Feb. 2, 1954 A. H. LAMB ET AL 2,668,208

SENSITIVE RELAY

Filed Sept. 15, 1951

2 Sheets-Sheet 1

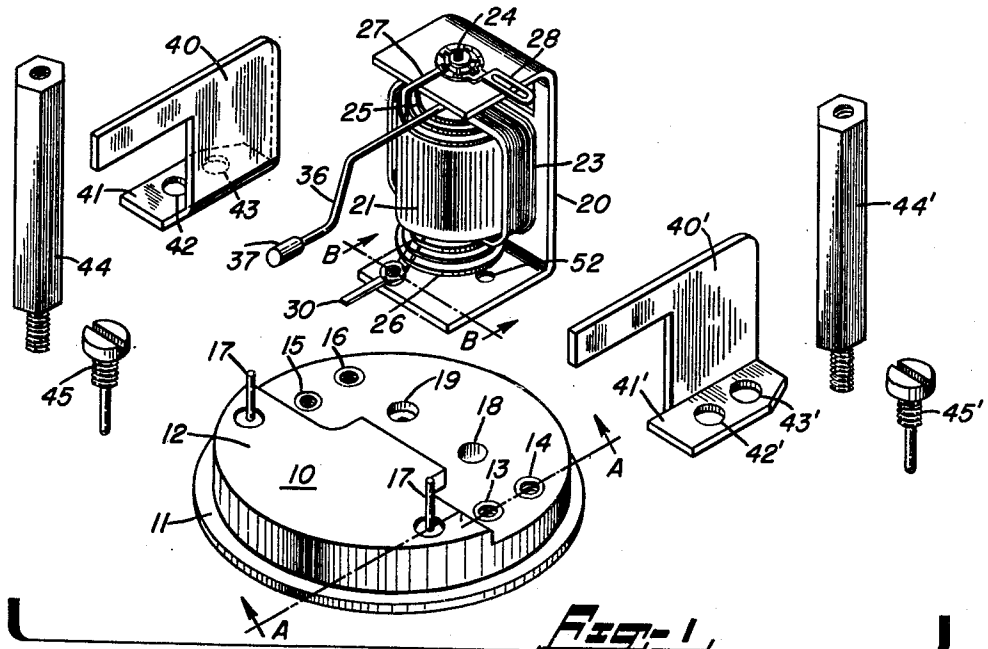

Fig-1

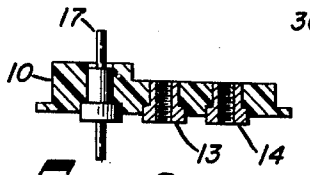

Fig-2

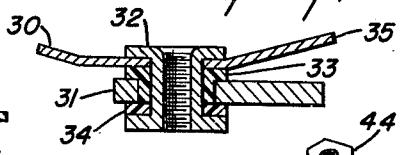

Fig-3

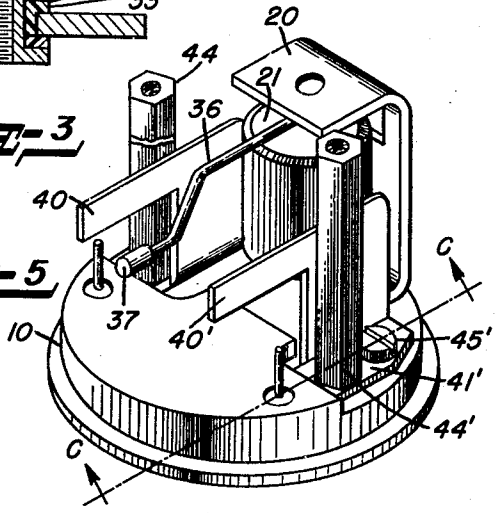

Fig-5

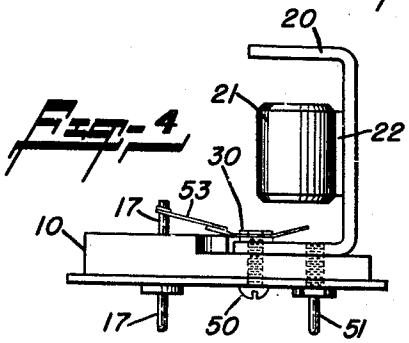

Fig-4

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SENSITIVE RELAY

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2 Sheets-Sheet 2

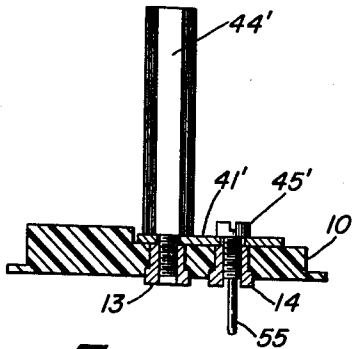

Fig-6

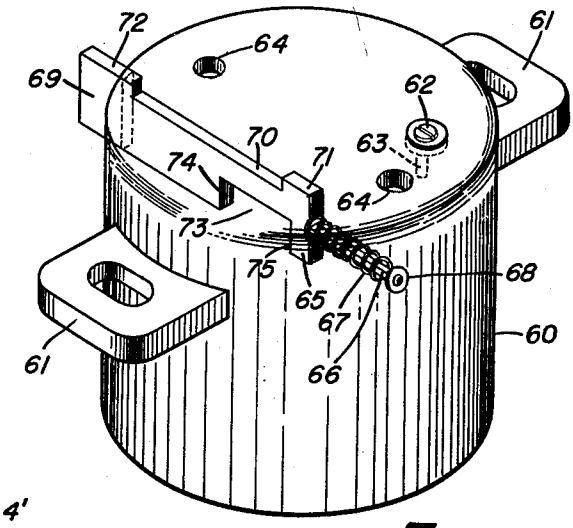

Fig-7

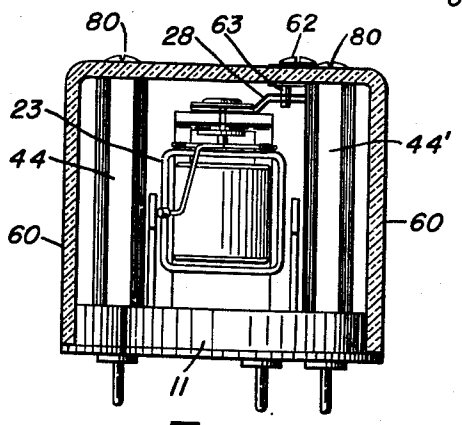

Fig-8

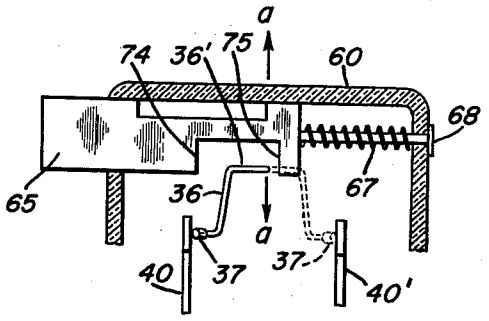

Fig-9

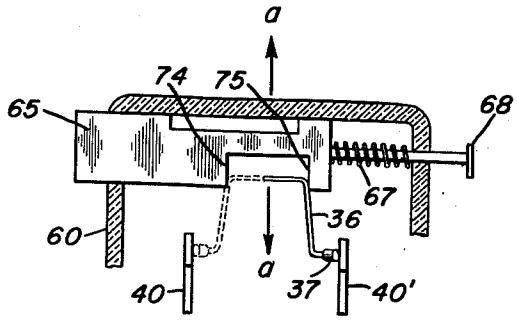

Fig-10

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UNITED STATES PATENT OFFICE

2,668,208

SENSITIVE RELAY

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Application September 15, 1951, Serial No. 246,726

10 Claims. (Cl. 200—110)

1

This invention relates to sensitive relays and more particularly to sensitive relays of the magnetic contact type.

Relays of the type contemplated by this invention include a movable contact arm carrying a contact in the form of a magnetic rider for cooperation with a stationary contact constituted by a small magnet. When the relay arm moves toward the stationary contact the rider comes into the field of magnetic influence of the magnet and is attracted thereto to provide a good, firm contact closure. In general, the magnetic contact so established requires some mechanical means for separating the rider from the magnet as the movable coil of the relay is incapable of generating sufficient torque for this purpose.

In prior relays of this type the stationary contact comprises a small permanent magnet suitably mounted to provide electrical isolation between the magnet and other parts of the relay. While such design has proven satisfactory for many applications, the manufacture of the permanent magnet and the assembly thereof in a relay is rather costly and does not lend itself to the production of inexpensive relays. The present invention is directed to a relay design employing the desirable features of a magnetic contact relay but which is of simple construction and which is adapted for the production of low cost relays. Specifically, the stationary contact comprises a soft-iron member disposed in the vicinity of the relay magnet such member being adjustably fastened to the relay base. By reason of its position in the magnetic field of the relay magnet such member becomes magnetic at its ends. By properly positioning the soft-iron member relative to the soft-iron rider carried by the relay movable arm, the member is made to serve as a stationary magnetic contact. At the same time, the soft-iron member serves to control the distribution of the magnetic flux emanating from the primary magnet of the relay thereby affording a ready means for altering the deflection characteristics of the relay coil.

A relay made in accordance with this invention includes numerous other features directed toward the provision of a small, low cost, high quality relay. The individual relay components are all supported from a common base made of insulating material, and are secured in position by novel means that also serve as terminals by which the relay can be connected into an external circuit. The relay case itself is of simple construction and consists of two parts, a base carrying the relay components, and a cover carrying a simple mechanical arrangement for separating the relay contacts.

2

An object of this invention is the provision of a permanent-magnet, movable-coil relay of the magnetic contact type wherein the relay contacts are actually made of a low reluctance magnetic material such as soft-iron.

An object of this invention is the provision of a permanent-magnet, movable-coil relay of the magnetic contact type wherein the stationary contacts comprise adjustable soft-iron members having portions lying in the magnetic flux field of the primary magnet of the relay.

An object of this invention is the provision of a sensitive relay comprising a permanent magnet core supported between the legs of a non-magnetic U-shaped bracket, a movable coil pivotally mounted between the legs of the said bracket and rotatable about the core, soft-iron members disposed on opposite sides of the core and spaced from the movable coil, a pointer or contact arm carried by the coil, and a magnetic material rider secured to the end of the pointer, said rider adapted to contact each of the said soft-iron members upon rotation of the movable coil.

An object of this invention is the provision of a sensitive relay comprising a base of insulating material, a non-magnetic U-shaped bracket secured in upright position to said base, a cylindrical permanent magnet core secured between the legs of the U-shaped bracket, a movable coil pivotally mounted between the legs of the U-shaped bracket and rotatable about the core, a pair of soft-iron members secured to the base and disposed on opposite sides of the said core, each of said members being spaced from the coil and including an elongated end, a contact arm carried by the coil, a magnetic material rider carried by the end of the contact arm, a cover member cooperating with the base to form a closed case, and a finger-operable mechanism carried by the cover and adapted upon operation to contact the said contact arm.

These and other objects and advantages will be apparent from the following description when taken with the accompanying drawings. The drawings are for purposes of illustration and are not to be construed as defining the scope or limits of the invention, reference being had for the latter purpose to the appended claims.

In the drawings wherein like reference characters denote like parts in the several views:

Figure 1 is an exploded view, in isometric,

showing the major components of a relay made in accordance with this invention;

Figure 2 is a cross sectional view taken along the line A—A of the base shown in Figure 1;

Figure 3 is a cross-sectional view taken along the line B—B of the mounting bracket shown in Figure 1;

Figure 4 is a side view showing the mounting bracket and permanent magnet core mounted upon the relay base;

Figure 5 is an isometric view showing the mounting bracket and the two soft-iron contact members mounted on the relay base;

Figure 6 is a cross-sectional view taken along the line C—C of Figure 5 and showing how one of the screws employed to secure the soft-iron contact members to the base also serves as a connection terminal;

Figure 7 is an isometric view of the relay cover that carries the finger-operable contact-resetting mechanism;

Figure 8 is a front view of the relay with the cover in place, the cover being shown in cross-section and the resetting mechanism being omitted for purposes of clarity; and

Figures 9 and 10 are fragmentary illustrations intended to facilitate an understanding of the operation of the resetting mechanism.

Referring now to Figure 1, the relay base 10, made of a suitable insulating material such as a plastic, is a unitary member provided with a shoulder 11 and raised portion 12. The base is provided with the threaded inserts 13, 14, 15 and 16, a pin-type terminal 17, a hole 18, and a recessed hole 19, the purpose of which will become clear as the description proceeds. The construction of the pin 17 and the threaded inserts is shown in Figure 2, it being apparent such members can be molded into the base 10 or force fitted into suitable holes provided for this purpose.

The relay mechanism comprises a U-shaped bracket 20 having a transversely-magnetized, permanent magnet core 21 secured thereto. It may here be stated the bracket 20 is made of a non-magnetic material, such as brass, and forms no part of the magnetic flux circuit. A wire wound movable coil 23 is pivotally supported between the legs of the U-shaped bracket, such coil being provided with conventional pivots rotatable within jewel screws, one such jewel screw 24 being visible in the drawing. As is well known in this art, current is conducted to the movable coil by a set of spiral springs 25, 26, each spring having an inner end secured to the adjacent pivot base and the outer end secured to an abutment. In the present case, the upper spring 25 is secured to the abutment 27 which is rotatable in response to rotation of the conventional zero-corrector arm 28. The abutment 27 and arm 28 are grounded to the bracket 20. In such case, the lower spring 26 must be electrically insulated from the bracket. This is accomplished by insulating the lower abutment 30 from the bracket 20 as shown more clearly in Figure 3 which is a cross sectional view taken along the line B—B of the lower leg of the bracket, shown in Figure 1. In Figure 3, the lower leg of the bracket is identified by the numeral 31. The abutment 30 is secured to the leg 31 by an internally-threaded rivet 32 and the abutment is insulated from the bracket leg by a combination of the insulator bushing 33 and insulator washer 34, as shown. The outer end of the lower spring 26 (Figure 1) is soldered to the inner end 35 of the abutment

30 (Figure 3). It is here pointed out that the recessed hole 18, in the relay base 10 is designed to accommodate the head of the rivet 32 and the insulating washer 34 when the relay mechanism is secured to the relay base, as will be explained with reference to Figure 4, below.

With further reference to Figure 1, the relay mechanism includes a pointer, or arm, 36 that is secured to the movable coil 23 said arm carrying a soft-iron rider 37 on its free end. As shown, the mechanism is complete in itself and can be assembled and adjusted outside of the relay case. All parts of the mechanism are readily visible and accessible thereby promoting reduced manufacturing costs.

The stationary contacts of the relay comprise the soft-iron members 40, 40' having reversely-bent base sections 41, 41', respectively, each base section provided with a pair of holes. The holes 42, 43, in the member 40 are spaced to aline with the threaded inserts 15, 16 in the relay base 10 and such member 40 can be secured to the base by a threaded post 44 and a screw 45, as will be described in detail hereinbelow with reference to Figures 5 and 6. The other soft-iron member 41 is likewise mountable on the base 10 by the post 44' and screw 45'.

Reference is now made to Figure 4 which is a side view showing the relay mechanism mounted on the relay base; the movable coil, springs, etc. being omitted for purposes of clarity. In this view the spacer member 22 is shown between the magnet and the bracket wall. The use of such specific spacer member, which can be soldered or welded to both the magnet and the bracket, is optional. The magnet can be spaced from the bracket wall by forming a longitudinal detent in the bracket. The U-shaped bracket 20 is secured to the base 10 by a screw 50 and a threaded terminal 51 passing through the holes 18, 19 shown in Figure 1. The screw 50 is threaded into the internally-threaded rivet 32 (see Figure 3) and the terminal 51 is threaded into a threaded hole 52 in the lower leg of the bracket (see Figure 1). Therefore, the lower leg of the bracket rests flat upon the surface of the base and the mechanism is secured firmly thereto. By soldering a lead 53 between the pin terminal 17 and the lower abutment 30, it will be apparent the movable coil of the relay can be connected to an external circuit by means of the pins 17 and 51 (since the lower coil spring is connected the abutment 30 and the upper coil spring is grounded to the bracket 20). It is also quite clear that the terminal 17 and the lead 53 can be omitted if the screw 50 be replaced by a threaded terminal pin similar to the pin 51. Such threaded terminal pin will serve the dual purpose of securing the bracket to the base and as a means for connecting the ungrounded side of the movable coil to an external electrical circuit.

Reference is now made to Figure 5. The relay mechanism is shown mounted on the base 10, as just explained; the movable coil, springs, abutments, etc., being omitted. However, the relay movable arm 36 and the iron rider 37 are shown in proper position relative to the stationary contact members 40, 40' now shown secured to the base 10. As shown in Figure 6, which is a cross sectional view taken along the line C—C of Figure 5, the lower, threaded end of the post 44' is threaded into the insert 13 and the screw 45' is threaded into the insert 14 it being noted that the reduced-diameter pin section 55 of the screw extends through the insert to provide a terminal for

connecting the soft-iron member 40' to an electrical circuit. The holes 42', 43' (see Figure 1) in the base section 41' of the soft-iron member 40' are enlarged, or clearance holes whereby the position of the member 40' can be adjusted relative to the magnetic core 21. The other soft-iron member 40 is secured, similarly, to the base 10 and lies diametrically opposite to the member 40' with respect to the core 25. In the illustrated construction the screw 55 has a reduced diameter pin section passing through the insert 14 to serve as an external connection terminal while the threaded end of the post 44' terminates within the threaded insert 13. To further reduce the cost of the relay a somewhat reverse arrangement is employed. Specifically, the post 44' includes an integral pin section extending from the externally-threaded end, such pin section passing through the insert 13 to serve as the external connection terminal. In such design the screw 55 and insert 14 can be omitted. In the event a more positive arrangement is desired to prevent possible rotation of the member 40' about the axis of the post 44' the relay base can be provided an integral recess having one or more side walls abutting against the edges of the base section of the member 40'.

It is to be noted the soft-iron members 40, 40' are spaced from the magnet core. Essentially, the core is a free magnet in space and the members 40, 40' are disposed, partially, in the path of the magnetic flux lines emanating from the transversely magnetized core. Since the movable coil rotates in the space between the core and the members 40, 40' the positioning of such members within the magnetic flux field alters, to some extent, the normal, free, flux distribution of the magnet core. Consequently, the deflection characteristics of the relay can be altered in several ways, namely, by the thickness and size of the members 40, 40', by the spacing of one or both of these members with respect to the core, and by appropriately shaping that portion of these members lying within the range of rotation of the movable coil. In the latter case, for example, the body of one or both of the soft-iron members 40, 40' may be arcuate instead of flat as shown. Since the members 40, 40' lie within the magnetic flux field, lines of flux will emanate from the edges thereof and such flux lines serve to attract the soft-iron rider 37 carried by the relay pointer 36. In a relay constructed as shown, the magnetic attraction holding the rider to the edge of the stationary soft-iron member is sufficient to prevent separation of the contacts even when the relay is subjected to severe mechanical shock.

It will be apparent from the description thus far presented that the individual parts of the relay are of simple construction, are easily assembled in proper relative position, and that the parts carried by the relay base constitute a complete, operative relay with the exception of a suitable mechanical means for separating the iron rider from either of the stationary contacts.

The resetting mechanism of our relay is carried by the relay cover, as shown in Figure 7. The cover 60 is made of a transparent plastic and has integral ears 61 extending from opposite sides, said ears serving as a means for mounting the complete relay on a panel or other apparatus. The top of the cover carries a rotatable zero adjuster screw 62 of more or less conventional construction. Rotation of the screw 62 imparts an oscillatory movement to the pin 63 which engages a suitable arm extending from the top of the relay mechanism as will be explained hereinbelow with reference to Figure 8. The top surface of the cover is also provided with holes 64 to accommodate suitable screws for fastening the cover in position over the relay base. The contact resetting mechanism comprises the flat rod or plate 65 having an integral tip 66, of rectangular cross section, which extends through a rectangular slot in the cover wall. Surrounding the tip 66 is a helical compression spring 67 having one end in contact with the inner wall of the cover and the other end abutting against the resulting shoulder of the plate 65, as shown. A suitable washer 68 is secured to the end of the tip 66 that lies outside of the cover from which it is apparent the spring 67 applies a mechanical bias to the plate 65 in a direction such that the washer 68 normally abuts against the cover 60. In such normal position of the resetting mechanism a substantial portion of the end 69 of the plate 65 extends outwardly of the cover through a suitable rectangular slot in the cover side wall. Finger pressure applied to the end 69 of the plate will cause the plate 65 to move along the axis of the spring 67 as the said spring is compressed. Release of such pressure permits the spring to return the plate to the position shown in Figure 7. Since the end 69 and tip 66 are of rectangular cross section, each operable with an appropriate rectangular slot in the side wall of the cover, a smooth monoplanar movement of the plate 65 is assured. As shown in the drawing, the upper side of the plate 65 may be provided with a recess 70 in the event the upper side edge of the plate 65 is designed to contact the inner surface of the cover top. In such case only the edges 71 and 72 of the plate will rub against the cover top during operation of the reset mechanism, thereby reducing the friction between the plate and cover top. More importantly, the plate 65 is provided with another recess 73 resulting in the downwardly-depending edges 74, 75. When the cover 60 is secured in position on the relay base the resetting mechanism will occupy a position such that the relay movable arm operates within the recess 73 and is subject to contact by the edge 74 or 75 for resetting purposes as will be described with reference to Figures 9 and 10.

Figure 8 illustrates the relay with the cover in place. For purposes of clarity the cover 60 is shown in cross section and the spiral springs and abutments of the mechanism have been omitted. It will be noted the open end of the cover 60 rests upon the lip 11 of the relay base 10 and the cover is secured in position by the screws 80 threaded into the upper ends of the posts 44, 44'. The tip 63 of the zero adjuster mechanism extends through a slot in the zero-adjuster arm 28 whereby the normal, or zero current, position of the movable coil 23 can be altered by rotation of the screw 62.

Reference is now made to Figures 9 and 10 which are fragmentary views taken from the front of the instrument. In Figure 9 the contact resetting mechanism is shown in its normal position, that is, the washer 68 abuts against the cover side wall. The movable arm 36 of the relay mechanism rotates about the axis a—a (defined by the pivots of the movable coil) and the plate 65 is so positioned that the downwardly-depending edges 74, 75 intersect the plane in which the upper section 36' of the arm 36 rotates. Consequently, when the plate 65 is in its normal position the extent of rotation of the arm 36 is limited by the edges 74, 75. Under such condition,

the iron rider 37 is free to contact the soft-iron member 40 but not the member 40'. Now, if the plate 65 be moved inwardly of the cover 60 the edge 74 will move the arm 36 causing a separation of the rider 37 and the member 40. The extent of linear movement of the plate 65 is such that the rider 37 is moved out of the magnetic field of influence of the member 40 whereby the position of the arm 36 will be controlled by the current flowing through the movable coil of the relay upon a subsequent return of the plate 65 to its normal position.

The innermost position of the plate 65 is shown in Figure 10. In such position of the plate the edge 74 prevents contact of the rider 37 with the stationary contact 40 while permitting contact between the rider and the contact 40'. Upon closure of the contacts constituted by the rider and the member 40' contact separation is accomplished when the plate 65 is returned to its normal position under the action of the spring 67, as shown in Figure 9.

It will now be apparent the plate 65 serves two purposes, namely, to condition the relay so that the iron rider can contact only one or the other of the stationary contacts and to separate the contacts so made upon selected movement of the reset mechanism. A relay of this construction is adapted for use in on-off control systems wherein a closure of one set of contacts results in, say, an energization of a load device after which such contacts are opened by manual or electromagnetic movement of the resetting plate. Upon such energization of the load device the relay is conditioned for a closure of the other set of contacts that results in a de-energization of the load device.

Having now described our invention the many features thereof are apparent. The individual parts are of simple construction and easy to assemble and replace. The stationary contacts are made of a low reluctance magnetic material positioned and shaped to control the magnitude and distribution of the magnetic flux field within which the movable coil operates. These same contacts become magnetized at their contact-making ends to provide a good magnetic contact type relay. Further, these contacts are secured to the base of the relay in such fashion that their position relative to the permanent magnet coil may be adjusted to alter the deflection characteristics of the relay. At the same time the means securing the stationary contacts to the base serve as the means for connecting them into an external electrical circuit thereby eliminating separate connection straps, terminals, etc. While the pin type connection terminals extending from the lower surface of the base can be used as soldering terminals for connecting the relay into a network such pin terminals, preferably, are designed to provide a plug-in type relay. In the latter case, the pin terminals establish friction contact with suitable, hollow terminals carried by a socket, the arrangement being similar to the conventional radio tube-socket combination. Still further, a simple, inexpensive reset mechanism is provided which not only separates the relay contacts but also conditions the relay properly for the next operating cycle. These features are attained in a relay of exceptionally small size and without sacrifice of any desired operating characteristics found in conventional relays of this class.

While we have illustrated and described a simple D.-C. version of the relay the invention is not limited thereto. The relay can be used on A.-C. currents by incorporating therein a suitable rectifier comprising a series of asymmetrically-conducting discs. Such discs, as well as resistors, can be disposed within a suitable recess provided in the relay base, particularly in the raised portion 12 as shown in Figure 1.

Numerous changes and modifications of the individual parts and their cooperating assembly will present themselves to those skilled in this art without departing from the spirit and scope of the invention as set forth in the following claims.

We claim:

1. In a relay of the type including a pair of stationary contacts and a cooperating movable contact for controlling an electrical circuit, the combination of a base of insulating material, a U-shaped bracket secured to the base, a permanent magnet core secured to the bracket and disposed between the legs of the bracket, a movable coil pivotally supported by the bracket and rotatable about said magnet core, a movable arm secured to the movable coil and having a free end normally extending beyond the range of magnetic influence of the magnet core, a rider of magnetic material carried by the free end of said movable arm, and soft-iron members secured to the base and electrically insulated from each other and the bracket, said members being disposed on opposite sides of and spaced from the movable coil and magnetic core and including portions disposed in the field of travel of the said rider, the said rider and soft-iron members constituting the contacts for controlling the electrical circuit.

2. The invention as recited in claim 1, wherein the said soft-iron members comprise a base portion secured to the relay base, an offset central portion spaced from the movable coil and a projecting end section lying in the path of travel of the rider.

3. The invention as recited in claim 1 wherein the soft-iron members are adjustably secured to the base.

4. The invention as recited in claim 1 wherein the said soft-iron members are secured to the base by a threaded member having a pin section projecting from the relay base.

5. A relay comprising a base of insulating material; a U-shaped bracket of non-magnetic material disposed in upright position on the base; a threaded, pin type terminal member passing through a hole in the base and into a threaded hole in a leg of the bracket, a movable coil carrying a pointer and pivotally supported between the legs of the bracket; a rider of magnetic material carried on the end of the pointer; a transversely-magnetized, substantially-cylindrical permanent magnet core secured to the base of the bracket and disposed within the movable coil; a soft-iron member having an end section disposed in the path of travel of the said rider, a mid-section spaced from the movable coil and magnetic core, and a base section adapted for flush contact with the relay base; a pair of holes in the base section of the soft-iron member; internally threaded inserts in the relay base said inserts alined with the holes in the base of the soft-iron member; and fastening members passing through the holes in the base section of the soft-iron member and into the inserts.

6. The invention as recited in claim 5 wherein one of the said fastening members includes an integral, reduced diameter extension passing through the associated insert.

7. The invention as recited in claim 5 wherein

one of the said fastening members is a post extending upwardly in spaced relation to the said soft-iron member.

8. The invention as recited in claim 7 in combination with a cover having an open end in contact with the relay base; a hole in the cover; and a screw member passing through the cover hole and threaded into an end of the post.

9. The invention as recited in claim 5 in combination with a cover; means removably securing the cover to the relay base; and an externally-operable reset rod supported by the cover for linear movement within the cover, said rod adapted to contact the said pointer upon a predetermined movement of the rod.

10. A sensitive relay comprising a base of insulating material provided with a shoulder, a pivoted movable coil rotatable about a substantially cylindrical, transversely magnetized permanent magnet; a U-shaped bracket supporting the movable coil and magnet in operative position; means securing a leg of the bracket to the base whereby the bracket extends upwardly from the base; a pointer secured to the movable coil and carrying a soft-iron rider; a pair of soft-iron members disposed on opposite sides of the permanent magnet and spaced from the movable coil and magnet, each said member including a section adapted for contact by the said rider; means securing the said soft-iron members to the relay base said means including a pair of

posts extending upwardly from the relay base; a cover having an open end disposed on the shoulder of the relay base and including a pair of holes alined with the said posts; screws passing through the cover holes and into the said posts; a transversely-movable reset rod having ends extending through apertures in opposed side walls of the cover; a spring biasing the said reset rod to a normal position; a recess in the wall of the reset rod said recess being defined by side walls adapted to engage the said pointer to separate the iron rider from either of the said soft-iron members.

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