July 25, 1950 E. M. SORENG ET AL 2,516,603

SOLENOID WITH SHOCK ABSORBING, COIL RETAINING ELEMENT

Filed March 6, 1948

Fig. 1.

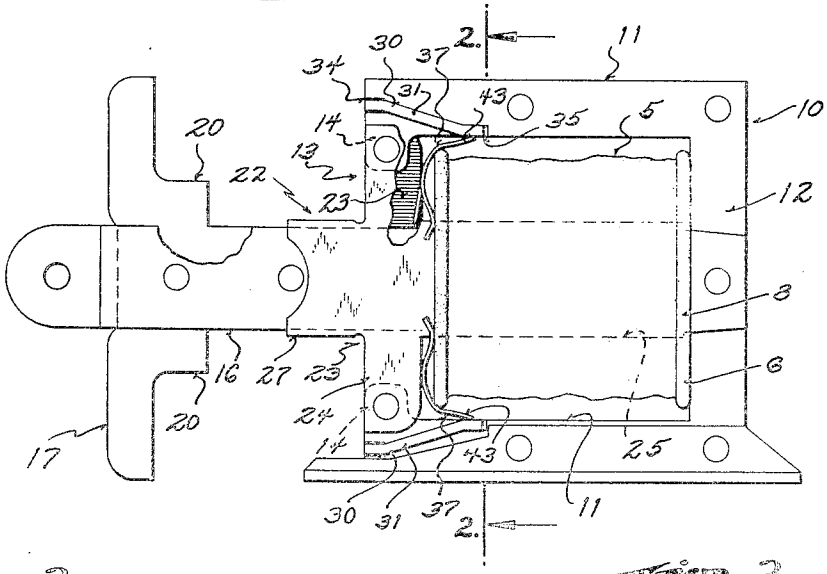


Fig. 2.

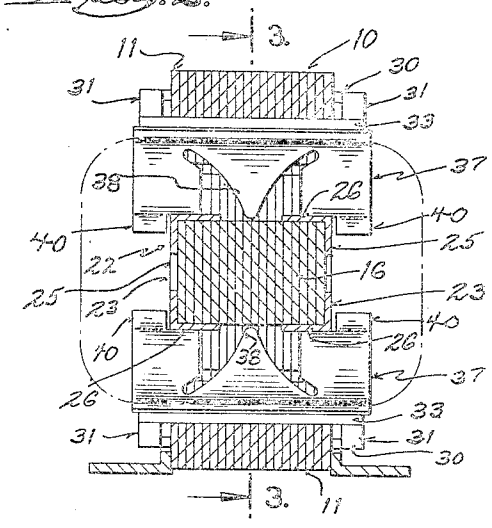


Fig. 3.

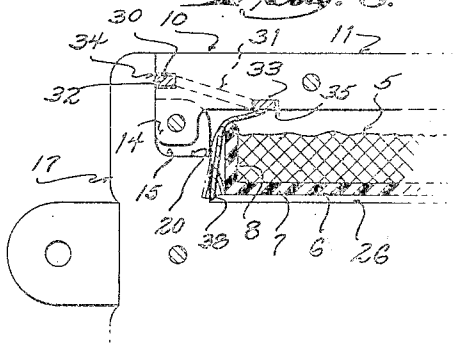


Fig. 4.

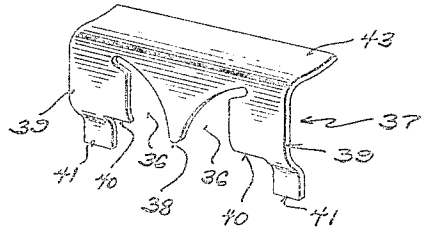
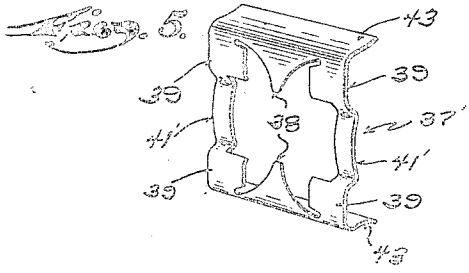


Fig. 5.



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SOLENOID WITH SHOCK ABSORBING, COIL RETAINING ELEMENT

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Application March 6, 1948, Serial No. 13,443

10 Claims. (Cl. 175—338)

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This invention relates to solenoids and refers more particularly to improvements in alternating current solenoids of the type shown and described in the copending application of Hardin Y. Fisher, Patent No. 2,468,052, filed May 8, 1947.

As in the aforementioned copending application it is also an object of this invention to provide an A. C. solenoid with shading coils so located on the frame of the solenoid as to preclude the formation of flux bottlenecks in the magnetic circuit; and to provide an enlarged head on the outer end of the plunger of the solenoid having shoulders at its underside adapted to enter an enlarged air gap opening in the frame during seating of the plunger for the purpose of increasing the tractive force of the plunger near the end of its stroke.

An additional object of the present invention, however, resides in the provision of novel means for retaining the shading coils in place on the frame of the solenoid, and which means also provides for cushioning of the plunger during final seating motion thereof.

More specifically this invention has as its main object the provision of novel spring blades confined between one end of the coil of the solenoid and the frame at its open end for retaining the shading coils in place on the frame, for cushioning the plunger during its final seating motion, and also for yieldingly pressing the winding against the closed end of the frame.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawing illustrates two complete examples of the physical embodiment of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a side elevational view of an alternating current solenoid having portions broken away to better illustrate the application of this invention thereto;

Figure 2 is a cross sectional view taken along the plane of the line 2—2 of Figure 1;

Figure 3 is a fragmentary longitudinal sectional view taken on the plane of the line 3—3 of Figure 2;

Figure 4 is a perspective view of one of the pair of spring blades required in the preferred embodiment of the invention; and

Figure 5 is a perspective view of a modified form of spring retaining blade.

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Referring now more particularly to the accompanying drawing in which like numerals indicate like parts, the numeral 5 designates the solenoid winding which is of conventional type wound on an insulating hollow spool or bobbin-like form 6. The spool, in the present case, comprises a tubular stem 7 having a substantially rectangular cross sectional shape, and end flanges 8 at opposite ends of the stem between which the windings are confined.

The frame 10 of the solenoid is generally U-shaped in side elevation and is preferably built up in the usual manner from a number of identical U-shaped laminae stacked together to form a bank and secured together by means of rivets. The winding 5 is received between the opposite legs 11 of the U-shaped frame with one end thereof seated against the closed end 12 of the frame and the opposite end adjacent to the open end 13 of the frame. Inward extensions 14 on the outer ends of the legs 11 project toward one another and overlie the front of the winding to define between their ends an air gap 15 through which the plunger 16 projects for reciprocatory motion inside the hollow center of the winding.

The plunger 16, which is also of laminated construction, is formed as in the aforementioned copending application of Hardin Y. Fisher, Serial No. 746,648, filed May 8, 1947, now Patent No. 2,468,052, in that it has a cross-head 17 on its outer end of a spread such as to completely span the open end of the frame when the plunger is seated.

In the seated position of the plunger shown in Figure 3, it will be noted that the underside of the cross-head 17 abuts the ends of the legs 11, and that shoulders 20 at opposite sides of the plunger beneath the cross-head enter the air gap 15 during final seating of the plunger to substantially bridge the space between the ends of the inward extensions 14 on the legs 11.

The plunger 16 is guided for endwise reciprocatory motion in a path parallel to the legs 11 of the frame and substantially midway therebetween by guide means indicated generally by the numeral 22. This guide means comprises cooperating substantially T-shaped guide parts 23 secured to opposite sides of the frame with their heads 24 overlying and spanning the space between the inward extensions 14 on the frame legs, and with their stems 25 projecting rearwardly from the

heads through the hollow center of the winding to the closed end of the frame.

The stems are substantially channel shaped in cross section with the flanges 26 thereof projecting inwardly toward one another from opposite side edges of the stems and cooperating to provide a substantially tubular guideway to reciprocably receive the inner end portion of the plunger in its interior and to mount the hollow winding 5 on its exterior. If desired, the channels of the guide parts may be extended a distance forwardly of their heads, as shown at 27, to provide proper support for the plunger in its withdrawn position.

As in the aforementioned copending application of Hardin Y. Fisher, the frame is provided with two shading coils 30. Each of these coils comprises a substantially rectangularly shaped loop of conductive material encircling a portion of one of the legs 11 of the frame at its outer extremity.

Two opposite sides 31 of each loop lie exteriorly of the sides of the frame, but the front and rear members 32 and 33 respectively of each of the loops are received in slots 34 and 35 cut into the legs 11. The slots 34 for the front members of the loops extend edgewise into the outer extremities of the legs 11 and run entirely transversely thereacross.

The other slots 35 for the rear members of the loops flatwise traverse the inner surfaces of the legs near the inner corners defined by the junctures between the legs 11 and the inward extensions 14 on their outer ends.

Consequently, it will be seen that the shading coils are assembled with the frame by first passing them over the extensions 14, and then engaging the front members 32 of the loops edgewise into their slots 34. As the front members 32 seat in their slots, the rear members 33 of the loops are brought into alignment with their slots 35 and seated therein. It will be understood, of course, that the slots 34 leading edgewise into the ends of the legs are wide enough to allow slight tilting of the loops during engagement of their front members in the slots 34; and that the engagement of the rear members of the loops in their slots 35 precludes forward motion of the loops in the direction to disengage the front members 32 from their slots.

Since the slots 35 are formed in the inner sides of the legs 11 of the frame while the slots 34 are located relatively close to the outer sides of the legs, it will be apparent that the opposite sides 31 of the coils extend substantially diagonally across the junctures between the legs and their inward extensions 14 so as to preclude flux bottlenecks in the main magnetic circuit, as brought out more fully in the aforementioned copending application of Hardin Y. Fisher.

Each of the shading coils 30 is retained in its proper position, that is, against tilting motion in a manner such as to disengage the rear member 33 thereof from its slot 35, by means of a spring blade retainer, generally designated 37, and shown best in Figure 4. Each of the blades comprises a body portion having a pair of cutouts 36 leading into the body from one longitudinal edge of the blade to define a central prong 38, and legs 39 at opposite sides of the prong. The legs 39 extend beyond the outer or free end of the prong, and have notches cut into their inner sides at their extremities to define shoulders 40 substantially on a level with the outer end of the prong,

and tangs 41 along the outer sides of the legs at their extreme ends.

The blades are seated edgewise on the tubular winding support ahead of the front of the winding 5 with their shoulders 40 resting on the flanges 26 of the support, and with the tangs 41 embracing the opposite sides of the tubular support to preclude lateral shifting of the blades. The legs 39 of the blades are confined between the heads 24 on the T-shaped guide parts and the adjacent end of the winding, and the blades thus press against the winding to hold it seated against the closed end of the frame under a degree of spring force.

Each blade 37 also has a flange 43 at its outer edge directed rearwardly therefrom at an angle to the body of the blade and these flanges reach around to the sides of the winding 5 at its front end and engage the rear members 33 of the shading coils under spring force to hold said members in their slots. Hence the blades maintain the shading coils assembled with the frame besides holding the winding against the closed end of the frame.

Confinement of the blades 37 in their position described also flexes the central prongs 38 on the blades forwardly into the air gap 15 between the inward extensions 14 and the adjacent sides of the plunger, so that the prongs lie in the path of inward travel of the shoulders 20 on the plunger. Hence, it will be apparent that the prongs 38 are engaged by the shoulders 20 during final inward or seating motion of the plunger to cushion the same and thereby relieve the frame of shock incidental to the engagement of the enlarged head 17 with the open end of the frame. Inasmuch as seating of the plunger causes rearward flexure of the prongs 38, it will also be seen that the prongs exert a force on the plunger tending to unseat the same and sufficient to overcome the effects on the plunger of residual magnetism at the time the winding is deenergized.

While two separate spring blades 37 are employed in the preferred embodiment of the invention, it will be readily appreciated that these blades may be combined into the single blade 37' shown in Figure 5, wherein the tangs 41 are joined with each other at each side of the plunger guide, as shown at 41'.

From the foregoing description taken in connection with the accompanying drawing, it will be readily apparent to those skilled in the art that this invention provides simple yet highly effective means in the nature of spring blades for retaining the shading coils of an alternating current solenoid in place on the frame of the solenoid; and which blades have the additional functions of cushioning the plunger of the solenoid during seating thereof, and of firmly holding the winding in position on the frame.

What we claim as our invention is:

1. In a solenoid of the character described: a winding having a hollow center; a substantially rectangular magnetically permeable frame embracing said winding and having an opening in one end thereof aligned with the hollow center of the winding; a spring blade confined between said end of the frame and the adjacent end of the winding so as to firmly press the winding against the opposite end of the frame; an elongated magnetically permeable plunger reciprocable axially in the hollow center of the winding and projecting out through said opening in the frame, said plunger being adapted to travel inwardly into the winding toward said

opposite end of the frame in response to energization of the winding; an enlarged head on the outer end of said stem adapted to abut the end of the frame adjacent to said opening therein upon such response of the plunger; and means for cushioning the plunger during seating thereof, said means comprising a shoulder on the plunger, and a part on said spring blade lying in the path of travel of the shoulder and engaged thereby just prior to final seating of the plunger, said part on the spring blade being adapted to exert a yielding force on said shoulder in the seated position of the plunger tending to effect unseating of the plunger.

2. In a solenoid of the character described: a substantially rectangular magnetically permeable frame comprising a bank of substantially U-shaped laminae secured together flatwise and with the space between the outer ends of the legs of the U-shaped laminae providing an opening at one end of the frame; a magnetically permeable elongated plunger projecting axially through said opening in the frame toward the closed end thereof; means carried by the frame at opposite sides thereof defining a substantially tubular plunger guideway in which the plunger is received and by which the plunger is guided for axial reciprocatory motion relative to the frame in a path parallel to the legs of the U-shaped frame and substantially midway therebetween; a winding mounted on said guideway and encircling the same so as to be confined between the legs of the frame, energization of said winding being adapted to effect endwise travel of the plunger into the frame toward the closed end thereof; cooperating stops on the plunger and the frame for limiting such response of the plunger to energization of the winding and consequently for defining the seated position of the plunger; a spring blade interposed between portions of the guide means, the winding and the legs of the frame adjacent to the opening in the frame for yieldingly holding the winding against the closed end of the frame; and means for cushioning the plunger during seating thereof comprising cooperating parts on the plunger and said spring blade brought into engagement just prior to final seating of the plunger, said part on the spring blade being adapted to exert a yielding force on the plunger in the seated position of the plunger tending to effect unseating thereof.

3. In a solenoid of the character described: a substantially U-shaped magnetically permeable frame; substantially T-shaped members fixed to the frame at opposite sides thereof with their heads extending across the space between the outer ends of the legs of the U-shaped frame, and with their stems cooperating to provide a substantially tubular winding support intermediate the legs of the frame and substantially parallel thereto; a winding carried by said tubular support and encircling the same; an elongated magnetically permeable plunger having its inner end portion received inside said tubular winding support and guided thereby for endwise reciprocatory motion, said plunger having its outer end portion projecting out through the open end of the U-shaped frame; a pair of shading coils each comprising a loop of conductive material encircling an outer end portion of one of the legs of the frame with opposite rim portions of each loop loosely received in transverse slots in its leg, the slot receiving one rim portion of each loop opening to the inner side of its leg; and resilient retaining means for said shading coils confined under spring tension between the stems of said T-shaped members and the rim portions of the shading coils received in said slots opening to the inner sides of the legs for maintaining the shading coils assembled with the frame.

4. The solenoid set forth in claim 3, wherein said resilient retaining means has portions bearing upon the underside of the heads on said T-shaped members and reacting against the adjacent end of the winding to press the winding rearwardly against the closed end of the U-shaped frame.

5. The solenoid set forth in claim 3 wherein said resilient retaining means comprises separate spring blades seated substantially edgewise on said winding support between the winding and the heads of the T-shaped members, and confined under spring tension between the rim portions of the shading coils received in said slots opening to the inner sides of the legs and the adjacent exterior surface of the winding support so as to maintain the coils assembled with the frame.

6. The structure set forth in claim 3 wherein said resilient retaining means comprises a single spring blade having a body portion encircling the tubular winding support and confined between the undersides of the heads on the winding support and the adjacent end of the winding, with opposite flanges on the outer marginal edges of said blade bearing under spring force against the rim portions of the shading coils received in said slots opening to the inner sides of the legs of the frame so as to maintain the coils assembled with the frame.

7. In a solenoid of the character described: a substantially U-shaped magnetically permeable frame; substantially T-shaped members fixed to the frame at opposite sides thereof with their heads extending across the space between the outer ends of the legs of the U-shaped frame and with their stems projecting rearwardly to the closed end of the frame and cooperating with one another to provide a substantially tubular winding support intermediate said legs and substantially parallel thereto; a winding carried by said support and encircling the same, said winding having its rear end adjacent to the closed end of the frame and its front end adjacent to the open end of the frame and contiguous to the undersides of said heads on the T-shaped members; an elongated magnetically permeable plunger having its inner end portion received inside said tubular winding support and guided thereby for endwise reciprocatory motion, the outer end of said plunger projecting forwardly through the open end of the frame between the heads of said T-shaped members; a pair of shading coils each comprising a loop of conductive material encircling an outer end portion of one of the legs of the frame with one rim portion of each loop loosely received in a transverse slot opening to the outer end of its leg and with an opposite rim portion of the loop received in a transverse slot opening to the inner side of its leg rearwardly of the heads of said T-shaped members so that the loops are held assembled with the frame as long as said opposite rim portions of the loops are in position in their last named slots; and resilient retaining means carried by said winding support and bearing against said opposite rim portions of the loops under spring force to maintain the

same in said last named slots and thereby hold the shading coils properly assembled with the frame.

8. The structure set forth in claim 7 wherein said resilient retaining means comprises a pair of identical spring blades seated substantially edgewise on the tubular winding support between the undersides of the heads thereof and the adjacent end of the winding; and tangs on each of said spring blades engaging opposite sides of the T-shaped members to preclude edgewise movement of the blades transversely of the frame.

9. The structure set forth in claim 7 further characterized by the provision of a shoulder on the plunger engageable with a yieldable portion of said resilient retaining means during inward travel of the plunger to a seated position.

10. In a solenoid of the character described: a winding having a hollow center; a substantially rectangular magnetically permeable frame embracing said winding and having opposite side faces and an opening in its front end aligned with the hollow center of the winding; an elongated magnetically permeable plunger reciprocable axially in the hollow center of the winding and projecting forwardly through said opening in the frame; a rearwardly facing shoulder on said plunger adapted to enter said frame opening during travel of the plunger to a seating position in response to energization of the winding; a spring

blade confined inside the frame between the front of the winding and inner surfaces on the frame opposite the front of the winding; a part on said blade lying in the path of said shoulder on the plunger to be engaged thereby just prior to final seating of the plunger to cushion the seating thereof, said part being adapted to exert a yielding force on the plunger when seated tending to effect unseating thereof; and interengaging means on the blade and the frame adjacent to the opposite side surfaces thereof for precluding displacement of the blade from said plunger cushioning position inside the frame.

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