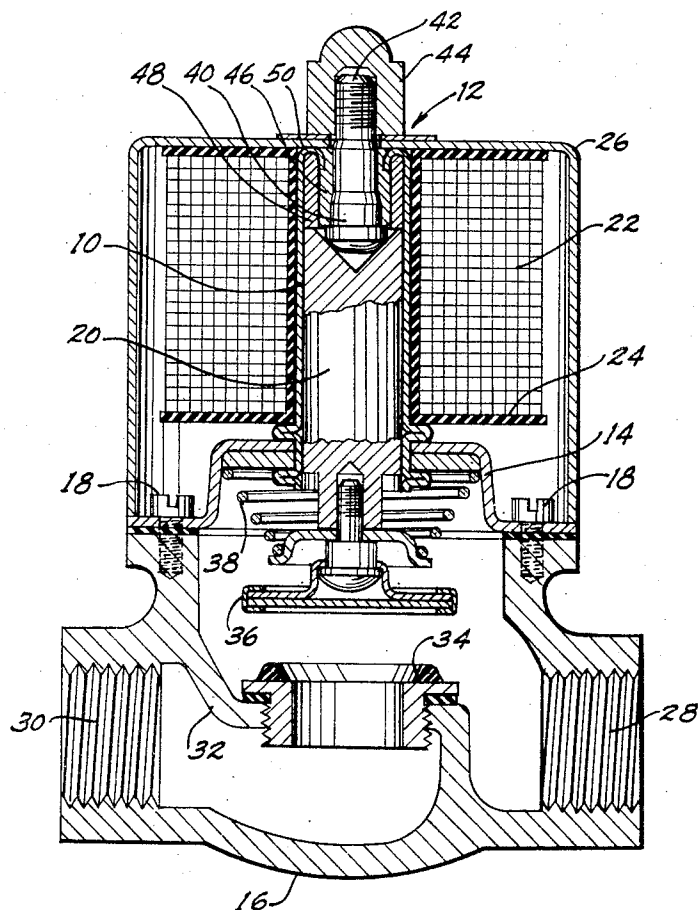


Filed June 5, 1957

SOLENOID CONSTRUCTION

2 Sheets-Sheet 1

FIG. 1.



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SOLENOID CONSTRUCTION

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FIG. 2.

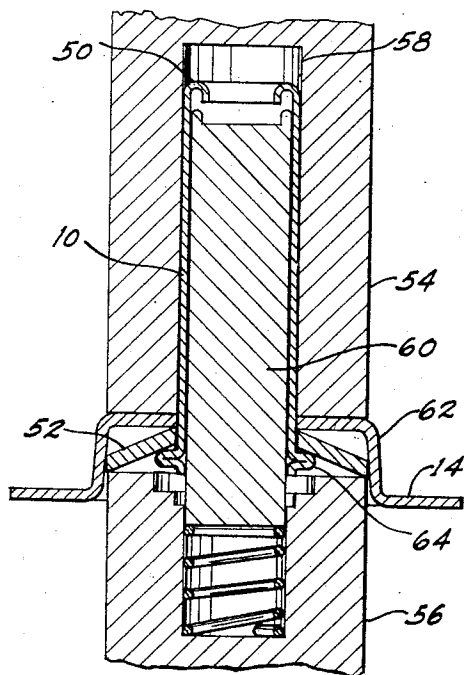


FIG. 3.

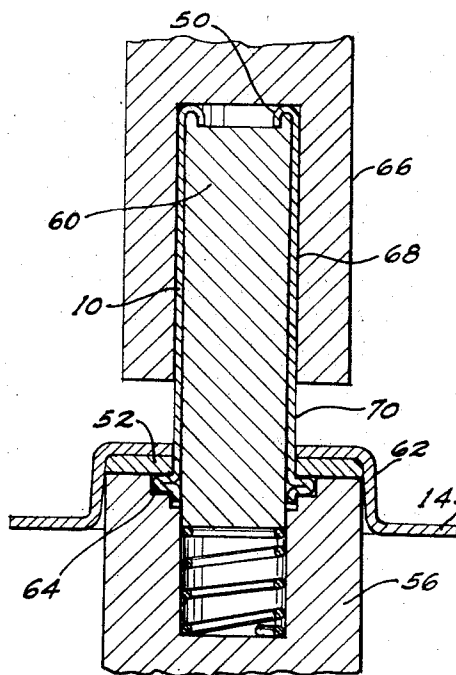


FIG. 4.

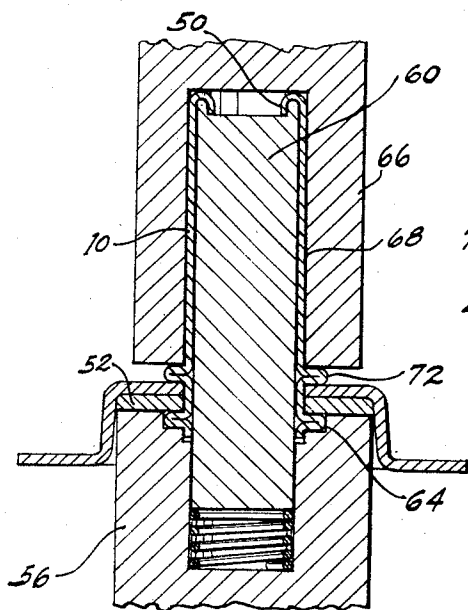


FIG. 5.

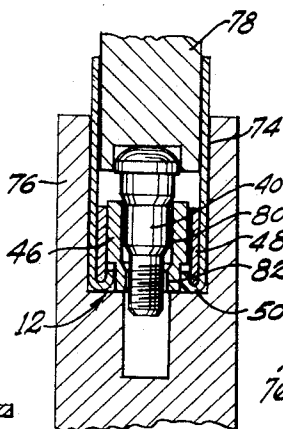
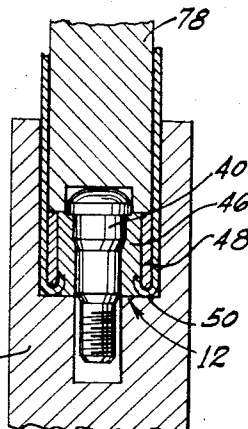


FIG. 6.



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SOLENOID CONSTRUCTION

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Application June 5, 1957, Serial No. 663,630

4 Claims. (Cl. 317-186)

This invention relates to A. C. solenoids of the type having a non-magnetic plunger guide sleeve which is closed at one end by a shaded magnetic stop member and is provided with a flange member of magnetic material at its open end which serves as a flux path and as a means of mounting the solenoid.

An object of the invention is to provide a solenoid construction of this kind which is particularly economical to manufacture.

A further object is to provide a solenoid of this type adapted to valve actuation wherein the shaded magnetic stop member and the magnetic mounting flange are assembled on the non-magnetic guide sleeve in a novel and economical manner so as to provide a fluid pressure tight seal.

These and other objects and advantages which appear from the following description and accompanying drawings form the purposes of the present invention.

In the drawings:

Fig. 1 is a cross-sectional view of a solenoid actuated gas valve showing a solenoid constructed in accordance with the present invention;

Figs. 2, 3, and 4 are longitudinal sectional views showing the method of assembling the mounting flange on the guide sleeve; and

Figs. 5 and 6 are fragmentary longitudinal sectional views showing the method of assembling the shaded magnetic stop member in the end of the plunger guide sleeve.

Referring to Fig. 1 of the drawings, the solenoid comprises a non-magnetic guide sleeve 10 having its upper end closed by a stop member generally indicated at 12, and having a flange member 14 of magnetic material at its lower end for mounting the solenoid on a valve body 16 by means of screws 18. The solenoid further includes a plunger 20 freely slidable in the guide sleeve 10, and a winding 22 wound on an insulating spool 24, which spool is fitted on the plunger guide sleeve 10. A magnetic casing member 26 of magnetic material completes a flux path which extends through the casing 26, the stop member 12, the flange 14, and the plunger 20 when in an attracted position.

The valve body 16 is provided with an inlet 28, an outlet 30, and a dividing partition 32 having an aperture therein around which a valve seat 34 is formed. The solenoid plunger 20 carries attached to the lower end thereof a valve 36 which cooperates with the seat 34 to control the flow through the valve body. The solenoid is shown in an energized position with the plunger 20 bearing against the stop member 12 and the valve 36 in an open position. When de-energized the valve and plunger fall freely to cut off flow through the valve body. A spring 38 is provided and is arranged to urge the plunger and valve 20 downward, thereby to preclude the possibility of the plunger sticking in an attracted position when de-energized due to residual magnetism. The spring 38 is preferably of the form having an eccentric coil at one end, as shown and described in the patent to Joseph A. Wasser, No. 2,650,617, issued September 1, 1953. This form of

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spring, in addition to providing a kick-off when the coil is de-energized, also holds the lower end of the plunger 20 against one side of its guide sleeve so as to prevent lateral vibration of the lower end of the plunger when it is in an energized position.

The plunger stop member 12 consists of a central plug 40 having a rounded head at the lower end thereof, and a screw-threaded upper end 42 which receives a nut 44 whereby the open end of the casing 26 is clamped against the rim of the flange 14. The stop member 12 further comprises a sleeve or shade ring 46 of non-magnetic material surrounding the plug 42, and finally a sleeve or ring 48 of magnetic material surrounding the non-magnetic sleeve 46. The upper end of the plunger 20 is provided with a conical recess which cooperates with the rounded head of central plug 40 to center the upper end of the plunger in the guide sleeve when it is in an attracted position.

When the solenoid winding 22 is energized by an A. C. power supply and the upper end of plunger 20 is bearing against the stop member 12, a portion of the magnetic flux generated by the winding 22 flows through the shaded plug 40 thereby generating a secondary magnetic flux which is approximately 90° out of phase with the main flux flowing through the outer sleeve 48. This arrangement provides a more constant magnetic force to hold the plunger vertically against its stop member even though the power source is alternating. A light break or gap in the main flux path between the upper end of magnetic ring 48 and magnetic casing 26 is provided by the inward folding of the upper end of non-magnetic guide sleeve 10, as indicated at 50. This provision precludes the possibility of the plunger sticking in an attracted position due to residual magnetism when the winding 22 is de-energized.

Figs. 2 to 6 illustrate how the non-magnetic plunger guide sleeve 10, the magnetic flange 14, and the stop member 12 are economically assembled to provide an effective fluid pressure tight seal for a valve body opening without resorting to the conventional and more expensive method of soldering or welding. In Fig. 2 the guide sleeve 10, the flange member 14, and a Belleville washer 52 of soft metal (preferably aluminum) are shown loosely assembled in upper movable and lower stationary press dies 54 and 56 respectively. The upper press die 54 has a bore 58 which slidably receives the sleeve 10, and the lower press die has a spring-loaded plunger 60 which slidably fits into the guide sleeve 10 to preclude any inward distortion of the sleeve. The flange member 14 has a central circular depression or cup portion 62 which need only be deep enough to receive the Belleville washer in its conical form. The sleeve 10 besides having its upper end folded inward, as indicated at 50, is additionally provided with a bead 64 at its lower end which has been formed in a manner to be described.

In the first step of the assembly operation, the upper press die 54 closes with the lower die 56. When this occurs the soft Belleville washer is pressed to a planar shape against the bottom of the cup portion of flange 14, and at the same time, the flange and washer are pressed against the bead 64, as shown in Fig. 3. The compression of the soft Belleville washer into a planar shape effects a fluid tight seal between the apertured washer 14 and sleeve 10. In the second step of the assembly operation a second upper movable die member 66 is substituted for die member 54. Die member 66 is provided with a bore 68 having a depth which is somewhat less than the free length of sleeve 10 extending above washer 14. When the press is operated and die member 66 closes, a force is applied at the upper end of sleeve 10. There being an unsupported, annular, exterior surface 70 on sleeve 10 between the lower end of die 66 and flange 14, the wall of sleeve 10 buckles outward in the area 70 and a second

bead 72 is formed against the upper surface of flange 14 and cooperates with lower bead 64 to complete a rigid connection of flange 14 and sleeve 10.

In the third step of the assembly operation, the flange and tube assembly are inverted and the end of the tube 10 is placed in a bore 74 in a stationary die member 76. The components of the stop member 12 are dropped in place, as indicated in Fig. 5. After these components are in place, a movable die plunger 78 is inserted from the flange end of the tube. The outer magnetic ring 48, it will be seen, fits into the annular groove provided by the inward folding of the end of sleeve 10. Inner, non-magnetic, shading ring 46 (which is preferably aluminum) has a reduced diameter portion at one end to accommodate the inward folded edge 50 of sleeve 10, and is further provided with stepped bores 80 and 82 to receive the stepped diameter magnetic plug 40. The bores 80 and 82 in the non-magnetic shading ring 46 are somewhat smaller than the respective stepped diameters of the plug 40 which are to be pressed into them, so that as the press plunger 78 is operated downward and the plug 40 is pressed into these bores, as indicated in Fig. 6, it will cause a flow of metal. Also, the length of the non-magnetic ring 46 is somewhat longer than the magnetic ring 48 plus the thickness of the sleeve, so that when the non-magnetic ring, which is softer than the plug 40, the ring 48, or sleeve 10, is compressed axially, metal will also flow thereby providing a complete sealing of all joints against fluid pressure leak.

From the foregoing, it will be seen that I have provided a solenoid assembly consisting of a non-magnetic plunger guide sleeve with a magnetic mounting and sealing flange at one end thereof and a shaded plunger stop member at the other end thereof, which elements are arranged to be assembled in a press to provide a fluid pressure tight assembly without the use of solder or welding. The lower bead 64 on sleeve 10 is preformed before assembly in a manner similar to that in which bead 72 is formed, and the inward folding of the sleeve end at 50 is also accomplished by press forming prior to assembly.

The foregoing description and accompanying drawings are intended to illustrate the invention, not limit it, the scope of the invention being set forth in the appended claims.

I claim:

1. In a solenoid, a plunger guide sleeve of non-magnetic metal having an annular, external shoulder formed at one end thereof, a flange of magnetic metal on said sleeve, said flange having a central perforation which slidably receives said sleeve and a central, concentric recess in one side thereof surrounding said perforation, said flange being placed on said sleeve with said recessed side thereof facing said shoulder, a Belleville washer of soft metal on said sleeve between said flange and said shoulder, said washer when in its normal frusto-conical form having a central perforation which slidably receives said sleeve and being of such outside diameter as to slidably fit into said flange recess, said soft metal washer being compressed between said shoulder and said flange to a planar form whereby its central perforation is reduced and its outside diameter is increased, thereby to form a fluid tight seal between said guide sleeve and said flange, and an annular external bead on said sleeve formed against the other face of said flange by longitudinal compression of said sleeve.

2. In an A. C. solenoid, a non-magnetic plunger guide sleeve having a short portion at one end thereof formed inwardly to provide an annular internal stop shoulder, a first short sleeve of magnetic metal fitted into said non-magnetic guide sleeve and bearing at one end thereof

against said internal shoulder, a second short sleeve of soft, non-magnetic metal fitted into said first short sleeve, and a plug of magnetic metal fitted into said second non-magnetic sleeve, said second soft, metal sleeve being slightly longer than said first magnetic sleeve before assembly and having a reduced diameter portion extending outwardly slightly beyond said shoulder, and being compressed longitudinally upon assembly so as to effect a transverse flow of metal, thereby providing a fluid pressure-tight seal between said first sleeve and said plug and between said plug and the inwardly formed end of said guide sleeve.

3. In an A. C. solenoid, a plunger guide sleeve of non-magnetic metal having a short portion at one end thereof formed inwardly to provide an internal annular shoulder, a shaded plunger stop in said sleeve at said end comprising a first short sleeve of magnetic metal fitted into said guide sleeve and bearing at one end against said shoulder, a second short sleeve of soft non-magnetic metal fitted into said first sleeve, and a plug of magnetic metal fitted into said second sleeve, said plug having an enlarged diameter portion forming a head at its interior end, which head bears against the interior end of said second short sleeve, and said plug being longer than said first and second sleeves and having a threaded portion extending exteriorly of said plunger guide sleeve, said internal annular shoulder having a width which is greater than the wall thickness of said first sleeve so as to provide a stop for both first and second short sleeves, but having a width which is less than the total of the wall thicknesses of said first and second short sleeves, said second short sleeve being longer than said first short sleeve and having a reduced outside diameter portion which extends outwardly beyond the interior face of said shoulder, and said second short sleeve being longer than said first short sleeve before assembly and being compressed longitudinally upon assembly to effect a fluid pressure-tight seal between said plug and said first short sleeve and between said plug and said guide sleeve shoulder.

4. In an A. C. solenoid, a plunger guide sleeve of non-magnetic metal having an annular external shoulder at one end thereof, a centrally perforated flange member of magnetic material and a Belleville washer of soft metal fitted on said sleeve with said Belleville washer lying between said bead and said flange member, said Belleville washer being compressed between said flange member and said bead into a planar form, a bead formed against said flange member by longitudinal compression of said guide sleeve thereby to rigidly attach said flange to said guide sleeve, said guide sleeve having a short portion of its opposite end formed inward to provide an internal annular shoulder, a shaded plunger stop member mounted in said opposite end of said guide sleeve comprising a first short sleeve of magnetic metal fitted into said guide sleeve and having one end bearing against said shoulder, a second short sleeve of soft non-magnetic metal fitted into said first sleeve, and a plug of magnetic metal fitted into said second sleeve, and said second soft metal sleeve being slightly longer than said first metal sleeve before assembly and being compressed longitudinally upon assembly thereby to form a fluid pressure-tight seal between said plug and said first sleeve.

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