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2,254,037

POLARIZED RELAY

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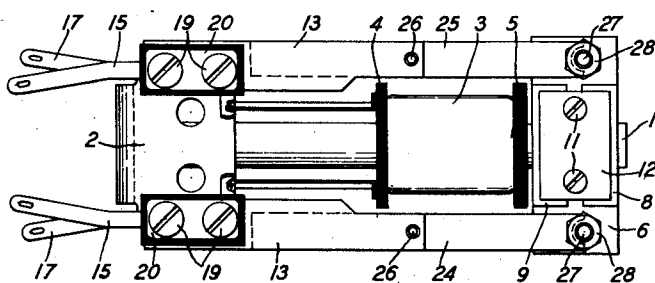


FIG. 3

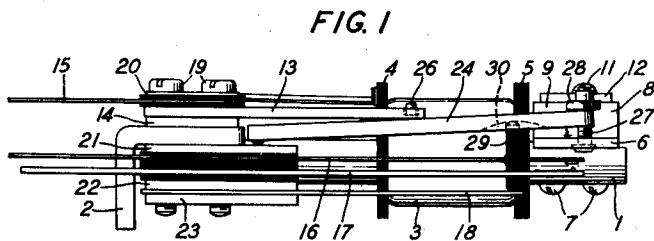


FIG. 1

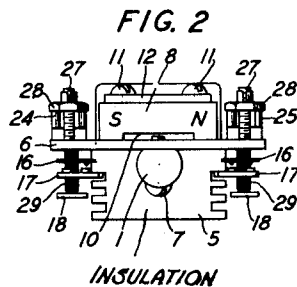


FIG. 2

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POLARIZED RELAY

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7 Claims. (Cl. 200—93)

This invention relates to an electromagnetic device and more particularly to a polarized relay.

It is often desirable in signaling systems to selectively close two work circuits by the operation of a polarized relay in response to the energization of its winding by current of either positive or negative polarity. If a polarized relay of the type which has a single armature biased to a neutral position is used for this type of service, there is always the possibility that if the armature is not accurately biased in its neutral position, it may fail to operate on current of one polarity or may operate falsely due to vibration when its winding is not energized or is energized with a non-operating value of current.

It is therefore the object of the present invention to provide a relay structure of the polarized type which has three very definite positions of which two are circuit closing and the third is a neutral or open-circuit position.

It is a further object of the invention to provide a polarized relay structure which has a suitable margin of safety against false operation when a high percentage of the operate current is flowing and the relay is at the same time subject to vibration.

It is a further object of the invention to provide a polarized relay structure which is economical to manufacture and which requires a minimum of maintenance.

In accordance with this invention, these objects have been attained by the use of the non-linear magnetic characteristic of a section of iron as a magnetic rectifier to admit or impede the flow of magnetic flux according to its polarity. The invention has been illustrated as particularly applicable to a relay of the general type disclosed in Patent 2,178,656, granted November 7, 1939, to P. W. Swenson. As illustrative of the manner in which a neutral relay of this type may be modified to secure a reliably operative and efficient polarized relay, a magnetic rectifier has been added which comprises a cross-bar of iron secured to the forward end of the relay core to the upper surface of which two C-shaped permanent magnets are clamped which also extend transversely to the core. The bar acts as a keeper for the magnets. The usual U-shaped armature is replaced by two armatures, one on either side of the operating coil, each pivoted to the heel-piece of the relay and extending forwardly over an end of the cross-bar with its free end maintained separated from the bar by a working air-gap. Flux from the core of the relay

is fed into the cross-bar and is directed to either end thereof to the working gaps between its ends and the armatures. In one end of the cross-bar, flux due to the electromagnet opposes the saturating flux set up in the bar by the permanent magnets making the sum of the two fluxes less than the saturating value and consequently operating flux reaches the air-gap between that end of the bar and the armature cooperating therewith. In the other end of the bar, the electromagnetic flux is in a direction to aid the saturating flux tending to create a flux greater than the saturating flux but since this is not possible, operating flux cannot reach the air-gap between that end of the bar and the other armature associated therewith. Depending upon the direction of the electromagnetic flux established due to the polarity of the current in the operating coil one or the other of the armatures will be operated.

For a more comprehensive understanding of the invention, reference may be had to the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is a top plan view of the relay in accordance with the present invention;

Fig. 2 is a front end view of the relay, the spring supports being omitted to clarify the disclosure; and,

Fig. 3 is a side elevational view of the relay.

As previously stated, the invention relates particularly to the modification of a relay of the type disclosed in Patent No. 2,178,656 for providing polar action. The relay comprises a core 1, the rear end of which is secured to the heel-piece or mounting bracket 2 by which the relay may be secured to a mounting rack. Surrounding the core 1 is an operating coil 3 having a rear spoolhead 4 and a front spoolhead 5 both of insulating material. Positioned transversely of the forward end of the core is an iron yoke or cross-bar 6 which is secured to the core by the screws 7. Positioned on the upper face of the bar 6 and also extending transversely of the core 1 are two permanent bar magnets 8 and 9. Each magnet is cut away as indicated at 10 so that only the polar ends thereof are in engagement with the bar 6. The magnets are clamped to the bar 6 by screws 11 which pass through holes in the clamping plate 12 of non-magnetic material, thence between the parallelly disposed magnets into threaded holes in the bar 6. The bar 6 serves as a keeper for the magnets 8 and 9 and is so proportioned that it is normally essentially

saturated by the flux flowing therethrough from the magnets 8 and 9.

Disposed on each lateral end of the heel-piece 2 is an assembly comprising an armature hinge bracket 13 and a coil terminal lug 15 positioned on the upper face of the heel-piece, as viewed in Fig. 1, and a spring pile-up comprising two contact springs 16 and 17 and a balancing spring 18 positioned beneath the heel-piece. For securing each assembly to the heel-piece 2, screws 19 extend through holes in the clamping plate 20, armature hinge bracket 13, separator 14, heel-piece 2, metal separator 21, springs 16 and 17, metal separator 22, spring 18, and into threaded holes in the clamping plate 23. The coil terminal lug 15 is insulated from the clamping plate 20 and from the armature hinge bracket 13 by interposed strips of insulating material and the springs 16 and 17 are similarly insulated from the separators 21 and 22 and from each other by strips of insulating material. The terminal lug 15 and the springs 16 and 17 are also insulated from the screws 19 in any suitable manner as by sleeves of insulating material surrounding the screws. Each coil terminal lug 15 is provided with an inwardly extending soldering lug to which an end of the coil winding is soldered.

Pivoted at substantially the mid-points of their length on the ends of the forwardly extending brackets 13 are two armatures 24 and 25 positioned respectively on opposite sides of the coil 3. Each armature is pivoted by means of a pivot pin 26 which extends loosely through a hole in the end of the hinge bracket 13. The forward ends of the armatures overlie the ends of the yoke bar 6 being normally separated therefrom by air-gaps which are determined by the back-stop screws 27 secured in holes in the ends of bar 6 and the back-stop nuts 28 threaded upon the ends of such screws. The armatures are normally biased as shown in Fig. 1 with their forward ends engaged beneath the back-stop nuts, with their mid-portions engaged beneath the ends of the brackets 13 and with their rear ends engaged against the spacers 21 by the balancing springs 18 which press against the armatures through the insulating studs 29. The studs 29 are staked in holes in the springs 16, pass freely through holes in the springs 17 and have their upper ends engaged in grooves 30 in the underside of the armatures. The engagement of the studs 29 in the grooves 30 prevents the rotational movement of the armatures around their pivots and thus maintains the armatures properly aligned with their backstop screws 27. The ends of the springs 17 are provided with laterally extending tangs which are engaged in notches in the edges of the front spoolhead 5 for determining the normally open gaps between such springs and their mate springs 16.

Considering the operation of this relay, the permanent magnets 8 and 9 and the yoke bar 6 are so proportioned that a flux density is normally produced in the yoke sufficiently large to operate the iron of the yoke above the knee of the saturation curve. In this high flux density condition, the yoke will still have a low reluctance compared with that of the air-gaps between the ends of the yoke bar and the ends of armatures 24 and 25 and thus the yoke bar 6 sufficiently shields the armatures magnetically so that there is a negligible attractive force applied to the armatures due to leakage or stray flux from the permanent magnets. Neglecting leakage the permanent flux may be visualized as leaving the

north poles of the magnets, proceeding through the bar 6 and entering the south poles of the magnets.

When the coil 3 is energized, a coil flux will be created which will flow through the core 1, dividing at its junction with the bar 6 and will tend to flow through the ends of the bar across the air-gaps through the armatures 24 and 25 and uniting again at the rear end of the core. The direction of the flow of flux in this divided flux path will, of course, depend upon the direction of the-energizing current flowing in the coil 3.

If the direction of flux due to current in the coil 3 is assumed as leaving the core and entering the bar 6, the coil flux opposes the permanent magnet flux at the end of the bar 6 adjacent the armature 25 and the flux density in that end of the bar 6 is therefore decreased and flux readily flows across the air-gap between that end of the bar and the armature 25 whereby the armature 25 is attracted to close the contacts of springs 16 and 17 associated therewith. At the same time, however, the coil flux aids the permanent magnet flux at the end of bar 6 adjacent the armature 24 but since this end of bar 6 is already almost or entirely saturated due to the permanent magnet flux, the increase in flux at this end of the bar will be slight or nil and armature 24 will be unaffected. Thus armature 25 will be operated and armature 24 will not be operated.

As the total amount of flux due to the coil 3 approaches that due to the permanent magnet, the entire flux will flow from the core 1 through the end of bar 6 adjacent to the armature 24 through the permanent magnets 8 and 9 across the air-gap between the other end of bar 6 and the armature 25 and through the armature 25 back to the core 1. This assumes that there is no leakage flux and that the end of the bar 6 towards the unoperated armature can carry no more than the initial permanent magnet flux. A current of opposite polarity in the coil 3, will reverse the direction of the coil flux and cause the attraction of armature 24 while armature 25 is unaffected.

It will be noted that the working flux is due to the current passed through the operating coil 3 and the performance is similar to that of two neutral relays having oppositely poled rectifiers in series with their windings. The function of the permanent magnets 8 and 9 is that of a magnetic rectifier directing working flux to either one of the armature gaps depending upon the polarity of the operating current. The sensitivity is thus comparable to that of a neutral relay, the pull on either armature being proportional to the square of the flux in the working gap due to the current in the coil.

In the unoperated condition, because of the permanent magnet flux in the bar 6, there is a magnetomotive force drop across it. This tends to send flux through the path including both armatures and their air-gaps and to produce some initial force on the armatures. Since the reluctance of the air-gaps is high compared to that of the yoke bar (even when it is operated at a high density), this flux and hence the initial steady pull on the armatures will be small. This will be true so long as the armatures remain unoperated and the air-gaps are large. When an armature is operated, however, the reluctance of the corresponding air-gap is reduced and being in parallel with the path from the core through an end of the bar 6, it will draw appreciable flux. Thus the permanent magnet flux

through this armature can be made to lock it in the operated position against the back pressure of the associated contact springs after it has been brought to this position by the coil 3. This locking feature can be easily avoided by the use of armature stop discs of non-magnetic material to prevent too great a reduction of the air-gap reluctance when an armature operates.

Since each armature is pivoted at a point approximately at its center of mass, it is in balance and thus provides a high margin of safety against false operation when a minimum non-operate current is applied to the coil and the relay is subjected to vibration.

What is claimed is:

1. In a polarized relay, a heel-piece, a core secured at one end thereto, a cross-member of magnetic material secured to the other end of said core, a permanent magnet having its polar ends in engagement with the ends of said member, an energizing coil on said core, two armatures positioned respectively on each side of said coil and pivoted to said heel-piece with their outer ends positioned above the ends of said member and a set of contact springs operatively associated with each of said armatures, whereby one or the other of said sets of springs will be operated dependent upon the polarity of the current applied to said coil.

2. In a polarized relay, a heel-piece, a core secured at one end thereto, a cross-member of magnetic material secured to the other end of said core, a permanent magnet having its polar ends in engagement with the ends of said member whereby said member is substantially magnetically saturated, an energizing coil on said core, two armatures positioned respectively on each side of said coil and pivoted to said heel-piece with their outer ends positioned above the ends of said member and a set of contact springs operatively associated with each of said armatures whereby one or the other of said sets of springs will be operated dependent upon the polarity of the current applied to said coil.

3. In a polarized relay, a heel-piece, a core secured at one end thereto, a cross-bar of magnetic material secured to the other end of said core, a permanent magnet having raised portions near its polar ends in engagement with one face of said bar near its ends whereby said bar serves as a keeper for said magnet, an energizing coil on said core, two armatures positioned respectively on either side of said coil and pivoted to said heel-piece with their outer ends positioned above the ends of said bar and a set of contact springs operatively associated with each of said armatures, whereby one or the other of said sets of springs will be operated dependent upon the polarity of the current applied to said coil.

4. In a polarized relay, a heel-piece, a core secured at one end thereto, a cross-bar of magnetic material secured to the other end of said core, two parallelly disposed permanent bar magnets having raised portions near their polar ends in engagement with one face of said cross-bar near its end whereby said cross-bar serves as a keeper for said magnets, a clamping plate of non-magnetic material disposed above said magnets, screws extending through holes in said plate and between said magnets into tapped holes in said cross-bar for clamping said magnets to said cross-bar, an energizing coil on said core, two armatures

positioned respectively on either side of said coil and pivoted to said heel-piece with their outer ends positioned above the ends of said cross-bar and a set of contact springs operatively associated with each of said armatures, whereby one or the other of said sets of springs will be operated dependent upon the polarity of the current applied to said coil.

5. In a polarized relay, a heel-piece, a core secured at one end thereto, a cross-member of magnetic material secured to the other end of said core, a permanent magnet having its polar ends in engagement with the ends of said member, an energizing coil on said core, an armature supporting bracket secured to each end of said heel-piece, said brackets having their ends extending forwardly on each side of said coil, two armatures positioned respectively on each side of said coil and pivoted at approximately the mid-points of their length on the ends of said brackets with their outer ends positioned above the ends of said cross-member, and a set of contact springs associated with each of said armatures, whereby one or the other of said sets of springs will be operated dependent upon the polarity of the current applied to said coil.

6. In a polarized relay, a heel-piece, a core secured at one end thereto, a cross-member of magnetic material secured to the other end of said core, a permanent magnet having its polar ends in engagement with the ends of said member, an energizing coil on said core, an armature supporting bracket secured to each end of said heel-piece, said brackets having their ends extending forwardly on each side of said coil, two armatures positioned respectively on each side of said coil and pivoted at approximately the mid-points of their length on the ends of said brackets with their outer ends positioned above the ends of said cross-member, a back stop screw secured to each end of said cross-member and having a nut thereon against which nuts the ends of said armatures are normally engaged, and a set of contact springs associated with each of said armatures whereby one or the other of said sets of springs will be operated dependent upon the polarity of the current applied to said coil.

7. In a polarized relay, a heel-piece, a core secured at one end thereto, a cross-member of magnetic material secured to the other end of said core, a permanent magnet having its polar ends in engagement with the ends of said member, an energizing coil on said core, an armature supporting bracket secured to each end of said heel-piece, said brackets having their ends extending forwardly on each side of said coil, two armatures positioned respectively on each side of said coil with their outer ends positioned above the ends of said cross-member, pivot pins secured to said armatures at approximately the mid-points of their length, which are engaged in holes in the ends of said brackets whereby said armatures are loosely hinged to said brackets, a set of contact springs associated with each of said armatures, and an operating stud secured to the operating spring of each set having one of its ends engaged in a groove in the associated armature for aligning the armatures with respect to the ends of said cross-member whereby one or the other of said contact sets will be operated dependent upon the polarity of the current applied to said coil.

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