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POLARIZED ELECTROMAGNETIC RELAY

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FIG. 1

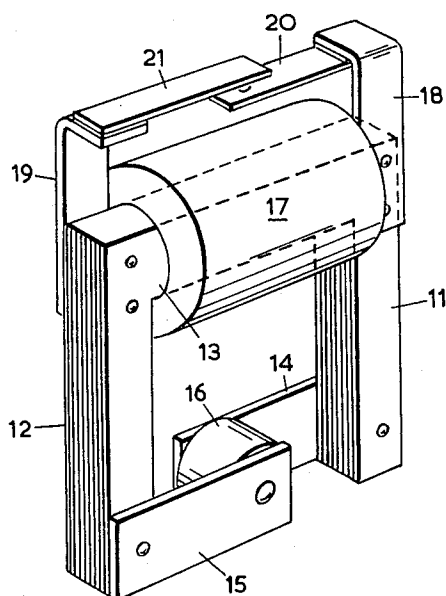
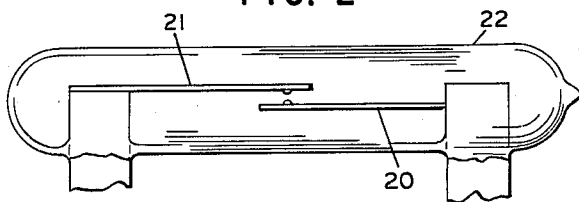


FIG. 2



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POLARIZED ELECTROMAGNETIC RELAY

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This invention relates to polarized electro-magnetic relays.

According to the present invention a polarized electro-magnetic relay comprises an electrical contact system for controlling an electrical circuit, and an electro-magnetic system for actuating the contact system, the electro-magnetic system including a first means defining a closed magnetic circuit which includes magnetically in series a first ferro-magnetic portion having a low magnetic reluctance, a second ferro-magnetic portion having a substantially higher reluctance, and a magnetic flux producing means for establishing across the lower reluctance portion a predetermined low magnetomotive force, a second means defining a magnetic path arranged magnetically in parallel with the said first ferro-magnetic portion so as to be influenced by the magnetomotive force developed across the first ferro-magnetic portion and including magnetically in series two resilient ferro-magnetic members having opposed portions thereof spaced apart but capable of movement towards one another whereby to effect actuation of the electrical contact system, and means responsive to a predetermined unidirectional electric input signal for opposing the magnetic flux in the said first ferro-magnetic portion whereby to increase the magnetomotive force developed across the magnetic path defined by the said second means to a predetermined higher value whereby to effect actuation of the contact system.

According to another feature of the present invention the said first ferro-magnetic portion is made of a ferro-magnetic material having a substantially rectangular hysteresis loop.

According to another feature of the present invention the said magnetic flux producing means is arranged in the said first means with its magnetic axis disposed in a position such that the action of the opposed portions of the said two resilient ferro-magnetic members in response to variations in the electric input signal is substantially uninfluenced by magnetic leakage flux of the flux producing means. Preferably the said resilient members are electrically insulated from the said first means, and together constitute the said electrical contact system.

One polarized electro-magnetic relay according to the present invention will now be described by way of example and with reference to the accompanying drawing in which:

FIG. 1 shows a perspective view of the relay; and

FIG. 2 shows a side elevation of part of the relay and illustrates a modification.

Referring now to the drawing, the relay includes a U-shaped magnetic core having flank members 11 and 12 joined by a transverse member 13. The core is built up from a stack of U-shaped laminations made from a soft ferro-magnetic material. Two iron limbs 14 and 15 secured to the free ends of the flank members 11 and 12 on opposite faces of the core together span the open end of the core, and between the opposed free ends of these limbs 14 and 15 is secured a permanent ring magnet 16 of an aluminum-nickel-cobalt alloy, with its magnetic, and geometric, axis disposed at right angles to the plane of the magnetic path provided by the core. An electrical coil 17 is mounted on the transverse member 13.

The assembly so far described constitutes a closed magnetic circuit in which, with the coil unenergized, a predetermined low magnetomotive force is established by the permanent magnet across the low reluctance magnetic path provided by the transverse member 13 of the core.

Two L-shaped steel brackets 18 and 19 secured firmly to the core at opposite ends of the transverse member 13 and on opposite faces thereof carry resilient reed-type contact members 20 and 21 which together constitute a normally-open electrical contact system of the relay. The contact members, which are electrically insulated from the brackets 18 and 19 by means of a cement commercially known as "Mexim" are made from a nickel-iron alloy having the properties of high electrical conductivity, low magnetic reluctance, and low residual magnetism. The free ends of the contact members 20 and 21 overlap one another, forming between small silver contact tips secured thereto a contact gap which for maximum relay sensitivity is made as small as possible consistent with the dielectric strength of the said medium present between the contact tips.

The two brackets 18 and 19 and the resilient contact members 20, 21 together constitute a magnetic path which is arranged magnetically in parallel with the magnetic path provided by the transverse member 13 of the aforesaid closed magnetic circuit, and which consequently is subjected to the same magnetomotive force as is the transverse member 13.

The shape, material and construction of the U-shaped core render the magnetic reluctance of the magnetic path between the brackets 18 and 19 through the transverse member 13 of very low value, whilst by dint of the materials used and the construction adopted for the parallel magnetic path through the brackets 18, 19 and the contact members 20, 21 the magnetic reluctance of this magnetic path is of a substantially higher value.

Likewise, by dint of the materials used and the form of construction adopted for that part of the closed magnetic circuit which includes the flank members 11, 12, the limbs 14, 15 and the permanent magnet 16, the magnetic reluctance of this part of the closed magnetic circuit is very much greater than that of either of the aforesaid two parallel magnetic paths extending between the ends of the transverse member 13.

It will therefore be appreciated that with the coil 17 unenergized and a substantial magnetic flux established in the transverse member 13 by the magnet 16 most of the magnetomotive force of the magnet is absorbed in driving the magnetic flux through the above-mentioned very high reluctance path, and that only a very small part of the total magnetomotive force of the magnet is developed across the two lower reluctance magnetic paths between the ends of the transverse member 13. This small magnetomotive force is insufficient to cause the contact members 20 and 21 to close together, so that the electric circuit through the electrical contact system of the relay remains open.

If the relay coil 17 is energized by an appropriately sensed direct current produced as a result of the application of an input voltage signal to the relay coil, the transverse member 13 is also subjected to an opposing magnetomotive force whose magnitude is dependent on the relay input signal, and the magnetic flux in the closed magnetic circuit is consequently reduced.

As a result the magnetomotive force absorbed in the aforesaid very high reluctance path is reduced, so that a greater magnetomotive force is developed across the two ends of the transverse member 13, and the magnetic flux in the path which includes the contact members 20 and 21 increases.

At a predetermined value of the relay input voltage

signal the increased magnetomotive force appearing across the ends of the transverse member 13 is sufficient to cause the contact members 20 and 21 to close together and thereby close the electric circuit through the electrical contact system of the relay.

It will be appreciated that since with the coil 17 unenergized only a very small magnetomotive force is developed across the ends of the transverse member, the coil 17 has to provide an opposing magnetomotive force of no greater value than this to cause the closure of the contact members 20 and 21. The relay can thus be made very sensitive by reducing as far as possible the reluctance of the magnetic path through the transverse member 13 in relation to that of the higher reluctance path through the members 11, 12, 14, 15 and 16. The reluctance of this latter path may be readily increased by providing small air gaps at the joints of the members 14 and 15 with the magnet 16 and with the flank members 11 and 12 of the core. Furthermore, the magnet 16 may be so designed as to have a high internal magnetic reluctance.

To further improve the sensitivity of the relay the gap between the silver contact tips carried by the contact members 20 and 21 may be considerably reduced by enclosing the contact members in a closed vessel 22 (see FIG. 2), for example of glass, and filling the closed vessel with a fluid medium, such as sulphur hexafluoride (SF₆) or a class B oil to British standard 148, having a dielectric strength which is substantially greater than that of the air dielectric normally used. The two media mentioned above both have a dielectric strength such as will enable a contact gap of approximately 0.125 millimetre to withstand an insulation test of 1 kv. applied across the gap.

The silver contact tips secured to the contact members 20 and 21 assist in effecting the opening of the contact members automatically after the energization of the coil 17 has been reduced to a low value.

The operating characteristic of the relay can be further improved by constructing the core of laminations made from a soft ferro-magnetic material having a relatively thin rectangular hysteresis loop. With such a modified relay the flux in the transverse member 13 can only be changed whereby to effect closure of the contact members 20 and 21 by reversing the magnetic flux in the transverse member, and this occurs only when the magnetomotive force due to the coil 17 reaches a predetermined value which is very precisely determined by the width of the hysteresis loop.

It is important in attempting to obtain a high sensitivity for the relay to avoid so far as is possible any adverse influence on the operation of the contact members 20 and 21 which may result from the induction of magnetic flux in the contact members by magnetic leakage from the permanent magnet 16. Thus in the construction described above, the permanent magnet has been arranged in the closed magnetic circuit with its magnetic axis disposed at right angles to the common plane which includes the other parts of the closed magnetic circuit and the parallel magnetic path which includes the contact members 20 and 21.

Though in the above-described relay the magnet 16 is a permanent magnet, in some suitable applications of the relay this magnet may, if desired, take the form of an electro-magnet suitably energized to cause the relay to have the desired operating characteristic. Furthermore, though in the above-described relay the resilient contact members 20 and 21 have been electrically insulated from

the brackets 18 and 19 so that they may constitute the electrical contact system of the relay, if desired these resilient members may be connected directly with the brackets 18 and 19 and be arranged to operate a mechanically and electrically separate electric contact system of the relay.

What I claim as my invention and desire to secure by Letters Patent, is:

1. A polarized electromagnetic relay including a pair of contacts and a magnetic system electrically energizable to actuate the contacts, the magnetic system comprising a first section of ferromagnetic material and having a low magnetic reluctance, a second section at least partly of ferromagnetic material and having a substantially higher magnetic reluctance, the first and second sections being magnetically connected together in a series magnetic circuit, a third section arranged magnetically in parallel with the first section, magnetic flux producing means arranged in the said series magnetic circuit for passing a flux through the circuit so as to develop across the first and third sections of the magnetic system a magneto-motive force of predetermined low magnitude, an electrically energizable coil mounted in magnetic relationship with the first section and operable when energized to produce a flux acting in the opposite direction to the said flux passing through the first section so as to increase the magneto-motive force across the first and third sections, and contact actuating means operative to actuate the contacts of the relay when the magneto-motive force across the third section is greater than the said predetermined low magnitude.

2. A relay according to claim 1, in which the said magnetic flux producing means is arranged so that its lines of leakage flux are oriented substantially at right angles to the said third section of the electromagnetic system.

3. A relay according to claim 2, in which the magnetic flux producing means is a permanent magnet arranged with its magnetic axis substantially at right angles to the said third section of the electromagnetic system.

4. A relay according to claim 1, in which the said contact actuating means includes two resilient ferromagnetic members forming at least part of the third section of the electromagnetic system and defining a gap between them, the resilient members being mounted to move relatively towards each other to close the said gap and to actuate the contacts of the relay when the magneto-motive force is greater than the said predetermined low magnitude.

5. A relay according to claim 4, in which a fluid of dielectric strength substantially greater than air and enclosed in a closed vessel provides a filling for the gap between the said resilient members.

6. A relay according to claim 1, in which the said first section of the electromagnetic circuit is made of ferromagnetic material having a substantially rectangular hysteresis loop.

7. A relay according to claim 1, in which the said second section includes a portion constituting an effective air gap.

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