June 29, 1948. L. H. SNYDER 2,444,118

SOLENOID WITH PLUNGER

Filed March 27, 1946

Fig. 1.

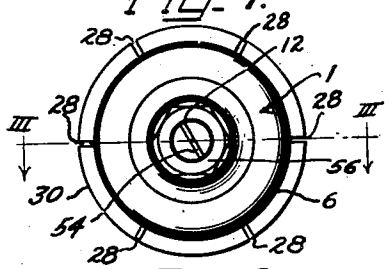


Fig. 2.

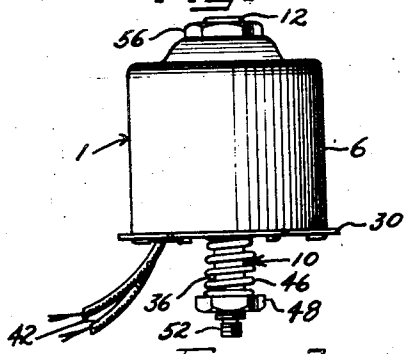
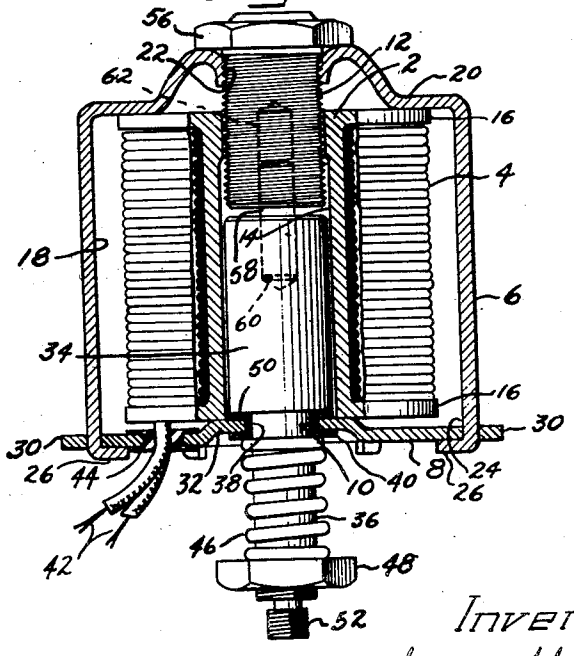


Fig. 3.



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Patented June 29, 1948 2,444,118

UNITED STATES PATENT OFFICE

2,444,118

SOLENOID WITH PLUNGER

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Application March 27, 1946, Serial No. 657,399

4 Claims. (Cl. 175—341)

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This invention relates to improvements in electric solenoids.

This application constitutes a continuation-in-part of my copending application Serial No. 619,353, filed September 29, 1945, now U. S. Patent No. 2,427,630, and provides a solenoid construction similar to that disclosed in my copending application but characterized by the elimination of several components thereof and simplification of the remaining components to adapt such components to manufacture by stamping or automatic machine operations.

The general object of the invention is to provide an improved solenoid of rugged construction capable of adjustment to vary the intensity of the vibratory action thereof and mounted in a dust-proof case.

A further object of the invention is to provide a solenoid which may be readily adjusted to vary the stroke and intensity of the magnetic pull thereof.

A particular object of this invention is to provide an improved solenoid construction requiring a minimum number of parts and susceptible to large quantity, low cost production methods for their manufacture.

The specific nature of the invention as well as other objects and advantages thereof will become apparent to those skilled in the art from the following detailed description of the annexed sheet of drawings which, by way of preferred example only, illustrates one specific embodiment of the invention.

On the drawing:

Figure 1 is a top elevational view of a solenoid construction embodying this invention.

Figure 2 is a side elevational view of the solenoid of Figure 1.

Figure 3 is an enlarged scale vertical sectional view of the solenoid of Figure 1 taken along the plane III—III thereof.

As shown on the drawing:

A solenoid construction embodying this invention is indicated on the drawing generally by the numeral 1 and essentially comprises an annular core member 2, a winding 4, a casing 6, a cover 8, a plunger 10, and an adjustable core piece 12.

The annular core member 2 is formed from magnetic material and defines an axial, cylindrical core opening 14. On each end of the core member 2, integral, radially projecting flanges 16 are provided, and in the space between such flanges 16, the coils of the winding 4 are mounted on the exterior of the core member 2 in circumferential relationship to the axis thereof.

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The casing 6 is also formed from magnetic material and comprises a hollow cylindrical member defining a cylindrical chamber 18 and having one integral end wall 20 thereof shaped in re-entrant fashion to define a small end opening 22 coaxially aligned with the chamber 18. Suitable interior threads are provided in end opening 22.

The other end opening 24 to chamber 18 is sufficiently large to permit the insertion of the annular core 2 and its associated winding 4 into the chamber 18 of casing 6. To close the large end opening 24 of casing 6, and further, to retain the core 2 snugly within the casing 6, a cover plate 8 is provided which is secured across the large end opening 24 of casing 6. Preferably cover plate 8 is secured to casing 6 through the cooperation of a plurality of peripherally spaced, integral tabs 26, which are provided on the casing 6 around the large end opening 24, with correspondingly located slots 28 provided in a peripheral portion 30 of cover plate 8 which extends beyond the periphery of casing 6. After insertion of tabs 26 through slots 28, the tabs 26 are bent over and thus firmly secure the cover plate 8 to casing 6.

The cover plate 8 is also formed from magnetic material and preferably has a portion of its inner surface, such as the integrally formed, central raised portion 32 disposed in metallic engagement with the adjacent end face of annular core member 2 and proportioned so as to urge the core member 2 tightly into engagement with the inner face of the opposite end wall 20 of casing 6 when cover plate 8 is assembled to the casing 6. With this construction, it will be apparent that a completely closed magnetic circuit is thus provided surrounding the coils of winding 4, formed by the core member 2, the casing 6, and the cover plate 8. It is thus assured that the winding 4 will produce a substantial amount of magnetic flux in the aforedescribed magnetic circuit and hence a powerful action can be obtained from the solenoid by a moderate voltage applied thereto.

The actuating plunger 10 of the solenoid construction comprises a bolt-like member having a cylindrical head portion 34 and a smaller diameter shank portion 36 secured thereto which projects out of casing 6 through a central hole 38 provided in cover plate 8. To prevent the passage of dust or other deleterious material into the interior of casing 6, a seal 40 of fiber or rubber-like material is provided between the central opening 38 of cover plate 8 and the shank portion 36 of actuating plunger 10. Likewise, the leads 42 by which voltage is applied to the solenoid winding 4 from a suitable power source (not shown) are brought

through cover plate 8 through a fiber grommet 44 disposed in a suitable hole.

The head portion 34 of actuating plunger 10 is freely slidable within the central core opening 14 of the annular core 2. The actuating plunger 10 is biased in an axial direction tending to remove head portion 34 from central core opening 14 by a spring 46 disposed on the shank portion 36 of plunger 10 exteriorly of casing 6 and which operates between the seal 40 and a suitable nut 48 which is threadably secured on the end of shank portion 36. The shoulder 50 formed by the juncture of shank portion 36 with head portion 34 of the actuating plunger effectively limits the outward movement of the plunger under the bias of spring 46 by engagement with the inner face of the seal 40. If desired, the end of shank portion 36 may be provided with a reduced diameter threaded portion 52 by which the mechanical connection of the solenoid plunger to any desired device to be operated may be accomplished. It should be further noted that, if desired, a flexible, resilient sealing member (not shown) may be mounted between the end of actuating plunger 10 and the projecting flange portion 30 of cover plate 8 in a manner similar to the mounting of the seal member described in my copending application.

An adjustable core piece 12 is provided comprising a threaded stud which is threadably engaged in the small opening 22 provided in end wall 20 of casing 6 and projects into the central core opening 14 an adjustable distance, depending upon how far it is screwed into the threads of opening 22. A suitable tool-engaging slot 54 may be provided in the exterior face of adjustable core member 12 to permit the convenient rotational adjustment thereof and a lock nut 56 may be provided to lock the core member 12 in any desired adjusted position.

The interior end of core piece 12 thus provides an adjustable air gap 58 between itself and the adjacent end face of the head portion 34 of the actuating plunger 10. As is apparent on the drawings, the core 2 is of relatively thin walled construction, and may be conveniently formed by stamping. Hence the core 2 has appreciable magnetic reluctance and saturates upon the application of a relatively small magnetizing force by current flow through the winding 4. The reluctance of the core 2 is therefore greatly reduced by the insertion of the actuating plunger 10 within the core 2, particularly when the plunger 10 is moved into abutment with core piece 12 to close air gap 58. Since every magnetic circuit exerts a force on the elements thereof to move such to a minimum reluctance position it is obvious that upon energization of the winding 4, a magentic force will be exerted upon the actuating plunger 10 in a direction to close the air gap 58. Upon the cessation of such energization, however, the spring 46 immediately returns the actuating plunger 10 to the position shown in Figure 3 of the drawing and thus reestablishes the air gap 58. The spring 46 is sufficiently strong that when alternating current of commercially available frequency is applied to the winding 4, the spring will return the actuating plunger 10 to its deenergized position each time that the alternating current passes through its zero value. Accordingly, the actuating plunger 10 will be reciprocated rapidly at a frequency dependent upon the frequency of the applied voltage.

To further guide the reciprocating movement of plunger 10, and to eliminate the necessity of metallic engagement between the exterior surface of the head portion 34 of the plunger and the interior surface of core opening 14, a pin 60 of suitable non-magnetic, metallic material may be secured into the end face of the head portion 34 of plunger 10 and cooperates in bearing relationship with an aligned hole 62 provided in the core piece 12.

From the construction described, it will be apparent that this invention provides an improved solenoid having a minimum number of component parts and characterized by the simplicity of such component parts and their adaptability to manufacture by large quantity production processes. The assembled solenoid is of rugged construction, substantially dust-proof, and the stroke of the actuating plunger may be conveniently adjusted without requiring the disassembly of the solenoid.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention, and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. In a solenoid construction having an annular magnetic core defining a central opening therethrough and a circumferentially disposed winding on said core, the improvements of a hollow cylindrical magnetic casing having one integrally formed end wall, said casing being constructed and arranged to surround said core and winding and having a large opening in the other end thereof to permit the insertion of said core and winding therein, a plurality of spaced integral tabs around the edge of said large opening, a circular magnetic cover plate having a plurality of peripherally spaced slots therein to respectively receive said tabs, said tabs being bent to rigidly secure said cover to said casing, said cover plate having a portion thereof in metallic engagement with said magnetic core to hold said core snugly against said end wall of said casing, thereby completing a closed magnetic circuit around said winding, a magnetic plunger projecting partly into said central core opening, resilient means urging said plunger outwardly relative to said core, and means adjustable relative to said casing for limiting inward movement of said plunger produced by energization of said winding.

2. In a solenoid construction having an annular magnetic core defining a central core opening therethrough and a circumferentially disposed winding on said core, the improvements of a hollow cylindrical magnetic casing having one integrally formed end wall defining a threaded hole, said casing being constructed and arranged to surround said core and winding and having a large opening in the other end thereof to permit the insertion of said core and winding therein, a magnetic cover plate secured across said large opening, said cover plate having a portion thereof in metallic engagement with said magnetic core to hold said core snugly against said end wall of said casing, thereby completing a closed magnetic circuit around said winding, a magnetic plunger having one portion thereof slidable in said central opening and another portion projecting through said cover plate, resilient means urging said plunger out of said central core opening, means on said

plunger engageable with said cover plate to position said plunger with said one portion projecting partly into said central opening, whereby energization of said winding draws said plunger further into said core opening against the bias of said resilient means, and a core piece extending into said core opening from the other end thereof to limit the inward movement of said plunger, said core piece having a threaded portion engageable with said threaded casing opening to adjustably position said core piece relative to said central core opening.

3. In a solenoid construction having an annular magnetic core defining a central opening therethrough and a circumferentially disposed winding on said core, the improvements of a hollow cylindrical magnetic casing having one integrally formed end wall defining an axially located threaded hole, said casing being constructed and arranged to snugly surround said core and winding and having a large opening in the other end thereof to permit the insertion of said core and winding therein, a magnetic cover plate secured across said large opening, said cover plate having a portion thereof in metallic engagement with said magnetic core to hold said core snugly against said end wall of said casing, thereby completing a closed magnetic circuit around said winding, a magnetic plunger having an enlarged head portion slidable in said core opening and a shank portion projecting through said cover plate, a spring surrounding said shank portion on the exterior side of said cover plate and operating between said cover plate and said plunger to urge said plunger outwardly, said plunger having a shoulder between said head and shank portions engageable with said cover plate to limit outward movement of said plunger, and a core piece extending into said central core opening from the other end thereof to limit the inward movement of said plunger, said core piece having a threaded portion engageable with said threaded casing opening to adjustably position said core piece relative to said central core opening.

4. In a solenoid construction having an annular magnetic core defining a central core opening therethrough and a circumferentially disposed winding on said core, the improvements of a hollow cylindrical magnetic casing having one integrally formed end wall defining an axially located threaded hole, said casing being constructed and arranged to snugly surround said core and winding and having a large opening in the other end thereof to permit the insertion of said core and winding therein, a plurality of spaced integral tabs around the edge of said large opening, a circular magnetic cover plate having a plurality of peripherally spaced slots therein to respectively receive said tabs, said tabs being bent to rigidly secure said cover plate to said casing, said cover plate having a portion thereof in metallic engagement with said magnetic core to hold said core snugly against said end wall of said casing, thereby completing a closed magnetic circuit around said winding, a magnetic plunger having an enlarged head portion slidable in said central core opening and a shank portion projecting through said cover plate, a spring surrounding said shank portion on the exterior side of said cover plate and operating between said cover plate and said plunger to urge said plunger outwardly, said plunger having a shoulder between said head and shank portions engageable with said cover plate to limit outward movement of said plunger, and a core piece extending into said central core opening from the other end thereof to limit the inward movement of said plunger, said core piece having a threaded portion engageable with said threaded casing opening to adjustably position said core piece relative to said central core opening.

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