United States Patent [19]

Richert

[11] **3,711,798**

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[54] **FLAT PACK REED RELAYS**

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[73] Assignee: **AMF Incorporated**

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[52] **U.S. Cl.** **335/153**

[51] **Int. Cl.** **H01h 51/22**

[58] **Field of Search** 335/153, 152

[56] **References Cited**

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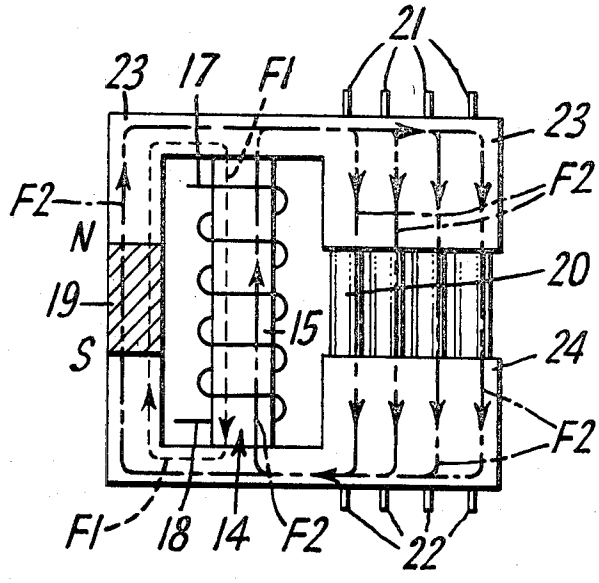
Primary Examiner—Roy N. Envall, Jr.

Attorney—George W. Price and Charles J. Worth

[57] **ABSTRACT**

An electromagnetic reed relay of polarized and magnetic latching configurations adapted for low profile packaging, having at least one electromagnet, at least one permanent magnet the polarity of which is uneffected by the electromagnet and at least one reed switch magnetically coupled together by a pair of pole pieces.

9 Claims, 11 Drawing Figures



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SHEET 1 OF 2

FIG. 1

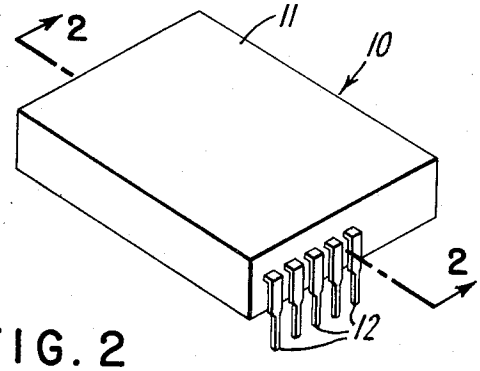

FIG. 2

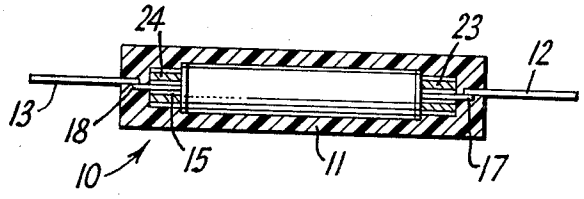

FIG. 3

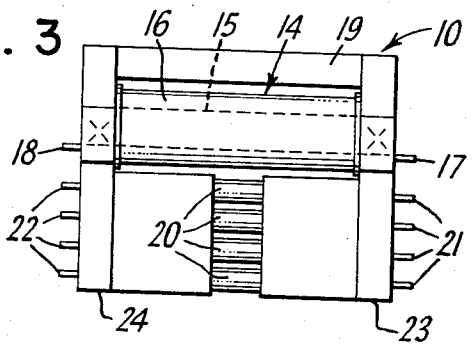

FIG. 4

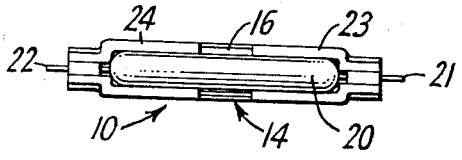

FIG. 7

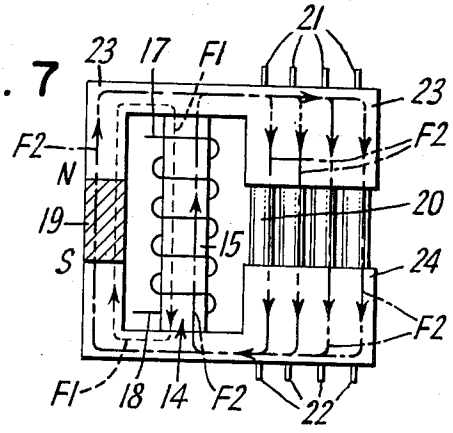

FIG. 5

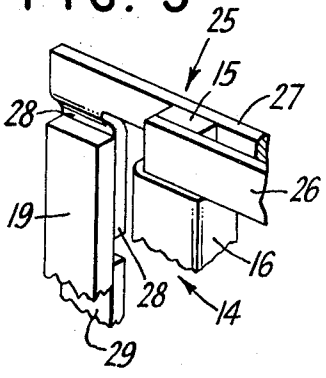

FIG. 6

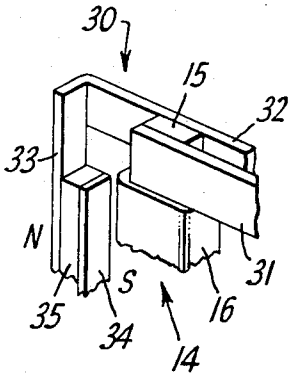

FIG. 8

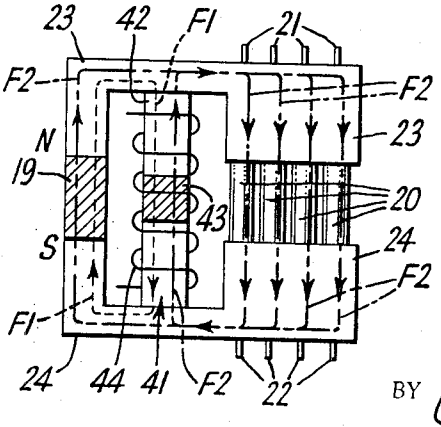

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FIG. 9

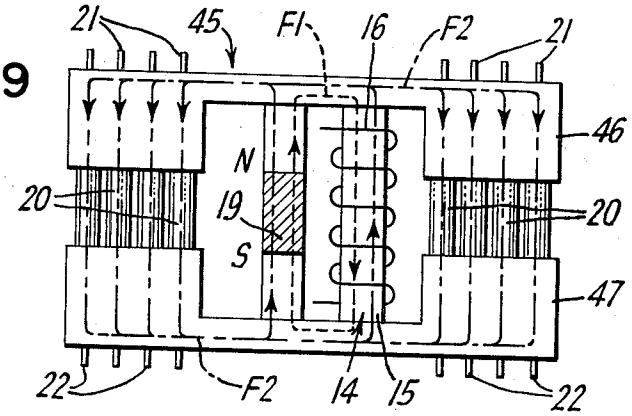


FIG. 10

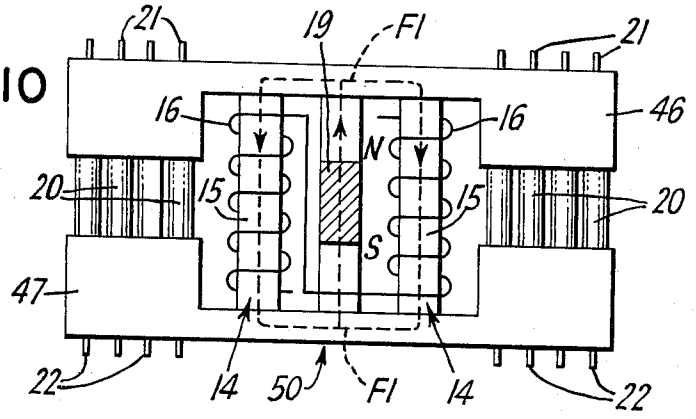
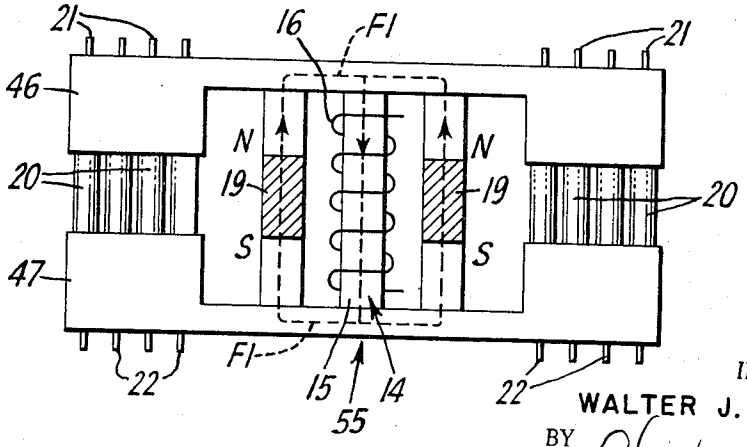


FIG. 11



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FLAT PACK REED RELAYS

This invention relates generally to reed relays and more particularly to polarized and magnetic latching types of multi-switch reed relays adapted for low profile or flat pack packaging.

While relays which have one or more reed switches and electromagnet switch actuation are generally old, however, difficulty has here-to-fore been encountered in providing such reed relays in low profile or flat pack packages. It might be noted that such encountered difficulty increases with additional relay parts.

A relay with multiple reed switches made in accordance with the present invention is particularly adapted for low profile or flat pack packaging and further includes a permanent magnet magnetically coupled to the reed contacts of the switches and the polarity of which is uneffected by energization of the electromagnet coil.

Accordingly, an object of the present invention is to provide a relay with a plurality of reed switches which is particularly adapted for low profile or flat pack packaging.

Another object of the present invention is to provide the foregoing relay with all of its component parts disposed substantially in a single mean plane.

And another object of the present invention is to provide the foregoing relay having a permanent magnet means magnetically coupled across the switches and the polarity of which is uneffected by energization of the electromagnet coil.

And still another object of the present invention is to provide the foregoing relay with the electromagnet core which, when the electromagnet coil is de-energized after energization, provides sufficient magnetic remanence which together with the permanent magnet flux causes latching.

The present invention contemplates an electromagnetic reed relay adapted for low profile packaging, comprising a pair of pole piece means of magnetic material; permanent magnet means having poles coupled to corresponding ends of the pair of the pole piece means; electromagnet means adjacent the permanent magnet means, having at least one core means connected at its ends to the pair of pole piece means thereby establishing a first flux path short circuiting the permanent magnet means in absence of opposing electromagnetic flux, and a coil means wrapped on and polarizing the core means when energized thereby providing electromagnetic flux opposing the flux provided by the permanent magnet means to the first flux path and establishing a second path for the total flux provided to operate switch means; switch means including a plurality of reed switches supported by corresponding ends of the pair of pole piece means opposite from the permanent magnet means; and each of the switches having at least two contact conductors magnetically coupled to the permanent magnet and electromagnet means by the pair of pole piece means and operable by the flux provided to the second flux path.

The foregoing and other objects and advantages will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein several embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for illustration purposes only and are not to be construed as defining the limits of the invention.

FIG. 1 is a perspective view of a relay in accordance with the present invention,

FIG. 2 is a sectional view taken of line 2—2 of FIG. 1,

FIGS. 3 and 4 are plan and end elevational views, respectively, of the relay of FIG. 1 prior to encapsulation,

FIGS. 5 and 6 are fragmentary perspective views illustrating other forms of pole piece/permanent magnet arrangements,

FIGS. 7 and 8 are diagrammatic views of a polarized and a latching relay, respectively, in accordance with the construction shown in FIGS. 1 to 4,

FIGS. 9 to 11 are diagrammatic views each illustrating a different modified relay in accordance with the present invention.

Referring now to the drawings and particularly to FIGS. 1 and 2, a novel relay 10 made in accordance with the present invention may be enclosed in a fabricated low profile case (not shown), or preferably is encapsulated or potted in the usual plastic material 11. The resulting package is a cubiform in which the length and width each substantially exceeds the height thereby providing what is presently known as a flat pack or low profile component.

To electrically connect the relay 10 into a circuit, two series of spaced terminals 12 and 13 preferably are provided which extend laterally from opposite ends or sides of the encapsulation and which may be bent 90 degrees in the usual manner to facilitate a plug-in type connection to a printed circuit board. The number of terminals 12 and 13 to be used is determined by the number of circuit connections to be made. It should be realized that the terminals 12 and 13 are a matter of choice and, alternatively, the wire terminals of the reed switches and coil leads can be provided with sufficient length to make the required electrical connections.

Considering also FIGS. 3 and 4, the relay 10 is provided with a electromagnet 14 having a core 15 of magnetic material within a winding or coil 16. The free ends 17 and 18 of the winding 16, which may be are located, as shown, at opposite ends of the core 15, are connected to one of each of the terminals 12 and 13, respectively, as shown in FIG. 2.

A permanent magnet core means 19 is connected at its ends or poles to corresponding ends of a pair of parallel spaced pole piece means 23 and 24 thereby forming a U-shaped magnetic structure. The core means 19 may be provided by a permanent magnet, a magnetic material embodying a permanent magnet member, or any other suitable composite construction. The electromagnet 14 is positioned substantially parallel to the permanent magnet means 19 with the ends of the core 15 thereof each connected to a different pole piece means 23 and 24.

Each of the pole piece means 23 and 24 may be provided by a pair of plates of magnetic material as shown in FIGS. 2 and 4 or, alternatively, a U-shaped member (not shown) with openings through the bight thereof as may be required to pass conductors and coil ends. With this type of construction, the poles of the permanent

magnet means 19 are at its ends which are connected to the pole piece means 23 and 24.

A modified pole piece/permanent magnet means is shown in part in FIG. 5 wherein a pole piece means 25, corresponding to the pole piece 23, is provided by a pair of plates 26 and 27 which are connected to opposite sides of one end of the core 15. One of the plates which, in this instance, is plate 26 may terminate as shown at the core 15. The plate 27 extends past the core 15 and terminates with an elongated end flange 28. The flange 28 is disposed in a plane parallel to and offset from the plane of the plate 27 and extends toward a second pole piece means (not shown), corresponding to the pole piece means 24, which has a corresponding end flange 29 (shown in part) disposed in the same plane and is spaced from the flange 28. The planar offset of the flanges 28 and 29 provides a recess or pocket for the permanent magnet 19 which is connected to the flanges.

Still another modified pole piece/permanent magnet means is shown in part in FIG. 6 wherein a pole piece means 30, corresponding to the pole piece 23, is provided by a pair of plates 31 and 32 which are connected to opposite sides of one end of the core 15. One of the plates which, in this instance, is plate 31 terminates at the core 15. The plate 32 extends past the core 15 and terminates with an elongated end flange 33. The flange 33 is disposed in a plane normal to the plane of the plate 32 and extends toward a second pole piece means (not shown), corresponding to the pole piece means 24, which has a corresponding end flange 34 (shown in part) disposed in a plane spaced between the electromagnet 14 and the plane of the flange 33. The flanges 33 and 34 lap one another and are connected to opposite sides or poles of a permanent magnet 35 disposed in the space therebetween.

Accordingly, the core 15 of the electromagnet 14 provides a flux path substantially parallel to the flux path of the permanent magnet 19, of FIG. 3, and substantially normal to the flux path of the permanent magnet 35 of FIG. 5. It should be noted, however, the ends of the flux paths thus provided, in each instance, are suitably connected to form a closed loop.

Referring again to FIGS. 1 to 4, the relay 10 is provided with a plurality of reed switches 20 disposed in spaced parallel series on the side of the electromagnet 14 opposite from the permanent magnet 19. Although four reed switches 20 are shown and described herein, the number of such switches is not to be construed as defining the limits of the present invention and may be changed in accordance with requirements of the environment of a particular relay. Each of the reed switches 20 is provided with the usual tubular case closed at its ends and at least a pair of reed contact members 21 and 22 each extending from a different end of the case and conductively connected to one of each of the terminals 12 and 13, respectively. The tubular cases of the switches 20 are supported at their ends with the reed members 21 and 22 magnetically coupled to and conductively insulated from the pole piece means 23 and 24, respectively. It should be obvious to one skilled in the art that by proper selection of switch contact material and flux orientation, switches 20 could be normally open or normally closed switches or of the type which "breaks" one connection and "makes" another. To facilitate disclosure of the present invention, the reed switches 20 are considered as being normally open switches.

Referring to FIG. 7, it will be seen that the relay 10 includes the electromagnet 14 which when energized provides flux in a predetermined direction, the permanent magnet 19 which provides a constant flux in a predetermined direction, and two flux paths F1 and F2 which are shown with arrowheads indicating the direction of the flux. The state of energization of the coil 16, in effect, alternately establishes the flux paths F1 and F2 both of which include the core 15 of the electromagnet 14 and the permanent magnet 19. It should be understood either flux path F1 (considered as the reset flux path) or flux path F2 (considered as the set flux path) will be established or predominant. Although in many instances there may be some flux in either of the flux paths whichever is not established, for practical purposes and to facilitate the description of the present invention such flux will not be considered.

The reset flux path F1 is a closed loop provided by the non-polarized core 16, the permanent magnet 19 and the intervening portions of the pole pieces 23 and 24. The flux path F1 is established only when the coil 16 is de-energized and the direction of flux at the core 15 is opposite to the direction of the flux at the permanent magnet 19. The set flux path F2 is considered as having two parallel paths at one end provided by the polarized core 16 and the permanent magnet 19, a plurality of parallel paths at the other end provided by the reed switches 20, and pole piece means 23 and 24 which magnetically couple the parallel paths at the two ends together to form a magnetic loop.

More specifically, when the relay 10 is in the reset condition with the coil 16 of the electromagnet 14 de-energized, the reset flux path F1 is established as a closed loop or low reluctance path in which the electromagnet core 15 short circuits or shunts the permanent magnet 19. Therefore, in the absence of operating flux across the reed switches 20 the relay 10 remains in the reset condition and the switch contacts 21 and 22 remain open. The flux path F2, which includes the reed switches 20, has a high or maximum reluctance state when the contacts 21 and 22 of the reed switches are open and a low or minimum reluctance state when the switch contacts are closed. However, the reluctance of the flux path F2 always exceeds the reluctance of path F1. Upon energization of the coil 16, the core 15 is polarized and the electromagnet 14 develops flux which opposes or bucks the flux provided to the closed loop flux path F1 by the permanent magnet 19. Accordingly, the closed loop flux path F1 only appears as a high reluctance flux path and therefore, the flux path F2 is established. Thus, the total or combined flux provided by the electromagnet 14 and the permanent magnet 19 provides a working flux across the reed switches 20 sufficient to pull in or cause the contacts 21 and 22 thereof to close thereby closing the working air gap of the set flux path F2 which is considered as being the air gaps between the open contacts of all of the switches 20. The relay 10 now is in its set or operated condition with the switches 20 closed or conducting, and the flux path F2 is in its low or minimum reluctance state and will remain so until the coil 16 is de-energized.

Upon de-energization of the coil 16, no electromagnetic flux is available to the relay 10. The core 15 therefore, again provides a lower reluctance path which shunts or short circuits the permanent magnet 19 to re-establish the flux path F1. The flux path F2, now being of relatively higher reluctance than path F1, becomes insufficient to keep the contacts 21 and 22 of the switches 20 closed and, consequently they reopen. Accordingly, the relay 10 returns to its unoperated or reset condition.

The polarized relay 10 can be modified to provide a latching relay 40, as shown in FIG. 8, which includes the permanent magnet 19, the reed switches 20 with their contacts 21 and 22, and the pole piece means 23 and 24. Instead of the electromagnet 14, an electromagnet 41 is provided having a core 42 and a coil 44. However, in this instance, the core 42 has remanence characteristics which in the drawings is diagrammatically shown as being provided by the center portion 43 disposed between two core end portions of magnetic material. It should be understood that the composite core construction 42–43 is merely to diagrammatically differentiate, shown in simplest form, between the core 15 of magnetic material and the remanent core 42, and is not to be construed as defining the limits of the present invention. The core 42 may be of any suitable remanent material, a permanent magnet, or a composite structure of any suitable construction with a permanent magnet or remanent material portion of any suitable configuration.

Considering the relay 40 first in the absence of remanence of the core 42, its operation would be similar to the operation of the relay 10. Accordingly, the reset flux path F1 would be established when the coil 44 is de-energized and core 42 short circuits or shunts the permanent magnet 19, and the set flux path F2 would be established when the coil 44 is energized and the combined flux provided by the permanent magnet 19 and the polarized core 42 is applied across the working air gap or the total air gap between the open contacts 21 and 22 of all of the switches 20.

While the polarity of the permanent magnet 19 is not effected by energization of the coil 16 of relay 10 or the coil 44 of relay 40, energization and the direction of energization of the coil 44 determines the degree and orientation of polarization of the remanent core or magnet 42. It should be realized that the coil 44 may have a single multi-turn winding which is reversely connectable to a source of current or may have two multi-turn winding each, when energized, polarizing the core 42 oppositely to the polarization resulting from energization of the other coil.

Now considering the relay 40 as actually shown in FIG. 8 with the core 42 having remanence, when the coil 44 is sufficiently and directionally energized to operate or set the relay 40, the remanent core 42 is polarized and electromagnetic flux is produced which opposes or bucks the flux provided by the permanent magnet 19 to the reset flux path F1. The resulting electromagnetic flux, while coil 44 is energized, is in the same direction as and combines with the flux by the permanent magnet 19 to provide a working flux. The total or working flux, as provided, establishes the set flux path, F2, and is sufficient and properly oriented across the working air gap to pull in or cause the contacts 21 and 22 of the switches 20 to close.

In a relay with magnetic latch characteristics, such as relay 40 of FIG. 8, the set flux path F2 is also the magnetic latch flux path as will now be discussed. When the coil 44 is de-energized, the total electromagnetic flux is no longer available. However, because of its remanence characteristics, the remanent core 42 provides sufficient remanent flux to continue to successfully block the flux provided by the permanent magnet 19 to the reset flux path F1. The blocking effect of the remanent flux causes the reset flux path F1 to appear to have a higher reluctance than the set flux path F2 with the contacts 21 and 22 of the switches 20 closed. The resulting permanent magnet flux and remanent flux provided by the magnet 19 and core 42, respectively, to the set flux path F2 combine to form a latching flux sufficient to maintain the flux path established and to keep the contacts 21 and 22 of the switches 20 closed thereby effecting magnetic latching of the relay 40.

To reset or cause the latched relay 40 to reassume its unoperated state, the coil 44 reversely energized by reverse current or a oppositely wound coil to reduce or reverse the polarity of the remanent core 42 so that upon de-energization of the coil 44 the resulting flux is insufficient to maintain the flux path F2 established or core magnet provides insufficient remanent flux or flux sufficient flux provided by the permanent magnet 19 is shunted opposite to its initial direction when the relay 40 was by the reset flux path F1. The reset flux path F1 is, initially set. Therefore, re-established and the closed contacts of the switches 20 reopen. The relay 40 is again in its reset condition.

When a relay as described above includes a relatively large number of reed switches, it has been found to be advantageous to divide the switches into two sets and locate the various flux sources between the sets. In this way, none of the reed switches will be excessively remote from the flux sources.

Three modified relays 45, 50 and 55 as shown in FIGS. 9 to 11 are provided to illustrate relays with two sets of switches 20 in accordance with the present invention. Again, the number of switches 20 of each switch set is an arbitrarily chosen quantity and is not to be construed as defining the limits of the present invention. It also should be understood that each of the relays 45, 50 and 55 may be either of a polarized configuration as relay 10 or of a magnetic latching configuration as relay 40 depending upon the electromagnet core material. To facilitate disclosure relays 45, 50 and 55 will be discussed only as polarized relays.

As shown in FIG. 9, the modified relay 45 has two sets of reed switches 20 each set being disposed at one end of a pair of pole piece means 46 and 47 corresponding to the pole piece means 23 and 24 of the relay 10. The electromagnet 14 and permanent magnet 19, disposed between the two sets of reed switches 20, are magnetically coupled at their ends to the pole piece means 46 and 47.

When the coil 16 of the electromagnet 14 is deenergized, the core 15 short circuits or shunts the permanent magnet 19 and the reset flux path F1 which is the established is similar to the reset flux path F1 of relay 10. When the coil 16 is energized, the set flux path F2 is established which now has two loops both including the core 15 and the permanent magnet 19 while each includes, a different set of switches 20. In the relay 45, the electromagnet 14 and the permanent

magnet 19 are each closer to a different one of the sets of switches 20 than the other. Although the unequal spacing of the flux sources from the different switch sets has been found normally to have little effect upon relay operation, such spacing differences can be eliminated as taught by the relays 50 and 55 each of which is a modification of the relay 45.

Referring now to FIG. 10, the relay 50 again includes two sets of reed switches 20 retained, as previously described, between corresponding ends of the pole piece means 46 and 47. In this instance, the permanent magnet 19 is disposed between two electromagnets 14 which replace the single electromagnet of the relay 45 and have their coils 16 conductively connected in series.

When the coils 16 are de-energized, both of the cores 15 short circuit or shunt the permanent magnet 19 thereby establishing the reset flux path F1 which, in this instance, is a double loop with a common leg formed by the permanent magnet. When the coils 16 are energized, both cores 15 are polarized in the same direction thereby establishing the double loop set flux path F2 (not shown) which is similar to the flux path F2 of the relay 45 except for the additional core 15 which also is common to both loops.

Alternatively, as in the relay 55 of FIG. 11 the electromagnet 14 is disposed between two permanent magnets or permanent magnet means 19 which replace the single permanent magnet or permanent magnet means of the relay 45. When the coil 16 is de-energized the core 15 short circuits or shunts both permanent magnets 19 thereby establishing the double loop reset flux path F1 as in the relay 50. However, in the relay 55 the leg common to both loops is the shunt or core 15. When the coil 16 is energized thereby establishing the double loop set flux path F2 of relay 55 which corresponds to the set flux path F2 of the relay 45 or 50, except that there are the two permanent magnets 19 and the single core 15 which are common to both loops in this instance.

Although but several embodiments of the invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes may also be made in the design and arrangement of the parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

What is claimed is:

1. In an electromagnetic reed relay adapted for low profile packaging, a combination comprising

a pair of magnetic material means each spaced from the other,

permanent magnet means magnetically coupled to said pair of magnetic material means and constantly providing flux in a predetermined direction,

said permanent magnet means being a permanent magnet with its poles at its ends which are each magnetically coupled to a different one of said pair of magnetic material means,

electromagnet means magnetically coupled to said pair of magnetic material means and short circuiting said permanent magnet means in the absence of flux opposing the shunting of the permanent magnet flux by the short circuit,

said electromagnet means when energized providing flux in the same direction as said permanent magnet means and which is sufficient to oppose the shunting of the permanent magnet flux,

said electromagnetic means comprising a pair of electromagnets each being disposed between said permanent magnet and a different one of said sets of switches,

each of said electromagnets having a coil and a core of magnetic material extending through said coil substantially parallel to said permanent magnet,

said cores each being magnetically coupled at each end to a different one of said pair of magnetic material means,

said coils being adapted for energization thereby polarizing said cores and providing flux substantially parallel to and in the same direction as the flux provided by said permanent magnet,

magnetically operable switch means including two sets of switches each being disposed at a different end of said pair of magnetic material means, and said permanent magnet and electromagnet means being disposed between said two sets of switches,

each of said sets of switches including at least one reed switch with at least two reed contact conductors magnetically coupled each to a different one of said pair of magnetic material means, and

each of said reed switches being unoperated when said permanent magnet means is short circuited, and operated by the total flux provided by said permanent magnet and electromagnet means when the flux provided by said electromagnet means opposes the shunting of the flux provided by said permanent magnet means.

2. The electromagnetic relay in accordance with claim 1, and said coils being connected for simultaneous energization.

3. In an electromagnetic reed relay adapted for low profile packaging, a combination comprising

a pair of magnetic material means each spaced from the other,

permanent magnet means magnetically coupled to said pair of magnetic material means and constantly providing flux in a predetermined direction,

said permanent magnet means being a pair of permanent magnets each with its poles at its ends which are each magnetically coupled to a different one of said pair of magnetic material means,

electromagnet means magnetically coupled to said pair of magnetic material means and short circuiting said permanent magnet means in the absence of flux opposing the shunting of the permanent magnet flux by the short circuit,

said electromagnet means when energized providing flux in the same direction as said permanent magnet means and which is sufficient to oppose the shunting of the permanent magnet flux,

said electromagnetic means being disposed between said pair of permanent magnets and comprising a coil and a core of magnetic material extending through said coil substantially parallel to said permanent magnet,

said core being magnetically coupled at each end to a different one of said pair of magnetic material means,

said coil being adapted for energization thereby polarizing said core and providing flux substantially parallel to and in the same direction as the flux provided by said permanent magnets,

magnetically operable switch means including two sets of switches each being disposed at a different end of said pair of magnetic material means, and said permanent magnet and electromagnet means being disposed between said two sets of switches,

each of said sets of switches including at least one reed switch with at least two reed contact conductors magnetically coupled each to a different one of said pair of magnetic material means, and

each of said reed switches being unoperated when said permanent magnet means is short circuited, and operated by the total flux provided by said permanent magnet and electromagnet means when the flux provided by said electromagnet means opposes the shunting of the flux provided by said permanent magnet means.

4. In an electromagnetic reed relay adapted for low profile packaging, a combination comprising

a pair of magnetic material means each spaced from the other,

permanent magnet means magnetically coupled to said pair of magnetic material means and constantly providing flux in a predetermined direction,

said permanent magnet means being a permanent magnet with its poles at its ends which are each magnetically coupled to a different one of said pair of magnetic material means,

electromagnet means magnetically coupled to said pair of magnetic material means and short circuiting said permanent magnet means in the absence of flux opposing the shunting of the permanent magnet flux by the short circuit,

said electromagnet means when energized providing flux in the same direction as said permanent magnet means and which is sufficient to oppose the shunting of the permanent magnet flux,

said electromagnetic means comprising a pair of electromagnets each being disposed between said permanent magnet and a different one of said sets of switches,

each of said electromagnets having coil means and a core of magnetic material with remanent characteristics extending through said coil means substantially parallel to said permanent magnet,

said cores each being magnetically coupled at each end to a different one of said pair of magnetic material means,

said coil means being adapted for energization thereby polarizing said cores and providing flux substantially parallel to and in the same direction as the flux provided by said permanent magnet, and for reverse energization thereby reversing their polarizing effect when said cores are providing remanent flux,

magnetically operable switch means including at least one reed switch with at least two reed contact conductors magnetically coupled each to a different one of said pair of magnetic material means,

each of said reed switches being unoperated when said permanent magnet means is short circuited, and operated by the total flux provided by said permanent magnet and electromagnet means when the flux provided by said electromagnet means opposes the shunting of the flux provided by said permanent magnet means,

said electromagnetic means upon deenergization when said switches are operated providing a remanent flux sufficient to oppose the shunting of the permanent magnet flux and with the permanent magnet flux to magnetically latch said operated switches, and being adapted for reverse energization to at least sufficiently reduce the remanent flux and upon de-energization to short circuit the permanent magnet means and permit said switches to again become unoperated,

said switch means having two sets of switches each including at least one of said reed switches and being disposed at a different end of said pair of magnetic material means, and

said permanent magnet and electromagnet means being disposed between said two sets of switches.

5. In an electromagnetic reed relay adapted for low profile packaging, a combination comprising

a pair of magnetic material means each spaced from the other,

permanent magnet means magnetically coupled to said pair of magnetic material means and constantly providing flux in a predetermined direction,

said permanent magnet means being a pair of permanent magnets each with its poles at its ends which are each magnetically coupled to a different one of said pair of magnetic material means,

electromagnet means magnetically coupled to said pair of magnetic material means and short circuiting said permanent magnet means in the absence of flux opposing the shunting of the permanent magnet flux by the short circuit,

said electromagnet means when energized providing flux in the same direction as said permanent magnet means and which is sufficient to oppose the shunting of the permanent magnet flux,

said electromagnetic means being disposed between said pair of permanent magnets and comprising coil means and a core of magnetic material with remanent characteristics extending through said coil means substantially parallel to said permanent magnets,

said core being magnetically coupled at each end to a different one of said pair of magnetic material means,

said coil means being adapted for energization thereby polarizing said core and providing flux substantially parallel to and in the same direction as the flux provided by said permanent magnets, and for reverse energization thereby reversing its polarizing effect when said core is providing remanent flux,

magnetically operable switch means including at least one reed switch with at least two reed contact conductors magnetically coupled each to a different one of said pair of magnetic material means,

each of said reed switches being unoperated when said permanent magnet means is short circuited, and operated by the total flux provided by said permanent magnet and electromagnet means

when the flux provided by said electromagnet means opposes the shunting of the flux provided by said permanent magnet means,

said electromagnetic means upon deenergization when said switches are operated providing a remanent flux sufficient to oppose the shunting of the permanent magnet flux and with the permanent magnet flux to magnetically latch said operated switches, and being adapted for reverse energization to at least sufficiently reduce the remanent flux and upon de-energization to short circuit the permanent magnet means and permit said switches to again become unoperated,

said switch means having two sets of switches each including at least one of said reed switches and being disposed at a different end of said pair of magnetic material means, and

said permanent magnet and electromagnet means being disposed between said two sets of switches.

6. In an electromagnetic reed relay adapted for low profile packaging, a combination comprising

a pair of pole pieces of magnetic material each being parallel to and spaced from the other thereby forming a gap therebetween,

at least one permanent magnet disposed across the gap and having its ends providing opposite poles magnetically coupled to said pole pieces and flux across the gap in a predetermined direction,

at least one electromagnet disposed across the gap, and having coil means and a core of magnetic material extending through said coil means parallel to said permanent magnet and being magnetically coupled at its ends to said pole pieces,

said permanent magnet, core and pole pieces providing a first flux path wherein said core shunts flux provided by said permanent magnet in the absence of flux opposing such shunting,

said coil being adapted for energization thereby polarizing said core to provide flux across the gap in the same direction as and opposing the shunting of the permanent magnet flux,

a plurality of magnetically operable reed switches disposed parallel to and spaced from each other across the gap and being unoperated when the permanent magnet flux is being shunted,

each of said reed switches having at least two reed contact conductors each magnetically coupled to a different one of said pole pieces,

said permanent magnet and said core providing with said pole pieces coupled to said switches a second flux path for permanent magnet and electromagnet flux to operate said switches when the shunting of the permanent magnet flux is opposed,

said electromagnet being disposed adjacent one of said switch sets, and another electromagnet disposed between said spaced switch sets and adjacent the other of said switch sets,

said permanent magnet being disposed between said two electromagnets, and

said plurality of reed switches being disposed in two sets parallel to and spaced from said permanent magnet and electromagnets each at a different end of said pair of pole pieces, and with said pole pieces all being disposed in a single common plane.

7. The relay in accordance with claim **6**, and

said cores of said two electromagnets having remanent characteristics and providing remanent flux blocking the shunting of the permanent magnet flux for magnetically latching said switches when said coil means of said two electromagnets are de-energized while said switches are operated, and

said coil means of said two electromagnets being adapted for reverse energization for causing said latched switches to become unoperated.

8. In an electromagnetic reed relay adapted for low profile packaging, a combination comprising

a pair of pole pieces of magnetic material each being parallel to and spaced from the other thereby forming a gap therebetween,

at least one permanent magnet disposed across the gap and having its ends providing opposite poles magnetically coupled to said pole pieces and flux across the gap in a predetermined direction,

at least one electromagnet disposed across the gap, and having coil means and a core of magnetic material extending through said coil means parallel to said permanent magnet and being magnetically coupled at its ends to said pole pieces,

said permanent magnet, core and pole pieces providing a first flux path wherein said core shunts flux provided by said permanent magnet in the absence of flux opposing such shunting,

said coil being adapted for energization thereby polarizing said core to provide flux across the gap in the same direction as and opposing the shunting of the permanent magnet flux,

a plurality of magnetically operable reed switches disposed parallel to and spaced from each other across the gap and being unoperated when the permanent magnet flux is being shunted,

each of said reed switches having at least two reed contact conductors each magnetically coupled to a different one of said pole pieces,

said permanent magnet and said core providing with said pole pieces coupled to said switches a second flux path for permanent magnet and electromagnet flux to operate said switches when the shunting of the permanent magnet flux is opposed,

said permanent magnet being disposed adjacent one of said switch sets and another permanent magnet disposed between said switch sets and adjacent the other of said switch sets,

said electromagnet being disposed between said two permanent magnets, and

said plurality of reed switches being disposed in two sets parallel to and spaced from said permanent magnets and electromagnet each at a different end of said pair of pole pieces, and with said pole pieces all being disposed in a single common plane.

9. The relay in accordance with claim **8**, and

said core having remanent characteristics and providing remanent flux blocking the shunting of the permanent magnet flux for magnetically latching said switches when said coil means is de-energized while said switches are operated, and

said coil means being adapted for reverse energization for causing said latched switches to become unoperated.

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