Aug. 9, 1955 E. A. BOGUE ET AL 2,715,199

SOLENOID

Filed Jan. 23, 1952

Fig. 1

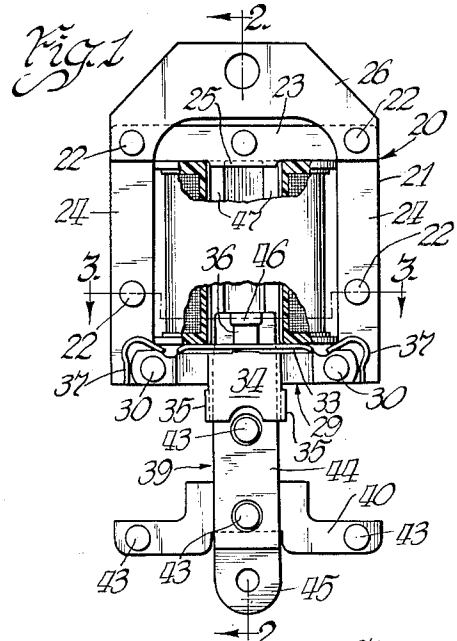


Fig. 2

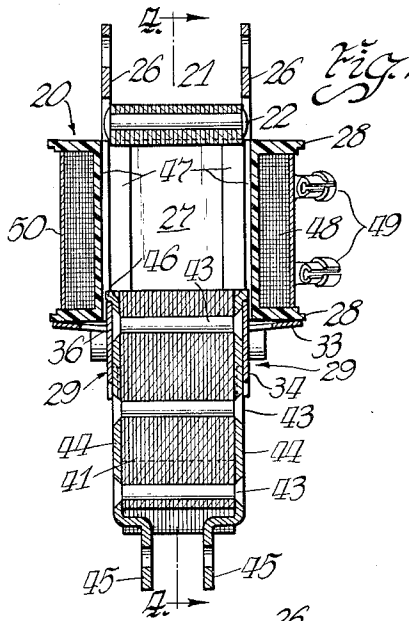


Fig. 3

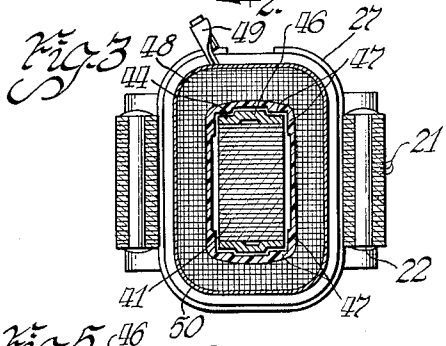


Fig. 4

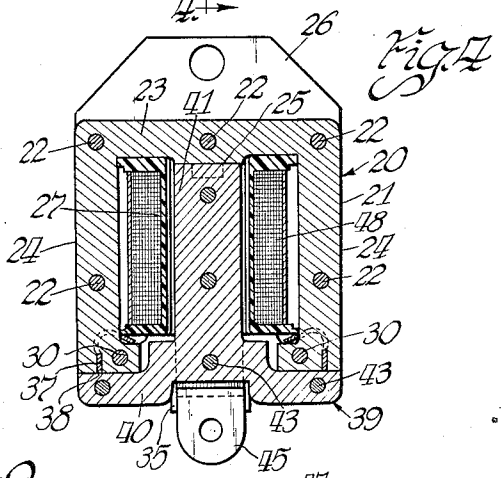


Fig. 5

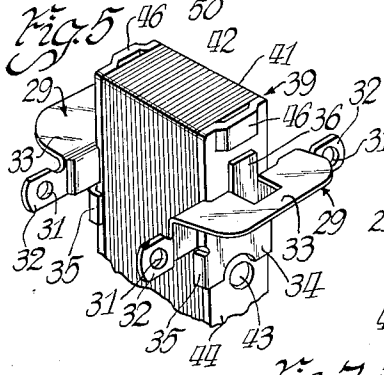


Fig. 9

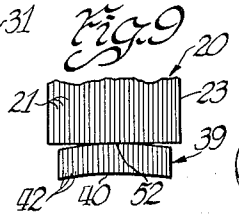


Fig. 6

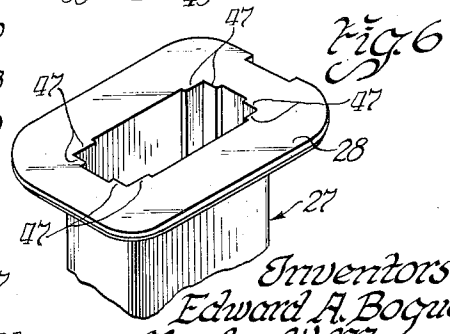


Fig. 7

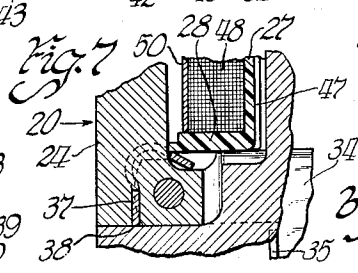
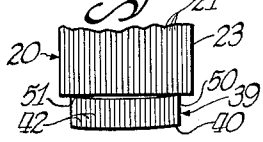


Fig. 8



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SOLENOID

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9 Claims. (Cl. 317—191)

This invention relates to solenoids. More specifically, it relates to the structural features and elements of solenoids having armatures that are movable into and from their associated magnetic frames.

An object of the present invention is to provide a new and improved guide for the movements of a retractable solenoid armature, which guide is non-conductive and non-magnetic, so as to promote good electrical and magnetic efficiency. This guide, in the disclosed structure, is included as a part of an insulating bobbin upon which the solenoid coil is wound. With the use of such a guide, magnetic efficiency is high and the eddy-current losses are appreciably reduced.

It is also within the purview of our invention to construct and shape the coacting faces of a solenoid armature and the magnetic frame in such a way that in the fully attracted position of the armature, those faces make stable contact, thereby to minimize or eliminate chatter and humming noises when the solenoid is used on alternating current.

As another object, our invention comprehends the provision of an effective and readily assembled retainer for holding within a solenoid frame the spool or bobbin upon which the solenoid coil is wound.

Our invention further includes the provision of shading coils which are constructed and arranged effectively to serve their purpose as such, as well as to provide additional retaining elements for holding the coil assembly in place relative to the magnetic frame upon which the coil is mounted.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings in which similar characters of reference indicate similar parts throughout the several views.

Referring to the drawings:

Fig. 1 is a side elevational view, with parts broken away so as to show details of structure, of the solenoid of our present invention, the armature being in retracted position;

Fig. 2 is a vertical section taken substantially on line 2—2 of Fig. 1 and in the direction of the arrows;

Fig. 3 is an end section taken substantially on the line 3—3 of Fig. 1 and in the direction of the arrows;

Fig. 4 is a longitudinal section taken substantially at the position of line 4—4 of Fig. 2, but depicting the solenoid armature in its closed position;

Fig. 5 is a perspective fragmentary view showing the structure and positions of certain retainer elements on the stationary part of the structure and the leg of the armature;

Fig. 6 is a fragmentary perspective view of one end of the bobbin or spool upon which the solenoid coil is wound;

Fig. 7 is a fragmentary sectional view showing a portion of the structure of Fig. 4; and

Figs. 8 and 9 are fragmentary side views of the solenoid of the present invention, showing how the ends of the armature head are shaped in our preferred structure

to have good seating engagement with the magnetic frame.

In the adaptation of the invention pictured in the drawing for exemplary purposes, the solenoid has a magnetic frame 20 comprising a stack of laminations 21, secured together by rivets 22. The laminations are made of highly permeable and readily demagnetizable metal, such as soft iron. Each lamination comprises a base portion 23 and substantially parallel side portions 24 extending therefrom so that the stationary frame of the solenoid is U-shaped. Each lamination has a projection or raised portion 25 on the inner face of the base 23 between the side portions 24. Supporting brackets 26 are secured to the laminations by the rivets 22 at the ends of the base portions 24.

A spool or bobbin 27 is mounted in the magnetic frame 20 so that the projections 25 on the laminations 21 of said frame fit within one end of the spool to center it and prevent lateral displacement from the frame. The legs 24 of the laminations extend along the outer sides of the spool 27 which spool has end flanges 28, one of which rests against the inner faces of the bases 23 of the laminations 21, and the other of which is engaged by two retainers 29. Edges of the flanges 28 engage the inner faces of the side portions 24 of the frame laminations.

The retainers 29, which are made of some non-magnetic metal such as brass, are secured by rivets 30 to the outer faces of the ends of the lamination side portions 24 opposite the base portions 23, the rivets passing through openings 31 in projecting lug portions 32 of the retainers. Each retainer has a main flange 33 which is bent to form an angle of somewhat more than 90° with a main body portion 34 of the retainer. Each flange 33 extends along and engages one flange 28 of the spool 27 at a slight angle thereto, so as resiliently to hold the spool in the magnetic frame 20. The main body portion 34 of each retainer has side flanges 35 and a tongue 36 formed integrally therewith, and the purposes of which will be presently described. The spool 27 is also held in the frame 20 by shading coils 37 which are bent to the form of Figs. 4 and 7 from flat rectangular loop blanks. There are two shading coils, one at the end of each side portion of the magnetic frame. One side portion of each shading coil 37 fits with comparative snugness in a groove 38 formed in the end of a side portion of the frame, and the opposite side portion engages a flange 28 on the spool 27.

The solenoid of our invention has an armature 39 mounted for linear movement relative to the magnetic frame 20 and spool 27, and which comprises a head 40 and a leg 41. The armature is made up of a plurality of laminations 42 which are fabricated from a highly permeable metal, such as soft iron, and are secured to one another by rivets 43. Outer strips 44 extend along the armature leg 41 and are secured thereto by the rivets 43 going through the leg. The strips have at one end beyond the armature head 40, attaching portions 45 which are displaced from the planes of the main parts of the strips so as to be relatively closely spaced. At the other end the strips 44 have protuberances 46 which are engageable with the tongues 36 on the retainers 29, as indicated in Fig. 5, to serve as positive stops limiting the movement of the armature outwardly from the magnetic frame. The side edges of the strips 44 and/or the legs of the adjacent laminations 42 are embraced by the side flanges of the retainers 29, whereby the armature 39 is guided during movements.

As depicted in Fig. 3, the armature leg 41 has four corners formed by the outer strips 44 which corners are engageable with the interior of the spool 27, where the armature leg is guided. The spool 27, in the disclosed

structure, is integrally molded of a wear resistant insulating material, such as nylon, and has, in section, the general shape of a hollow rectangle, the interior corners of which are raised and thickened, as shown at **47** in Figs. 3 and 6, to provide bearing surfaces which can stand the wear to which they are subjected as the armature leg **41** moves in and out of the frame **20**.

A coil **48** is wound on the spool **27** and has terminals **49** through which alternating current or direct current may be applied. The shading coils **37** adapt the solenoid to operation with alternating current. The coil has an insulating covering **50**.

The laminations **42** of the armature are coined after assembly, or otherwise contoured so that one end of the armature head **40** presents a concave face toward the end of one frame side portion **23**, which concave face has two regions **51** which contact the frame, as shown in Fig. 8, and the other end of the armature head **40** presents a convex face toward the end of the other frame side portion **23**, which convex face has one region **52** adapted to contact the frame, as shown in Fig. 9. By providing for these three points of contact, both ends of the armature head **40** contact the magnetic frame **20** in a stable manner in the completely inserted position of the armature **39**, and there is no rocking of the armature head on the frame. Such stable contact between the frame and armature tend to eliminate vibration and hum when the solenoid is operated on alternating current.

In operation of the solenoid of the present invention, the armature **39** will assume the position of Figs. 1 and 2 with respect to the frame **20**, the spool **27**, and the coil **48**, when the coil is deenergized. Any part which is to be actuated thereby may be connected to it by the attaching portions **45** of the outer strips **44**. Engagement of the protuberances **46** on the strips **44** attached to the armature leg **41** with the tongues **36** on the retainers **27** prevents retraction of the armature beyond the position of Figs. 1 and 2. The application of current to the coil **48** causes the armature **39** to move to the position of Fig. 4, in which the end of the armature leg **41** contacts the projections **25** formed on the base portions **24** of the frame laminations and the three regions **51** and **52** on the armature head **40** engage the ends of the side portions **23** of the frame laminations, as shown in Figs. 8 and 9. By virtue of the three contact regions, both ends of the armature head **40** contact the magnetic frame **20** in the inserted position of the armature, and rests stably thereagainst without rocking, and humming and other noises are eliminated or kept to a minimum. Since the spool **27** is non-metallic and directly guides the armature leg **41** without special metallic devices throughout the length of the spool, the eddy-current losses are relatively low and are limited. Furthermore, the magnetic efficiency is promoted by the proximity of the winding to the movable armature and the freedom from diverting flux paths.

While we have illustrated a preferred embodiment of our invention, many modifications may be made without departing from the spirit of the invention, and we do not wish to be limited to the precise details of construction set forth, but desire to avail ourselves of all changes within the scope of the appended claims.

We claim:

1. A solenoid comprising a magnetic frame having a base portion and side portions extending from the base portion in spaced relation to one another and in the same direction, a coil having a central opening and located in the frame so that the central opening extends along and between the side portions of the frame, an armature having a leg movable into and from the coil opening and a head movable into and from positions of engagement with the ends of the side portions of the frame, a spool of insulating material having a hollow tubular portion extending through the coil opening so as to support the coil, said hollow tubular portion of the spool having integral internal surface portions providing guide bearings in which the leg is linearly slidable, and a non-magnetic retainer secured to the extending ends of the side portions of the frame and extending across the adjacent end of the spool to prevent dislodgement of the spool and coil from the frame, said retainer having a stop thereon in position for engagement with a protuberance on the armature leg for preventing complete retraction of the armature leg from the spool, and the retainer being spaced from the base portion of the frame so as to leave the spool and the armature leg directly adjacent one another throughout the greater portion of the length of the armature leg.

2. The solenoid specified in claim 1, and further comprising a shading coil encompassing a part of the end of one side portion of the frame and disposed generally at a diagonal to the one side portion of the frame at a position for engagement with the adjacent end of the spool to aid in retaining the spool and said coil in the frame.

3. The solenoid specified in claim 1, and wherein the said retainer is at one face of the frame and has thereon an integrally formed guide channel extending outwardly beyond the ends of the side portions of the frame, and the solenoid further having another retainer secured to the end of the side portions of the frame in opposed relationship to the first mentioned retainer at the opposite face of the frame and having a corresponding integrally formed guide channel in opposed relationship to the first mentioned guide channel.

4. The solenoid specified in claim 1, and further comprising two shading coils associated with the ends of the side portions of the frame and each engaging the adjacent end of the spool at a position between the retainers to aid in holding the spool and said coil in the frame.

5. The solenoid specified in claim 1, and wherein the retainer has a flange engaging the adjacent end of the spool, and an integral tongue thereon which extends a short distance into the spool at a position to engage with said protuberance on the armature leg at the end thereof away from the head to serve as said stop for preventing complete withdrawal of the armature from the frame.

6. The solenoid specified in claim 1, and wherein the retainer has a flange extending along and projecting outwardly from the side portions of the frame at an angle to the adjacent end of the spool such that the outer portions of the flange have resilient engagement with the end surfaces of the spool.

7. The solenoid specified in claim 1, and wherein the portion of the armature head engaging one side portion of the frame presents a convex surface and the portion of the armature head engaging the other side portion of the frame presents a concave surface whereby the armature head has three-point contact with the side portions of the frame.

8. A solenoid comprising a magnetic frame having a base portion with side portions extending therefrom in spaced relation and in the same direction, a coil having a central opening and located in the frame so that the central opening extends along and between the side portions of the frame, an armature having a leg movable into and from the coil opening and a head portion movable into and from engagement with the ends of the side portions of the frame, and a spool of insulating material having a hollow portion extending through the coil opening so as to provide a support for the coil, said hollow portion of the spool also surrounding the armature leg and having internally raised rib portions extending longitudinally of the inner surface thereof to provide guide bearing surfaces for the armature leg, the said hollow portion of the spool and the armature leg being directly associated with one another throughout the greater portion of the length of the coil, said armature leg being rectangular in section and having four corners, and the hol-

low portion of the spool having a rectangular opening, and said raised rib portions being at the four corners of the hollow portion of the spool to provide thickened bearing portions at the corners which have sliding engagement with the four corners of the armature leg.

9. A solenoid comprising a magnetic frame having a base portion with side portions extending therefrom in spaced relation and in the same direction, a coil having a central opening and located in the frame so that the central opening extends along and between the side portions of the frame, an armature having a leg movable into and from the coil opening and a head portion movable into and from engagement with the ends of the side portions of the frame, and a spool of insulating material having a hollow portion extending through the coil opening so as to provide a support for the coil, said hollow portion of the spool also surrounding the armature leg and having internally raised rib portions extending longitudinally of the inner surface thereof to provide guide bearing surfaces for the armature leg, the said hollow portion of the spool and the armature leg being directly associated with one another throughout the greater portion of the length of the coil, said sectional shape of the

armature leg being such that it has a plurality of corners, and the hollow portion of the spool being an opening with the same plurality of corners and said raised rib portions being at the corners of the internal surface of the hollow portion of the spool and having sliding engagement with the armature leg.

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