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ELECTROMAGNETIC SWITCHING DEVICE

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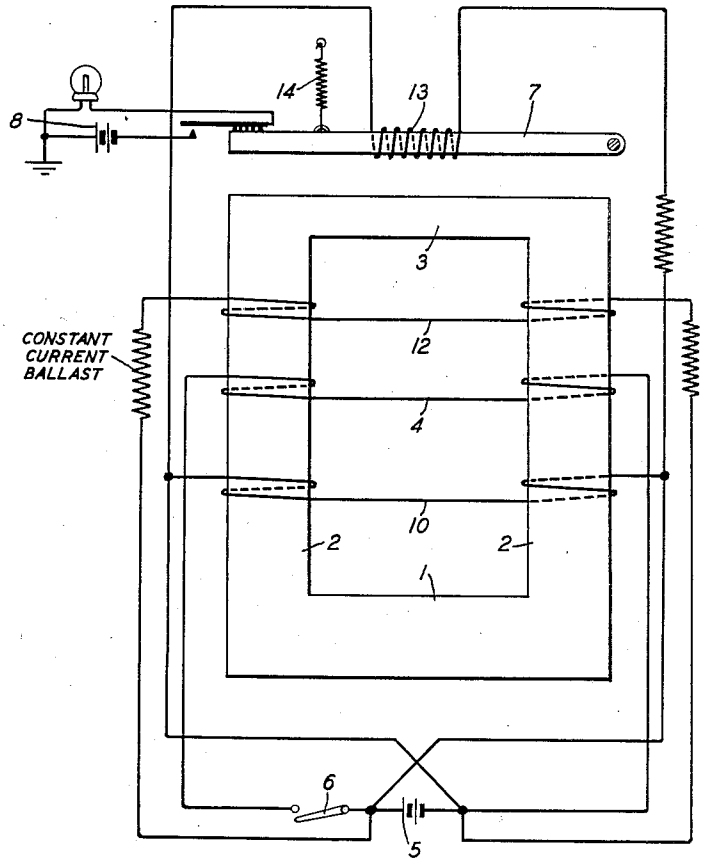

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ELECTROMAGNETIC SWITCHING DEVICE

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4 Claims. (Cl. 175—320)

This invention relates to the design of electromagnetic switching devices and particularly to electromagnetic relays of the slow-acting type.

Slow-acting relays are characterized by a time lag, or lapse of time between the closure or opening of the relay energizing circuit and the consequent operation or release of the armature. Heretofore, this retarded effect has been produced in various ways, either mechanically or electrically. The mechanical instrumentalities, for example the dash-pot, relied upon render the relay cumbersome and unreliable, whereas the electrical expedients, such as the short-circuited winding, copper sleeve, etc., resorted to, while producing a more compact and less expensive structure have been found inadequate in cases where a large time constant is desirable, that is, where the lapse of time between the closure or opening of the relay energizing circuit and the consequent actuation of the armature should be relatively great.

It is accordingly, the object of this invention to provide a simple, reliable and inexpensive relay of the slow-acting type having a relatively large time constant and one which is capable of great flexibility in delay periods of operation and release.

This object is attained, in accordance with a feature of the invention, by utilizing in a structure of this type, a closed magnetic circuit of low reluctance and providing a magnetic bias which serves to increase the time constant afforded by this type of magnetic circuit.

More specifically, this object is attained by employing a four-legged closed magnetic element in which the leg opposite the movable element or armature, is of a smaller cross-section than that of any of the other legs. A permanently energized reverse bias winding is mounted on the core in such a manner as to be in flux generating opposition to the relay operating winding.

Another feature of the invention provides compensation for voltage variations in the operating current by adding to the structure previously described a normal fixed bias winding which generates flux in a direction opposing that of the reverse bias winding.

Other features of the invention, which will be readily understood from the following detailed description made with reference to the accompanying drawing, contemplate the use of armature polarizing windings and relay windings in various combinations for varying the operate and release characteristics of the relay.

The drawing constitutes a diagrammatic illustration of a relay embodying the features of this invention.

The relay of this invention depends fundamentally upon the large time constant afforded by a closed magnetic circuit of low reluctance The consequent large inductance per unit resistance of exciting winding and any coupled winding greatly retards changes in excitation. After the change in excitation has been in progress for a sufficiently prolonged time, a portion of the magnetic member, or armature, to be moved by the change in excitation, becomes saturated with the increase in flux. The change in reluctance of this portion of the magnetic circuit reduces the retarding effect upon the exciting current which changes more rapidly toward its final value. The change in flux through the movable member due to the change in current and bridge reluctance accomplishes the transfer of this member to operate or release the relay.

Referring to the drawing, the fundamental system contemplates the use of a closed magnetic circuit consisting of a core comprising a main portion 1, from which extends two integral legs, 2, 2 connected at their ends by a cross-piece or bridge 3. The portions 1 and 2 may be of substantially the same dimensions but the bridge piece 3 must of necessity be narrower than the remainder of the magnetic circuit. An operating winding is shown at 4 which is adapted to be energized from any suitable source 5 of current by the actuation of a key 6. The narrow magnetic bridge across the operating winding effected by member 3 serves to maintain a high initial inductance until the operating flux builds up to the saturation region. The increased reluctance of the bridge results in an increase of flux across the air-gap, which pulls over the armature 7 which controls a load circuit generally indicated by the numeral 8.

It is a mathematical fact that the larger the time constant in a relay, the slower the rate of build-up of exciting current and flux which is proportional to the current, the time constant being the ratio of effective inductance of exciting winding to the effective resistance of exciting winding.

In the fundamental system already described the effective inductance, due to the narrow magnetic bridge 3, is high initially, until the magnetic flux through the exciting winding 4 builds up with the current to the saturation region. The inductance decreases with saturation and with the inductance so reduced, the current and

flux through the exciting winding increase rapidly to their final values.

The flux through the armature is proportional to the magnetomotive force developed across it. With the low reluctance of the magnetic bridge shunting it, the armature carries little flux. With the bridge saturated, the increased magnetomotive force caused by the greater reluctance drop across the bridge results in an increased flux through the armature to pull it into its operated position.

From the foregoing, it is apparent that the closed magnetic circuit of low reluctance, provided by the narrow bridge piece 3, imparts a large time constant to the relay of this invention. The lapse of time between the closure of the switch 6 and operation of the armature 7 is therefore considerable.

The time of operation of the present relay may be doubled or considerably increased by resorting to the use of a reverse magnetic bias derived, for example, from the winding 10, which as shown, is permanently connected to the source of current 5 in such a manner as to set up flux in opposition to that generated by the operating winding 4. The flux from the reverse bias winding 10 should nearly saturate the magnetic bridge 3. The time of operation may be controlled by adjustment of this bias. As opposed to a reverse bias, a normal bias, driving flux in the same direction through the magnetic circuit as the operating winding will decrease the time of operation.

In order to render the time of operation of the relay system so far described, immune to the effects of variations in the exciting voltage, a normal bias winding 12 may be used in conjunction with the reverse bias which is made proportional to the exciting voltage.

A system comprising an operating winding and a reverse biasing winding may be made slow releasing by polarizing the armature by means of polarizing winding 13 wound on the armature 7. The reverse bias winding 10 saturates the bridge 3 and keeps the armature in its released position. As saturation develops in operation, the mechanical bias of the armature, due to spring 14, is overcome and the armature 7 is actuated. On opening of the exciting winding 4 by opening key 6, the reverse bias winding, with its high time constant, retards the collapse of the operating flux. Upon the resumption of reverse saturation, the armature, which has been held up by its flux through 1 and 3, is released. The delay in release may be controlled by the magnitude of the time constant of the reverse bias winding and by the proportions of the reverse bias.

From the foregoing description it is apparent that the relay design of this invention is simple in construction, inexpensive and capable of great flexibility in delay periods of operation and release.

What is claimed is:

1. An electromagnet having a core comprising four joined legs, one of said legs having a smaller sectional area than the other legs, a movable magnetic circuit controlling member oppositely disposed to said one of said legs, an operating winding for said electromagnet and a permanently energized winding for maintaining said one of said legs in substantial magnetic saturation in a direction opposed to the magnetic influence of said operating winding.

2. An electromagnet having a core comprising a closed rectangle of magnetic material, one of the legs thereof having a smaller sectional area than any of the other legs, a movable magnetic member oppositely disposed to said leg of small sectional area, an operating winding, a normally energized reverse biasing winding, and a normal fixed biasing winding, said windings coacting in the generation of flux in said leg of smaller area to render said electromagnet immune to the effects of operating voltage variations in its time control of the relay armature.

3. An electromagnet having a closed core including a cross-piece of smaller sectional area than the remainder of said core, an armature oppositely disposed to said cross-piece, an exciting winding on said core, a normally energized reverse biasing winding on said core and a polarizing winding on said armature connected in parallel with said biasing winding.

4. An electromagnet having a closed core of low magnetic reluctance including a cross-piece of relatively small sectional area, an armature oppositely disposed to said cross-piece, an exciting winding on said core, a normal biasing winding on said core connected in parallel with said exciting winding, a reverse biasing winding on said core and a polarizing winding on said armature connected in parallel with said biasing winding.

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