MANUALLY OPERABLE SOLENOID VALVE
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This invention relates to solenoid valves and has for its primary object the provision of a solenoid valve having an improved manually actuatable by-pass for operating the valve manually.

It is recognized that a solenoid valve capable of manual operation has definite advantage over an ordinary solenoid valve in permitting independent inspection and testing of the pressure and electrical sides of an air pressure system incorporating the valve and in some installations enhancing the valve in the event of a failure in the electrical side. However, the advantages of manual operability, particularly in periodic inspection and testing, are far outweighed by the disadvantages, unless the valve is practically foolproof against accidental manual operation and its adaptation to manual operation does not interfere with maintenance. It is these disadvantages that have been the stumbling block to previous attempts to adapt a solenoid valve for manual operation, but, with the valve modified in accordance with this invention, they are a stumbling block no longer.

It therefore is an object of the present invention to provide a solenoid valve which is made manually operable without danger of accidental manual operation or interference with maintenance.

Another object of the invention is to provide a solenoid valve manually actuatable means for shifting the plunger which normally is locked in a position out of the way of the plunger and can operate the plunger only when a plurality of different motions, thereby not only preventing interference with normal servicing of the valve but insuring against accidental manual operation.

A further object of the invention is to provide in a solenoid valve manually actuatable means of the character described above which not only requires a plurality of motions to move it from inoperative to operative position but will automatically return to inoperative position on being given one of those motions.

Another object of the invention is to provide in a solenoid valve means of simple and sturdy construction for manually operating the valve as to ensure satisfactory operation over an extended service life.

Other objects and advantages of the invention will appear from the following detailed description, be particularly pointed out in the appended claims and be illustrated in the accompanying drawings, in which:

FIGURE 1 is an end elevational view of a preferred embodiment of the manually operable solenoid valve of the present invention;

FIGURE 2 is a vertical sectional view taken along lines 2—2 of FIGURE 1;

FIGURE 3 is a fragmentary vertical sectional view on the section of FIGURE 2 but with the manually actuated means for operating the valve in operative position;

FIGURE 4 is a fragmentary vertical sectional view taken along lines 4—4 of FIGURE 2;

FIGURE 5 is a fragmentary vertical sectional view taken along lines 5—5 of FIGURE 3; and

FIGURE 6 is an isometric view of the manually actuated operating member removed from the valve.

Referring now in detail to the drawings in which like reference characters designate like parts, the improved solenoid valve of this invention is designed for manual operation to by-pass or simulate manually the action of the solenoid on the plunger in the normal electrical operation of the valve. Applicable to both normally open and normally closed valves, the improvement of this invention has been embodied for purposes of illustration in a normally closed solenoid valve generally similar to that illustrated in my Patent No. 2,887,126, issued May 19, 1959.

In its illustrated form, the improved solenoid valve is a three-way valve having an inlet port 1 alternately connectable to an exhaust port or atmospheric bleed 2 and an outlet port 3 and normally disconnected from or closed to both ports, in keeping with the "normally closed" characteristic of the particular valve. To enable the operating components of the valve to be removed for inspection and, if necessary, repair or replacement without disturbing fluid connections to the inlet and outlet ports 1 and 3, these ports desirably are formed in a mounting bracket 4 permanently mountable on a suitable base (not shown) and the solenoid 5, plunger 6 and other operating components are mounted on or in a body or main part or housing 7. The body 7, in turn, is secured on and removably attached, as by bolting, to the mounting bracket 4 and has a central or axial valve chamber 8 to which the inlet port is fluid-connectable and the outlet port fluid-connected through inlet and outlet passages 9 and 10, respectively. To facilitate application and removal of the plunger 6, the valve chamber 8 is accessible through the lower end of the body 7 and normally is closed at its lower end by a plug 11 threaded into the body. In addition to normally closing access to the valve chamber 8, the plug 11 conveniently carries at its upper end a lower valve seat 12 at or adjacent the lower end of the valve chamber 8 and confronting and axially aligned with an upper valve seat 13 in the body at the opposite end of the valve chamber, each valve seat preferably being in the form of an axially bored frusto-conical tip.

The valve chamber 8 of the illustrated valve has a relatively restricted upper portion 14 in which the plunger 6 is slidably received and, altogether, is part of a stepped, preferably cylindrical axial or central bore 15 extending from the upper valve seat 13 to the lower end of the body. The inlet and outlet passages 9 and 10 open in axially spaced relation onto the wider, lower portion 16 of the bore, the outlet passage directly into and the inlet passage below the valve chamber with access between the inlet passage and valve chamber obtainable through the lower valve seat 12 and radial and axial ways 17 and 18 in the shank or stem 19 of the plug. The shank 19 of the plug in the main is of less cross-section than and spaced radially inwardly from the side wall 20 of the bore 15 over the lower portion 16, but, intermediate the lower valve seat 12 and the radial ways 17, has a peripherally grooved annular shoulder 21 carrying or seating an O-ring or like gasket 22 engaging the wall of the bore between the inlet and outlet passages and blocking fluid connection therebetween except through the valve seat 12 and valve chamber 8.

The exhaust port 2 of the illustrated valve is in the form of radial drillings or apertures in a cap 23 screwed onto the upper end of the body 7 and cooperate with an abutment 24 therebelow on the body for holding the solenoid 5 in place. Except for its radial apertures 2, the cap 23 closes the upper end of an exhaust passage 25 extending axially in the body from its upper end through the upper valve seat 13 to the valve chamber 8.

The preferred plunger 6 is of the same multi-part construction as that disclosed in my patent, No. 2,887,126.
Thus, it has a casing 26 which, externally, is of round-cornered, substantially square cross-section to slidably engage the side wall 20 of the bore 15 in the body 7 about the upper portion 14 of the valve chamber 8 without interfering with flow of fluid past the sides of the plunger between the corners. The casing has a central cavity 29 extending through it and through the lower end of that cavity a centrally apertured closure member or cap 27 having about its lower end a radially extending or outstanding flange 28 of substantially the diameter of the lower portion 16 of the bore 15. The cavity 29 in the casing and the apertured 30 in the closure member 27 together contain a pair of rubber pads 31, one adjacent each end of the plunger, and an interposed rigid spacer 32. Projecting or extending upwardly into the solenoid 5 and with its casing 26 made of suitable magnetizable material, such as magnetic stainless steel, the plunger 6 energizing of the solenoid is lifted or shifted upwardly, against the force of a return spring 33 by which it is shifted in the opposite direction to normal position when the solenoid is deenergized. With the rubber pads 31 adapted alternately to close the upper valve seat 12 and 13 and the lower valve seat normally closed, the return spring 33 may be a coil spring surrounding the casing 26 and acting between the upper face 34 of the flange 28 and a confronting shoulder 35 marking the upper end of the lower portion 16 of the bore 15, the spring thus serving yieldably to oppose the action of the solenoid and normally to hold the lower of the pads against the lower seat.

Constructed in the above manner, the illustrated valve normally has its inlet port 1 disconnected from its outlet and exhaust ports 2 and 2 and, on energizing of the solenoid 5, is adapted to connect the inlet port to the outlet port and, at the same time, shut off the exhaust port from the valve chamber 8. If the valve is to be operable manually as well as electrically, as is here intended, the plunger 6 must be movable or actuated manually in simulation or duplication of the action upon it of the solenoid and, since the plunger itself is inaccessible except on removal of the plug, means must be provided which are both accessible from the outside or exterior of the valve and capable on actuation of energizing and acting upon or actuating the plunger so as to move or displace the latter from normal or at rest position against the force of the return spring 33. The manually operable by-pass or adapter provided for the purpose in the valve of this invention shares, with previous attempts at modifying solenoid valves for manual operation, the capability of simulating the action of the solenoid upon the plunger but differs from such prior attempt in its ability to ensure against interference by it with the normal electrical operation or the servicing of the valve.

In its preferred form, the manually actuable operating means, by-pass or adapter, designated generally as 36, is comprised of a plunger-actuating member or actuator 37 mounted on and projecting from a side 38, here the front, of the body 7 and projectable through the side wall 39 of the body into engagement with the plunger 6 for displacing the latter from normal position. Required to be both pushed in and turned and thus to move both axially and rotatably from inactive or normal position to its operative position in which it displaces the plunger 6, the actuator 37 has a cylindrical head or hub 40 slidable received in and rotatably and axially movable relative to an opening, aperture or guideway 41 of corresponding cylindricality, extending substantially radially through the side wall 41 and opening inwardly onto the valve chamber 8, preferably within the longitudinal or axial confines of the lower portion 16 of the bore 15. Thus exposed to the pressure within the valve chamber, the guideway 41 must be sealed against leakage about the head 40 of the actuator and this is accomplished by interposing therebetween sealing means, conveniently in the form of an O-ring 42 seated in a peripheral groove 43 in the head and wiping against the guideway.

In addition to the head 40, the actuator has a stem 44 of relatively reduced cross-section which is integral or rigid with the head and projects outwardly or outwards therefrom from substantially coaxial or concentric therewith. Normally disposed outwardly beyond the body 7, the stem 44 has or carries at or adjacent its outer end a handle 45 satisfactorily in the form of a pin or bar extending radially through the actuated portion of the actuator for engagement in the hands of the operator. Radially inwardly relative to the body 7, there is provided resilient means acting between the handle and the confronting side or face 38 of the body, preferably in the form of a coil spring 46 encircling the stem.

 Normally disposed either within the side wall 39 of the body 7 clear of the bore or at least clear of any part of the plunger disposed thereabove, the cam 47 is a side cam capable of translating rotary movement of the actuator into axial movement of the plunger 6 and has a side or camming surface 48 which preferably is cylindrical and rotatable either concentric with or eccentric relative to the head 40, except for a preferably flat or chordal area or face 49 interrupting the cylindricality and extending longitudinally substantially parallel to the axis of the head. Conveniently using the lower face 50 of the peripheral flange 38 on the closure member 27 as its contact bearing with that member and itself disposed below the flange by the position of the guideway 41 axially of the body 7, the cam 47, on shifting of the actuator 37 inwardly from an inactive position, is intended initially to be positioned to engage and act on the plunger 6 by having its flat face 49 disposed or facing toward the confronting face 50 of the flange with the faces substantially in contact and, adjacent and, on subsequent turning of the actuator in either direction, to exert a camming action by engaging the flange first by a corner of the flat face 49 and finally by the cylindrical portion of its camming surface 48.

Double-acting by virtue of the preferred configuration of its camming surface 48 and adapted to act on the lower or underface 50 of the flange 28 to lift the plunger 6 from the lower seat 12, the cam 47 is forced initially to present its flat face 49 to the flange 28 by locking or fixing the actuator 37 against rotation out of that position except after the actuator has been manually moved or actuated inwardly to the position in which the cam can engage and act upon the plunger. For this purpose, the cylindrical head 40 of the actuator is interrupted peripherally by a notch 51 extending inwardly longitudinally or axially from the head's outer end on the place 52 which adequately accommodate the required axial movement of the actuator and adapted to receive or interfere with a lip or shoulder 53 of corresponding configuration stationarily mounted on the body 7 and projecting radially into the outer end or portion of the guideway 41. Limiting outward movement of the actuator 37 under force of the spring 46 by engagement with the shoulder 54 bounding the inner end of the notch 51 and preventing rotation of the actuator except after the latter has been pushed inwardly against the force of the spring into position to engage the cam 47 with the flange 28 on the plunger 6, the lip 53, by engagement with the outer end 52 of the head 40 on turning of the actuator at the end of its inward movement to displace the plunger, also serves to lock or hold the actuator in operative position. With the stem 44 preferably cylindrical and, in any event, only extending in the area as to be turnable or rotatable within the lip 53, the lip and the notch 51 in and axially spaced, outwardly facing faces or surfaces 52 and 54 on the head 40 thus co-act or cooperate to lock the actuator against rotation except when it is in its inward or plunger-actuating position and also prevent outward axial movement of the actuator under force of the spring in both the operative and inactive positions of the actuator.
The maximum dimension of the cam 47 radially of its axis preferably is such as to shift or cam the plunger from its normal or lower seat-closing position to its upper position in which it seats on and closes the upper seat 13 and the lip 53 conveniently is formed as part of a retainer plate 55 related not integrally to the normal cam body 7 so as to enable the head 40 of the actuator to be inserted into and removed from the guideway 41. Otherwise arranged and constructed in the manner earlier described, the actuator thus normally will be locked in inoperative position against rotary and axial movement and in that position, if desired, be adapted not integrally to the normal electrical operation of the valve or with application and removal of the plunger 6 through the lower end of the body 7. However, when it is desired manually to by-pass or simulate the action of the solenoid 5 upon the plunger 6, it is simply a matter of pushing the actuator or sufficiently to free the lip 53 from the notch 51 and then turning the actuator in either a clockwise or counter-clockwise direction sufficiently to engage the lip fully with the outer end 52 of the head. Conversely, when, after a manual actuation, it is desired to restore the valve to normal condition for electric operation, it is desired to clamp the plunger in the path of removal of plunger into engagement therewith for displacement thereof from said normal position, means releasably connected to said body for holding the plunger limberly onto said actuator outwardly against said limiting means, said actuator at the outward limit of its movement. In other opening being disengaged on and out of the way of removal thereof of said plunger through said access opening.  

4. A solenoid valve comprising a valve body mounting a solenoid, a valve chamber in said body, a removable plunger in said chamber and shiftable against yieldable resistance from a normal position relative to a valve seat therein on energizing of said solenoid, said body having a normally plugged access opening from an exterior thereof onto an end of said plunger for removal of said plunger therethrough and another opening from an exterior thereof onto a side of said chamber a manually actutable actuator movably received in said other opening, said actuator being movable in said other opening into the path of removal of said plunger and into engagement therewith for displacement thereof from said normal position, means releasably connected to said body for limiting outward movement of said actuator in said other opening, and yieldable means normally urging said actuator outwardly against said limiting means, said actuator at the outward limit of its movement. In other opening being disengaged from and out of the way of removal thereof of said plunger from said body through said access opening.  

5. A solenoid valve comprising a valve body mounting a solenoid, a valve chamber in said body, a plunger in said chamber and shiftable against yieldable resistance from a normal position relative to a valve seat therein on energizing of said solenoid, said body having a normally plugged access opening from an exterior thereof onto an end of said chamber for removal of said plunger therethrough, manually actutable means projectable into said chamber through a side thereof for the path of removal of said plunger and into engagement therewith for simulating the action thereon of said solenoid, said means normally being disengaged from and disposed out of the way of removal thereof of said plunger from said body through said opening. 

2. A solenoid valve comprising a valve body mounting a solenoid, a valve chamber in said body, a removable plunger in said chamber and shiftable against yieldable resistance from a normal position relative to a valve seat therein on energizing of said solenoid, said body having a normally plugged access opening from an exterior thereof onto an end of said chamber for removal of said plunger therethrough, manually actutable means projectable into said chamber through the path of removal of said plunger for simulating the action thereon of said solenoid, and spring means acting between said first-named means and said body for normally holding said first-named means disengaged from and out of the way of removal thereof of said plunger from said body through said opening.  

3. A solenoid valve comprising a valve body mounting a solenoid, a valve chamber in said body, a removable plunger in said chamber and shiftable against yieldable resistance from a normal position relative to a valve seat therein on energizing of said solenoid, said body having a normally plugged access opening from an exterior thereof onto an end of said chamber for removal of said plunger therethrough, manually actutable means projectable into said chamber through a side thereof for the path of removal of said plunger and into engagement therewith for simulating the action thereon of said solenoid, and spring means acting between said first-named means and said body for normally holding said first-named means disengaged from and out of the way of removal thereof of said plunger from said body through said opening.  

6. A solenoid valve comprising a valve body mounting a solenoid, a valve chamber in said body, a plunger in said chamber and shiftable against yieldable resistance from a normal position relative to a valve seat therein on energizing of said solenoid, said body having a normally plugged access opening from a side thereof onto a side of said valve chamber, a manually actutable actuator movable rotatably and axially in said other opening, cam means on said actuator and on inward axial movement thereof for engagement with a confronting face on said plunger, said cam means on subsequent rotation of said actuator acting through said face on said plunger for discharging said plunger from said normal position, means connected to said body for locking said actuator against rotation except after said inward axial movement thereof, yieldable means normally urging said actuator axially outwardly of said other opening, and axially spaced means on said actuator and alternately engageable with means connected to said body for holding said actuator against the force of said yieldable means respectively in plunger-displacing posi-
tion and in a position disengaged from said plunger and out of the way of removal thereof from said body through said access opening.

7. A solenoid valve comprising a valve body mounting a solenoid, a valve chamber in said body, a plunger in said chamber and shiftable against yieldable resistance from a normal position relative to a valve seat therein on energizing of said solenoid, said body having a normally plugged access opening from an exterior thereof onto said chamber for removal of said plunger therethrough, said body having another opening spaced from said access opening and through a side wall of said body onto a side of said valve chamber, a manual actuator movable rotatably and axially in said other opening, cam means on said actuator and on inward axial movement thereof presented for engagement with a confronting face on said plunger, said cam means on subsequent rotation of said actuator acting through said face on and displacing said plunger from said normal position, spring means acting between said actuator and body for normally urging said actuator axially outwardly of said opening, and retainer means releasably connected to said body and projecting radially into an outer portion of said other opening and receivable in a longitudinally extending notch in said actuator for locking said actuator against rotary movement except after said inward axial movement thereof, said retainer means being alternately engageable with axially spaced means on said actuator for holding said actuator respectively in plunger-displacing position and in a position disengaged from and out of the way of removal of said plunger from said body through said access opening.

8. A solenoid valve comprising a valve body mounting a solenoid, a valve chamber in said body, a plunger in said chamber and shiftable against yieldable resistance from a normal position relative to a valve seat therein on energizing of said solenoid, said body having a normally plugged access opening from an exterior thereof and aligned axially with and opening inwardly onto said chamber for removal of said plunger therethrough, said body having a cylindrical opening extending through a side wall thereof substantially radially of and into said chamber, an actuator having a cylindrical head in and movable rotatably and axially of said cylindrical opening, an O-ring carried by said head and wiping against said cylindrical opening for sealing against escape of fluid therebetween, a cam rigid with and instanting from said head and having at its side a cylindrical surface coaxial with said head and interrupted by a substantially flat surface, a notch extending longitudinally of said head inwardly from an outer end thereof, a retainer connected to said body and projecting radially into said cylindrical opening and receivable in said notch, said retainer being so disposed about said cylindrical opening as when received in said notch to lock said head against rotation in a position in which on said inward axial shifting said flat face will be initially presented for engagement with said plunger, a stem of relatively reduced cross-section fixed to and projecting outwardly from and substantially coaxial with said head, a handle carried by an outer end portion of said stem, spring means encircling said stem and acting outwardly on said actuator between said handle and a confronting face of said body for urging said head outwardly of said cylindrical opening, and axially spaced surfaces on said head and alternately engageable with said retainer means for holding said cam means respectively in plunger-displacing position and in a position out of engagement with said plunger and out of the way of removal thereof from said body through said access opening.

9. In a solenoid valve having a valve body mounting a solenoid, a valve chamber in said body, and a plunger in said chamber and shiftable against yieldable resistance from a normal position relative to a valve seat therein on energizing of said solenoid, the combination of a normally plugged access opening in said body and opening inwardly onto an end of said chamber for removal of said plunger therethrough and manually actuable means projectable into said chamber through a side thereof into the path of removal of said plunger and into engagement therewith for simulating the action thereon of said solenoid, said means normally being disengaged from and disposed out of the way of removal thereafter of said plunger from said body through said access opening.

References Cited by the Examiner

UNITED STATES PATENTS

1,013,695 1/1912 Storer et al. 137—322
1,587,921 6/1926 Ray 251—141
2,043,194 6/1936 Eggleston 251—130 X
2,310,745 2/1943 Polka 251—141
2,614,584 10/1952 Gooperich 251—139
3,082,359 3/1963 Mangiapino et al. 251—141

FOREIGN PATENTS

1,193,948 11/1959 France 19,109 9/1908 Great Britain
27,516 12/1907 Great Britain

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