July 14, 1964 T. N. LOWRY 3,141,079

MAGNETICALLY CONTROLLED SWITCHING DEVICES

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FIG. 2A FIG. 2B FIG. 2C

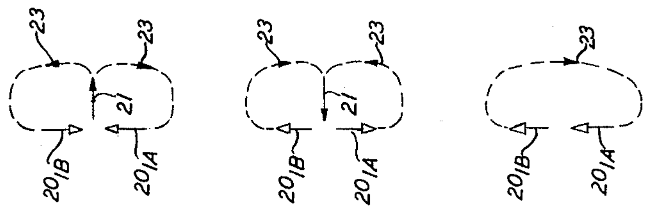
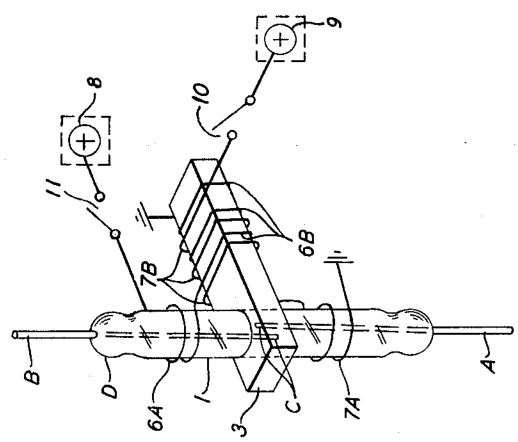


FIG. I



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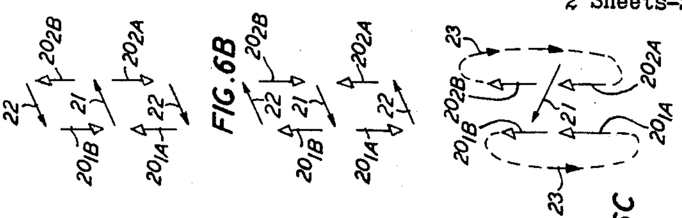

FIG. 6A FIG. 6B FIG. 6C

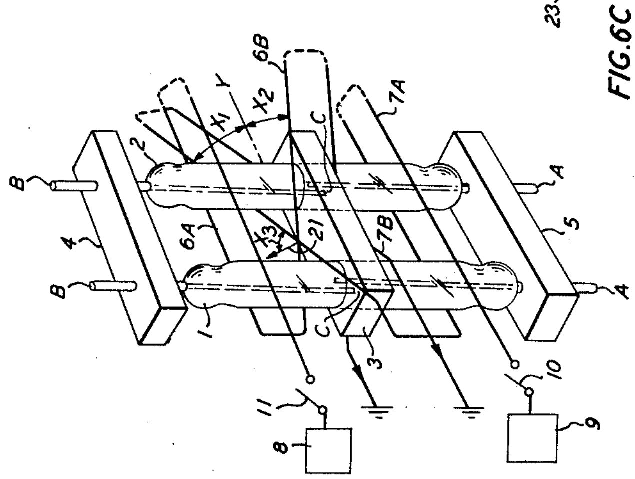

FIG. 5

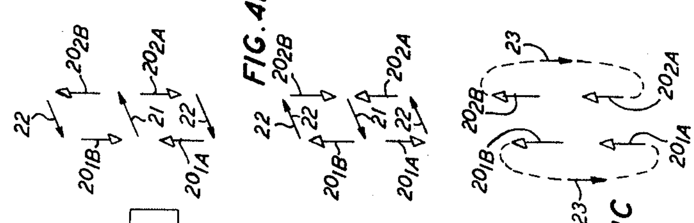

FIG. 4A FIG. 4B FIG. 4C

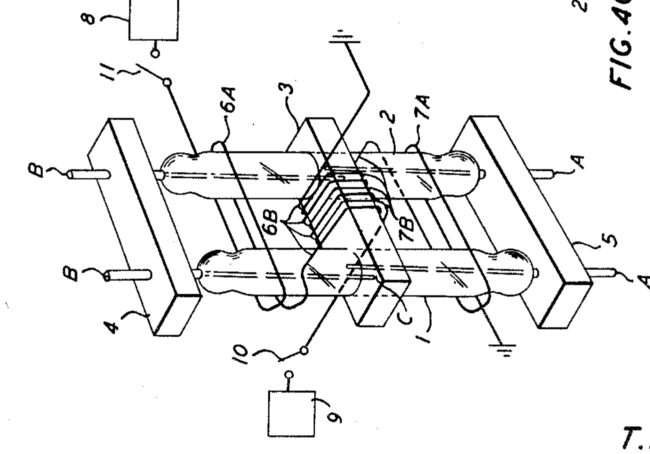

FIG. 3

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MAGNETICALLY CONTROLLED SWITCHING DEVICES

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Filed June 29, 1962, Ser. No. 206,501
19 Claims. (Cl. 200—87)

This invention relates generally to switching devices, particularly to such devices utilizing magnetic fields to effectuate movements of the contacting elements thereof, more particularly to such devices further employing shunt magnetic flux to control the magnetic fields and fluxes in the neighborhood of the contacting elements, and specifically to such devices which employ combinations of the shunt magnetic flux and the contact magnetic fluxes to control the operations of the contacting elements.

In the prior art there are various examples of switching devices which employ a combination of contact magnetic fluxes and shunt magnetic fluxes to effectuate control of their operations. These devices tend to have a permanent magnet and a highly permeable magnetic shunt. A bias flux is produced by the permanent magnet, and a shunt flux is produced in the shunt. The direction and magnitude of the bias flux are controlled in a particular manner by the shunt flux, and consequently the operation of the device is selectively controlled. These aforementioned and other operating characteristics can be more readily understood by considering specific examples of such prior art devices.

One example of such devices employs a sealed reed switch having a permanent magnet adjacent substantially the lengths of both of the reeds and a magnetic shunt magnetically coupled to the permanent magnet. Normally, a substantial portion of the bias magnetic flux from the permanent magnet flows into the shunt and the remainder of the flux flows through the reeds but is of an insufficient quantity to operate the device. To operate the device an actuation current is applied to the shunt to cause a magnetic flux annular to the axis of the shunt. This shunt flux displaces the bias flux and causes the bias flux to flow into the reeds in a more substantial quantity sufficient to effect their mutual operation. The switch is held operated by continuosuly applying an actuation signal to cause a continuous flux in the shunt.

Another example of such devices comprises a magnetic shunt substantially within the neighborhood of the contact areas of a sealed reed switch, a permanent magnet attached to at least one of the reeds, and two windings, one about the shunt and the other about the one reed. A released condition is attained by energizing only one of the windings. This causes a substantial portion of the bias magnetic flux from the permanet magnet to flow through only the one reed and into the magnetic shunt. Very little of the bias flux flows into the other reed, and the shunt flux is not of sufficient magnitude to displace the bias flux. In this manner, the reeds are caused to be released or are held in a released condition. When both windings are simultaneously energized, the bias flux is weakened and the magnetic flux generated in the shunt is consequently of sufficient quantity to cause the weakened bias flux to be displaced from the shunt. The bias flux is consequently caused to flow through both reeds thereby causing their operation. The switch is held operated by the bias flux.

From these two examples of the prior art, it is readily apparent that at least one disadvantage is inherent in these devices. On the one hand, a bias flux is needed to put the device in one state of operation, and the shunt flux is needed to displace the bias flux and thereby cause a different state of operation. On the other hand, the

use of both a permanent magnet-type biasing means and a magnetic shunt renders undue complications to the devices and decreases their efficiency and utility. The structural arrangements of the parts of such devices are complex, and the minimum number of parts required to make an operative device is greater than may be desired in some cases. Furthermore, the magnitudes of the actuation signals must be within precisely specified ranges.

A further disadvantage exists in these prior art devices. To keep the switches operated, either the actuation signals must be continuously applied or provisions must be made for employing the same or another bias means. In the first case, the power required to keep the switch operated may be substantial. In both of these cases, the net result is that the devices and the circuitry required to operate and release such devices are complex and require the use of a substantial amount of power.

A perhaps still greater disadvantage is that the bias and shunt fluxes must be of precise magnitudes and directions relative to each other. Any deviations from these precisely determined magnitudes will result in false operations and consequent inefficiencies.

Accordingly, it is an object of my invention to eliminate the permanent magnetic biasing means in a switching device which employs shunt magnetic flux to effectuate control thereof. Thus, it is a subsidiary object of my invention to simplify such devices.

A further object of my invention is to eliminate the necessity for precisely determining the magnitudes of the bias or other flux and shunt flux with respect to each other and to increase the upper and lower limits of the magnitudes of such fluxes. Thus, related to this particular object, it is another object of my invention to increase the efficiency of such devices.

Another object of my invention is to improve and to make more economical the control mechanisms of such devices by increasing the ranges of permissible magnitudes of actuation signals applied thereto.

A yet further object of my invention is to eliminate the necessity for applying a continuous holding current or for the provision of an additional bias means to keep the switch closed after initial operation thereof. Thus, other related objects of my invention are to increase the utility of such devices and to decrease their power consumption.

These and other objects of my invention are attained in a specific illustrative embodiment thereof which briefly comprises a sealed reed switch of the type disclosed in Patent 3,059,075 granted to R. L. Peek Jr. of October 16, 1962 having reeds of remanently magnetic material and a highly permeable magnetic shunt positioned adjacent the contacting ends of the reeds. Two sets of windings are provided, each set having windings about a respective reed and about the shunt. The windings about the shunt are wound in magnetically opposing directions; that is, in directions such that when the two shunt windings are concurrently energized by similar polarity pulses, the magnetic fluxes caused by the respective windings will be canceled in the shunt. The windings about the respective reeds are wound in the same magnetic direction; that is, in directions such that when the two reed windings are concurrently energized by similar polarity pulses, the resulting magnetic fluxes will be in the same direction. Pulse sources of like polarity (e.g. positive polarity) are connectable to the two sets of windings enabling energization of the windings.

Remanently magnetic materials are well known in the art and have the properties of high coercivity and low permeability. They exhibit two stable states of magnetic remanence, which remanences can be set by substantially short duration electrical signals.

My invention employs a differential mode of excitation; that is to say, switch operation is attained by concurrent multiple like-polarity signal actuation causing appropriate flux cancellations within a magnetizing structure; and switch release is advantageously attained by using only one actuation signal without any substantial flux cancellation occurring in the magnetizing structure. The employed signals must, of course, be of sufficient magnitudes to cause the desired flux conditions in the magnetic structure; however, they are not limited in their upper limit of magnitude, and advantageously can be of any appropriate value, above that required. This type of control excitation is disclosed, for example, in my Patent 3,037,085 of May 29, 1962.

In accordance with the principles of my invention, a released state is caused by applying a positive polarity pulse of appropriate duration and magnitude from the pulse source to only one of the sets of windings. As a result, a magnetic flux (called first flux for purposes of explanation) tends to be produced axial of the winding and in line with the associated reed and another magnetic flux (called second flux) is generated in the shunt directed in line with the contacting ends of the reeds. The second flux is more dominant in magnitude than the first flux. Consequently, a substantial portion of the second flux is caused to be driven from the shunt through the contact openings of the reeds, then in separate branches, one through one reed, through the air, and back through the shunt and the other through the other reed, through the air, and back to the shunt. The second flux overcomes the first flux and establishes the magnetic remanences of the two reeds such that similar magnetic poles are induced at the respective contact ends of the reeds. The similar poles cause the reeds to mutually repel and with the help of the natural stiffnesses of the reeds cause them to open or to remain open.

The operate condition of the switch is caused, in accordance with the principles of my invention, by applying positive polarity pulses of appropriate durations and magnitudes concurrently from the pulse sources to both sets of windings. As a result there are four different fluxes tending to be generated by the windings, two first fluxes in line with the reeds and in similar directions and two second fluxes in the shunt which are in opposite directions to each other but of equal magnitude. Consequently, the second fluxes in the shunt are mutually canceled therein and the first fluxes in the reeds are added together and flux is caused to flow between the contacting ends of the reeds and across the air gap therebetween. The remanences of the reeds are set such that opposite magnetic poles are induced at the respective contact ends of the reeds. The opposite poles cause the reeds to mutually attract and close.

In an alternative embodiment of my invention, the windings about the shunt are disposed at substantial acute angles with respect to a line perpendicular of the contacting ends of the reeds. When only one of the sets of windings is energized, a substantial portion of the second flux will, as in the previously-described embodiment, be caused to flow into the two reeds effecting their release. However, when both of the sets of windings are concurrently energized, the two second fluxes add vectorially resulting in the total flux flowing in a direction substantially diverted from the contacting portions or ends of the reeds. To say this another way, the vectorial sum of second fluxes is substantially zero in the direction toward the contacting portions of the reeds. Thus, the second fluxes, as in the previously-described embodiment, have no effect upon the first fluxes which cause operation of the reeds.

In another alternative embodiment of my invention I employ a pair of parallelly disposed sealed reed switches and a shunt situated at right angles to and between two switches and adjacent the contacting ends of the reeds of the two switches. At the corresponding terminal ends of both switches I provide highly permeable magnetic members to interconnect the terminal ends of the respective switches. Two sets of windings are wound about the shunt and the reeds in the same manner as that described for the first and second embodiments except that the windings couple both switches instead of only the one switch.

The operate condition is effected in the same manner as described in the two previous embodiments and involves no changes in the magnetic circuits except that there are two separate flux paths, one through the reeds of each switch.

The released condition of the switches is caused in the same manner as above described, that is, by energizing only one set of windings with a positive polarity pulse from a pulse source. In this embodiment, in a manner similar to the previously-described embodiments, a second magnetic flux from the shunt is driven in separate paths through the two reeds of each switch. However, one magnetic flux flows from the shunt, through one reed of one switch, through an end interconnecting member, through one reed of the other switch and back to the shunt. Similarly, the other magnetic flux flows from the shunt, through the other reed of the first switch, through the other end interconnecting member, through the other reed of the other switch and back to the shunt. The end interconnecting members and the reeds of the second switch provide a flux path which is lower in reluctance than that presented by air and enable the attainment of a released state of the switches with substantially less power than the above-described embodiments which completed their flux paths through the air.

A feature of my invention is a switching device wherein I provide a pair of contact members held in operative relationship to each other, first means for selectively magnetizing the contact members, and second means for driving a magnetic flux into the vicinity of the operative parts of the contact members when only one of the contact members is magnetized by the first means and for preventing the magnetic flux from being driven into the vicinity of the operative parts of the members when both contact members are magnetized by the first means.

Another feature of my invention is such a device wherein I provide that the first means comprise a winding about each of the members and wherein I provide that the second means comprises at least a pair of windings.

A further feature of my invention is such a device wherein I provide that the second means further comprise a magnetic shunt disposed substantially within the vicinity of the operative parts of the members and wherein I dispose the pair of windings about the magnetic shunt in opposing magnetic directions.

Another feature of my invention is such a device wherein I provide that the second means further comprise circuit means for connecting one of the shunt windings to one of the member windings and circuit means for connecting the other shunt winding to the other member winding, and wherein I further provide means for energizing one of the interconnected windings to cause one member to tend to be magnetized and to cause shunt magnetic flux to flow through both of the members and means for concurrently energizing the two interconnected windings to cause concurrent magnetizations of the members and to prevent the shunt magnetic flux from influencing the members.

A still further feature of my invention is such a device wherein I provide that the members comprise remanently magnetic material and the magnetic shunt comprise a soft magnetic material.

A complete understanding of these and other objects, features, and advantages of my invention can be attained from a consideration of the following detailed description and accompanying drawing, in which:

FIG. 1 depicts an illustrative embodiment of my invention which employs a single sealed reed switch and a particular winding arrangement;

FIGS. 2A, 2B, 2C depict with representative arrows the remanent magnetization states of the reeds of FIG. 1 and magnetic flux flow causing operation and release of the reeds;

FIG. 3 depicts another illustrative embodiment which employs a pair of sealed reed switches and a winding arrangement similar to the embodiment of FIG. 1;

FIGS. 4A, 4B, 4C depict with representative arrows, in a manner similar to FIGS. 2A, 2B, 2C, the remanent magnetization states of the reeds of FIG. 3 and magnetic flux flow causing operation and release of the pair of switches;

FIG. 5 depicts still another embodiment which is similar to the embodiment of FIG. 3 with the exception that a different winding arrangement is employed; and

FIGS. 6A, 6B, 6C are similar to FIGS. 4A, 4B, 4C with the exception that FIG. 6C depicts the flux pattern caused by the winding arrangement employed in FIG. 5.

Turning now to the drawing, in FIG. 1 I depict a sealed reed switch 1 having a pair of remanently magnetic reeds A and B supported to form overlapping contact areas C and enclosed within a protective appropriate atmosphere, e.g. Nitrogen-Hydrogen mixture, by glass envelope D. A soft magnetic shunt 3 is disposed about the envelope D and substantially within the vicinity of the contact surfaces C. The shunt 3 can be of any highly permeable material such as soft iron. Two sets of windings are provided; winding 6 A is wound about reed B and is serially connected to winding 6B which is wound about shunt 3; and winding 7A is wound about reed A and is serially connected to winding 7B which is wound about shunt 3. The number of turns of winding 6A and 7A need not be precisely determined. However, the windings 7B and 6B must be substantially equal in the number of turns and wound in magnetically opposing directions. The amount of magnetic flux which is generated by winding 7B must be substantially greater than the magnetic flux which is or tends to be generated by winding 7A and likewise the magnetic flux which is generated by winding 6B must be substantially greater than the magnetic flux which is or tends to be generated by winding 6A. These fluxes are produced when sources 8 and 9 are connected through respective switches 11 and 10 to the respective windings 6A and 7A. The sources 8 and 9 are depicted as being batteries. They can, however, be of any other known types, such as generators, oscillators, et cetera, so long as the required amounts, polarities and durations of current can be supplied thereby.

Operation of the embodiment of FIG. 1 can best be understood with reference to FIGS. 2A, 2B, 2C. In FIGS. 2A, 2B, 2C open headed arrows 20_{1A} and 20_{1B} represent the remanent magnetization states or remanences of the respective reeds A and B of sealed reed switch 1. The closed arrows 21 represent the magnetic flux flow in shunt 3. The dotted lines and closed arrows 23 represent magnetic fluxes traveling through the air to close magnetic circuits between the reeds and shunts in FIGS. 2A and 2B and between the reeds in FIG. 2C. FIGS. 2A and 2B represent the remanent magnetization states and magnetic flux flow during the released condition (contact areas C not in contact) of the switch. FIG. 2C represents the remanent magnetization states and magnetic flux flow during the operated condition (contact areas C in contact) of the switch.

A released condition of the switch 1 of FIG. 1 is attained by energizing only one of the two sets of windings 7A, 7B and 6A, 6B. For example, by closing switch 10 for a brief interval of time, source 9 applies a positive polarity signal through winding 7B and through winding 7A to ground. The magnetic condition of the device for this example is depicted in FIG. 2B. This causes winding 7A to tend to produce a magnetic flux which would tend to set the remanence of reed A to point up, i.e., toward the top of the figure. However, winding 7B simultaneously generates a magnetic flux 21, pointing to the left in FIG. 2B, which is greater than the flux which is tended

to be generated by winding 7A. The flux 21 is driven into the reeds A and B at their contact areas C. It overcomes any flux which winding 7A tended to produce and causes the remanence of reed A to be set in the direction as depicted by open arrow 20_{1A} pointing down in FIG. 2B. Moreover, flux 21 is driven through reed B to cause the remanence thereof to be in the direction as depicted by open arrow 20_{1B} pointing up in FIG. 2B. The magnetic flux 21 is caused to be driven through the reeds rather than through the air due to the lower magnetic reluctances presented by the reeds in comparison to the reluctance presented by air. The remanent material employed in the reeds should, therefore, be appropriate to insure this relationship of reluctances. Similar remanent magnetic poles are induced at the respective contact ends C of the reeds A and B causing the reeds to mutually repel and thus be in a released condition. The magnetic circuits are completed by magnetic fluxes (represented by dotted lines and closed arrows 23) returning from the reeds A and B, respectively, through the air, back to the shunt 3, in the manner depicted.

Release can also be affected by closing only switch 11 for a brief period of time. Source 8 is then connected to winding 6A and applies a positive polarity signal through winding 6A and through winding 6B to ground. The magnetic condition of the device for this case is depicted in FIG. 2A. In a manner similar to that just explained, dominant magnetic flux 21 is generated by winding 6B in the shunt 3. This dominant flux is driven into reeds A and B and overcomes the flux in reed B which is or tends to be generated by winding 6A. As a result, the remanent magnetization states of reeds A and B are set in the directions as depicted by open arrow 20_{1A} pointing up and open arrow 20_{1B} pointing down in FIG. 2A. Consequently, similar remanent magnetic poles are induced at the contact ends C of the reeds A and B, thereby effecting mutual release thereof. The magnetic circuits are completed by magnetic fluxes, represented by dotted lines and closed arrows 23, flowing from the shunt 3 through the air, and back to the reeds, as depicted in FIG. 2A.

An operated condition of the embodiment of FIG. 1 is attained by concurrently applying signals to the two sets of windings 6A, 6B and 7A, 7B. The magnetic conditions of the device for this situation are depicted in FIG. 2C. This is done by closing, for a brief period of time, switches 10 and 11 to connect sources 9 and 8 to respective windings 7B and 6A. Positive polarity signals from these respective sources flow through the windings to ground. The magnetic flux tending to be generated by winding 7B within the shunt 3 is canceled by the flux tending to be generated within the shunt 3 by winding 6B. Thus, as distinguished from the above-described released condition, no dominant magnetic flux is available to overcome or dominate any flux which is or tends to be produced by either of the windings 7A or 6A. As a result only those fluxes produced by windings 7A and 6A will have effect upon the changing of the remanent states of the reeds A and B. The magnetic flux generated by winding 7A causes the remanence of reed A to be in a direction as depicted by open arrow 20_{1A} pointing up in FIG. 2C. Likewise magnetic flux generated by winding 6A causes the remanence of reed B to be in a direction as depicted by open arrow 20_{1B} pointing up in FIG. 2C. Opposite remanent magnetic poles are induced at the contact ends of the reeds causing the reeds to mutually attract and close. The magnetic circuit is closed by flux flowing through both reeds and through the air back to the reeds as shown by the dotted lines and closed arrow 23 pointing clockwise in FIG. 2C. Once the switch is closed, the remanent magnetization of the reeds holds the reeds closed until a released condition is affected in the above-described manner.

FIG. 3 depicts structural elements corresponding to those of the embodiment of FIG. 1 and employs the same numbering scheme therefor. In addition, FIG. 3 depicts a second sealed reed switch 2 and a pair of soft magnetic shunts 4 and 5 disposed in the manner depicted. The shunt 3 in this embodiment is magnetically coupled to the contact ends C of both reed switches 1 and 2. Furthermore, windings 6A and 7A in this embodiment are wound about the respective reeds of both switches.

FIGS. 4A, 4B and 4C depict the same open arrows 20_{1A} and 20_{1B} and closed arrows 21 as the corresponding FIGS. 2A, 2B and 2C. In addition, closed arrows 22 in FIGS. 4A and 4B depict the directions of magnetic flux flow in magnetic shunts 4 and 5 and open arrows 20_{2A} and 20_{2B} represent the remanent magnetization states or remanences of the respective reeds of the added switch 2. FIG. 4A represents the magnetic conditions of the embodiment of FIG. 3 in the released condition when source 8 alone is connected to windings 6A and 6B. FIG. 4B represents the magnetic conditions of the same embodiment in the released condition when source 9 alone is connected to windings 7A and 7B. FIG. 4C represents the magnetic conditions of the same embodiment in the operate condition when both sources 8 and 9 are connected to the windings.

A released condition of both switches 1 and 2 is attained, as in the embodiment of FIG. 1, by energizing only one of the sets of windings 6A, 6B and 7A, 7B. The difference between the embodiment of FIG. 3 and the embodiment of FIG. 1 is that in the released condition of FIG. 3 the magnetic shunts 4 and 5 and the reeds of second switch 2 enable a more efficient utilization of the magnetic flux. Accordingly, while in FIG. 1, in the released condition, magnetic flux circuits were completed by magnetic fluxes flowing through the air between the shunt and the reeds, in this embodiment of FIG. 3, the magnetic circuits in the released condition, are substantially completed through the reeds and the magnetic shunts 3, 4 and 5 without any substantial amount of flux escaping through the air. For example, FIG. 4A represents the magnetic conditions when source 8 is connected to winding 6A. Magnetic flux, shown as closed arrow 21 pointing to the right, is produced which splits into two paths, one path which extends counterclockwise through reed B of switch 2, through shunt 4 as represented by closed arrow 22 pointing to the left, and through reed B of switch 1 back to the shunt 3, and the other path which extends clockwise through reed A of switch 2, through shunt 5 as represented by closed arrow 22 pointing to the left, and through reed A of switch 1 back to the shunt 3. FIG. 4B depicts the magnetic conditions when source 9 is connected to winding 7B, and the directions of magnetic flux flow are opposite that of FIG. 4A.

An operate condition of the two switches is attained in a manner similar to that described above in FIG. 1, the only difference being that in the embodiment of FIG. 3 a pair of switches 1 and 2 is closed while in FIG. 1 only one switch is closed. The magnetic condition of the embodiment is depicted in FIG. 4C. There are two magnetic return paths, one for each switch and are shown by dotted lines and closed arrows 23.

FIG. 5 depicts an embodiment similar to that disclosed in FIG. 3 with the exception that the windings 6A, 6B and 7A, 7B are disposed in a different manner. Winding 6B is positioned at an acute angle X_2 with respect to a line Y extending through the contact areas of switches 1 and 2. Similarly, winding 7B makes an acute angle X_1 with respect to that line Y. The angles X_1 and X_2 can be, for example, 45°. The windings 6B and 7B can be of more than the depicted one turn, as long as the angular positions with respect to the mentioned line Y are maintained and a dominant flux is generated by these windings, as discussed above. The various elements of FIG. 5 are numbered in the same manner as that of the embodiment of FIG. 3.

FIGS. 6A and 6B are identical to respective FIGS. 4A and 4B. FIG. 6C is similar to FIG. 4C with the exception that closed arrow 21 represents a magnetic flux within shunt 3 during the operate condition.

A released condition of the embodiment of FIG. 5 is attained in the manner similar to that above described for the embodiments of FIG. 1 and FIG. 3, that is, by energizing only one of the two sets of windings 7A, 7B and 6A, 6B. The remanent states of the reeds of both switches 1 and 2 and the magnetic flux generated in shunt 3 and the resulting magnetic flux flow are similar to that described for the embodiment of FIG. 3. However, the magnetic flux through shunt 3 as represented by arrow 21, will be in a direction slightly offset from the contact areas. For example, in the case where angles X_1 and X_2 are each 45°, the flux represented by arrow 21 will be offset 45° from the mentioned line Y between the contact areas of the switches 1 and 2. This does not affect in any substantial degree the described manner of causing release of the device.

The operate condition is, however, attained in a different manner. As in the embodiments of FIGS. 1 and 3 to effect an operate condition both sets of windings 7A, 7B and 6A, 6B are concurrently energized. However, instead of the magnetic flux generated by winding 6B within shunt 3 being canceled by the magnetic flux generated by winding 7B, these two fluxes are vectorially added. The resultant flux is in a direction such as shown by arrow 21 making an angle X_3 with winding 7B in FIG. 5 and pointing to the left in FIG. 6C. In the case where angles X_1 and X_2 are each 45° and where equal magnetizing forces are caused by windings 6B and 7B, angle X_3 will be 45°, i.e., at an angle of 90° from the line Y. This direction is substantially diverted from the contact ends of the reeds of switches 1 and 2. Accordingly, the fluxes generated by windings 6B and 7B in shunt 3 do not substantially influence or overcome the fluxes generated by windings 6A and 7A. As a result the remanences of the reeds of both switches 1 and 2 are set in the directions as depicted by closed arrows 20_{1A}, 20_{1B}, 20_{2A} and 20_{2B} pointing up in FIG. 6C. Magnetic fluxes are caused to flow through the reeds of both switches thereby causing their closure. The fluxes then return through the air as shown by dotted lines and arrows 23.

It is to be understood that the above-described embodiments are illustrative of the principles of my invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of my invention.

What is claimed is:

1. A magnetically controlled switching device comprising at least a pair of contact members each having a contact surface adjacent to a mating contact surface of the other said member; biasing means individual to said members for causing a first flux to flow through said members; in the same direction; fluid guide means for directing a second magnetic flux to said adjacent contact surfaces; first control means magnetically coupled to said guide means and effective when only one of said biasing means is energized for causing a second flux to flow along said guide and through said members in opposite directions to overcome said first flux and to inhibit the mating of said contact surfaces; and second control means magnetically coupled to said guide means and effective when both said biasing means are concurrently energized for causing a third flux which in vectorial addition with said second flux produces substantially zero flux flow along said guide to said adjacent contact surfaces enabling said surfaces to mate under control of said first flux.

2. The invention defined in claim 1 wherein said biasing means comprises a pair of first windings, one about each respective member.

3. The invention defined in claim 2 wherein said guide means comprises a soft magnetic shunt about said contact surfaces of said members and wherein said first control means comprises at least one second winding inductively coupled to said shunt.

4. The invention defined in claim 3 wherein said second control means comprises another second winding disposed about said shunt and wherein means are provided for connecting each of said second windings to a respective one of said first windings, defining thereby two sets of windings, each set comprising a first and a second winding.

5. The invention defined in claim 4 wherein said members are of remanently magnetic material and wherein further is provided a pair of sources of similar polarity current and means for connecting each of said sources to a respective one of said sets of windings whereby concurrent energization by said sources of both of said sets of windings causes the remanent magnetization states of said members to be in similar directions to effect mating of said contact surfaces and whereby energization by said sources of only one of said sets of windings causes said second flux to establish the remanent magnetization states of said members in opposite directions inhibiting contact mating.

6. The invention defined in claim 4 further comprising a second pair of contact members each having a contact surface adjacent to a mating contact surface of the other second pair member, said second pair being disposed such that said guide means is magnetically coupled to the contact surfaces of both pairs of members and wherein each winding of said pair of first windings is coupled to at least one member of each of said pairs of members.

7. The invention defined in claim 6 wherein said second windings have their respective axes in different lines and make similar acute angles with respect to a line extending through said guide means and between said contact surfaces of both pairs of members.

8. A switching device comprising

(1) A pair of magnetizable contact elements supported in operative relationship to each other,

(2) first means individual to said elements for causing a first flux to magnetize said elements in the same direction,

(3) shunt means common to said elements and magnetically coupled to operative parts of said elements, and

(4) control means inductively coupled to said shunt means and to said elements and electrically connected to both said first means and effective when only one of said first means is energized for driving a dominant second flux from said shunt means and through both said elements to overcome said first flux to inhibit the operation of said elements and effective when both said first means are concurrently energized for diverting said dominant second flux from said elements to enable said first flux to effect the operation of said elements.

9. The invention defined in claim 8 wherein said first means comprises a pair of first energizable windings each inductively coupled to an associated element and wherein said control means comprises a pair of second energizable windings each electrically connected to a corresponding one of said first windings and inductively coupled to said shunt means whereby energization of only one corresponding set of first and second windings causes a first flux to flow in its associated element and causes a more dominant second flux to flow in said shunt means to overcome said first flux and to effect the release of said elements and whereby concurrent energization of both sets of corresponding first and second windings causes said first flux to flow through both elements and said second flux in said shunt means to be diverted from said elements to effect the operation of said elements.

10. The invention defined in claim 9 wherein said second windings have their respective axes in different lines, and wherein each of said axes forms an acute angle with respect to said shunt means.

11. A magnetically controlled switching device comprising

(1) a pair of magnetic contact members supported so that one end of a first contact member defines a magnetic air gap with one end of the second contact member;

(2) first means energizable to generate in said first contact member a first magnetic flux poled in a first direction with respect to said air gap and of a first magnitude;

(3) second means energizable to generate in said second contact member a second magnetic flux poled in the opposite direction with respect to said air gap and of said first magnitude;

(4) a magnetic shunt member adjacent to said air gap;

(5) third means energizable to generate in said shunt member a third magnetic flux poled in said first direction with respect to said air gap and of a second magnitude greater than said first magnitude;

(6) fourth means energizable to generate in said shunt member a fourth magnetic flux poled in said opposite direction with respect to said air gap and of said second magnitude;

(7) and, means for enabling concurrent energization of said first and third means and for separately enabling concurrent energization of said second and fourth means; whereby either said concurrent energization acting alone causes the respective one of said third and fourth shunt member fluxes to traverse said air gap and produce flux flow in said two contact members in the same direction with respect to said air gap; and whereby both said concurrent energizations acting together cause substantial cancellation within said shunt member of said third and fourth fluxes and permit said first and second fluxes to be produced within said two contact members.

12. The invention defined in claim 11

(1) wherein said first and second and third and fourth means comprise windings magnetically linking said contact members and said shunt member,

(2) and wherein said enabling means comprises interconnections among said windings.

13. The invention defined in claim 12

(1) wherein said contact members comprise elongated magnetic reeds,

(2) wherein the said reed ends comprise contact surfaces in overlapping relationship,

(3) and wherein said shunt member comprises an elongated magnetic shunt having one end thereof adjacent to said contact surfaces.

14. The invention defined in claim 13 wherein said shunt is disposed such that the longitudinal axis thereof is perpendicular to an axis extending through said reeds.

15. A magnetically controlled switching device comprising a pair of contacts, a pair of remanent magnetic members for controlling said contacts, a shunt magnetic member positioned in shunt to said magnetic members, first winding means including a first coil on said shunt member and a second coil series connected thereto and on one of said remanent members, and second winding means including a first coil on said shunt member and a second coil series connected thereto and on the other of said remanent members, said first coils being of more turns than said second coils and arranged to prevent any substantial flux from said shunt member passing through said remanent members on concurrent energization of said first and said second winding means.

16. The invention defined in claim 15 wherein said first coils are of substantially the same number of turns to effect substantial cancellation of flux in said shunt member on said concurrent energization of said first and said second winding means.

17. A magnetically controlled switching device comprising a pair of contact members each having a contact surface adjacent to a mating contact surface on the other said member, biasing means individual to said members for selectively magnetizing said members in the same direction, flux guide means for directing flux flow to said ad-

jacent contact surfaces, first control winding means having an axis in angular disposition to said guide means and effective when one of said biasing means is energized for causing a second flux to flow along said guide means through both said contact members in opposite directions to inhibit the mating of said contact surfaces, and second control winding means magnetically coupled to said flux guide having an axis in angular disposition to said guide means and effective when concurrently energized with said first control winding means and the other of said biasing means for generating a third flux which in vectorial addition with said second flux produces a component of substantially zero flux along said guide means and another component of flux perpendicular to said guide means and diverted from said contact surfaces causing said contact surfaces to mate.

18. A magnetically controlled switching device comprising a pair of contact members each having a contact surface adjacent to a mating contact surface of the other said member and each having an axis, biasing means individual to said members for causing a first flux to flow through said members in the same direction, flux guide means having an axis in angular disposition to said member axes for directing flux flow to said adjacent contact surfaces, a first control winding encompassing said guide and having an axis in angular disposition to said guide axis and effective when one of said biasing means is energized for causing a component of a second flux to flow along said guide axis and through both said contact members in opposite directions to inhibit the mating of said contact surfaces, and a second control winding encompassing said guide and having an axis in angular disposition to said guide axis and said first control winding axis and effective when energized concurrently with the other said biasing means and said first control winding for generating a third flux which in vectorial addition with said second flux produces a component of substantially zero flux along said guide axis and another component diverted from said contact surfaces causing said contact surfaces to mate.

19. A pair of contact members each having a contact surface adjacent to a mating contact surface of the other said member; biasing means individual to said members for selectively magnetizing said members in the same direction; flux guide means for directing flux flow to said adjacent contact surfaces; first control winding means having an axis and effective when energized for causing a second flux to flow along said guide and through both said contact members in opposite directions to inhibit the mating of said surfaces, and second control winding means having an axis in angular disposition with respect to said first control winding axis and effective when concurrently energized with said first control winding means and said biasing means for causing a third flux which in vectorial addition with said second flux produces a component of substantially zero flux along said guide and another component of flux remote from said contact surfaces causing said surfaces to mate.

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