March 9, 1965 W. J. ADAMS ETAL 3,172,637

SOLENOID CONTROL VALVE

Original Filed May 22, 1961

FIG. 1

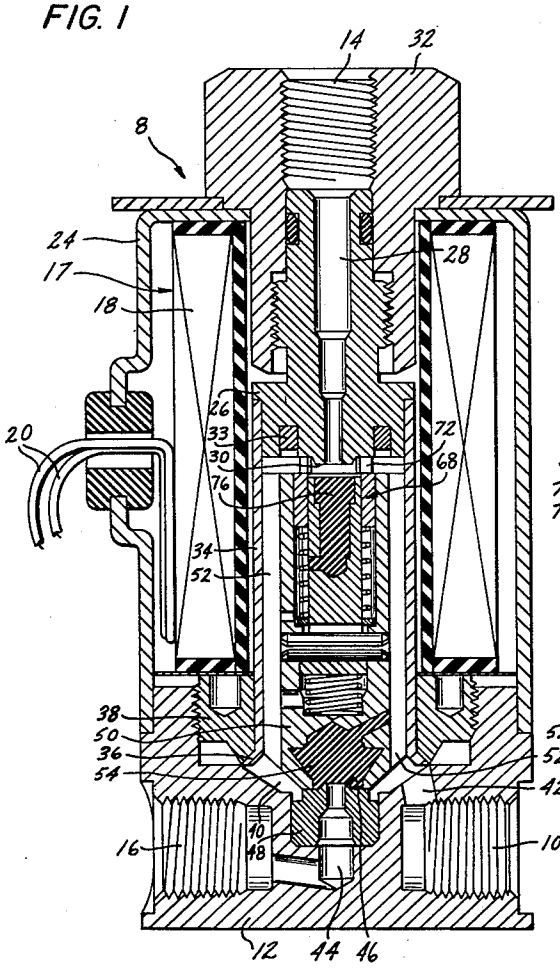


FIG. 2

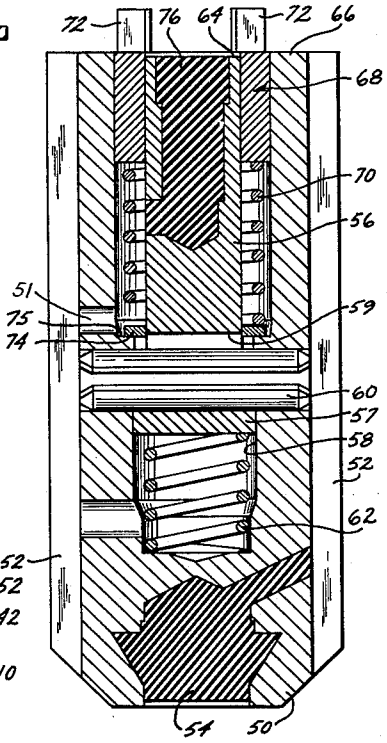
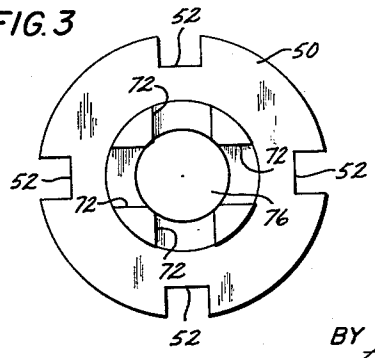


FIG. 3



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SOLENOID CONTROL VALVE

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6 Claims. (Cl. 251—85)

The present invention relates generally to solenoid operated fluid flow control valves, and more particularly to an improved solenoid control valve of the plunger type. This application is a continuation of our copending application Serial No. 111,661, filed May 22, 1961, now abandoned.

It is an object of this invention to provide an improved solenoid control valve which is rugged, compact and dependable and which is capable of being produced in small sizes without limiting its operational effectiveness or mechanical and magnetic efficiency.

It is another object of this invention to provide a solenoid control valve having a novel and improved armature and valve member arrangement that ensures quiet and dependable valve operation and which can be economically constructed and readily assembled.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth and the scope of the application which will be indicated in the appended claims.

In the drawings:

FIG. 1 is a sectional view of a solenoid control valve constructed in accordance with the present invention;

FIG. 2 is an enlarged sectional view of an armature subassembly embodied in the solenoid control valve of FIG. 1; and

FIG. 3 is a top end view of the armature subassembly of FIG. 2.

Referring to FIG. 1, there is shown a solenoid control valve, generally designated by the numeral 8, of the type with which the present invention is particularly suitable. Generally, the valve 8 has a valve body in which there is a valve port 10 adapted to have alternate communication with two other valve ports 14 and 16. Supported upon a valve base 12 of the valve body is a solenoid, generally designated 17, including an operating coil 18 enclosed within a casing 24 and having lead-in wires 20 for connection to a suitable power source. The solenoid 17 has a pole piece of magnetic material comprising a cap 32 in engagement with the end of the casing 24 and a nipple 26 threaded thereon which is axially bored to provide a passage 28 communicating at its outer end with the port 14 and terminating at its inner end in a valve seat 30 projecting from the nipple. Concentric with the passage 28 and valve seat 30 is an annular slot in the pole piece nipple 26 containing the usual shading ring 33 of copper or other highly conductive material.

Extending axially within the solenoid 17 is a sleeve 34 of nonmagnetic material which has one end in sealing engagement with the inner end of the pole piece nipple 26 and the other end secured and sealed to the valve base 12 by the engagement between the flared end 36 of the sleeve and a nut 38 threaded into an aperture in the base. The sleeve 34 defines a substantially cylindrical chamber 40 which communicates with the port 10 through passage 42 and with the port 16 by a passage 44 that terminates at its inner end in an inwardly projecting valve seat 46 on a valve seat insert 48.

Slidably mounted within the cylindrical chamber 40

is an armature or plunger 50 which has on the external surface thereof a plurality of elongated slots 52 that provide fluid passages between the ends of the chamber 40. Within the end of the plunger adjacent the valve seat insert 48, there is provided an insert 54 of rubber or the like which serves as a valve member with the valve seat 46 for preventing fluid flow through the passage 44 when the plunger is in its lower position as shown in FIG. 1.

As most clearly seen in FIG. 2, the plunger 50 is provided with an axial bore which receives a plunger insert 56 that has an enlarged end 57 slidably engaging the bore side wall. The enlarged insert end 57 is provided with a transverse passageway or opening 59 that loosely receives a roll pin retainer or stop 60 to retain the insert within the plunger bore. A return spring 62 acts to bias the plunger insert upwardly as shown in the drawings and against the roll pin at which position the end face 64 of the insert is located slightly below the adjacent end face 66 of the plunger. Mounted within the annular defined between the side wall of the plunger bore and the plunger insert is a spacer or guide sleeve 68 and a plunger return spring 70. The guide sleeve 68 is dimensioned to permit sliding movement of the plunger 50 and the plunger insert 56, however, the close dimensional tolerances (as shown in the drawings) between the plunger 50, the plunger insert 56, and the guide sleeve are such that the guide sleeve 68 positively guides the sliding movement of the plunger insert 56 at all times and also seals the upper end of the plunger bore to provide a dampening chamber therein having a fluid bleed passage 51 for cushioning the forces of impact upon seating of the insert valve member as will be subsequently described. The inner end of the guide sleeve 68 is in engagement with an end of the spring 70 and the outer end of the guide sleeve 68 which is provided with four equally spaced fluid passages or slots 72 surrounds the valve seat 30 and engages the pole piece nipple 26. The spring 70 has its opposite end in engagement with a washer 74 that rests upon a radial shoulder 75 on the bore side wall so that the spring 70 continually urges the plunger 50 and valve member 54 downwardly into engagement with the valve seat insert 48. Preferably, the sleeve 68, the roll pin 60, the spring 70 and the washer 74 are all of stainless steel.

A second insert 76 of rubber or the like is positioned within the end of the plunger insert 56 to serve as a valve member to seal the valve seat 30 and thereby close the passage 28 when the plunger is moved towards the nipple 26.

When the coil 18 is energized, the magnetic field produced exerts a force upon the plunger 50 that overcomes the bias of spring 70 and moves the valve member 76 into engagement with the valve seat 30 with the nipple extension acting to center the plunger insert and thereby ensure accurate seating of the valve member on the valve seat. The plunger 50 continues to move or overtravels against the bias of both springs 70 and 62 until the end 66 is in low reluctance contact with the inner end of the nipple 26. Any plunger vibration that occurs does not materially affect the sealing engagement of the valve member 76 because there is a continuous closing bias on the valve insert by the spring 62 and further because the sleeve 68, located intermediate the plunger and the plunger insert, cooperates with these parts to provide a dampening chamber which together with the springs largely dampen the vibrations that might otherwise affect the seating of the valve member 76.

Accordingly, it can be seen that the solenoid control valve of this invention incorporates a unique plunger and valve assembly that permits the plunger return spring to be contained within a plunger having a "floating seat" so as to ensure reliable operation of the valve and which can

be economically manufactured in unusually small sizes without reducing its mechanical and electromagnetic efficiency.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

We claim:

1. A solenoid valve assembly comprising, a valve body having an inlet port, an outlet port, and a fluid passageway extending therebetween, one of said ports being provided with a valve seat, a plunger disposed in said passageway for movement toward and away from said valve seat, said plunger being provided with an axial bore opening towards said seat, a sleeve mounted within said bore, a compression spring disposed within said bore and in engagement with the sleeve to continuously urge the sleeve into engagement with the valve body and to urge the plunger away from said valve seat, a valve member slidably carried by the plunger for engagement with said valve seat, said valve member being located within and engaged by said sleeve to be guided thereby, said plunger having means engaging the sleeve to prevent lateral movement thereof, and a solenoid in the valve body disposed about the plunger whereby energization of the solenoid moves the plunger against the spring force.

2. A solenoid valve assembly comprising, a coil, a coil pole piece having a fluid passage therein extending from the center of one end thereof, a sleeve extending from said one end of the pole piece, a plunger slidably mounted in said sleeve for movement between a first position spaced from the pole piece and a second position responsive to the energizing of the coil, a valve member slidably received in one end of the plunger adjacent the pole piece closing the pole piece passage when the plunger is in its second position, a guide sleeve mounted in said one end of the plunger around and in engagement with the valve member to guide the valve member and having its outer end in engagement with the pole piece, said sleeve being engaged by the plunger and thereby restrained against lateral movement, fluid passages in said outer end of the guide sleeve, and a compression spring in engagement with the inner end of the guide sleeve and with the plunger urging the plunger away from the pole piece.

3. A solenoid valve comprising a valve body having an inlet port, an outlet port and a fluid passageway extending therebetween, one of said ports being provided with a valve seat, a plunger disposed in said passageway for movement toward and away from said valve seat, said plunger being provided with an axial bore opening toward said seat, a sleeve mounted within said bore in engagement with said plunger and restrained against lateral movement thereby, said sleeve having its outer end surrounding the valve seat and engaging the valve body, a compression spring disposed within said bore engaging the sleeve and the plunger to urge the sleeve against the valve body and the plunger away from the valve seat, a valve member disposed within the bore of the plunger for slidable movement toward and away from said valve seat, said valve member being received and engaged by said sleeve to be guided thereby, means biasing said valve member outwardly from the plunger toward said valve seat, and a solenoid disposed about the plunger so that upon energization of the solenoid the plunger will move toward the valve seat to thereby cause said valve member to move against said valve seat to close said one port.

4. A solenoid valve assembly comprising a solenoid coil, a coil pole piece having a fluid passage therein extending from one end thereof, a sleeve extending from said one end of the pole piece, a plunger slidably mounted within the sleeve for movement between a first position spaced from the pole piece and a second position responsive to the energizing of the coil, said plunger being provided with an axial bore opening towards the pole piece, a plunger insert reciprocable in the plunger bore for movement toward and away from the pole piece, a valve member on the outer end of the plunger insert closing the pole piece passage when the plunger is in its second position, a spring urging the plunger insert outwardly toward the valve seat, means limiting the outward movement of the plunger insert relative to the plunger, a guide sleeve mounted within the plunger bore having its outer end in engagement with the pole piece, said guide sleeve being engaged by the plunger and thereby restrained against lateral movement and said guide sleeve receiving and engaging the plunger insert to guide the same, and a compression spring in engagement with the inner end of the guide sleeve and with the plunger urging the plunger away from the pole piece.

5. A solenoid valve assembly comprising, a valve body having an inlet port, an outlet port, and a fluid passageway extending therebetween, one of said ports being provided with a valve seat, a plunger disposed in said passageway for movement toward and away from said valve seat, said plunger being provided with an axial bore opening towards said seat, a sleeve mounted within said bore in engagement with said plunger and thereby restrained against lateral movement, said sleeve having its outer end surrounding the valve seat and engaging the valve body, a compression spring disposed within said bore engaging the inner end of the sleeve and the plunger and urging the sleeve against the valve body and urging the plunger away from the valve seat, a plunger insert slidably mounted within and engaged by said sleeve to be guided thereby, said plunger insert having a valve member on the outer end thereof for engagement with the valve seat, a compression spring urging the plunger insert outwardly from the plunger, means limiting outward movement of the plunger insert relative to the plunger, and a solenoid coil disposed about the plunger whereby the energizing of the solenoid moves the plunger and plunger insert toward the valve seat.

6. A solenoid valve assembly comprising, a valve body having an inlet port, an outlet port, and a fluid passageway extending therebetween, one of said ports being provided with a projecting valve seat, a plunger disposed in said passageway for movement toward and away from said valve seat, said plunger being provided with an axial bore opening towards said seat, a sleeve mounted within said bore having its outer end surrounding the projecting valve seat and engaging the valve body, said outer end of the sleeve having fluid passages therein, a compression spring disposed within said bore engaging the inner end of the sleeve and the plunger and urging the plunger away from the valve seat, a plunger insert slidably mounted within the sleeve having a valve member on the outer end thereof for engagement with the valve seat, said plunger insert having a through opening at the inner end thereof, a stop pin fixed within the plunger and loosely received within the plunger insert opening, a compression spring engaging the plunger insert and the plunger urging the insert outwardly against the stop pin, and a solenoid coil disposed about the plunger whereby the energizing of the solenoid coil moves the plunger and plunger insert toward the valve seat.

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