in any way connected to the diaphragm and is not opposed in any way by the adjusting spring 76. The only opposition to the movement of the armature is the force of the relatively light springs 84, 44, hence in operation, only a relatively light force is required to move the armature downwardly until it contacts the valve member 30 and closes the exhaust passage 64. The spacing between the exhaust valve seat 66 and the valve member 30 is less than the spacing between the bottom surface 72 of enlarged head 70 of the exhaust plunger and the top edge 74 of the hollow stem 56 in which the exhaust plunger operates. Hence, after the exhaust valve 66 is closed, the plunger 62 can continue to move downwardly to open valve member 30 and connect the inlet cavity 20 with the delivery cavity 22. To minimize the force required to open the inlet valve against the pressure in the inlet cavity acting on the valve 30 in a closing direction, the stem 32 of the valve member, as more clearly seen in FIG. 2, is arranged to substantially reduce the area beneath the valve exposed to inlet pressure. This reduces the force required to open the valve to approximately the force of the light springs 44 and 84 and some additional small mechanical and air pressure force.

After the valve 30 is opened air pressure enters the delivery cavity and flows out through the delivery port 18 to the pressure receiver (not shown). As the pressure builds up in the pressure receiver the pressure simultaneously builds up in the delivery cavity and when the total upward force exerted on the diaphragm by the pressure in the delivery cavity exceeds the downward force exerted by the adjusting spring 76, the diaphragm moves upwardly. Since the lower side 72 of the upper end 70 of the exhaust plunger is already engaged with the edge 74 of the upper end of the stem 56 carried by the diaphragm, the exhaust plunger is moved upwardly against the downward force of the solenoid until the valve member 30 closes on the valve seat 28 to cut off further flow of pressure from the inlet to the delivery cavity.

Under these conditions, with the solenoid still energized, the valve of the invention laps with both the inlet port and the exhaust valve seat 66 closed. When the solenoid is deenergized, the spring 84 acts on the exhaust plunger to move it upwardly with respect to the diaphragm until the snap ring 86 engages the flanged member 54. Upon this occurrence the exhaust valve seat 66 is pulled upwardly away from the valve member 30 thus connecting the delivery cavity to atmosphere. As soon as the pressure in the delivery cavity is reduced the diaphragm 46 is moved immediately downwardly by the spring 76 until the flange member 54 again engages the shoulder 82 and the parts of the valve partake of the position of FIG. 1.

In order to change the setting of the delivery pressure the screw 88 is turned in one direction or the other to vary the compression loading of the spring 76. This will obviously have the effect of moving the solenoid coil 90 with respect to the armature 92. However, the amount of movement of the solenoid required to vary the delivery pressure over a wide range is so slight that it has substantially no effect on the ability of the solenoid winding to pull in the armature.

From the foregoing it will be apparent that the present invention has provided a solenoid-operated feed valve which is unique in that the electrically operated part of the valve operates substantially independently of the pressure responsive part of the valve, particularly during closing of the exhaust passage and opening of the inlet valve. When the valve of the invention is in lap condition the only electrical force required is that sufficient to maintain the exhaust plunger valve seat in engagement

with the inlet valve. In addition by arranging the inlet valve with a downward extension exposed to atmosphere, only a relatively small residual area is exposed to pressure in the inlet cavity. Thus the total force required to be exerted by the solenoid armature is slight and the solenoid can be relatively small and economical. In view of the fact that the forces on the valve members in lap position are substantially equal and the pressure receiving areas may be relatively small compared to the area of the diaphragm, the difference between opening and closing pressures on the valve can be quite small so that the valve delivers a substantially constant delivery pressure for any given setting of the adjusting spring.

It will be apparent to those skilled in the art that the valve of the invention may be constructed in a variety of ways without, however, departing from the scope and spirit of the appended claims.

What is claimed is:

1. An electromagnetic pressure reducing valve for delivering fluid pressure from a source to a receiver at a pressure less than that of the source comprising a body having an inlet port and inlet cavity connected to said source and having a delivery port and delivery cavity connected to the receiver, a valve port between said inlet and delivery cavities, a valve resiliently urged to a position closing said port, a pressure responsive element having one side exposed to the pressure in said delivery cavity, resilient means acting on said element in opposition to the pressure in said delivery cavity, a stem connected to said element for movement therewith and having a passage therein, a plunger slideable in the passage in said stem and having an exhaust passage therethrough, said plunger being movable with respect to said element and said stem against said valve to close off said exhaust passage with continued movement of said plunger opening said valve, a second resilient means within said delivery cavity for urging said plunger out of engagement with said valve, electromagnetic means including a winding interposed between said first named resilient means and the upper portion of said body and including also a movable armature abutting the upper end of said plunger for moving said plunger independently of the first named resilient means and against said valve to close said exhaust passage and open said valve upon energization of said electromagnetic means, stop means integral with said element to limit movement of said plunger with respect to said element after opening of said valve, said element causing said stop means to act on said plunger to move it in a direction away from said valve upon movement of said element by the force of pressure in said delivery cavity slightly in excess of the opposing forces of said first named resilient means and said electromagnetic means and means for adjusting the position of said winding towards or away from said element to vary the compression of said first named resilient means.

2. An electromagnetic valve comprising a body having fluid pressure inlet and delivery ports and a fluid passage affording a connection between said ports, a valve in said passage normally resiliently urged to a position disconnecting said inlet and delivery ports, a fluid pressure responsive member in said body having a motive area exposed to the pressure at said delivery port and having a passageway therethrough, resilient means acting on said pressure responsive member in opposition to fluid pressure at said delivery port, a plunger slideable in said passageway independently of said resilient means and having an exhaust passage therethrough for connecting said delivery port to atmosphere, said plunger being movable against said valve to close off said exhaust passage with continued movement of said plunger opening said valve, stop means carried by said member to limit the movement of said plunger with respect to said member upon opening of said valve by movement of said plunger theretowards, electromagnetic means including a winding within the body and positioned above said first named

resilient means and including also a movable armature abutting the upper end of said plunger for moving it in a valve opening direction upon energization of said electromagnetic means, the first named resilient means comprising a compression spring interposed between said solenoid winding and said member, and means for varying the compression of said spring by adjusting the position of said solenoid winding towards or away from said member.

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