May 26, 1942. W. F. OLIVER 2,284,011

SOLENOID

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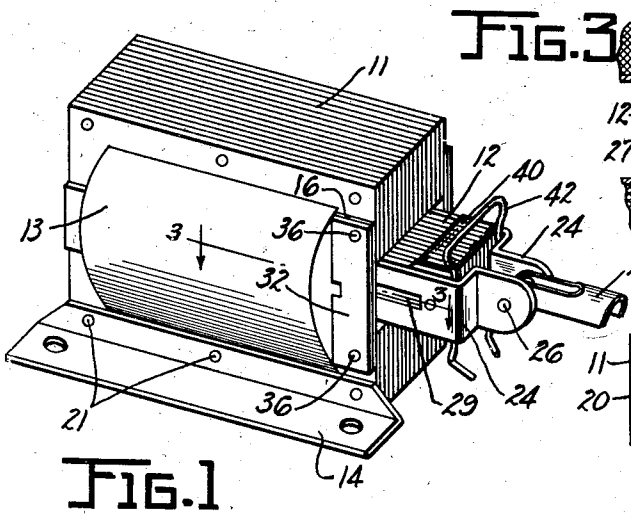


FIG. 1

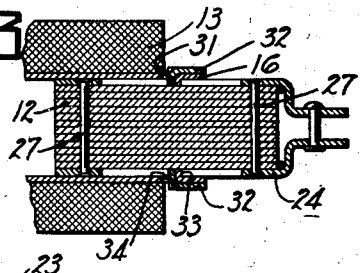


FIG. 3

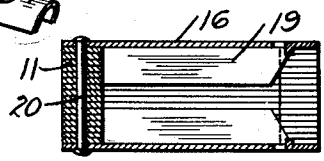


FIG. 4

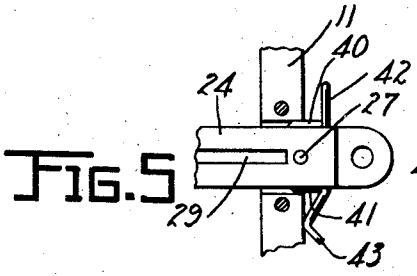


FIG. 5

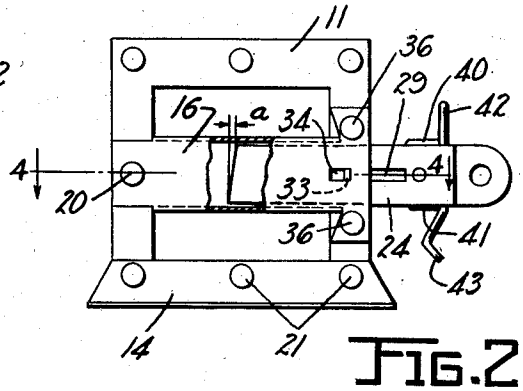


FIG. 2

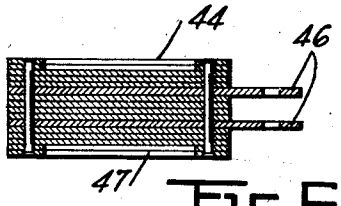


FIG. 6

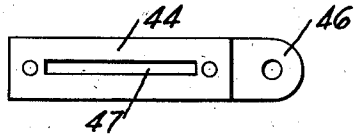


FIG. 7

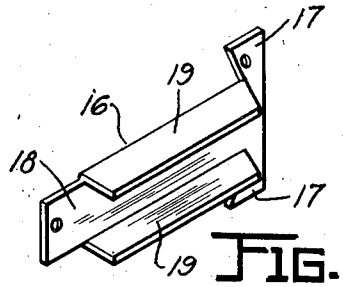


FIG. 8

INVENTOR.
WALLACE F. OLIVER
BY Booth & MacDuff
ATTORNEYS.

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SOLENOID

Wallace F. Oliver, South Bend, Ind., assignor to Bendix Home Appliances, Inc., South Bend, Ind., a corporation of Delaware

Application September 18, 1939, Serial No. 295,401

5 Claims. (Cl. 175—341)

This invention relates to solenoids and has been illustrated as embodied in a solenoid which is especially suitable for alternating currents.

The electrical theories and characteristics of solenoids are of course well known. Solenoids manufactured before my invention have, however, been relatively expensive, inflexible as to their uses, and sometimes unreliable from the standpoint of mechanical reliability and smoothness of operation.

One object of the present invention is to provide a construction for a solenoid which can be produced quite inexpensively and which is nevertheless thoroughly satisfactory in its operation, especially from the standpoint of mechanical reliability and smoothness.

Another object of the invention is to provide a solenoid in which the tendency to heat is materially reduced.

Still another object of the invention is to provide a solenoid which will release readily when de-energized.

Additional objects and advantages of the invention will be apparent from the following description and from the accompanying drawing, in which:

Figure 1 is a perspective view of the solenoid of this invention arranged to serve as a pull type solenoid;

Figure 2 is a side view of the yoke structure with the coil and certain other parts omitted for the sake of clarity;

Figure 3 is a fragmentary sectional view taken on the line 3—3 of Fig. 1;

Figure 4 is a sectional view taken on the line 4—4 of Fig. 2 with the plunger omitted;

Figure 5 is an enlarged partial side view with the plunger in its innermost position and with parts omitted for the sake of clarity;

Figure 6 is a plan view of a modified plunger construction;

Figure 7 is a side view of the plunger of Figure 6; and

Figure 8 is a perspective view of the combined guide and brace plate.

Although this invention may take numerous forms, only one general form, with two adaptations, has been shown. With both adaptations the solenoid includes a stack 11 of C-shaped laminations, a stack 12 of straight laminations forming the plunger, a coil 13, and a pair of securing angle strips 14. The term "C-shaped" is not intended to mean some one exact form but rather any suitable form having the necessary opening on one side.

There is also included in both forms of the solenoid a combined brace and guide plate 16. As seen best in Fig. 8, this guide plate includes lateral extensions 17 which form the head of a T, the body portion 18 being the leg of the T. The leg of the T is provided with flanges 19. This brace and guide plate 16 is secured to the C-shaped stack of laminations as seen best in Fig. 2 with the head 17 secured across the gap of the C and the leg 18 secured by a rivet 20 to the back of the C. The flanges 19 extend in contact with the ends of the C and thereby space the plunger from the C-shaped laminations to insure its smooth operation. Furthermore, the remaining lengths of the flanges 19 guide the plunger throughout its stroke, in effect forming a smooth walled housing therefor. It should be mentioned of course that the brace and guide plates 16 are formed of a non-magnetic material such as brass or aluminum so that they will not interfere with the magnetic functions of the solenoid. In effect, the legs 18 with the flanges 19 form a housing which supports the coil 13 on the outside thereof and guides the plunger on the inside thereof.

The securing strips 14 may advantageously be secured to the stack 11 by rivets 21 which serve also to hold the several laminations of the stack together. While two securing strips 14 in the form of angle bars have been shown mounted on the bottom of the solenoid it will be understood that different forms of securing strips could be employed fastened to the solenoid in different positions to suit different mounting environments.

The plunger illustrated in Figures 1 to 5 is formed by the laminations 12 secured between side plates 24 by rivets 27 or the like. At the outer end the side plates 24 are offset and spaced apart to receive between them a U-shaped coupling link 23 which may be pivotally connected to the side plates by a pin or rivet 26. The solenoid has been shown as a pull type solenoid which, when energized, draws the plunger into the coil to exert a pull on the end of the link attached to the pin 26. The plunger will be pulled out again by some form of return spring associated with the link or with the controlled mechanism.

It is desirable to have some means for limiting the movement of the plunger so that it cannot be drawn beyond the position at which adequate force is applied thereto by the solenoid. In the adaptation of the invention shown in Figs. 1 to 5 the side plates 24 are provided with slots

29 which co-act with lugs 31 formed on plates 32 which are secured outside of the plates 16. The plates 16 are preferably also formed with pressed out lugs 33 extending into the slots 29 and leaving openings 34 through which the lugs 31 project. It will be understood of course that the plate 32, the head 17 of plate 16, and the ends of the C-shaped stack of laminations will all be secured together by rivets 36. The plates 32 with their lugs 31 could be omitted if desired but when used the lugs 31 serve to reinforce the lugs 33 as will be apparent. In use the lugs 31 and 33 cooperate with the ends of slot 29 to prevent withdrawal of the plunger from the solenoid.

According to another feature of the invention means are provided to reduce the air gap between the open ends of the C frame and the plunger when the plunger is drawn into the solenoid to reduce heating. As shown, this means is formed by projecting portions 40 on the upper edges of the laminations 12 and similar projecting portions 41 on the lower edges of the laminations. As best seen in Figures 2 and 5 the portions 40 are of greater height than the portions 41 so that when the plunger is in its innermost position (Figure 5) the air gap between projections 40 and the adjacent pole face of the C frame will be less than the air gap between projections 41 and the other pole face. This insures that the plunger will always tend to swing in the direction of the projections 40 to close the smaller air gap regardless of slight inaccuracies in construction.

In order to loosen the plunger when the coil is de-energized to overcome the effect of any slight residual magnetism, a spring is provided acting between the plunger and the C frame during the last part of the inward movement and the initial outward movement of the plunger. As shown the spring is formed by a wire loop 42 having its sides pressed and held between the ends of the laminations 12 and the side plates 24. On the side of the projections 40 the loop 42 is substantially parallel to the ends of the laminations 12 but on the side of the projections 41 the loop is bent inwardly as shown at 43 to engage the end of the C frame. Thus the spring action occurs only on one side tending to press the projections 40 into engagement with the adjacent pole face and also at the point where it is most effective to release the plunger. It will be understood that various other types of springs might be employed but it is preferred to have the spring action at only one side of the plunger.

In view of the fact that the plunger tilts slightly to one side during its final closing movement it would normally not seat properly at its rear end against the frame and so would introduce resistance into the magnetic circuit. To correct this difficulty the rear end of the plunger is cut off at a slight angle as shown in exaggerated scale in Figure 2 so that when the plunger tilts during its final closing movement its rear end will seat flat against the magnetic frame.

Figures 6 and 7 illustrate a slightly modified plunger construction which is formed by a series of relatively thin laminations 44 and two relatively thicker laminations 46 spaced apart in the central portion of the stack. The laminations 46 extend beyond the ends of laminations 44 and are perforated to receive a rivet or pin for connection to an operating member such as the link 23 of Figure 1. The outer laminations 44 are formed with elongated slots 47 to receive stop pins or lugs such as 31 and 33, the slots being shown as extending through the two outer laminations on each side to give greater depth.

Although I have described my invention in the preferred embodiment, it is understood that the invention is not limited thereto, but changes and modifications may be made therein, all within the scope of the appended claims.

What is claimed is:

1. A solenoid comprising a magnetic frame having an opening therein defined by spaced pole faces, a magnetic plunger slidable through said opening and clearing the pole faces to provide an air gap, and enlarged portions on said plunger registering with said pole faces when the plunger is in its innermost position to reduce the air gap, one of said enlarged portions being closer to its adjacent pole face than the other whereby the plunger will always be biased toward the same pole face, and resilient means acting between the frame and the plunger on one side only of the plunger during the last part of the inward movement thereof.

2. A solenoid comprising a magnetic frame having an opening therein defined by spaced pole faces, a magnetic plunger slidable through said opening and clearing the pole faces to provide an air gap, and enlarged portions on said plunger registering with said pole faces when the plunger is in its innermost position to reduce the air gap, one of said enlarged portions being closer to its adjacent pole face than the other whereby the plunger will always be biased toward the same pole face, and a spring carried by the plunger and engaging the frame on one side only of the plunger during the last part of the inward plunger movement.

3. A solenoid comprising a magnetic frame having an opening therein defined by spaced pole faces, a magnetic plunger slidable through said opening and clearing the pole faces to provide an air gap, enlarged portions on the opposite sides of the plunger to register with the pole faces only after the plunger nears its innermost position, one of said portions being larger than the other, and a spring carried by the plunger and extending laterally therefrom to engage the frame only on the side of the plunger adjacent the smaller enlarged portion during the final part of the plunger inward movement.

4. In a solenoid, a plunger comprising an elongated magnetic member, side plates secured to the opposite sides of said member, said side plates extending beyond one end of the member and being offset inwardly at said end, and a spring secured between the end of the member and the offset portions of the side plates and extending laterally beyond the member.

5. A solenoid comprising a magnetic frame having an opening in one side, a plunger slidable through the opening and having its inner end seating against the frame, and combined spring and magnetic means to tilt the plunger to one side of the opening during its final inward movement, the inner end of the plunger being cut at an angle to seat flat against the frame when the plunger is tilted.

WALLACE F. OLIVER.