May 8, 1962 W. JUPTNER 3,033,956

SWITCHING DEVICE

Filed Aug. 14, 1957 2 Sheets-Sheet 1

FIG. 2

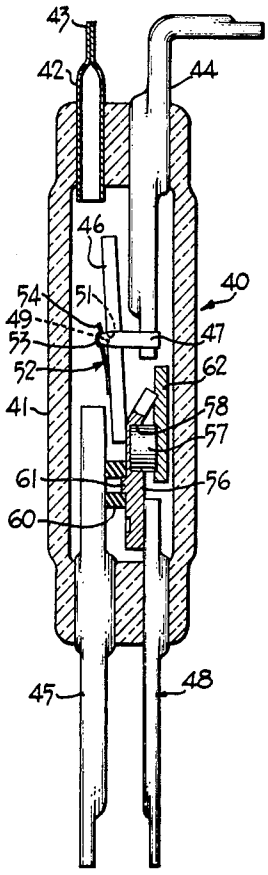
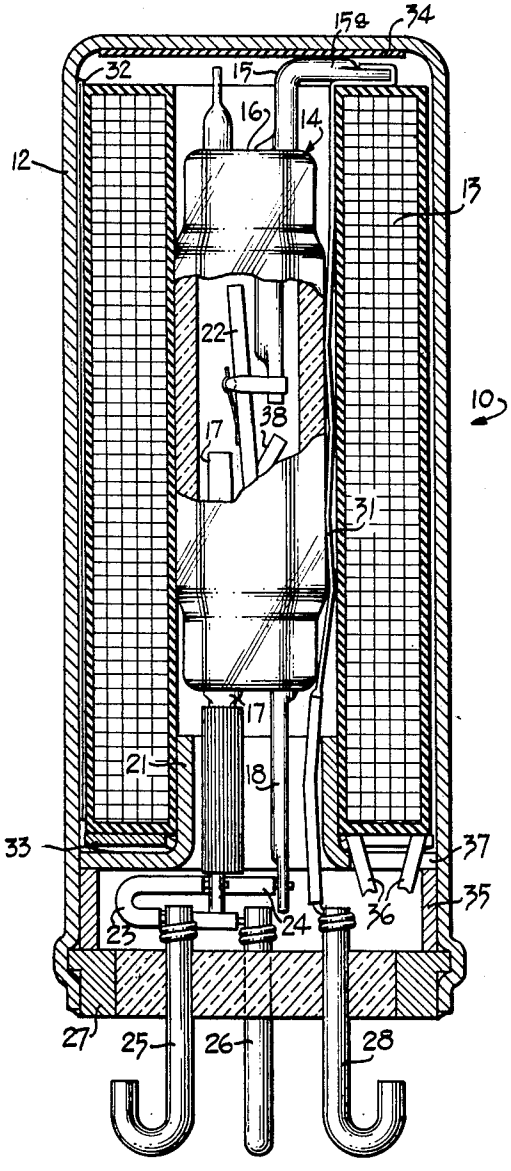


FIG. 1



INVENTOR

Wilhelm Juptner

by

Mason, Kalehmainen, Rathburn and Wyss

ATTORNEYS.

May 8, 1962 W. JUPTNER 3,033,956

SWITCHING DEVICE

Filed Aug. 14, 1957 2 Sheets-Sheet 2

FIG.3

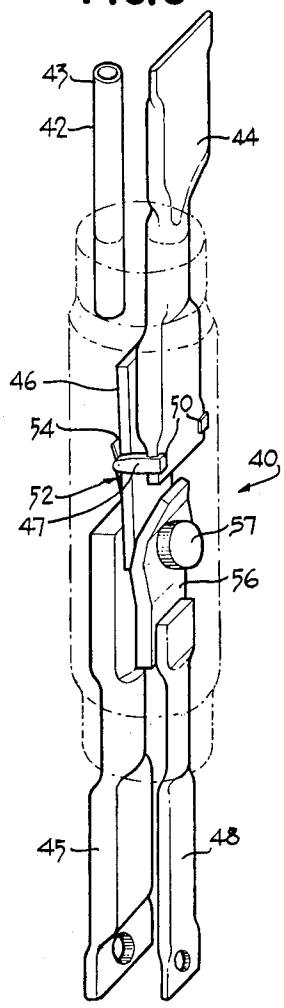


FIG.4

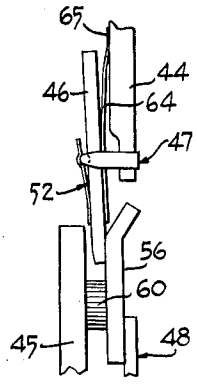


FIG.5

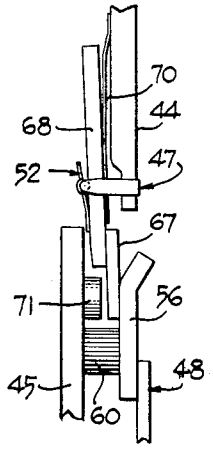
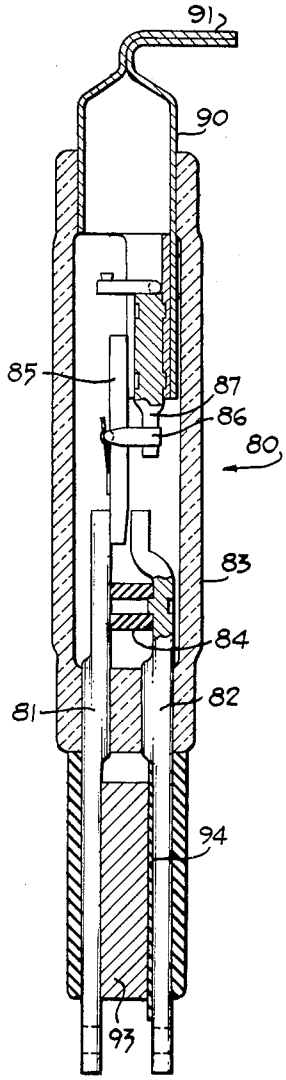


FIG.7



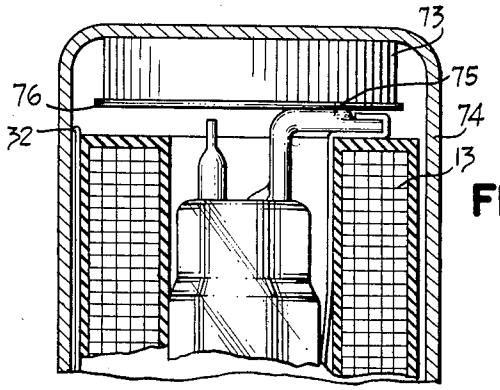


FIG.6

INVENTOR
Wilhelm Juptner
by
Mason, Kolehmainen, Rathburn and Wyss.
ATTORNEYS.

United States Patent Office

3,033,956
Patented May 8, 1962

3,033,956

SWITCHING DEVICE

Wilhelm Juptner, Elgin, Ill., assignor to C. P. Clare & Company, Chicago, Ill., a corporation of Delaware

Filed Aug. 14, 1957, Ser. No. 678,236
15 Claims. (Cl. 200—93)

The present invention relates to switching devices and more particularly to an improved magnetically operated switching unit, particularly suited for use in electromagnetic relays, in which the switching contacts are provided within a separate enclosure or cartridge for facilitating the maintenance of a suitable atmosphere for the contacts so that the disturbing effects of other relay components and of ambient conditions do not adversely affect the switching action of the unit.

It is an object of the present invention to provide a magnetically operated switching device which by the use of small and balanced moving parts provides for high speed operation and has excellent shock and vibration resisting properties.

Another object of the present invention is to provide an improved switching unit having improved contact reliability and having operating characteristics which are substantially unaffected by storage or by severe ambient conditions such as extreme temperature variations, high altitudes, and the like.

Briefly, the above and further objects are realized in accordance wtih the present invention by providing a switching unit comprising as its principal elements a balanced, pivotally mounted armature and two or more electrically conductive terminal members which extend from the switching unit, at least two of the terminals being ferromagnetic so as to function as heel pieces as well as electric terminals. In the case of a side stable relay, the armature is biased toward one of its limiting and switching positions either by means of a spring or by means of a permanent magnet, and in the case of a bistable polarized relay, the armature is maintained in either of its two switching positions by means of a permanent magnet which is located outside of the switching unit. In the case of a bistable polarized relay, one or two permanent magnets may be employed.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a side elevational view, partially in section, of a relay embodying certain aspects of the present invention;

FIG. 2 is a perspective view showing the switching unit of the relay illustrated in FIG. 1;

FIG. 3 is a fragmentary perspective view of a switching unit embodying the present invention;

FIGS. 4 and 5 are fragmentary side elevational views of switching units embodying other aspects of the present invention;

FIG. 6 is a fragmentary side elevational view of the upper portion of a relay embodying certain aspects of the present invention; and

FIG. 7 is a side elevational view of a relay switching unit embodying certain aspects of the present invention.

Referring now to the drawings and more particularly to FIG. 1 thereof, there is shown a complete relay 10 which comprises as its principal elements a generally cylindrical housing or can 12 in which is mounted a control winding or coil 13 and a hermetically sealed switching unit or cartridge 14. In the unit 14, a ferromagnetic electrically conductive terminal and heel piece 15 protrudes from the top of a hermetically sealed glass housing 16 from the bottom of which extend two terminal members 17 and 18. The terminal 17 is ferromagnetic so

that it also functions as a heel piece. The members 15 and 17 thus cooperate with the can 12 and a tubular ferromagnetic sleeve 21 to provide a stator having an air gap in which a balanced ferromagnetic and electrically conductive armature 22 is pivotally mounted for selectively connecting the terminal member 15 to either the terminal member 17 or the terminal member 18.

The terminals 17 and 18 are respectively connected through conductors 23 and 24, to two terminal pins 25 and 26. These terminal pins are conventionally mounted in a disk-shaped header 27 which is formed of insulating material and is secured in place, as shown, to close the bottom opening in the can 12. A third terminal pin 28 extends through the header 27 and is electrically connected to the upper terminal member 15 by means of a resilient wave shaped connector 31 of rectangular cross-section, which also functions to bias the switching unit 14 against the opposite side of the inner wall of the coil 13, thereby to eliminate any radial play between the switching unit 14 and the coil 13.

Radial play between the coil 13 and the housing 12 is prevented by means of a plurality of elongated resilient and folded inserts 32 which are positioned between the coil 13 and the inner wall of the housing 12. Axial movement of the coil 13 with respect to the housing 12 is prevented by means of a washer 33 which is interposed between the sleeve 21 and the lower end of the coil 13 and has one or more resilient pretensioned crimps therein for resiliently biasing the coil 13 upward against the bottom surface of the off-turned portion of the terminal 15. The terminal 15 is thus resiliently urged against an insulating disk 34 positioned at the top of the housing 12. The flanged sleeve 21 is supported within the housing 12 by means of a tubular sleeve 35 which is interposed between the sleeve 21 and the header 27. The pretensioned washer 33 thus not only acts to force the terminal member 15 to the top of the can 12 but also acts to bias the sleeve 21 and the sleeve 35 toward the header 27, thereby to prevent relative movement of the switching unit 14 either with respect to the winding 13 or with respect to the can 12. The winding 13 is provided with a pair of input leads 36 which extend through a suitable slot 37 in the sleeve 21 and are respectively connected to terminal pins (not shown) which extend through and are supported by the header 27.

Considering the operation of the relay of FIG. 1, let it be assumed that the armature 22 is normally biased by means not visible in the drawing into engagement with a nonmagnetic contact member 38 which is welded to the terminal member 18 so that when no current is supplied to the coil 13 the armature is positioned in the manner illustrated in FIG. 1 and electrically connects the terminal 15 to the terminal 18. Accordingly, the terminal pins 26 and 28 are interconnected within the relay 10.

When a current of sufficient value is supplied to the winding 13 to operate the relay 10, a magnetic field is established which causes flux traversal of the magnetic circuit. This circuit extends from the top portion of the winding 13 through the bent-over portion 15*a* of the terminal member 15, through the terminal member 15 to the armature 22 across the air gap between the lower portion of the armature 22 and the upper portion of the terminal member 17, through the terminal member 17, across the relatively short gap to the sleeve 21, through the sleeve 21 and the walls of the can 12 back to the bent-over portion 15*a* of the terminal member 15. The magnetic flux which is thus caused to traverse the gap between the armature 22 and the terminal 17 causes the armature 22 to pivot clockwise so that the armature 22 engages the terminal 17. When this occurs, the terminal pins 25 and 28 are interconnected and the

terminal pin 26 is disconnected from the terminal pin 28. Upon termination of the supply of current to the winding 13, the armature 22 pivots counterclockwise under the influence of the biasing force exerted thereon to its normal position in which the terminal pins 26 and 28 are connected.

Referring now more particularly to FIGS. 2 and 3, the details of a sealed switching unit or cartridge 40 of the side stable type are there illustrated. Briefly, this unit comprises a hermetically sealed housing 41, preferably formed of glass, which may either be evacuated or filled with a suitable arc suppressing gaseous medium at a desired pressure through a tube 42 which opens into the housing and is pinched off at its upper end 43 after the desired atmosphere has been established in the housing 41. A set of ferromagnetic, electrically conductive terminals 44, 45 and 48 respectively extend through the upper and lower ends of the housing 41 and facilitate connection of the unit 40 in the electrical and magnetic circuits of the relay. A balanced armature 46 is pivotally mounted on the terminal 44 and selectively connects it to either of the terminals 45 and 48.

As best shown in FIGS. 2 and 3, the armature 46 is pivotally mounted on a ferromagnetic and electrically conductive supporting structure 47 which is attached to the lower end of the terminal 44. The support 47 comprises a pair of side members 50 which are received in suitable recesses at the sides of the terminal member 44 and between the ends of which extends a cylindrical pivot bar 51. The armature 46 is attached to the support 47 by means of a cantilever type of spring 52 which has its lower end secured, as by welding or the like, to the armature 46 and may be provided with a semi-cylindrical upper end portion 53 which is adapted to engage the bar 51 and which is positioned opposite a semi-cylindrical recess 49 in the armature 46. In initially mounting the armature 46 upon the support 47, which has previously been attached to the terminal 44, the left-hand surface of the armature 46, as viewed in FIG. 2, is slid along the right-hand edge of the pivot bar 51 so that as the off-turned upper end 54 of the spring 52 engages the bar 51 the upper end of the spring 52 moves toward the left away from the body of the armature 46 to cause the spring to ride over the bar 51 until the depression 53 and the recess 49 are aligned with the bar, at which time the spring 52 snaps toward the right, thereby pivotally to attach the armature 46 to the support 47. Since the supporting posts 50 and the bar 51 are formed of ferromagnetic material, they are magnetically connected to the terminal 44. Therefore, when a magnetic field is established between the terminals 44 and 45, the armature 46 pivots clockwise into engagement with the upper portion of the terminal 45 thereby to establish a conductive path between the terminals 44 and 45.

In the arrangement shown in FIGS. 2 and 3, the armature 46 is biased into engagement with the terminal 48 by means of a small cylindrically shaped permanent magnet 57 which is mounted in a recess 58 in the rear surface of a nonmagnetic contact 56 supported upon the terminal 48. In order to maximize the ratio of the flux path reluctance of the terminal 48 to that of the terminal 45, the nonmagnetic contact 56, such, for example, as silver, is welded to the upper end of the terminal 48. The spacing between the contact portions of the terminals 45 and 48 is established by means of a nonmagnetic insulating spacer sleeve 60 which partially surrounds a cylindrical boss on the front side of the nonmagnetic contact member 56. The length of the spacer 60 thus determines the length of the air gap between the armature 46 and the terminal 45 and thus the air gap flux density required to operate the relay against the attractive force of the permanent magnet 57.

It may thus be seen that the magnet 57 biases the armature 46 in its limiting counterclockwise position as shown in FIG. 2. If an increased biasing force is desired, a magnetic yoke 62 may be attached to the back of the magnet 57 so that the upper portion of the yoke 62 is in proximity to the lower end of the terminal 44 thereby to provide a low reluctance magnetic circuit for the biasing magnet 57 which extends through the yoke 62 across the gap to the terminal 44, through the support 47 and back to the opposite pole of the magnet 57 through the lower half of the armature.

Bounce suppression during snap return of the armature to its biased position is obtained by the magnetic attraction of armature 46 to the permanent magnet 57. When the relay operates and the armature rotates clockwise to strike the terminal 45, bounce is prevented by the strong magnetic field which exists between the armature 46 and the contact 45 to which it is directly connected.

In assembling the parts of the switching unit 40, the terminal 44 with the support 47 mounted thereon and the tube 42 are first sealed into the upper end of the tubular glass housing 41. This assembly operation is performed with the lower end of the housing fully open. The armature 46 is next inserted into the housing through the open lower end thereof and pivotally mounted upon the pivot bar 51 of the support 47 in the manner described above. The terminal 48 with the parts 56, 57 and 62 mounted thereon, and the terminal 45 are next inserted into the open lower end of the housing 41 until they are brought into the desired positions relative to the terminal 44 and the armature 46. During this positioning operation, the terminals 45 and 48 are fixedly held in their desired relative positions with the spacer 60 positioned therebetween. When the parts 41, 44, 45, 46, and 48 are thus correctly positioned relative to each other and while being held in their correct relative positions, the lower end of the tubular housing 41 is sealed off to complete the assembly. Finally, the interior of the housing is evacuated or filled with a suitable arc suppressing gas through the tube 42 after which this tube is pinched off and sealed.

Referring now to FIG. 4, an alternative embodiment of a portion of the switching unit is there shown, wherein a spring 64 is used to bias the armature into engagement with the nonmagnetic contact member 56. Since this embodiment is a modification of the switching unit 40, similar parts are designated by like reference numbers. As shown, the armature 46 is magnetically and electrically mounted on the common terminal 44 by means of the support 47 and the spring 52. The armature 46 is shown in its normal position in engagement with the forward face of the non-magnetic contact member 56 which is spaced from the magnetic terminal member 45 by means of the spacer sleeve 60. A preformed spring 64 having a pretensioned resilient off-turned end portion 65 is secured at its lower end, as by spot welding or the like, to the armature 46 and the upper end thereof bears against the forward face of the terminal 44 to bias the armature 46 in a counterclockwise direction into engagement with the contact member 56. It should be noted that as the armature 46 is released and pivots counterclockwise, the off-turned portion 65 of the spring 64 slides downwardly against the face of the terminal 44 as the armature 46 moves into contact with contact 56 on terminal 48.

Referring to FIG. 5 an alternative embodiment of the invention is there shown which constitutes a modification of the spring biased armature arrangement shown in FIG. 5. The unit of FIG. 5 is particularly suitable for use in handling heavy switching currents and thus includes a relatively large area contact 67 which is attached as by spot welding to the lower end of the principal body portion of an armature 68. The armature 68 is pivotally supported on the terminal 44 by means of the support 47 and the spring 52 and the contact 67 is biased against the non-magnetic contact member 56 by means of a biasing spring 70 which is attached at its lower end to

the armature 68. As shown, the armature 68 is pivoted at a point approximately at its center of gravity, thus providing a balanced armature which requires a minimum of current in the control winding to effect operation of the relay. Also, a large area contact button 71 is mounted on the terminal member 45 for electrical engagement with the contact member 67 of the armature 68 when the relay is operated. The thickness of the contact member 71 exceeds that of the armature 68 so that a residual gap is provided between the armature 68 and the terminal 45 when the relay is operated.

Referring now to FIG. 6, there is shown the upper portion of a relay embodying an alternative aspect of the invention and which includes a permanent magnet 73 disposed in the upper portion of a ferromagnetic housing or can 74 to provide a permanent magnetic field across the air gap in the associated switching unit (not shown). The magnet 73 is wedged between an upper terminal 75 and the top of the can 74 and since the terminal member 75 is both a part of the magnetic circuit and an electrical conductor connected in the external switching circuit, an insulating disk 76 is positioned between the magnet 73 and the terminal member 75 to maintain the can 74 isolated from the electrical circuits. Therefore, by using the cartridge 40 in the embodiment of FIG. 6, the relay may be biased toward an operate or release position depending upon the polarity of the magnet 73. More specifically, with the magnet 73 polarized in one direction, more current of a particular polarity must flow through the winding 13 to effect operation of the armature from its released position to its operated position, whereas if the magnet 73 is polarized in the opposite direction, a lesser current flow of the same polarity through the winding 13 is required to overcome the normal armature bias and effect operation of the armature to its operated position.

Referring now to FIG. 7, a bistable, polar switching unit 80 is there shown. This unit comprises a set of ferromagnetic terminal members 81 and 82 which extend through and are sealed to the bottom of the housing 83 and are spaced apart by a nonconductive spacer sleeve 84 located within the housing. The unit 80 also includes an armature 85 pivotally mounted on a support 86 which is attached to a common terminal member and heel piece 87. The terminal 87 is electrically and magnetically connected to a ferromagnetic and conductive tube 90 which extends from the upper end of the housing 83 and which is pinched off and bent over at its upper end 91 to seal the housing and to provide the off-turned upper end of the terminal for use in conjunction with the coil and associated structure as shown, for example, in FIG. 1. A permanent magnet 93 is disposed outside the housing 83 between the lower portions of the terminals 81 and 82 and is insulated from the terminal 82 by means of a nonmagnetic insulating spacer 94. The magnet is polarized in a direction from right-to-left and serves to bias the armature 85 in either of its limiting positions in contact with either of the terminals 81 or 82.

The unit 80 may be used in a side stable relay by using it in conjunction with the embodiment shown in FIG. 6 which includes the permanent magnet 73. Depending upon the polarities of the magnets 73 and 93, the flux densities produced by each across the air gaps between the armature 85 and the terminals 81 and 82 will be in opposition in one instance and in aiding relationship in the other. Consequently, the armature 85 is biased so as to close the latter air gap. In such a side stable relay, properly polarized current in the relay winding overcomes the magnetic field of the magnets 73 and 93, thereby causing the relay to operate. There is thus provided a side stable polar relay from which the biasing spring has been eliminated.

While the invention has been described in connection with particular embodiments thereof, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention as defined in the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a relay construction, a winding, a hermetically sealed switching unit of cylindrical configuration mounted within said winding in axial alignment therewith and comprising a first conductive terminal member extending through one end of said unit, a second conductive terminal member extending through the other end of said unit, said first and second terminal members being formed of a ferromagnetic material and spaced apart to provide an air gap, said second terminal member being provided with a contact part, an armature within said unit and pivotally mounted intermediate its ends on said first terminal member for movement into and out of connecting engagement with the contact part on said second terminal element so as to controllably bridge said air gap in response to the presence or absence of a predetermined current in said coil, and means for biasing said armature out of engagement with the contact part on said second terminal member.

2. A switching unit comprising a housing, a plurality of terminal members extending into said housing, a ferromagnetic switching armature pivotally mounted within said housing for selectively connecting one of said terminal members to either of the other two of said terminal members, one of said other two terminal members having a nonmagnetic contact portion and the other being fully magnetic, and a permanent magnet mounted on said nonmagnetic terminal member in proximity to said armature for biasing said armature into engagement with said nonmagnetic terminal member.

3. A side stable switching unit comprising a housing; first, second, and third terminal members disposed in said housing, said first and second terminal members being magnetic and said third member being at least partially nonmagnetic; a pivot defining structure carried on said first terminal member and formed of electrically conductive material; a magnetic armature pivotally connected to said structure intermediate the ends of said armature, said armature being pivotable to move one end of said armature into engagement with either of said second and third terminal members so that said first terminal member is electrically connected to either of said second and third terminal members; and means for biasing said one end of said armature into engagement with said third terminal so that the other end of said armature is spaced from said first terminal member and said one end of the armature is spaced from said second terminal member.

4. A switching unit as set forth in claim 3, wherein said housing is elongated, and said first terminal extends from one end thereof and said second terminal extends from the opposite end thereof.

5. A switching unit as set forth in claim 3, wherein said biasing means is a spring.

6. A switching unit as set forth in claim 3, wherein said biasing means is a permanent magnet mounted on said third terminal member.

7. A switching unit as set forth in claim 3, wherein said third terminal member comprises a magnetic portion, the cross sectional area of said portion being substantially less than the cross sectional area of said second terminal member.

8. A switching unit comprising an elongated housing, a first terminal member extending from one end of said housing, second and third terminal members extending from the other end of said housing, said first and second terminal members being magnetic and said third terminal member being at least partially nonmagnetic, a magnetic switching armature pivotally mounted on said first terminal member for selective connection to either of said second or third terminal members, and permanently magnetized means mounted on said third terminal member in proximity to said first terminal member.

9. A switching unit as set forth in claim 8, wherein said permanently magnetized means is mounted within a recess in the rear face of said third terminal member.

10. A circuit controlling device comprising a magnet, a nonmagnetic layer on said magnet, an elongated and unbiased magnetic member, said member being movably mounted and having a portion of one face thereof in physical contact with said layer on said magnet, the member and magnet being magnetically separated by said layer, the return field path of the magnet passing longitudinally through at least a portion of the member, a magnetic contact having a portion overlapping the other face of the member, and a signal coil encompassing the magnet, member, and contact whereby energization of the coil overcomes the effect of the return path through said member and causes the member to move relative to the magnet.

11. A circuit controller comprising a support, spaced parallel electrodes of magnetic material secured to one end of the support, a magnet carried on the free end of one of said electrodes, a layer of nonmagnetic and electrically conductive material on said magnet, a magnetic element movably supported from the opposite end of said support and extending generally parallel to said electrodes, said element having a portion adjacent one end attracted by said magnet into electrical contact with said layer and overlapping but spaced from the other of said electrodes, and an operating magnet means, which, when activated provides a magnetic field through the element and said other electrode to overcome the field of said magnet in said element so that said element is moved away from said magnet and attracted to said other electrode.

12. A switching device comprising a sealed dielectric envelope, a first magnetic terminal extending into one end of said envelope, a second magnetic terminal extending into the opposite end of said envelope, a magnetic armature, means pivotally mounting said armature on said second terminal with one free end portion thereof overlapping a portion of said first terminal, a magnet rigidly mounted within said envelope and mating with said free end portion of said armature, the return field of said magnet passing through said free end portion of said armature and attracting said armature toward said magnet and away from said portion of said first terminal, and a winding for establishing a magnetic field through said first and second terminals and said armature to overcome the return field of said magnet and to move said end portion of said armature toward said portion of said first terminal.

13. A switching device comprising a sealed dielectric housing; first, second and third terminal means extending into said housing at positions spaced from each other, said first and second terminal means being both electrically conductive and magnetic, said third terminal means being electrically conductive and formed at least in part of nonmagnetic material; a magnetic armature disposed in said housing; pivot means disposed in said housing and interconnecting said first terminal means and said armature to pivotally mount said armature on said first terminal means; and resilient means engaging said armature for normally biasing said armature into engagement with said third terminal means so that said first and third terminal means are electrically connected through said armature and so that said first and second terminal means can be electrically connected by said armature when the bias of said resilient means is overcome.

14. The switching device set forth in claim 13 in which said resilient means comprises a spring interposed between and bearing against surfaces of said armature and said first terminal.

15. A polarized relay comprising a plurality of magnetic terminal members, an armature movably mounted on a first one of said members and selectively movable into engagement with second and third ones of said members, first permanent magnetic means for establishing a first magnetic field between said second and third ones of said members, a second permanent magnetic means for establishing a second magnetic field between said first one of said members and said second and third ones of said members, said first and second magnetic fields being in opposing relation in the third one of said members and in an aiding relationship in the second one of said members to normally hold said armature in engagement with the second one of said members, and a winding for moving said armature out of engagement with said second member and into engagement with said third member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,245,391	Dickten	June 10, 1941
2,277,215	Ellwood	Mar. 24, 1942
2,406,008	Ellwood et al.	Aug. 20, 1946
2,458,939	Hall	Jan. 11, 1949
2,483,723	Burton	Oct. 4, 1949
2,485,024	Vale et al.	Oct. 18, 1949
2,504,101	Reifel	Apr. 18, 1950
2,570,315	Brewer	Oct. 9, 1951
2,683,304	Channell	July 13, 1954
2,692,422	Pierce	Oct. 26, 1954
2,702,841	Bernstein	Feb. 22, 1955
2,706,756	Brewer	Apr. 19, 1955
2,834,848	Ellwood	May 13, 1958
2,881,365	Bernstein	Apr. 7, 1959