

Sept. 1, 1959

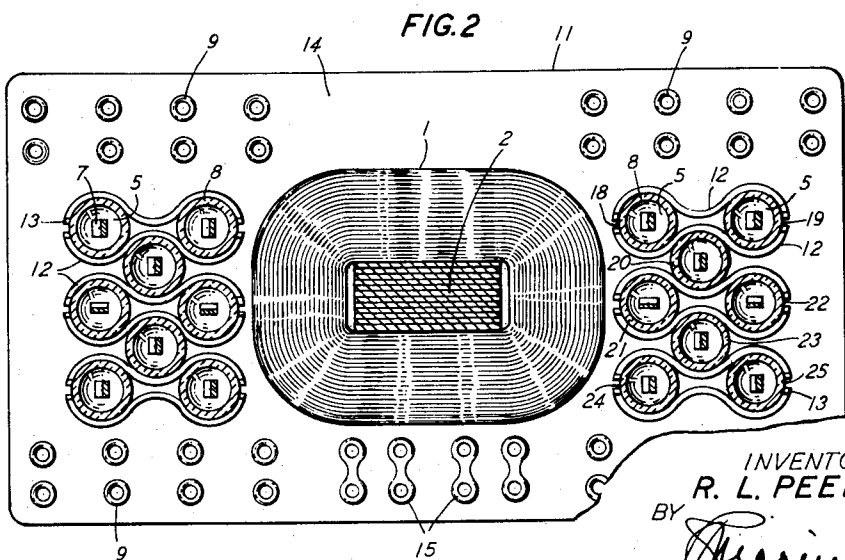
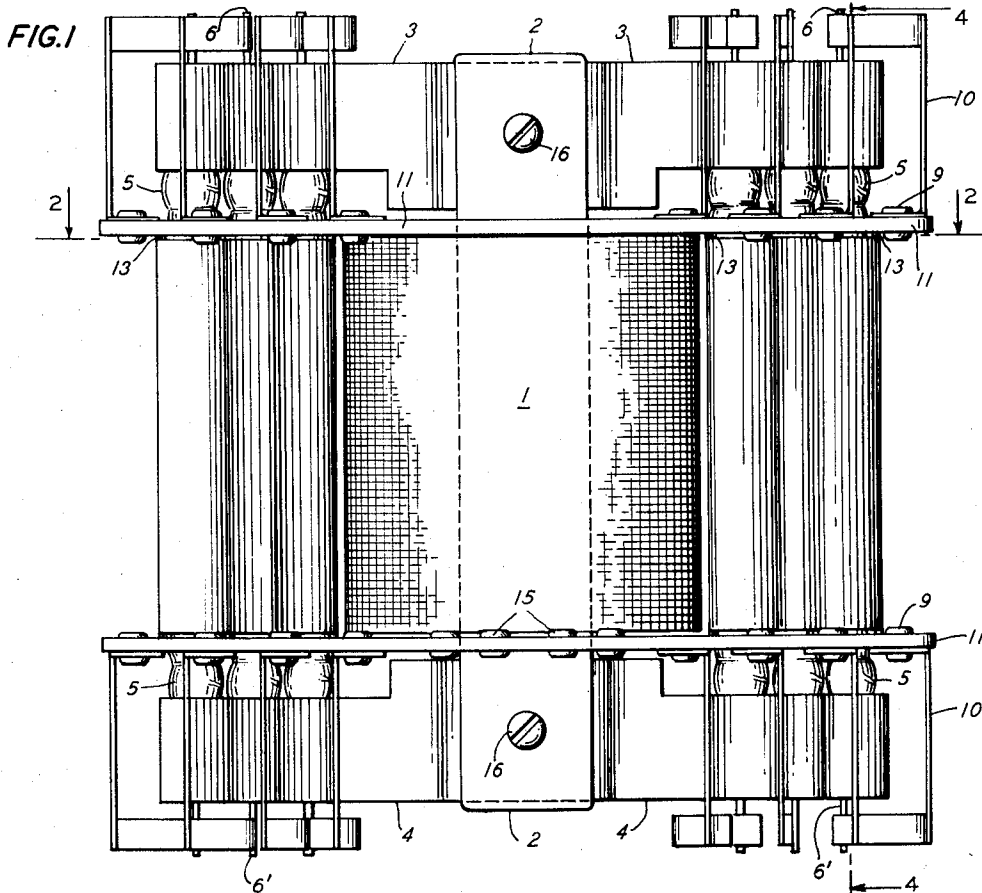
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2,902,558

LAMINATED CORE DRY REED RELAY

Filed Feb. 17, 1955

3 Sheets-Sheet 1



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FIG. 3

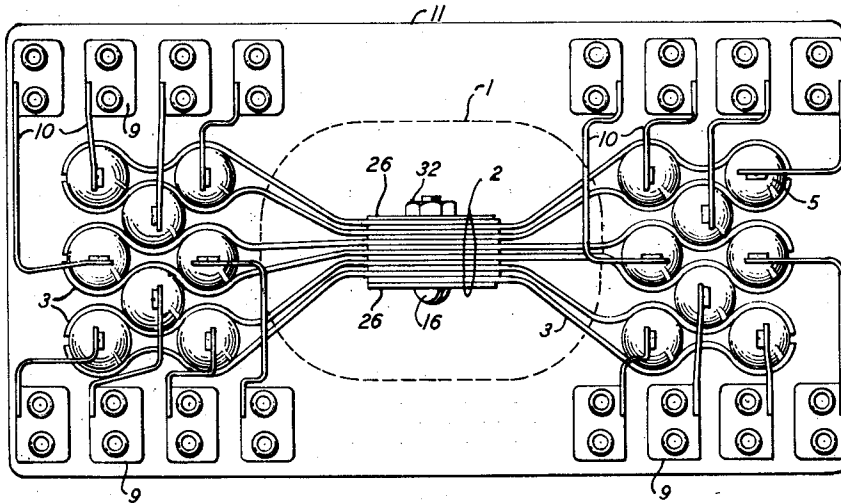
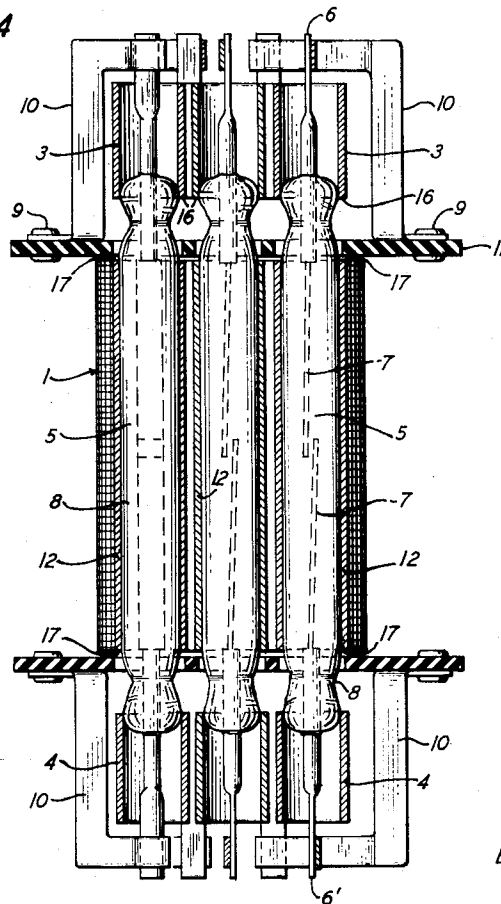


FIG. 4



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FIG. 5

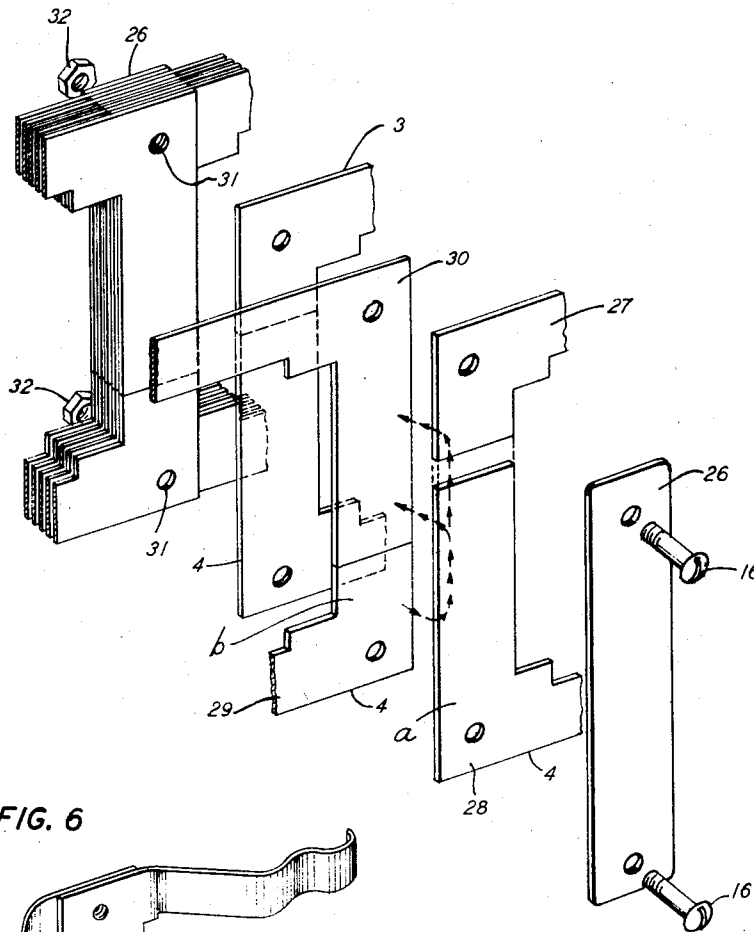
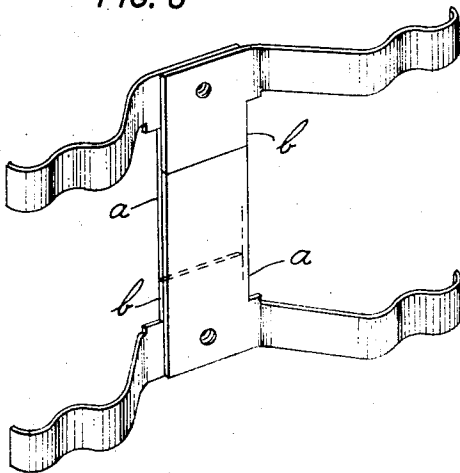


FIG. 6



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LAMINATED CORE DRY REED RELAY

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Application February 17, 1955, Serial No. 488,778

9 Claims. (Cl. 200—87)

This invention relates to relays of the electro-magnetic circuit controlling type having sealed reed switch units as the contact-making elements.

Relays of the general type herein contemplated are well known in the art, as is illustrated by Patent 2,289,830 granted July 14, 1942 to W. B. Ellwood. Such relays are widely used in the field of communications, especially in telephone switching systems, although they have been used in other systems, for example, lighting systems to which design of the relay disclosed in Patent 593,230 granted to Daniel McFarlan Moore on November 9, 1897, was specifically directed.

Relays having enclosed, sealed contact-making devices or switch elements are advantageous in that the contacts are not subject to corrosion or malfunctioning because of misalignment or deposits of foreign matter upon the surfaces thereof. Switch elements are aligned during manufacture and permanently sealed in place within the enclosures, thus preventing subsequent misalignment or other misadjustment. In addition, these relays have advantages such as rapid speed of operation. In prior art relays, however, realization of these advantages has not been without partial sacrifice of other desirable characteristics. For example, relays of this latter type have generally been more bulky, more expensive to manufacture, and somewhat less sensitive than similar varieties having non-sealed contacts.

Heretofore proposed relays of the type comprehended by this invention have been arranged structurally to include the mounting of the associated sealed reed switch units both within and without the energizing coil. Where large numbers of units are to be controlled by one coil, preference has been given to those designs in which the units are mounted external to the coil, the reason being the possibility of using a coil of superior efficiency. Superior efficiency is possible because the coil is smaller (the opening within the coil being smaller in designs in which switches are mounted outside the coil) and because the coil operating power required varies as the square of the coil mean length of turn. Where only a few sealed switch units are to be controlled by one coil, they may be mounted within or projecting through the energizing coil without unduly increasing its size. The subject-matter of the invention disclosed in Patent No. 2,836,676, granted to H. J. Wirth, Jr., on May 27, 1958, is based on this type of design and is enabled thereby to incorporate a unique magnetic structure whereby cost is greatly decreased, assembly and disassembly are facilitated, and bulk is substantially minimized.

One principal object of this invention is to improve sealed switch relays in respect to their magnetic efficiency, size, cost and sensitivity of operation, and to exemplify the attained improvements in relays of the above type having a plurality of sealed switch units mounted external to the core.

According to one feature of the invention, a laminated magnetic core structure is provided with lamination extensions formed to follow the curvature of the switch unit

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enclosures, whereby the extensions serve both as paths for the magnetic flux and as clamps to hold the sealed switch units, thus simplifying assembly and facilitating switch removal for replacement.

In accordance with another feature of this invention, magnetic core lamination extensions are made to diverge and are curved to closely follow the switch structure enclosure surfaces, thereby decreasing the bulk inherent in such structures and providing more efficient paths for magnetic operating flux, thus increasing sensitivity.

In accordance with another feature of this invention, the magnetic members may be stamped and pressed from resilient sheet magnetic material, and the switch units are held in place by frictional forces existing between the magnetic member extremities and the units, thereby resulting in a simplified relay structure that facilitates assembly and disassembly and thereby reducing manufacturing and maintenance costs.

These and other features of this invention will be apparent from the following description with reference to the drawing in which:

Fig. 1 shows a front elevation of an embodiment of the invention;

Fig. 2 is a horizontal view taken through the section line 2—2 of Fig. 1;

Fig. 3 is a plan view of the embodiment of Fig. 1;

Fig. 4 is a side sectional elevation along the section line 4—4 of Fig. 1;

Fig. 5 shows a partially exploded perspective view of the laminated core; and

Fig. 6 shows an assembly of four contiguous members complete with their curved extremities.

Now referring to the figures in which the same designations refer to the same parts, it will be noted that the relay comprises three main parts, the coil 1, the magnetic structure comprising the members 2, 3 and 4, and the plurality of sealed reed switch units 5. Each of these will now be described in detail, after which the various subordinate members will be individually discussed. Finally, the assembly and interrelation of the members will be explained.

The coil 1 may be of conventional design in that it may comprise a plurality of layers, each layer having turns of some suitable highly conductive material, such as silver, copper or aluminum wire. Each layer should preferably be separated from adjacent layers by a suitable insulating medium such as impregnated paper or sheets of cellulose acetate. The number of turns and the size of wire comprising the winding will depend upon the operating potential. Thus, by way of example, one representative energizing coil for use in a relay having ten sealed switch units, for instance, and for operation with 50 volts across its terminals, may comprise 76 layers, each layer having 460 turns of No. 41 copper wire, thus comprising a total of 34,960 turns.

The magnetic core 2 is made up of complementary and substantially L-shaped laminations (3 and 4) of a suitable magnetic material such as soft iron. A lamination 3 differs from a lamination 4 only in the length of its core leg, the remaining legs of both being bent at appropriate angles contoured at their extremities to rest yieldably on the surface of the switch enclosures and to hold them securely in position. As shown in Fig. 5, the core 2 is produced by alternately interleaving a lamination having a long core leg (a) with a lamination having a short core leg (b), and to butt the long core leg (a) of a lamination having said long core leg (a) against the short core leg (b) of a lamination having said short core leg (b). In this manner, each group of four contiguous laminations form an H-shaped pattern, the bottom and upper exterior legs of the several laminations extending oppositely to engage switch units being bent

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and contoured in accordance with the location of said units. As more particularly illustrated in Fig. 6, this pattern is repeated for each four laminations to obtain a staggering of butt joints throughout, thereby to reduce magnetic reluctance. The laminations, when interleaved as above described, are stacked together and clamped by holding bolts 16 and nuts 32. In addition, the magnetic members 2, 3 and 4 serve as low reluctance paths to convey magnetic flux induced by the coil 1 from the coil to the individual switch units to provide operating flux, the magnetic flux flowing from the laminated core 2 through the divergent members 3, across the air gaps separating members 3 and the reeds 7, through the reeds (and across the gaps separating the reed contacts when they are open), across the air gaps at the opposite extremities of the switch units, through magnetic structure members 4 and back to the laminated core 2.

Magnetic paths through the core structure 2 may be visualized by considering members 29 and 30 in Fig. 5, together with members lying adjacent thereto. One obvious magnetic path connecting members 29 and 30 lies across the minute air gap at the butt joint between the members. Other and somewhat less obvious paths are indicated by the dotted arrows. One of these paths lies across the minute air gap between the adjacent contacting surfaces of members 29 and 28, through the vertical section of member 28, past the adjacent butt joint between members 29 and 30, and across the minute air gap separating the adjacent surfaces of members 28 and 30. Another parallel path lies across the minute air gap separating the adjacent surfaces of members 29 and 28, through the vertical section of member 28, across the minute air gap at the butt joint between members 28 and 27, into the vertical section of member 27, and across the minute air gap separating the adjacent surfaces of members 27 and 30. Other similar parallel paths exist through similar laminated members also located adjacent to members 29 and 30 but lying at the opposite side thereof. Repetitive staggering of the laminated members results in the provision of similar parallel magnetic paths around each butt joint with the exception of the two outer butt joints, and for these, substantially similar paths exist through the outside holding members 26. By means of this arrangement or others similar to it, a magnetic path of low reluctance is obtained.

The sealed reed switch units 5 may be of the type disclosed in the hereinbefore-mentioned patent to W. B. Ellwood, and each may take the form of a cylindrical enclosure 8 of electrically insulating non-magnetic material such as glass, into which are extended a pair of reeds 7 from substantially opposite ends. These reeds 7, which are of magnetic material such as soft iron and which may be coated with other material or have precious metal contact surfaces, are positioned to overlap at their inner extremities, which in the absence of magnetic flux, are separated by a small distance. In response to induction of magnetic flux within the reeds, the extremities are engaged, thereby completing an electrical path through the switch unit from one electrode 6 to the opposite electrode 6'.

Supporting and auxiliary members are required to secure assembly of the major parts heretofore mentioned and to provide support for connecting terminals. Supporting members 11 are positioned immediately adjacent to the ends of the coil 1 and may be of any suitable non-magnetic material such as phenolic fibre. They are drilled to allow insertion of the sealed reed switch units 5 and provide for mounting the sealed switch terminals 9. The lower member is also drilled to accommodate terminals 15, of which two per coil winding would be required, the illustrated embodiment showing four terminals for a coil 1 having two windings. Conductive members 10, two of which are provided to connect sealed switch

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electrodes 6 and 6' to terminals 9, may be soldered to the electrodes and riveted to the terminals 9 and supporting members 11. Similarly, leads from the coil 2 may be soldered to the terminals 15, which may also be riveted to the supporting member 11.

The sealed reed switch units 5 are divided into two groups located at opposite sides of the energizing coil 1. The curved magnetic biasing members 12 partially surround the switch units, extend along their axes the major part of the distance between the two supporting members 11, and may be fabricated from any suitable permanent magnet material such as vicalloy. The outer biasing members may be retained in position by any suitable device as, for example, cement or the tabs 13 which fit into slots in the supporting members 11, whereas the inner members may be held in place by the switch units themselves. The use of magnetic biasing members permits altering the operating characteristics of the dry reed switch units to provide units having normally closed contacts and units having magnetically locked contacts in addition to the non-biased units which have normally open contacts. Normally closed contacts are those contacts that are closed when the coil is deenergized and which are open when the coil is energized, whereas, magnetically locked contacts are those contacts that remain closed after the coil has been energized and which are reset to the open position by a resetting pulse of opposite polarity introduced through the coil winding. Thereafter, the magnetically locked contacts remain open until the coil is reenergized with proper polarity. Either normally closed or magnetically locked contacts may be obtained through the use of similarly shaped members, the difference in operating characteristics being caused by a difference in strength of the coercive magnetic force exerted. A biasing member having a moderate coercive force is used to obtain locking of the contacts subsequent to closure, whereas a member having a strong coercive force is used to obtain normally closed contacts. The polarities of the biasing members 12 should be arranged in a manner dependent upon the polarity of the energizing coil, the principle of operation being as follows: For normally closed contacts, the flux induced by the permanent magnet biasing members 12 should be of opposite polarity to that induced by the coil 1 in order that energization of the coil may result in substantial cancellation of flux in the reeds 7 to allow the reeds to separate. In the case of the magnetically locked contacts, polarity of the flux induced by the permanent magnet biasing members 12 should be the same as that of the flux induced by the operating coil in order that the two fluxes may aid each other in operating the contacts. For magnetically locked contacts, the flux produced by the permanent magnet biasing members 12 should not be of sufficient magnitude to cause the contacts to close, however, because much less flux is required to maintain them closed than to close them; the permanent magnet biasing members 12 should be designed to have sufficient flux to retain the contacts in the closed position, but not to cause them to close when open. The coil 1 ordinarily is designed to provide sufficient magnetic flux to saturate the reeds without any assisting bias flux; and in those embodiments of this invention that have magnetically locked contacts, reset is accomplished by reversing the polarity of the coil induced magnetic flux to cause sufficient reduction of the resultant flux to allow the reeds or contacts to separate. If the biasing means for one or more of the magnetically locked switches is oriented to display a polarity opposite to that of the others, the resetting pulse for the others will be the operating pulse for the oppositely polarized switches and vice versa.

As previously mentioned, the sealed reed switch units 5 are arranged in two groups located at opposite sides of the energizing coil 1. In accordance with the embodiment illustrated, it is necessary that all switch units

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within a group have similar operating characteristics, that is, all be normally open, all be normally closed, or all be magnetically locked. The reason for this will be apparent from a consideration of the right-hand group of sealed switch units, as shown in Fig. 2, to which identifying designations 18, 19, 20, 21, 22, 23, 24 and 25 have been additionally assigned. In order to provide magnetic bias for switch units 18 and 19 it is necessary to install two magnetic biasing members 12. However, the inner member 12, when installed, will provide half bias for switch unit 20, and in order to effect correct operation of the latter unit it is necessary to install an additional member to provide full bias. When this additional member is installed, full bias will be provided for unit 20; however, the additional member will also provide half bias for units 21 and 22, thereby necessitating the installation of an additional biasing member. Similar unbalance results with the addition of each biasing member until the outermost member adjacent to units 24 and 25 is added. It can, therefore, be seen that it is necessary for all units in a group to have the same bias. However, any combination of contacts may be had as between groups, for example, one group may contain all normally open contacts and the other group all normally closed contacts; or one group may contain all normally closed contacts and the other group all magnetically locked contacts; or one group may contain all normally open contacts and the other group all magnetically locked contacts; or both groups may contain all normally open contacts, or all normally closed contacts, or all magnetically locked contacts.

Modification of the magnetic biasing members 12 may be made, however, to provide individual biasing for each switch unit, thereby permitting the inclusion of contact-making members having different operating characteristics within a given group. This modification comprises altering the shape of the magnetic biasing members 12 to form cylinders individual to each switch unit. Each switch unit may thus be biased separately and, as previously explained, may either be mounted without a biasing member to operate normally, be mounted enclosed in a high coercive force cylindrical member to operate normally closed, or be mounted enclosed in a medium coercive force cylindrical member to operate magnetically locked.

Relays constructed in accordance with the present invention and having all normally open contacts may be constructed with increased sensitivity by altering the shape of the clasp elements 3 and 4. Referring to Fig. 1, the width of these elements and their location with respect to the switch units 5 are influenced by the quantity of flux required to operate a switch, said flux being in turn a function of the number of ampere-turns in the energizing coil 1, the reluctance of the magnetic circuit, and the coercive force exerted by the magnetic biasing members 12. With the biasing members present, there are two sources of coercive force, namely, the energizing coil and the biasing members. Each source has parallel magnetic circuits for the induction of magnetic flux, the coil having one circuit from the core 2, through magnetic structure members 3, across the air gaps to the switch reeds 7, along the reeds, across the air gaps to members 4, and then back through magnetic structure members 4 to the coil core 2; an additional circuit comprising the core 2, the upper magnetic structure members 3, the air gaps and support member 11 separating the inner horizontal surfaces 16 (Fig. 4) of structure members 3 from the horizontal surfaces 17 of biasing members 12, the biasing members 12, and similar magnetic path elements back to the core. Because of these parallel paths, the distance between the above-mentioned horizontal surfaces is made substantially greater than the distance from structure members 4 to the switch reeds, thereby causing the path from the

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structure members to the reeds to have a substantially lower reluctance than the path from the structure members to the biasing members; and the major portion of the coil-induced magnetic flux will, therefore, follow the path of least reluctance through the switch unit reeds to operate the reed contacts.

Similarly, permanent magnet biasing members 12 have parallel circuits in which to induce magnetic flux, one obvious circuit being through the switch units, another being through the magnetic structure via the latter route above described as being a circuit for flux induced by the coil. Inasmuch as flux induced in the latter circuit is of no value in providing bias, it is desired to provide an air gap between the surfaces 16 and 17 of substantially greater length than the air and glass gaps between the biasing members 12 and the switch reeds 7, thus concentrating the bias flux in the switch unit reeds. Therefore, in designs of the type comprehended by this invention, if biased switch units are to be included, it is necessary to design and install the magnetic structure extremity members 3 and 4 in such manner that their ends 16 are separated from the ends 17 of the magnetic biasing members 12 by a relatively substantial distance. This design prevents substantial extension of the width (Fig. 4) of the magnetic structure extremity members 3 and 4, thereby preventing further substantial enlargement of the inner surface areas from which magnetic operating flux must flow across the air gap to the switch unit reeds as previously explained. Inasmuch as the major portion of the total operating circuit magnetic reluctance resides in the aforementioned gaps between members 3, 4 and the reeds, and inasmuch as the reluctance of each gap varies inversely as a function of the area of the surfaces at the extremities of the gap, further substantial lowering of magnetic circuit reluctance is prevented.

Recognizing, as hereinbefore explained, that lowered operating circuit reluctance may be reflected in increased operating sensitivity, advantage is taken of the elimination of the shunt magnetic operating flux paths through the biasing members 12 in designs comprehending all normally open contacts. There, the magnetic structure extremities 3 and 4 may be substantially extended along the axes of the switch units toward the centers thereof to increase the surface areas adjacent to the air gaps, thereby resulting in lowered circuit reluctance. This lowered circuit reluctance is reflected in a reduction in the number of operating coil ampere turns required to operate the switch units.

While I have illustrated my invention by a particular embodiment thereof, said invention is not limited in its application to the specific apparatus and particular arrangement therein disclosed. Various applications, modifications and arrangements of the invention will readily occur to those skilled in the art.

What is claimed is:

1. In a relay having an energizing coil, a magnetic circuit for said coil including magnetic structure and at least one switch unit arranged serially in said circuit and exterior to said coil, said magnetic structure comprising a member extending through said coil and having a curved surface at its extremity to engage and grip said switch unit at one end of the enclosure thereof.

2. In a relay having an energizing coil, a magnetic circuit for said coil including magnetic structure and a plurality of sealed switch units arranged in parallel magnetically, each of said plurality of switch units being arranged serially in said magnetic circuit and exterior to said coil, said magnetic structure comprising a member mounted within said coil and extending without said coil, having at its extremities a plurality of curved surfaces adapted to engage and grip the ends of the enclosures of one or more of said switch units.

3. In a relay having an energizing coil, a magnetic circuit for said coil including magnetic structure and a

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plurality of sealed switch units arranged in parallel magnetically and in parallel axially, each one of said plurality of switches being arranged serially in said magnetic circuit and exterior to said coil, said magnetic structure comprising a plurality of members mounted within said coil and extending without said coil, each of said members having a curved surface at its extremity to partially surround and grip one or more of said switch unit enclosures at the end thereof.

4. In a relay having an energizing coil, a magnetic circuit for said coil including magnetic structure and a plurality of sealed switch units arranged in parallel magnetically and in parallel axially, each of said plurality of switches being arranged serially in said magnetic circuit and exterior to said coil, said magnetic structure comprising a plurality of metallic laminations mounted within said coil and extending without said coil, said laminations having curved surfaces to partially surround and grip said switch units.

5. In a relay having an energizing coil, a metallic magnetic circuit for said coil including magnetic structure and a plurality of sealed switch units arranged in parallel magnetically and in parallel axially, each of said plurality of switches being arranged serially in said magnetic circuit and exterior to said coil, said magnetic structure comprising a plurality of nonlinear metallic laminations mounted within said coil and extending without said coil, said laminations having semicylindrical surfaces near their extremities to partly surround and grip said switch units at the ends thereof.

6. A relay according to claim 5 in which said magnetic structure further comprises magnetic biasing means arranged adjacent to said switches to hold said switches in their operated position after the deenergization of said coil and until said coil induces magnetic flux of a given opposite polarity.

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7. A relay according to claim 5 in which said magnetic structure further comprises magnetic biasing means arranged adjacent to said switches to cause said switches to operate and to remain operated until said coil induces flux of a given polarity, said biasing means being arranged to cause said switches to open in response to said operating coil flux.

8. A relay having a magnetic structure comprising a core and a plurality of pairs of pole-pieces, an energizing coil mounted on said core, and a switch unit for each of said pairs of pole-pieces, each of said pairs of pole-pieces being formed to partially surround and hold a switch unit.

9. A relay according to claim 5 in which said magnetic structure further comprises a biasing means for each one of said switches, certain of said biasing means being of one polarity and others of said biasing means being of an opposite polarity, the flux of certain of said biasing means holding their associated switches in their operated position after energization and deenergization of said coil, the reduction of the flux in said others of said biasing means releasing their associated switches from their operated position concurrent with the energization and deenergization of the said coil.

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