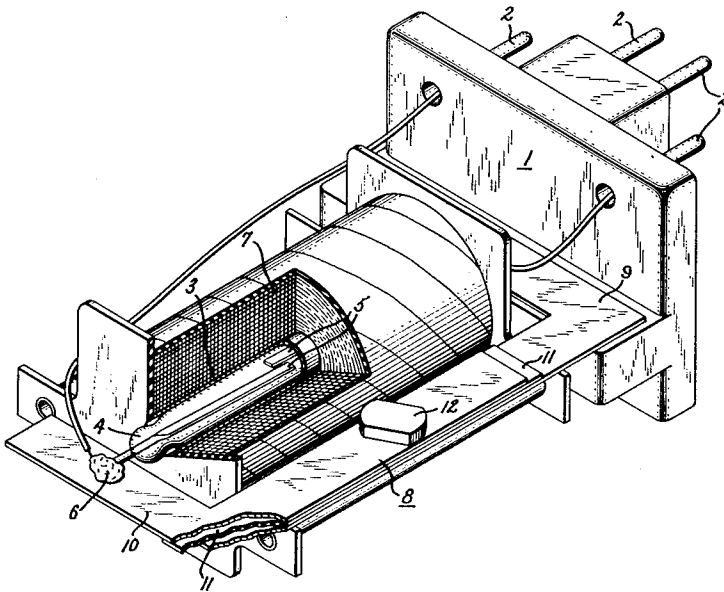


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ELECTROMAGNETIC RELAY

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ELECTROMAGNETIC RELAY

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This invention relates to electromagnetic relays and more particularly to relays employing reed switches to make and break contact with an electrical circuit.

A reed switch usually comprises a pair of elongated and overlapping resilient contact members of soft magnetic material sealed within a non-magnetic non-conducting enclosure. The switch is actuated by axially directed components of an induced magnetic field which causes the two contact members to have a mutual attraction. When the induced field becomes strong enough it overcomes the inherent resilience of the contact members and closes the contacts; when the field strength falls below a certain level the resilience of the contact members again opens the contacts. Such reed switches have been employed in electromagnetic relays heretofore but in constructions with relatively low magnetic efficiency.

It is an object of this invention to provide an efficient reed switch relay having a construction which minimizes the ampere turns required to operate it.

It is another object of the invention to provide a reed switch relay offering a unique adjustment feature to vary the sensitivity of the relay.

The invention has as a still further object the provision of a bistable reed switch relay operable by intermittent electrical pulses of small amplitude.

By way of a brief summary of a preferred embodiment of the present invention a relay is provided in which the actuating windings are coaxial with and surround a reed switch of the type referred to above. The ends of the magnetic reeds in this form of the invention extend beyond the ends of the windings where they are joined to a magnetically permeable yoke which with the reed switch itself completes a magnetic circuit through the inside and around the outside of the actuating windings. In order to prevent short circuiting the ends of the reed switch the yoke is formed of a pair of laminations which overlap each other for a considerable portion of their length, but which are electrically insulated from one another. A rotatably adjustable permanent magnet is affixed to the overlapping portion of the yoke laminations to introduce into the magnetic circuit a flux component which is of a maximum value when the magnet is aligned with the magnetic circuit and of a minimum value when it is transverse to the magnetic circuit.

While the scope of this invention in its broadest aspects is not to be limited except by the appended claims, further details of the invention as well as additional objects and advantages will become more apparent with reference to the accompanying drawing which represents a preferred construction of a plug-in reed switch relay constructed in accordance with these teachings.

In the drawing the relay shown is mounted on a base 1 having plug-in terminals 2 for connection to a socket not shown. At the heart of the relay is situated a magnetic reed switch 3 having a sealed glass envelope 4 enclosing a pair of elongated flexible magnetic contact members or reeds 5. The overlapping ends of these contact members are preferably plated with a suitable contact material such as rhodium, while their opposite ends pass through the envelope to form a pair of external terminals 6. The operating efficiency of a reed switch relay is improved when the switch is placed axially within its operating windings. Windings 7 therefore surround the reed switch to

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supply the operating fluxes lengthwise of the magnetic reeds.

In order to reduce the total ampere turns required to supply the requisite flux component to operate the switch, a magnetic yoke 8 spans the two ends of the reed switch projecting beyond the windings. The combination of the yoke 8 and the reed switch 3 constitute a closed loop magnetic circuit which extends through the inside and about the outside of the operating windings. Beside containing the operating fluxes within a high efficiency magnetic circuit and thereby improving the relay's sensitivity, the magnetic yoke 8 also renders the relay relatively insensitive to external stray magnetic fluxes which might unpredictably alter the operation of the switch.

Naturally, the yoke 8 must be so constructed that it does not electrically short-circuit the two ends of the reed switch rendering it inoperative. One way this might be accomplished would be to form the yoke of an electrically non-conductive magnetic material such as a ferrite. We prefer, however, to form a yoke of a pair of laminations 9 and 10 of a high permeability ferromagnetic material. These laminations overlap each other for a considerable portion of their length, being separated from each other by a thin electrically insulating strip 11. With such a construction the yoke introduces an air gap into the magnetic circuit, but if the area of the overlap between the laminations is made large enough with respect to the thickness of the insulating material, the effect of the air gap on the magnetic circuit is negligible. Our tests have shown that a reed switch relay equipped with such a yoke can be switched with less than one half the ampere turns required to operate a similar relay without the yoke.

This relay incorporates another feature by which the relay can be adjusted to an even greater sensitivity and, if desired, converted to a bistable condition. A permanent magnet 12 is mounted on the magnetic circuit in a region where the magnetic laminations overlap each other. A large portion of the flux produced by the permanent magnet will merely be shunted between its poles by the underlying laminations. However, a significant portion of its flux will traverse the magnetic circuit through the magnetic reeds providing a certain minimum or biasing flux within the reeds. The operating windings therefore have only to produce the differential value of magnetic flux required to close the switch contacts, thereby reducing still further the ampere turns required to operate the switch. Adjustment of the amount of biasing flux introduced by the permanent magnet may be varied simply by rotating the magnet in place. When the magnet is aligned generally parallel to the laminations it will produce the greatest effect, whereas when it is oriented transverse to the laminations its effect will be least.

The adjustment afforded by the rotatable permanent magnet can be employed in many different ways to alter the operation of this switch. Thus, for example, the switch may be adjusted not only for sensitivity but also for precision of response to vary the exact pick-up and drop-out ampere turns to operate the switch. One way a precisely calibrated relay of this sort might be used is as an overvoltage and undervoltage sensing device in a protective circuit.

Again the flux introduced into the magnetic reeds by the permanent magnet can be adjusted to a value great enough to maintain the contacts closed once they have come into contact, but insufficient to close the contacts of its own force. Such an adjustment renders the relay bistable such that it may be opened or closed by a short duration pulse of the proper polarity. The operating windings then, whether opening or closing the contacts, have only to produce a comparatively small differential

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value of magnetic flux. Naturally the windings may be composed of a single continuous coil energized by currents of opposite polarities or of a multiplicity of coils each energized by currents of a single polarity.

The relay illustrated may be given a normally closed operation by increasing the biasing effect of the permanent magnet still further so that the magnetic field of the contact tips of the reed switch is just sufficient to close the contacts. The contacts may be opened then by fluxes of opposing polarity produced by the control windings reducing the field intensity at the contact surfaces thereby permitting the switch to be opened by the inherent resilience of the magnetic reeds. After the desired adjustment of the position of the permanent magnet is achieved, the permanent magnet may be fastened securely in place by cementing, by clamping, or by other means to insure the permanency of adjustment.

Although but one physical embodiment of this invention has been illustrated and described, it will be readily understood by those skilled in the art to which these teachings pertain not only that the invention is capable of multiple uses, but also that many variations in construction will be permissible within the scope of this invention in its broader aspects.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A reed switch relay comprising: a magnetic reed switch including a pair of elongated contact members of magnetic material having contact surfaces overlapping each other, said contact surfaces being biased toward normally open positions and being relatively movable to normally closed positions by a magnetic flux component of sufficient magnitude directed lengthwise of said contact members causing mutual attraction thereof; means for producing switch operating fluxes through said contact members comprising a coil surrounding said contact members and having its magnetic axis generally parallel to the longitudinal axis of said contact members; a pair of magnetic laminations in magnetic contact with opposite ends of said contact members extending exteriorly of said coil into close proximity with each other to form with said contact members a closed magnetic circuit for containing switch-closing magnetic flux components; and magnetic biasing means for said magnetic circuit comprising a permanent magnet spaced from said contact members and mounted on said laminations and providing a magnetic flux component within said circuit insufficient of itself to close said contact members when open but sufficient to maintain said contacts closed.

2. A reed switch relay comprising: a pair of elongated contact members of magnetic material having contact surfaces overlapping each other, said contact surfaces being biased toward normally open positions and being relatively movable to normally closed positions by a magnetic flux component of sufficient magnitude directed lengthwise of said contact members to cause a mutual attraction thereof; control winding means for producing switch operating fluxes through said contact members comprising a coil surrounding said contact members and having its magnetic axis generally parallel to the longitudinal axis of said contact members, a pair of magnetic laminations fixed to opposite ends of said contact members extending exteriorly of said coil into overlapping relationship with each other, said laminations being electrically insulated from each other except through the normally open contact members of said reed switch, said laminations forming with said contact members a closed magnetic circuit for containing switch-closing magnetic flux components; and magnetic biasing means for said magnetic circuit comprising a permanent magnet spaced from said contact members and mounted on the overlapping portions of said magnetic laminations and providing a predetermined magnetic flux component within said circuit thereby reducing the amount of additional flux required to close said contact surfaces.

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3. A reed switch relay comprising: a magnetic reed switch including a pair of elongated contact members of magnetic material having contact surfaces overlapping each other, said contact surfaces being biased toward normally open positions and being relatively movable to normally closed positions by a magnetic flux component of sufficient magnitude directed lengthwise of said contact members causing mutual attraction thereof; means for producing switch operating fluxes through said contact members comprising a coil surrounding said contact members and having its magnetic axis generally parallel to the longitudinal axis of said contact members; a pair of L-shaped magnetic laminations each in magnetic contact with the exterior end of a different one of said contact members said laminations extending exteriorly of said coil into overlapping relationship with each other to form with said contact members a closed magnetic circuit for containing switch-closing magnetic flux components; and adjustable biasing means for said magnetic circuit comprising a permanent magnet spaced from said contact members and rotatably mounted on said laminations.

4. A reed switch relay comprising: a pair of elongated contact members of magnetic material having contact surfaces overlapping each other, said contact surfaces being biased toward normally open positions and being relatively movable to normally closed positions by a magnetic flux component of sufficient magnitude directed lengthwise of said contact members to cause a mutual attraction thereof; control winding means for producing switch operating fluxes through said contact members comprising a coil surrounding said contact members and having its magnetic axis generally parallel to the longitudinal axis of said contact members; a pair of elongated magnetic laminations fixed to respectively opposite ends of said contact members and extending exteriorly of said coil into overlapping relationship with each other, and forming with said contact members a closed magnetic circuit for containing switch-closing magnetic flux components; electrical insulating means disposed between the overlapping portions of said laminations; and magnetic biasing means comprising a permanent magnet spaced from said contact members and rotatably mounted on the overlapping portions of said magnetic laminations.

5. A reed switch relay comprising: a magnetic reed switch including a pair of elongated contact members of magnetic material having contact surfaces overlapping each other, said contact surfaces being biased toward normally open positions and being relatively movable to normally closed positions by a magnetic flux component of sufficient magnitude directed lengthwise of said contact members causing mutual attraction thereof; means for producing switch operating fluxes through said contact members comprising a coil surrounding said contact members and having its magnetic axis generally parallel to the longitudinal axis of said contact members; a pair of L-shaped magnetic laminations having their short sides in magnetic contact with opposite ends of said contact members, and having their long sides extending exteriorly of said coil along one side only of said coil in overlapping relation with each other to form with said contact members a closed magnetic circuit for containing switch-closing magnetic flux components; and insulation between the overlapping portions of said laminations, biasing means spaced from said contact members and disposed to introduce into said laminations a biasing magnetic flux of variable magnitude which traverses said magnetic circuit.

6. A reed switch relay comprising: a magnetic reed switch including a pair of elongated contact members of magnetic material having contact surfaces overlapping each other, said contact surfaces being biased toward normally open positions and being relatively movable to normally closed positions by a magnetic flux component of sufficient magnitude directed lengthwise of said con-

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tact members causing mutual attraction thereof; means for producing switch operating fluxes through said contact members comprising a coil surrounding said contact members and having its magnetic axis generally parallel to the longitudinal axis of said contact members; a pair of L-shaped magnetic laminations having short sides in magnetic contact with opposite ends of said contact members, and having long sides extending exteriorly of said coil along one side only of said coil in overlapping relation to form with said contact members a closed magnetic circuit for containing switch-closing magnetic flux components, insulation between the overlapping portions of said laminations, and a permanent magnet spaced from said contact members and rotatably mounted on the overlapping portions of said laminations.

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References Cited in the file of this patent

UNITED STATES PATENTS

2,289,830	Ellwood	July 14, 1942
2,318,405	Leveridge	May 4, 1943
2,332,338	Peek	Oct. 19, 1943
2,397,123	Brown	Mar. 26, 1946
2,567,827	Stoller	Sept. 11, 1951
2,877,315	Oliver	Mar. 10, 1959
2,898,422	Peek	Aug. 4, 1959
2,902,558	Peek	Sept. 1, 1959
2,907,846	Wilhelm	Oct. 6, 1959
2,978,556	Lohs et al.	Apr. 4, 1961
2,983,792	Nitsch	May 9, 1961