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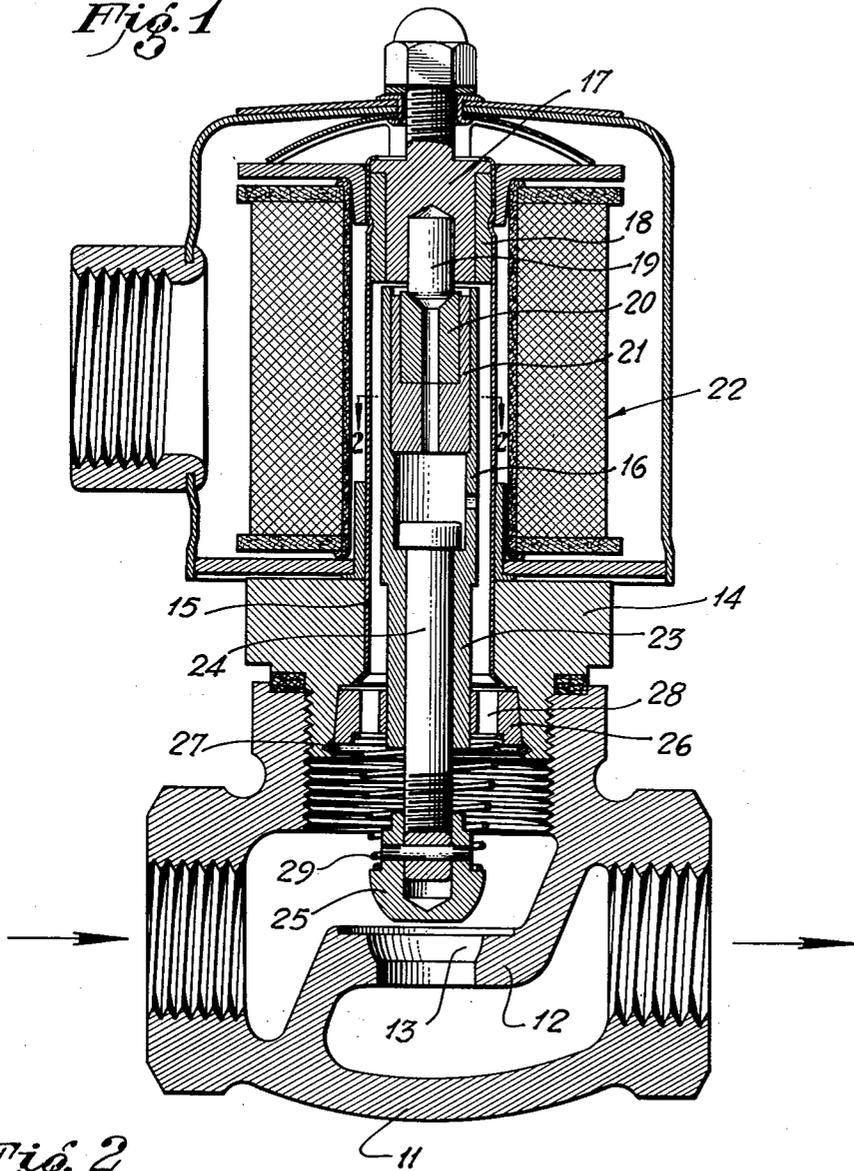
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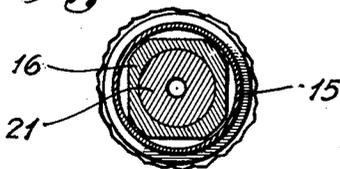
SOLENOID

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*Fig. 1*



*Fig. 2*



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# UNITED STATES PATENT OFFICE

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## SOLENOID

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5 Claims. (Cl. 175—341)

My present invention relates to electromagnetic operators and in particular to an alternating current solenoid operator employing a reciprocable plunger.

It has been found that, in such an operator, it is essential to very accurately center or guide both ends of the plunger in order that the operator shall be hum-free when energized. A typical example of means for that purpose is disclosed in Patent No. 2,098,195, issued to me November 2, 1937.

It is an object of my present invention to provide improved guiding means for a solenoid plunger, which means will assure accurate centering of the plunger within the tube in which it is reciprocable.

In a solenoid operator of the type described, it is generally necessary or desirable that guiding means for the outer end of the plunger be provided as a separate member which, in assembly, must be accurately secured in position.

It is therefore a particular object of my invention to provide a guide bushing for the plunger, and means for accurately centering the bushing with respect to the plunger tube.

Other objects and advantages of my invention will be found in the description, the drawing, and the appended claims.

For complete understanding of the invention, reference may be had to the following detailed description and accompanying drawing, wherein:

Figure 1 is a sectional view of a solenoid valve embodying my present invention; and

Fig. 2 is a fragmentary section taken along the line 2—2 of Fig. 1.

In the drawing, the solenoid operator of my invention is shown, by way of example, applied to a fluid control valve comprising a casing 11 having an inlet and an outlet separated by a ported partition 12 provided with a valve seat 13. Threadedly supported in an upper extension of said casing is a base member 14 for the operator, having a central cylindrical opening there-through wherein is sealingly secured the lower end portion of a plunger tube 15 of non-magnetic material.

Reciprocable within said plunger tube is a plunger member 16, of magnetic material, the upper outer portion of which is generally square in cross-section and has rounded corners conforming to the curvature of the plunger tube, as shown in Fig. 2. The diameter of the plunger across its corners is appreciably less than the inner diameter of the tube.

The upper end of the plunger tube is closed

by a member 17 of non-magnetic material carrying an outer ring 18 and a plunger stop member 19, both of magnetic material. The lower end of the stop member is of generally conical form and is cooperable, when the plunger is in its attracted position as shown, with a concentric recess formed in a magnetic member 20 which is carried by the plunger tube, a non-magnetic member 21 being interposed therebetween.

The magnetic function of the members referred to in the preceding paragraph has been described in detail in my Patent No. 2,098,195. It suffices herein to state that the cooperating members 19 and 20 serve to accurately center the upper end of the plunger in the tube when the solenoid is energized by current flow in coil member 22.

Slidable in the bore of the cylindrical lower end portion 23 of plunger 16 is a rod 24 carrying on its lower end a valve member 25 cooperable with the seat 13. This rod serves to provide "impact action" in the opening of the valve.

The lower end of the opening in the base member 14 is outwardly tapered to receive a frusto-conical guide bushing 26 having a concentric bore which is a close sliding fit for the cylindrical lower end 23 of the plunger. A recessed wire snap-ring 27 retains the guide bushing 26 tightly in position in the tapered seat or recess of member 14. Openings 28 permit fluid communication with the space surrounding the upper end of the plunger. A spring 29, compressed between the valve member and a recessed bottom surface of the guide bushing 26, urges the plunger downward.

It will be seen that, by my present invention, I have provided simple, effective means for ensuring the accuracy of centering of the plunger in production manufacture of solenoids.

I wish it to be understood that modifications may be made in the specific embodiment of my invention, herein shown and described, without departing from the spirit of my invention and that I intend therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a solenoid operator, a plunger tube, a plunger reciprocable in said tube, a base member for rigidly supporting an end portion of said tube, a bushing for continuously and closely guiding said plunger, said base member being provided with a tapered recess in axial alignment with said tube and said bushing having a corresponding taper on its outer wall cooperable with said recess, and means for locking said bushing against movement in said recess.

2. In a solenoid operator, an apertured base member, a cylindrical plunger tube rigidly supported at one end in the aperture of said base member, a plunger freely reciprocable in said tube, a frusto-conical member having a concentric cylindrical opening for closely guiding said plunger throughout its complete stroke, a portion of the inner side wall at the free end of the aperture of said base member having a corresponding taper so as to receive said guide member in axial alignment with said tube, the taper having substantial area of contact with the frusto-conical member, and means for retaining said guide member against movement in said tapered aperture.

3. In a solenoid operator, a base member having a cylindrical opening therethrough, a cylindrical plunger tube rigidly supported in one end of said opening, the other end of said opening being outwardly tapered, a plunger freely reciprocable in said tube, a frusto-conical member fitting the tapered end of said opening and having a concentric hole therethrough for continuously and closely guiding a portion of said plunger whereby the plunger is maintained out of engagement with the inner wall of said tube, and means for continuously retaining said guide member against movement in said tapered opening.

4. In a solenoid operator, a base member having a cylindrical opening therethrough, a cylindrical plunger tube rigidly supported in one end

of said opening, the other end of said opening being outwardly tapered, a plunger freely reciprocable in said tube, means mounted in the free end of said tube and engageable with one end of said plunger for centering the same in said tube, a frusto-conical member having a taper fitting the tapered end of said opening and having a concentric hole therethrough for closely guiding the other end portion of said plunger throughout its complete stroke, and means for continuously retaining said guide member against movement in the tapered end of said opening.

5. In a solenoid operator, a base member having a cylindrical opening therethrough, a cylindrical plunger tube closed at one end and rigidly supported at its other end in one end of said opening, the other end of said opening being outwardly tapered, a plunger freely reciprocable in said tube, means mounted in the closed end of said tube and engageable with one end of said plunger for centering the same in said tube, a frusto-conical member having a taper fitting the tapered end of said opening and having a concentric hole therethrough for continuously and closely guiding the other end portion of said plunger, said guide member having a passage therethrough communicating with the interior of said tube, and means for continuously retaining said guide member against movement in the tapered end of said opening.

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