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CIRCUIT CONTROLLING DEVICE

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FIG. 1

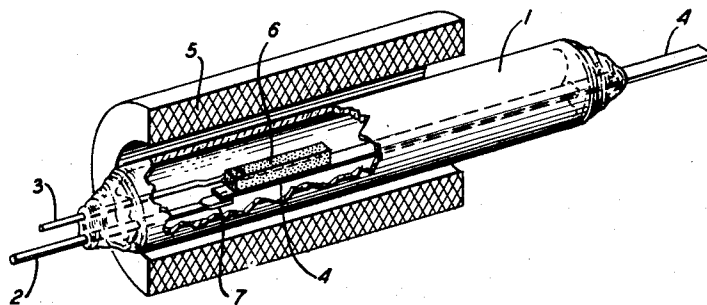


FIG. 2

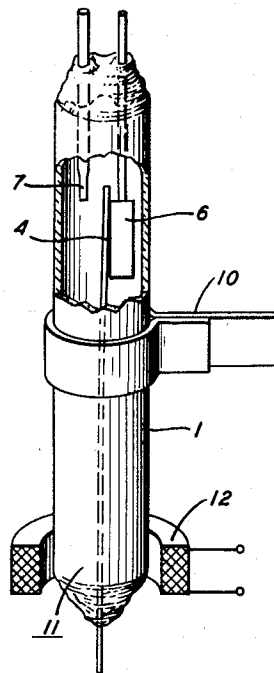
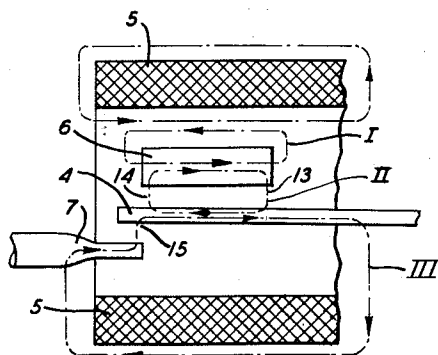


FIG. 3



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CIRCUIT CONTROLLING DEVICE

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9 Claims. (Cl. 200—93)

This invention relates to circuit controlling devices and more particularly to reed type switches or relays of the type disclosed in Patent 2,289,830, granted July 14, 1942, to W. P. Elwood.

Switches of the type disclosed in the noted patent comprise in general a magnetic flexible member or reed which serves as one contact and a second magnetic member which may be rigid or flexible and serves as a second contact, the two members being related so that in response to a magnetic field produced as by energization of a signal coil, the first magnetic member or reed moves relative to the second, thereby to effect engagement or disengagement of the contacts.

Important among the criteria for evaluation of such devices are physical size, sensitivity of operation, stability in both the operated and unoperated states, and facility of assembly.

One general object of this invention is to improve the performance characteristics of reed type switches or relays.

Another general object of this invention is to simplify the structure and facilitate the manufacture of such switches or relays.

It is a specific object of the invention to provide a compact reed type switch or relay that requires no mechanical bias and operates wholly magnetically.

It is another specific object of the invention to provide a reed type switch or relay of economical construction that has positive switching action and which is highly insensitive to shock and vibration.

It is still another specific object of the invention to provide a sealed transfer contact switch that is small, reliable, sensitive, fast, and easy to fabricate.

In one illustrative embodiment of this invention a transfer switch comprises a pair of magnetic contact members and a flexible magnetic member or reed extending between the contact members. The elements recited are mounted in cooperative relationship within a hermetically sealed envelope which is encompassed by a signal coil.

According to one feature of the invention a permanent bar magnet serves as one of the contacts of the switch and a nonmagnetic metal is coated on both contacts and the reed member of the switch.

According to another feature of the invention, the permanent bar magnet provides positive back contact force for the switch and maintains the reed member in a stable position during the unoperated condition of the switch.

According to still another feature of the invention, a signal coil is arranged to provide a flux in the operated condition of the relay which opposes or nullifies the permanent magnet field whereby the reed positively engages the other contact member without the necessity of mechanical bias.

These and other features of the invention will be more fully apprehended from the following detailed speci-

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cation taken in conjunction with the appended drawing in which:

Fig. 1 discloses a perspective view of an illustrative embodiment of the invention with the parts broken away;

Fig. 2 indicates the final step in assembling the embodiment of Fig. 1; and

Fig. 3 discloses a schematic of the magnetic circuits of the switch.

Referring to Fig. 1, the switch consists of a hermetically sealed glass envelope 1 in which are located two conducting members 2 and 3 at one end of the envelope, termed the "contact end." A reed member 4 is positioned at the other end of the envelope, termed the "reed end," so that each face of the reed is adjacent to a conducting member. The reed member 4 and conducting member 2 are made of soft magnetic material. A signal coil 5 encompasses the glass envelope and causes the relay action inside the envelope, as will be explained in detail hereinafter.

A permanent magnet 6 is attached to the conducting member 3 to serve as a back contact. The magnet is further from the "contact end" of the tube than the front contact 7 of the conducting member 2. The reed member 4 normally mates with the magnet and it also extends slightly beyond the magnet and overlaps the contact 7. The reed, the front contact member, and the magnet have plated metal coatings. The inner coating of the members is silver-plate which provides nonmagnetic separation between the members for satisfactory performance of the switch, as will be explained hereinafter. The outer coating of the members is a gold flash since the magnet, reed and front contact are sealed in air and film formation must be minimized for good contact performance. If an inert gas were used, as might be employed in some designs, another choice of contact material could be made, and gold has been chosen herein for purposes of illustration only.

In assembling the switch, the magnet is first spot welded to the conducting member 3 and the magnet and front contact member are positioned with reference to each other in the glass envelope 1 by means of a jig (not shown) while the "contact end" glass seal is made. Turning now to Fig. 2, the final step in assembling the switch is shown. The envelope 1 is held in a support 10 with the "contact end" thereof in the upper position. The reed 4 is inserted into the envelope so that it reaches its normal position which is in contact with the magnet and overlapping the contact 7. The reed is held in this position by the magnet without the use of jigs or other positioning devices while the "reed end" glass seal 11 is made with heating device 12. It will be evident that in the completed structure the reed is properly positioned in its normal position and is free of mechanical strain or bias. Further, the simplicity of construction and ease of fabrication render the switch suitable for mass production techniques.

The operation of the switch will now be described with reference to Fig. 3. In the normal unoperated condition of the switch the reed 4 is in physical and electrical contact with the magnet 6. However, the reed and magnet are separated by small nonmagnetic gaps 13 and 14. A nonmagnetic gap 15 also exists between the reed 4 and the front contact 7 and this gap is relatively large as compared to gaps 13 and 14. The nonmagnetic gaps comprise the coatings on the elements described hereinbefore as well as the air gaps between the elements. The magnetic circuit of the switch has been simplified by representing the coatings on elements 4, 6 and 7 as air gaps.

When the relay is operated and the reed 4 moves away from the magnet 6 and makes physical and electrical

contact with the member 7, the gap 15 becomes small and the gaps 13 and 14 become relatively large.

The magnet field has two principal parts which follow the paths marked I and II. The field in path I follows an air return path whereas the field in path II passes through the gap 13 and the reed 4, and for the most part returns to the magnet through the gap 14. A very small portion of the field in the path II passes through the air gap 15 and returns to the magnet through the air path between the magnet 6 and the front contact 7 (not shown). Because of the length of the latter air path the field returning by way of the gap 15 is very small compared to the field returning by way of the gap 14. Hence, in the normal or unoperated condition of the switch substantially all of the magnet field passes through the gaps 13 and 14 where it exerts forces attracting the reed to the magnet 6.

In the operated condition of the switch the coil 5 is energized so as to produce a field in the same direction as that within the magnet 6. The coil field predominately follows a path III and it passes through the reed 4 in the sense opposite to the field in path II. As a consequence, the magnet field in the reed is substantially nullified and diverted to follow path I thereby decreasing the field in the gaps 13 and 14. As this occurs, the coil field in gap 15 increases so that at a predetermined level of coil energization the pull at the contact member 7 exceeds the opposite pull of the fields in the gaps 13 and 14. The reed, as a result, moves from the magnet to the contact member 7 and is held there by the field through the now shortened gap 15 while the coil is energized.

Deenergization of the coil destroys the field of path III, and the magnet field in path II then restores the reed to the normal position. As the reed moves, the gaps 13 and 14 become smaller and the field in path II increases at the expense of the field in path I. Consequently, the pull on the reed increases as it approaches the normal position.

The nonmagnetic coating on the reed and magnet serves to limit the field in the path II during operation of the switch. The nonmagnetic coating on the contact member 7 serves to keep the field in gap 15 small upon deenergization of the coil. Thus, the coatings contribute to the proper performance of the switch.

It will be noted that the coil field substantially nullifies and replaces the permanent magnet field or, in effect, the coil field shunts out the permanent magnet field. In contrast, the coil field of prior art devices serially combines with at least one or more permanent magnet fields in combination with mechanical bias to effect a switching action. Thus, in the present invention, a single permanent magnet and signal coil accomplish switching action without the aid of mechanical bias. The present invention, therefore, provides a small and compact relay which is of economical construction and less expensive to manufacture than prior art transfer relays of the reed type.

Since the reed is moved by the coil and the permanent magnet fields only, the switch does not require mechanical bias. Further, the magnetic fields of the switch positively position the reed in both the operated and unoperated conditions, so that the relay is relatively insensitive to shock and vibration.

The invention offers a number of convenient means for controlling the sensitivity of the switch during and after manufacture. For example, the thickness of the nonmagnetic coating, and the overlap of the front contact are factors which may be readily controlled during manufacture for desired switch sensitivity. The use of metal shielding members on the coil 5, as is well known in the prior art, would reduce the reluctances of the air return paths or effectively shorten such paths thereby offering other possible means for controlling the sensitivity of the switch. It has also been determined that positioning the

coil 5 so that the magnet 6 and contact 7 are covered thereby also improves the sensitivity of the switch.

Finally, the stiffness of the reed and the force of the magnet are amenable to ready control during manufacture whereby desired speed, contact force and sensitivity can be realized. After assembly of the switch, the magnetization of the permanent magnet may be adjusted through energization of an appropriately poled coil disposed about the magnet, thereby further controlling the characteristics of the relay.

In summary there has been disclosed herein a reed switch having a novel configuration and magnetic circuit for accomplishing switching action. The switch is of small physical size and readily fabricated in manufacture. The operation of the switch is improved in that it is positive, highly insensitive to shock, and requires no mechanical bias, as the switching is performed wholly magnetically. Also, the sensitivity of the switch is amenable to control during and after manufacture.

It is to be understood that the above-described structure is illustrative of the application of the principles of this invention. Numerous other modifications of the structure may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A circuit controlling device comprising a rigid magnet, a magnetic member fixed at one end and having a portion normally mating with said magnet, the return field path of said magnet passing through the member, a magnetic contact member in cooperative relation with said member, and means for substantially nullifying the return field through said member whereby the member moves relative to said contact.

2. A circuit controlling device comprising a bar magnet having poles at opposite ends of one major face thereof, an unbiased magnetic reed fixed at one end and having a portion spaced from said end normally mating with said major face, said reed being magnetically separated from said magnet, the return field path of said magnet passing through the reed, a magnetic contact facing the face of said reed opposite said major face of said magnet, and means for substantially nullifying the return field through said reed, whereby the reed moves relative to said contact.

3. A circuit controlling device comprising a bar magnet having poles at opposite ends of one major face thereof, a magnetic reed fixed at one end and having a portion spaced from the other end normally mating with said major face, said reed lying in the return field path of said magnet, a magnetic contact facing the face of said reed opposite said major face of said magnet, said reed, magnetic contact and magnet being coated with a nonmagnetic material, and means for substantially nullifying the return field through said member whereby the member moves relative to said contact.

4. A circuit controlling device comprising an unbiased magnetic reed mounted at one end thereof, a magnetic contact opposite one face of said reed and overlapping the other end of said reed, a bar magnet opposite the other face of said reed and normally mating with said reed at a position spaced from the other end of the reed, said magnet, contact, and reed being coated with a nonmagnetic material, and a signal coil encompassing said reed, magnet, and contact whereby energization of the coil causes the reed to move relative to said contact.

5. A circuit controlling device comprising an unbiased magnetic reed fixed at one end, a bar magnet having poles at opposite ends of one major face thereof, said major face normally mating with one side of said reed at a first predetermined distance from the unfixed end of said reed, the return field of said magnet passing through the reed, a magnetic member facing the other side of the reed and overlapping the unfixed end of the reed for a second predetermined distance, the second pre-

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determined distance being less than the first predetermined distance, said magnet, magnetic member, and reed being coated with a nonmagnetic metal, and means for substantially nullifying the return field of the magnet whereby the reed moves relative to the contact.

6. A circuit controlling device comprising an unbiased magnetic reed fixed at one end, a bar magnet having poles at opposite ends of one major face thereof, said major face normally mating with one side of said reed at a position spaced from the unfixed end of said reed, a magnetic member facing the other side of the reed and overlapping the unfixed end of said reed, the return field of said magnet passing through the reed, said magnet, magnetic member, and reed being coated with both a nonmagnetic metal and an oxidizing resistant metal, and a signal coil encompassing said magnet, reed and contact whereby energization of the coil causes said reed to move relative to said contact.

7. A circuit controlling device comprising an unbiased magnetic reed fixed at one end, a bar magnet having poles at opposite ends of one major face thereof, said major face normally mating with one side of said reed at a position spaced from the unfixed end of said reed, a magnetic contact facing the other side of the reed and overlapping the unfixed end of the reed, said magnet, reed, and contact being coated with both a nonmagnetic metal and an oxidizing resistant metal, the magnet, reed and contact being mounted within a sealed vessel, and a coil surrounding the vessel and encompassing the magnet, reed, and contact whereby energization of the coil causes the reed to move relative to the contact.

8. A circuit controlling device comprising a bar magnet having a nonmagnetic plating thereon, an unbiased magnetic member having a nonmagnetic plating thereon, said member being fixed at one end and having a por-

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tion of one face thereof in physical contact with said plated magnet, the member and magnet being magnetically separated by said plating, the return field path of the magnet passing through the member, a magnetic contact having a nonmagnetic plating thereon and overlapping the other face of the member, and a signal coil encompassing the magnet, member, and contact whereby energization of the coil nullifies the return through the field member and causes the member to move relative to the magnet.

9. A circuit controller comprising a support, spaced parallel electrodes of magnetic material secured to one end of the support, one of said electrodes including at its free end a bar magnet extending beyond the other electrode toward the other end of the support, a flexible reed secured to said other end of the support in generally parallel relation to said electrodes and having a portion adjacent its free end attracted by and in electrical contact with the magnet and overlapping but spaced from said other electrode, the interfaces of the bar magnet, the reed, and the other electrode each having a nonmagnetic conducting layer thereon, and an operating magnet means, which, when activated provides a magnetic field through the reed and said other electrode, said field being in a direction to oppose the bar magnet field in the reed whereby the reed is released from the magnet and attracted to said other electrode.

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