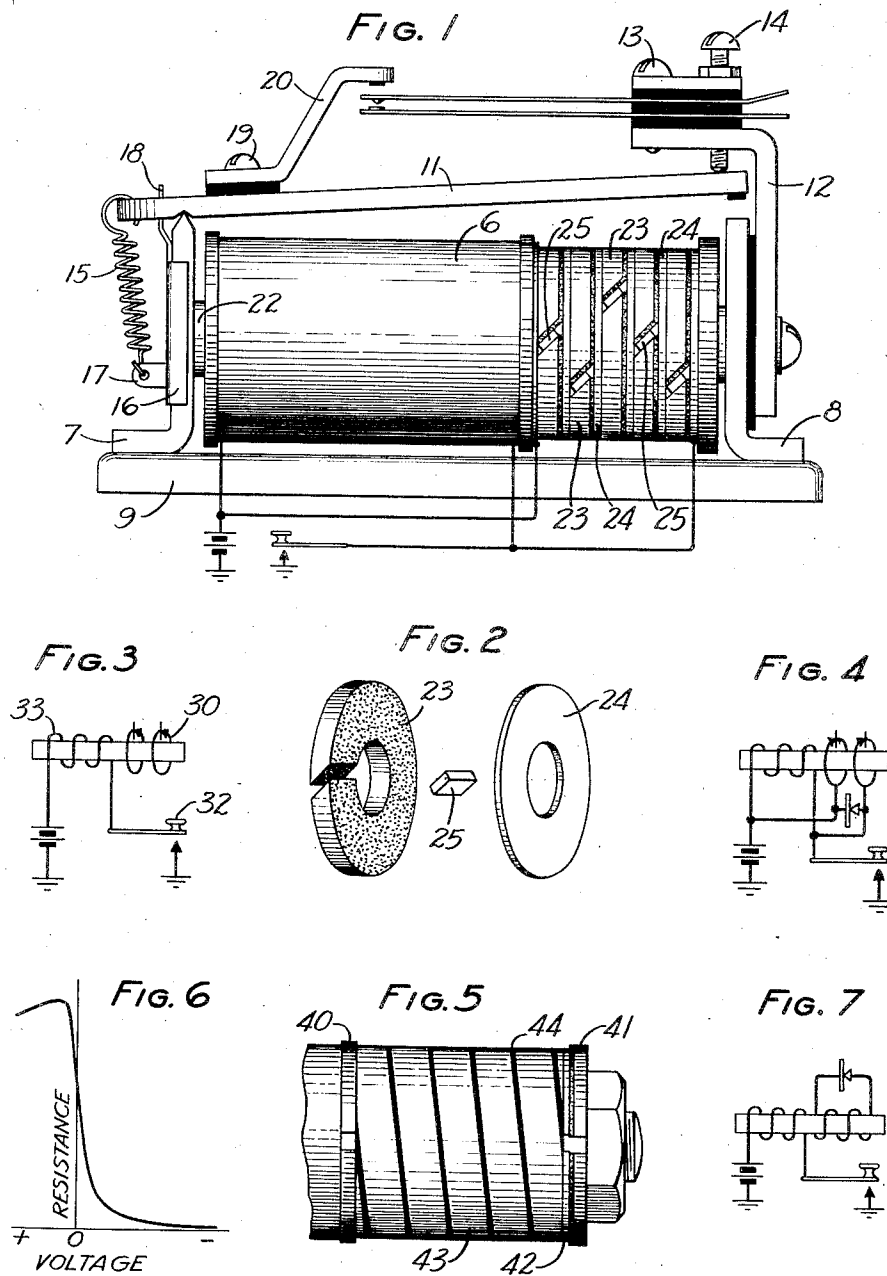


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ELECTROMAGNETIC DEVICE
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ELECTROMAGNETIC DEVICE

Application filed November 7, 1929. Serial No. 405,361.

This invention relates to electromagnetic devices and more particularly to electromagnetic relays of the slow acting type.

One of the most commonly employed methods for effecting slow acting characteristics in electromagnetic relays is the use of a short-circuited secondary, usually in the form of a copper slug or tube associated with the relay core. In such an arrangement, any change in the core flux sets up a current and magnetomotive force in the short-circuited copper element in such a direction as to oppose the change of current and magnetomotive force in the operating winding. That is, a magnetomotive force is established in the copper secondary which, upon the establishment of current in the operating winding, delays the build-up of the flux in the relay core and upon interruption of the operating current tends to sustain the flux and retard its decay. This time phase displacement between the change of current in the operating winding and the corresponding flux change in the core provides the time lag in the action of the relay.

Since this time lag occurs both upon the opening and closing of the operating circuit, it is evident that, unless some other precaution is taken, a relay provided with a copper tube or slug will be inherently slow operating as well as slow releasing.

In a copending application, Serial No. 385,865, filed August 14, 1929, by F. H. Hibbard, there is disclosed a slow acting relay in which the copper discs of a copper oxide rectifier mounted on the relay core, are utilized as a means for emphasizing the sluggish characteristics already imparted to the relay by the shunt valve action of the rectifier. The shunt valve action of the rectifier is described in Patent No. 1,742,367 issued Jan. 7, 1930, to L. L. Nettleton et al.

In electrical systems generally and telephone systems particularly, circuit requirements are often such that a relay is called upon to perform certain functions which require sluggish action of the relay while operating and quick action while releasing, or vice versa. As hereinbefore stated, the well known copper slug relay would not serve

satisfactorily in this capacity, being inherently slow operating as well as slow releasing.

It is the object of this invention to provide an improved slow acting relay of the copper slug type in which the delayed action of the relay armature is confined to either its operate or release function.

This object is attained in accordance with a feature of the invention by the provision of a unidirectional current conducting device mounted on the relay core and so constructed as to permit the passage of currents induced therein in one direction only.

The invention will be readily understood from the following detailed description made with reference to the accompanying drawing in which Fig. 1 is a side elevation of an electromagnetic relay showing an adaptation of applicant's invention thereto; Fig. 2 is an exploded perspective view of the several elements which constitute a rectifier unit employed in this invention; Fig. 3 is a circuit schematic representing the condition effected by the use of the rectifier unit of this invention when mounted on the relay core; Fig. 4 is a circuit schematic representing the condition effected by the rectifier unit when mounted on the relay core and electrically connected in shunt with the relay winding; Fig. 5 is an alternative arrangement for the rectifier units shown in Fig. 1; Fig. 6 is a graph plotted against rectifier resistance and induced voltage showing a characteristic curve of a copper oxide rectifier; Fig. 7 is a circuit schematic representing the condition effected by the rectifier shown in Fig. 5.

The relay which applicant has elected to disclose, comprises essentially an electromagnet 6 horizontally disposed intermediate the angular pole pieces 7 and 8 which are secured to the support or mounting base 9 in any suitable manner. The upper end of the pole piece 7 is provided with a knife edge adapted to register with a groove formed in the armature 11 so as to effect a pivotal mounting for the armature. The free end of armature 11, when actuated upon the energization of the electromagnet 6, comes in contact with the end of the pole piece 8. Mount-

ed adjacent to the pole piece 8 and insulated therefrom is an angular mounting member 12. The upper or horizontal portion of member 12 supports the springs which control an external circuit and which are insulatively mounted on the member 12 by means of screws 13 and 14, the latter also serving as a means for adjusting the air gap between the end of the pole piece 8 and the armature 11, and as a back stop for the armature. A helical spring 15 is attached to the fixed end of armature 11 and serves as a restoring spring therefor. The other end of spring 15 is secured to the projection 17 of a trough-like element 16 which embraces and is slidably adjustable on the pole piece 7, to permit the tension of spring 15 to be varied. The spring 15 serves both as a retractile spring and as a holding spring to firmly seat the armature 11 on its supporting knife edge. The fastening element 16 is provided at its upper end with a tongue portion 18 adapted to extend through an aperture in the armature 11, thus preventing any lateral shifting of the armature on its knife edge mounting. Insulatively mounted on the armature 11 by means of a screw 19 is a rigid contact actuating member 20 which moves with the armature to cause the closure of the external circuit contacts.

The core 22 of the electromagnet 6 serves not only as a mounting for the magnet coil but also for the elements of the dry rectifiers. Each rectifier, as shown in Fig. 2, consists of a split copper disc 23 having an oxidized surface on one side only, a lead washer 24 and a lead shim 23 which is adapted to fit into the opening in the copper disc effected by the split. As shown in Fig. 1, a plurality of these rectifiers may be mounted on the portion of the core 22 not occupied by the magnet coil.

To accomplish the object of this invention, a copper disc such as is shown by 23, Fig. 2 is mounted in any suitable manner on the relay core.

The copper disc 23 is in effect the equivalent of a short-circuited turn polarized with a rectifier in series, as schematically represented by the numeral 30 in Fig. 3. The short-circuited turn accordingly, is effective as a low resistance path in one direction only. It is evident therefore that a relay, on the core of which is mounted a copper disc such as is shown at 23, will be either slow operating-quick release or quick operating-slow release.

The theory of the split copper oxidized disc and its effect on the time characteristics of the relay may be described as follows: The oxidized copper disc 23 due to its rectifying characteristic permits the passage of current in one direction only, that is, from the lead surface to the oxidized surface. When current is applied to the winding of the electro-

magnet by the closure of a switch such as 32, Fig. 3, the current in the winding 33 builds up from zero value to its maximum value. During this change in current value and because of it, the varying flux set up acts upon the short-circuited turn with the result that an E. M. F. is induced in the turn in a direction such as to oppose the operating current in the magnet winding. If the copper disc is poled in such a manner as to permit the passage of current in the disc in this direction, that is, in a direction such as to oppose the operating current in the magnet winding, the relay is slow to operate. This is in accordance with the well known theory of the copper slug or short-circuited turn.

Upon the opening of key 32 the operating circuit for the relay is broken. The current in winding 33 accordingly decays, diminishing from its maximum value to zero value. In this instance, the same inductive action is repeated except for the fact that the induced E. M. F. in the copper disc is in a reverse direction. Owing to the direction in which the copper disc is poled no current will flow therein at this time. The effect of the copper disc in this case therefore is nil, and the relay releases quickly. By poling the copper disc in a reverse manner the relay becomes a quick operating-slow releasing relay. It is evident from the foregoing that by the use of this invention a unidirectional-slow acting characteristic may be imparted to an electromagnetic device, that is, the sluggish action of the armature may be confined to either its operate or release functions. Heretofore the sluggish characteristics in relays effected by the short-circuited turn or copper slug overlapped, that is, a slow-to-operate relay was inherently slow-to-release and vice versa.

In the event that an increased or emphasized sluggish release characteristic is desired, a plurality of rectifiers of the split copper disc type may be mounted on the magnet core as shown in Fig. 1 and the extreme terminals connected to the terminals of the coil so that the pile-up of rectifiers would be connected in shunt with the magnet winding. Fig. 4 is a schematic showing of this arrangement. It is believed unnecessary to enter into a detailed description of the action that occurs with an arrangement of this type. The split copper disc action is the same as hereinbefore described in connection with a single disc mounted on the core, and the shunt valve action effected by shunting the coil winding with the rectifier pile-up is the same as that disclosed and described in the above mentioned Bascom application. The combination of the two materially increases the sluggish characteristic of the relay in one direction, that is, the release of the relay is materially retarded without affecting its time of operation.

The arrangement shown in Fig. 5 consists of a split copper washer 40, a split oxidized copper washer 41, a lead shim 42 and a copper helix 43 having its adjacent convolutions insulated from each other by an insulating member 44.

Referring to the graph shown in Fig. 6 it will be observed that for relatively small values of voltages induced in the rectifier disc the resistance to the resultant current flow is large. It follows from this that when a single copper disc, which is the equivalent of a single turn, is employed, the induced voltage is small and the resistance relatively large. By utilizing a plurality of turns the induced voltage is increased accordingly and the resistance to the resulting current flow is very small. Hence, by employing an arrangement such as is schematically shown in Fig. 7, a greater current is induced in the rectifying element and the sluggish characteristic of the relay increased. The equivalent of a plurality of turns is effected by the copper helix 43, Fig. 5, and by virtue of the split copper oxide washer 41 the sluggish characteristic of the relay is confined to either its operate or release function.

What is claimed is:

1. In an electromagnetic device, a core, an operating winding mounted on said core, and a unidirectional current conducting copper disc also mounted on said core and inductively associated with said operating winding.

2. In an electromagnetic device, a core, an operating winding mounted on said core, and a split copper oxidized disc mounted on said core, said disc constituting a rectifier.

3. In an electromagnetic device, a core, an operating winding mounted on said core and a split copper disc also mounted on said core and having one of the surfaces effected by the split and one of its lateral surfaces oxidized to effect a unidirectional current conducting disc.

4. In an electromagnetic device having an operate and a release function, a core, an operating winding mounted on said core and a split copper disc mounted on said core for rendering said electromagnetic device sluggish in its operate function only.

5. In an electromagnetic device having an operate and a release function, a core, an operating winding mounted on said core and a split copper disc mounted on said core for rendering said electromagnetic device sluggish in its release function only.

6. In an electromagnetic device, a core, an operating winding mounted on said core, and a rectifier connected in shunt with said operating winding, said rectifier including a plurality of unidirectional current conducting discs.

7. In an electromagnetic device, a core, an operating winding mounted on said core, and a rectifier connected in shunt with said oper-

ating winding, said rectifier including a plurality of split copper oxidized discs.

In witness whereof, I hereunto subscribe my name this 31st day of October, 1929.

HUMPHREYS O. SIEGMUND.

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